Changing professional landscapes:

The influence of education on the origin and evolution of radiography advanced practice

Volume 1 of 2

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ACKNOWLEDGEMENTS

Registration for a PhD by Published Works at the University of Salford is a maximum of twelve months. However the research and scholarship underpinning the writing of the articles and book chapters around which the thesis is built takes many years. Acknowledgements to those who have supported my personal development through this time therefore go back several years, rather than being related purely to the PhD registration period. I would therefore like to offer my sincere thanks to all the co-authors and co-editors of the articles and books presented within the thesis, for their inspiration in developing the published works and for their agreement for me to use the works within this thesis. It has been a privilege to work with a number of different co-authors, each one contributing in unique ways to my own professional development. Whilst the authors are too many to name here, I would particularly like to thank Professor Peter Hogg for his guidance and support in the development of the earlier works, as he made me believe that what I had to contribute to the field of radiography was worthwhile. More recently Professor Stuart Mackay and Professor Steven Shardlow have acted in the capacity as my PhD academic supervisors. Both have supported and challenged me in equal measure, and have encouraged me to strive for excellence.

Most of all I would like to thank my husband Graham and children Christopher and Jonathan, who have patiently put up with many 'out of office' hours of studying over the last few years.

DECLARATION

I declare that Volume 1 of this thesis is my own work and has not previously been published or submitted for assessment. The published works in Volume 2 are already in the public domain, and in some cases are jointly authored with other individuals. The contribution that I have made to each published work has been outlined within the thesis, and has been agreed by the co-authors.

Julie Nightingale

05.05.09

ABSTRACT

Throughout the twentieth century clear professional demarcations have existed between the professions of radiography and radiology in respect of the nature of practitioners' work and responsibilities. Yet, in the last two decades, an extended scope of radiography practice has begun to blur traditional professional boundaries. In particular, the concept of advanced practice in radiography has the potential to improve the quality and quantity of services available for the benefit of patients.

This thesis presents thirteen works published between 1998 and 2009, which collectively explore this changing professional landscape. Critical analysis of the contribution of the published works via extensive literature review, book reviews and citation / download analysis, demonstrated their utility and impact. The published works offer a distinctive and original contribution that supports the general development of radiography advanced practice, and in particular the emerging sub-specialty of gastrointestinal imaging.

Thematic analysis of the published works reveals their contribution to knowledge and understanding of radiography advanced practice in respect to the following themes: the drivers and barriers to implementation; the consequences of advanced practice; dissemination of advanced practice both within the United Kingdom and overseas;

the influence of education; the required knowledge base, teaching, learning and assessment.

The published works demonstrate that the concept of advanced practice has now been embraced within the UK radiography workforce, with increasing international interest in adopting practices pioneered by radiographers within the United Kingdom. The importance of reliable evidence for the success (or otherwise) of these emerging radiographer roles, coupled with the creation of relevant educational materials to support knowledge and skills development, is not to be underestimated if the contemporary professional landscape, to which this thesis contributes, is to significantly benefit patient care.

PART 1 THE PUBLISHED WORKS IN CONTEXT

1.1 INTRODUCTION

This thesis explores the origins and evolution of radiography advanced practice over the last decade. It investigates, through critical review of a range of published works (1998-2009), the nature of advanced practice, the facilitators and barriers to its introduction and widespread dissemination (both within the UK and overseas), and the role of education in supporting and promoting advanced practitioners. This chapter defines the scope of the thesis, explores the professional landscape in which radiographers work, addresses the question of timeliness of the work, and articulates the reasons behind the selection of the published works.

1.1.1 DEVELOPMENT OF THE RADIOGRAPHY PROFESSION

The successful modernisation of the National Health Service (NHS) is dependent upon the development of a multi-professional workforce capable of delivering high quality, patient centred care in a timely and cost-effective manner. Radiographers are key members of this multi-professional health care team, working in partnership with radiologists to provide a wide range of clinical imaging and radiotherapy services. The rapidly changing health care environment has challenged the relationship between these two professions, resulting in a radiographer with a much expanded scope of professional practice. The role of the contemporary radiographer is far removed from that of the early radiography pioneers, as elucidated in the following quotation:

> I think you will agree that the primary function of the radiographer is to be of the utmost possible service to the radiologist.
>
> (Furby, 1944, p9)

The profession of radiography emerged formally in 1920, following the creation of the Society of Radiographers, amidst on-going territorial disputes between doctors who specialised in interpreting x-rays (radiologists), and lay persons who performed the x-rays, but, at that time, also interpreted them (radiographers). Amendments to the Articles of Association in the mid 1920s clearly laid a boundary between the two professions, with radiographers from thence forth legally prevented from interpreting x-rays (Price, 2001).

Furby's much-quoted (and often miss-quoted) statement above clearly echoed the sentiments of many radiographers and radiologists at that time, and indeed for many years to come. However in the same paper Furby, a radiographer, acknowledged that radiographers had an important role to play in partnership with the radiologists, rather than in a subservient role, and he advocated the development of formal education for radiographers:

> ...any step we can take to improve the training and examination of radiography will ensure the future of the radiographer.
>
> (Furby, 1944, p9)

Bentley (2005), reflecting on Furby's paper, acknowledged that much of what Furby foresaw has come to pass, but also that in the space of sixty years much has happened which could not have been foreseen by Furby's generation. Along with enormous technological innovation and upheaval of the education system, the most

striking of these changes is the dramatic culture shift taking place within the radiography profession. In particular, the introduction of an extended scope of practice and a new career structure has dramatically changed the professional landscape. The follow section explores a number of critical terms and phrases which are used frequently throughout the thesis.

1.1.2 RADIOGRAPHER

The term 'Radiographer' confers a protected title which refers to a qualified non-medical professional working within the practice of radiography. Radiographers have to be registered with the regulatory body, the Health Professions Council (HPC), to practice in the United Kingdom. There are two distinct branches of the profession: therapy and diagnostic. A diagnostic radiographer:

> ...employs a range of different imaging techniques and sophisticated equipment to produce high quality images of an injury or disease. Diagnostic radiographers will take the images and very often report on them so that the correct treatment can be given.
>
> (The Society of Radiographers Careers Information, 2008)

Conversely, a therapeutic radiographer:

> ...plays a vital role in the treatment of cancer as the only health professionals qualified to plan and deliver radiotherapy. Radiotherapy is used either on its own or in combination with surgery and/or chemotherapy. They manage the patient pathway through the many radiotherapy processes...providing care and support for patients throughout their radiotherapy treatment.
>
> (The Society of Radiographers Careers Information, 2008)

Whilst both of the branches of radiography have witnessed changes to their traditional scope of practice, this thesis is centred upon the scope of practice of the diagnostic radiographer. Most diagnostic radiographers are located in the acute (secondary care) sector. Radiographers are initially educated and trained to work across many areas of the radiology department – they are often described as 'general' radiographers. As radiographers gain experience they have traditionally specialised in different imaging modalities (technologies), including medical ultrasound, computed tomography (CT), magnetic resonance imaging (MRI), mammography and nuclear medicine. However more recently, with the development of advanced clinical roles, they have begun to specialise in new areas related to anatomical and pathological systems, rather than technological modalities. These have included roles closely aligned to the medical sub-specialties including trauma and orthopaedics, gastrointestinal (GI) imaging, breast imaging and neurology.

In response to the changing health care environment, a new career progression framework for radiography was introduced which outlined four main bands or grades: assistant practitioner (band 4); practitioner (bands 5-6); advanced practitioner (band 7); consultant practitioner (band 8). The Department of Health (1999, 2000) issued criteria for each grade, with the professional body for radiographers later outlining their own definitions (The College of Radiographers, 2005).

1.1.3 RADIOLOGIST

A radiologist is a medically qualified professional who has specialised in the interpretation of medical images. Radiologists are registered with the General Medical Council in the United Kingdom. According to the Royal College of Radiologists (2008), clinical radiologists are:

> ...medical specialists who provide a diagnostic imaging service to patients referred to them by family practitioners and hospital doctors. Patients are referred to clinical radiologists for assistance in both diagnosis and deciding upon the best management of a patient's problems. In appropriate cases, radiologists use minimally invasive methods to treat diseases...In addition, biopsy of tissues is carried out on a regular basis. These procedures (and others) help to avoid the need for surgical intervention in numerous cases.
>
> http://www.rcr.ac.uk/content.aspx?PageID=322

Radiologists work closely with radiographers, and are located primarily within the acute sector.

1.1.4 ROLE DEVELOPMENT

Role development in radiography is often seen to follow technology innovations. In this sense, Price (2006) argues that role development in radiography:

> ...can be described as a process of adoption, diffusion and assimilation of techniques to support the effective operation of a new imaging modality. (p17)

Role developments can be a lateral expansion of the scope of practice, whereby radiographers take on new duties that confer the same level of practice and

responsibility. These role developments can become part of the normal scope of practice of radiographers over time. Within role development, however, there is an important sub-section of roles that it could be argued constitute 'role extension'. These are often roles which were traditionally undertaken by other professionals, usually medical practitioners, resulting in a degree of blurring of inter-professional role boundaries. Such roles may extend the scope of practice vertically rather than laterally – resulting in a higher level of practice and increased responsibility and autonomy, raising particular questions around clinical governance which must be addressed (Price, 2006). Hardy and Snaith (2006) explain that role extension describes the acquisition of additional skills, duties or responsibilities beyond those expected at first post. They argue that the extended role is a natural development for a professional radiographer and that it could be seen as a legitimate expectation of employment in the modern NHS. The College of Radiographers has steered clear of providing working definitions of the terms 'role development', 'extended role' and 'advanced role'. Thus the terms are often used interchangeably, which may have:

> ...created confusion and hindered professional acknowledgement of the true nature of radiographer roles.
>
> (Hardy and Snaith, 2006, p328).

1.1.5 ADVANCED PRACTICE

Whilst many articles refer to role development and extended roles, a lack of clarity has persisted around a definition of radiography advanced practice (Price, 2005). The term 'advanced practice' was first discussed within radiography by Evans (1999) who presented a re-structured career framework for the breast screening service.

Following the publication of the NHS Plan (2000) which promoted the development of the roles of allied health professionals, a Department of Health skills mix document recommended a new 'four tier' career structure for radiographers (Department of Health, 2003). A new NHS career escalator and pay structure, known as Agenda for Change (2004), further embraced the concept of advanced practice.

Early responses to this new career structure, including attempts to define the new advanced practice roles in the context of modern medical imaging, were made by Nightingale and Hogg (2003a; 2003b). Subsequently other authors have attempted to define key terms and concepts further, most notable being Hardy and Snaith in 2006. These authors suggest that 'advancement' does not purely indicate an increase in the nature or complexity of skills. They suggest that:

> ...working at an advanced level implies greater accountability, responsibility and autonomy for broader aspects of service management and patient care underpinned by a high level of knowledge and skill developed through role extension within a chosen practice speciality.
> (Hardy and Snaith, 2006, p329).

In this context, a radiographer who performs an extended role, whist having increased responsibilities, will not necessarily be working at an advanced practice level. To perform at this higher level (as expected of an advanced practitioner) would require them to be actively developing practice for the benefit of their patients. The College of Radiographers (2003) also stress that advanced practice, whilst predominantly relating to expert clinical practice, is usually associated with one or more other functions, such as team leadership, research, or service development.

These functions are clearly articulated in a subsequent publication offering guidance to managers related to the scope of practice of an 'advanced practitioner' (The College of Radiographers, 2005).

Three visions of the nature of radiography advanced practice are therefore easily identifiable within the professional literature: the professional body offers a framework within which the advanced practitioner can become embedded (The College of Radiographers, 2005); Hardy and Snaith (2006) and Snaith and Hardy (2007) illuminate further the fundamental requirements for achievement of advanced practitioner status; Nightingale offers further insight by contextualising advanced practice within various sub-specialties of radiography (Nightingale and Hogg, 2003a and b; Nightingale and Hogg, 2007; Kelly et al, 2008; Nightingale et al, 2009 *in press*). The combined vision offered by these authors is that to attain the status of advanced practitioner, a radiographer should be working at an advanced professional level within a defined field of clinical practice, research or service delivery. Whilst expert clinical practice is normally a key component of the role, advanced practitioners should also demonstrate:

- Delivery of specialist care to patients
- Contribution to, and evaluation of, the evidence base to develop practice
- Education and training of other staff
- Recognition of knowledge and expertise – expert resource
- Team leadership, including service management and planning

An additional view would also suggest that the advanced practitioner often works across traditional health care boundaries, being fully integrated into new care

pathways and the multi-disciplinary team. This clearly delineates the advanced practitioner from the largely uni-professional focus of the practitioner grade. Radiography practitioners who are working towards advanced practitioner status are often able to demonstrate expert clinical practice within a defined field, yet they must ensure that their discrete task-based practices evolve within the wider context of health care provision (Hardy and Snaith, 2006) by encompassing the role elements noted above. Achievement of these elements is reliant upon the synthesis of personal and professional attributes (ranging from practical and intellectual skills to highly developed inter-personal abilities), coupled with the needs of the radiology service (Nightingale and Hogg 2003a). The transition from practitioner to advanced practitioner requires significant investment at the individual, service and organisational level if it is to succeed and become firmly embedded within health care practice. In summary, an advanced practitioner is:

> ...autonomous in clinical practice, defines the scope of practice of others and continuously develops clinical practice within a defined field.
> (The College of Radiographers, 2005 p13)

1.1.6 CONSULTANT PRACTICE

The role criteria required of consultant practice was first outlined in *Meeting the Challenge: A strategy for the Allied Health professions* (Department of Health, 2000). Consultant practitioners are at the pinnacle of the modern health professions career structure, and their job descriptions are defined as a result of local service need. Their roles nominally comprise at least fifty per cent clinical work (The College of

Radiographers, 2005). A frequently-used definition for a consultant practitioner follows:

> A consultant [radiographer] practitioner provides clinical leadership within a specialism or area of service, bringing strategic direction, innovation and influence through practice, research and education, based on specialised knowledge and skills. (The College of Radiographers, 2005 p12)

The identification of a role description for a consultant practitioner follows a rigorous process. The College of Radiographers (2005), in their advice to service managers, state that there is an expectation that consultant roles will have significant emphasis on the following:

- Communication and relationship skills;
- Knowledge, training and experience;
- Professional leadership within specialism;
- Analytical and judgemental skills;
- Planning and organisational skills;
- Physical skills;
- Responsibility for patient/client care;
- Responsibilities for research and development;
- Freedom to act;
- Emotional effort.

Whilst this thesis is focused primarily to the concept of advanced practice, it is essential to understand the differentiation of these closely aligned roles along the career continuum.

1.1.7 SCOPE OF THE THESIS

Role development, and the emergence of advanced practice, is not peculiar to radiography alone. Many other health professions, including nursing and

physiotherapy, have also developed their professional role in response to many similar drivers for change. Whilst the findings of the published works may be seen as potentially transferable to these other settings, the thesis concentrates upon the changing scope of practice of diagnostic radiographers. In particular, but not exclusively, it focuses upon the development of radiography advanced practice, using examples from the specialist fields of gastrointestinal and trauma imaging. It explores the changing professional environment, the nature of radiography advanced practice, the drivers for its introduction and widespread dissemination, and the role of education. The timeframe for the thesis has been focused to the previous decade (1998-2009), coinciding with the publication record.

1.1.8 THE TIMELINESS OF THE THESIS

This thesis, being focused to the debate surrounding radiography advanced practice, is extremely timely. The published works have been selected to fall within an eleven year period (1998-2009), during which new clinical roles were introduced, a new radiography career structure was developed, and the scope of advanced practice became more clearly defined.

Following the emergence of radiography as a profession in the early 1920s, the scope of practice of the radiographer remained largely unaltered for some fifty years (Price, 2001). In the 1970s radiographers began to develop their scope of practice within a new modality, medical ultrasound. It was not until the mid 1980s, however, when technological expansion and increasing patient workloads had led to greater pressures on the radiology service, that more widespread role developments were

introduced. The initial effects of their introduction were minimal, as outlined by an Audit Commission Report (1995) which gave a damning account of radiology services, highlighting that in many cases radiological reports were not issued at all, or were issued too late to influence patient management. Clearly this situation was unacceptable, and further change was inevitable.

Early pioneers of 'skills mix' initiatives argued that experienced radiographers could be trained to take on some of the traditional radiology workload. The most notable published skills mix initiatives took place in the early 1990s, focusing upon radiographer-performed double contrast barium enema examinations (DCBE) (Mannion et al, 1995), and radiographer reporting of plain film examinations (Loughran, 1995; Robinson et al, 1999). Whilst all three studies were essentially pilot studies, assessing the developing skills and expertise of only a handful of carefully selected radiographers, they nevertheless were ground-breaking, pioneering the way for the subsequent introduction of role development across the UK. Increasingly such developments were supported by higher education, which was itself in a state of rapid transition following a move from diploma to degree-level entry to the radiography profession.

In the decade following the introduction of skills mix by the early pioneers, a range of role developments and advanced practices has become firmly embedded within radiography. More recently the introduction of a new career structure has caused much discussion and debate within radiography literature, with the criteria for moving between the different radiography grades heavily contested.

The thesis is therefore timely, as it provides an opportunity to reflect upon a decade of significant change within the radiography profession. The published works have contributed to an on-going debate over the last decade surrounding the emergence and implementation of the now well-integrated advanced practitioner role within the UK. However, with only thirty-one consultant radiographers currently in post (Kelly et al, 2008), it is clear that this highest tier of clinical practice is still emerging and is not yet fully embedded within the profession. The thesis is therefore produced at a pivotal point within the development of radiography as a profession, with the future expansion of consultant practice still a matter for debate.

1.1.9 DEVELOPMENT OF THE BODY OF PUBLISHED WORKS

The thesis author (Julie Nightingale) qualified as a diagnostic radiographer in 1987, and worked for six years as a general radiographer and clinical educator prior to securing her first academic post in 1994 at the University College Salford (later to merge with the University of Salford).

The author was fortunate to be involved in the design and validation of three of the first UK postgraduate programmes aiming to support radiographer role development initiatives. At the same time the author had commenced a Masters degree in Medical Imaging, during which emphasis was placed upon the theoretical underpinning of radiographer role development.

For the MSc dissertation the author gained an affinity with the concept of postgraduate study for radiographers, which was at that time still a very new and unexplored area. A qualitative study was undertaken to explore the stress encountered by radiographers undertaking postgraduate study, and it was subsequently published in a peer reviewed journal (Innes,1998). This article was the beginning of what was to be a developing research, scholarship and publication record over the following ten years, focusing on the role of education to support the developing role of the radiographer.

In 2003 the author contributed to the debate surrounding advanced clinical practice by publishing two invited discussion articles, one focusing upon the generic requirements and drivers for change (Nightingale and Hogg 2003a), and one exploring a specific area of advanced practice in detail (Nightingale and Hogg, 2003b). As an educator leading advanced practice programmes, the author was aware of the dearth of educational materials that were focused towards advanced practice radiographers, and a logical step was to produce materials tailored to this new audience. New insights into the development of advanced practice within the UK (and indeed overseas) culminated in further articles, edited books and book chapters. As time progressed more emphasis was placed on evaluating the success or otherwise of advanced roles, determining the medico-legal framework in which they work, and comparing the UK experience to that of other nations.

The author has a well-developed external profile which enables participation in advanced practice leadership at a national and international level. For the last four

years the researcher has held leadership positions within and outside the institution, including Faculty Director of Postgraduate Studies and Director of Radiography at the University of Salford, Chair of the national special interest group for gastrointestinal radiographers (GIRSIG), and Secretary of the UK Heads of Radiography Education group. These posts, along with invited positions on working groups and committees associated with the professional body for radiology (The Royal College of Radiologists) and with the Society of Radiographers, enable the author to be in a position to influence the development of advanced and consultant practice at the highest level. Working at this level has also assisted the author to ensure that the publications have been well-informed, relevant and timely.

The total publication outputs range from 1998-2009, and comprise ten peer reviewed articles, eight professional journal articles, two edited books (one currently in press), four book chapters, six refereed conference abstracts and four book reviews. A complete listing of the publications and outputs of the total body of work can be seen in Appendix 1.

When reflecting upon this scholarship over the last ten years, the author is aware that whilst there are clear links between the publications and outputs, there may also be gaps that need to be addressed. The PhD by Published Works provides a framework within which one can reflect on the publications from a critical perspective, thus ascertaining the original contribution to knowledge and understanding of the field. The next section will articulate the aims of the thesis, and will outline the technical requirements of a PhD by Published Works.

1.2 ACADEMIC REQUIREMENTS, TITLE OF THESIS AND RESEARCH AIMS

The following section will outline the specific requirements for submission of a PhD by Published Works, and will introduce both the academic objectives and the thesis aims.

1.2.1 ACADEMIC REQUIREMENTS FOR A PHD BY PUBLISHED WORKS:

According to the University of Salford AQA (2008/09) Research Award Regulations, the PhD by Published Works thesis is required, in addition to the published works, to provide a critical review of up to 15,000 words. Excerpts from the regulations related to the PhD by Published Works can be found in Appendix 2.

The regulations state that the thesis submitted for the award of PhD by Published Works should be roughly comparable in word count to a traditional PhD. The total word count for the published works is 62,173 words. Combined with the critical appraisal of the works in Part 2 (14,787 words minus tabulated matter) and the introductory chapters in Part 1 (4,700 minus tabulated matter and quotations) this combines to a total word count of 81,660 for the thesis, not including front matter (eg. Tables of Contents, appendices and references).

The following sections of this thesis outline the discipline-specific (substantive) aims of the thesis and offer justification for the selection of the published works. Part 2 of

this thesis presents a critical appraisal of the works and develops the themes of originality and impact of the collective works. Part 3 discusses the extent to which both the technical (academic) requirements and the substantive research aims have been addressed.

1.2.2 DISCIPLINE SPECIFIC AIMS

The thesis, entitled 'Changing professional landscapes: the influence of education on the origin and evolution of radiography advanced practice', encompasses three discipline specific research aims. These aims are to:

1. Analyse critically published literature related to the nature of radiography advanced practice, establish how it differs from standard practice, and determine the factors related to its successful introduction and dissemination.

2. Evaluate critically published literature to determine the extent of, and reasons for, any variation in the scope of practice of radiographers working in the United Kingdom and in other international health care systems.

3. Analyse critically the changing nature of knowledge required for safe and effective advanced radiography practice, and explore the influence of education on its' origin and evolution

1.3 SELECTION OF MATERIALS FOR THE PHD FROM THE LARGER BODY OF WORK

This section outlines the criteria used in the selection of the published works, and identifies the coding system used to refer to the published works within this thesis.

The University of Salford regulations for PhD by Published Works offer advice in terms of selection of published works (see Appendix 2). Within this thesis, the term 'published works' is used to refer to the works selected from the total body of work of the author for the purposes of the thesis. The total body of the author's publications is comprised of thirty-five separate works published between 1998 and 2009 (see Appendix 1).

The thirteen selected works meet the above criteria as they are all in the public domain, with one work that has been accepted for publication (in press). All have been submitted within ten years of registration for the PhD, with the oldest publication being 1998. All other works have been published within the last six years (2003-2009). All journal articles are published within international peer reviewed journals with one exception, which is an example of a professional journal article written to promote radiographer continuing professional development. One edited book and three book chapters have been included in the submission as they fit neatly within the scope of the thesis.

The published works have been selected from a larger body of work because they demonstrate a relationship to one or more of the substantive aims of the thesis, and they have been selected to show the development of ideas over time. They have also been selected from the total body of work with the technical requirements of the thesis in mind – they have the potential to demonstrate a depth of scholarship and originality, and are embedded within a coherent programme of research related to advanced practice in radiography.

Throughout the thesis, each of the published works will be referred to by a coding system based in order of the year of their acceptance (PW1; PW2; PW3 etc). The selected published works and their relationship to the substantive aims are listed in the Table 1 below.

TABLE 1 SELECTED WORKS AND THEIR RELATIONSHIP TO THE AIMS OF THE THESIS

Code	Date	Reference	Publication type	Relationship to aims
PW1	May 1998	Innes J (1998). A qualitative insight into the experiences of postgraduate students: causes of stress and methods of coping. *Radiography*, 4(2), 89-100.	Peer reviewed journal	Aim 1 Aim 3
PW2	Feb 2003	Nightingale J & Hogg P (2003). Clinical Practice at an Advanced Level. *Radiography*, 9(1), 77-83.	Peer reviewed journal	Aim 1
PW3	May 2003	Nightingale J & Hogg P (2003). The Gastrointestinal Advanced Practitioner: An Emerging Role for the Modern Radiology Service. *Radiography,* 9(2), 151-160.	Peer reviewed journal	Aim 1 Aim 3
PW4	May 2004	Owen A, Hogg P & Nightingale J (2004). A critical analysis of a locally agreed protocol for clinical practice. *Radiography*, 10(2), 139-144.	Peer reviewed journal	Aim 1 Aim 3

PW5	July 2005	McConnell J, Eyres R & Nightingale J (2005). *Interpreting Trauma Radiographs*. Oxford: Blackwell Publications	Edited Book: 1 book chapter	Aim 3
PW6	March 2007	Nightingale J & Hogg P (2007). The role of the GI radiographer: A UK perspective. *Radiologic Technology*, 78(4), 284-290.	Peer reviewed journal	Aim 1 Aim 2
PW7	Jan 2008	Scarles E & Nightingale J (2008). Colorectal carcinoma in a patient with prior breast cancer: Is there a causal link? *Radiography,* 14, 2-7.	Peer reviewed journal	Aim 3
PW8	Nov 2008	Nightingale J, Mackay S & Mollo B (2008). Enhancing the learning opportunities of part-time postgraduate students using distance learning. In O'Doherty E (Ed.) (2008) *The Fourth Education in a Changing Environment Conference Book 2007* "Best Papers" Volume 4. (pp155-172) California: Informing Science Press.	Book chapter within edited work	Aim1 Aim 3
PW9	Feb 2009	Nightingale J & Mackay S (2009). An analysis of changes in practice introduced during an educational programme for practitioner-led swallowing investigations. *Radiography*, 15(1), 63-69.	Peer reviewed journal	Aim 1 Aim 3
PW10	Dec 2008	Nightingale J (2008). Developing protocols for advanced and consultant practice. [Electronic version]. *Radiography*, 14(Supplement 1), e55-e60.	Peer reviewed journal – electronic supplement	Aim 3
PW11	Dec 2008	Kelly J, Piper K & Nightingale J (2008). Factors influencing the development and implementation of advanced and consultant radiographer practice: A review of the literature. [Electronic version]. *Radiography*. 14(Supplement 1), e71-e78.	Peer reviewed journal – electronic supplement	Aim 1
PW12	2009	Nightingale J, Kudlas M & Ricote L. Chapter 1 - Evolving practice and shifting boundaries in GI Tract Imaging. In Nightingale J & Law R (Eds.) *Gastrointestinal Tract Imaging: An evidence based practice guide*. Oxford: Churchill Livingstone / Elsevier. In press.	Edited Book: 2 book chapters, 1 submitted (in press)	Aim 1 Aim 2 Aim 3
PW13	Jan 2009	Nightingale J & Newman R (2009). Practical Reporting: Interpreting swallowing function by videofluoroscopy. *Synergy – Imaging and Therapy Practice*, January 2009, 16-22.	Professional journal	Aim 3

This section explores the incidence of collaboration within academic writing, and within the scientific and medical fields in particular. The potential benefits and disadvantages of co-authorship are discussed. The various collaborations within the published works are outlined alongside evidence of co-contributor agreements.

It is common within the medical and health sciences for work to be jointly authored, with co-authorship adding a new dimension to the work and improving article quality (Hart, 2000). There is also evidence of an increasing trend towards co-authorship in the social sciences (Hart, 2000). In his survey of co-authorship in academic library literature, Hart discovered that co-authors overwhelming highlighted three reasons for engaging in article collaborations: improved quality of the article; the expertise of the co-author; and the co-author's valuable ideas. Rated as being of lesser importance to the co-authors were: the benefits of the division of labour; learning from a co-author; and benefiting from additional publications (Hart, 2000). It is interesting to note that this paper was published nine years ago, and the latter benefit of increasing personal and collective publication outputs may be seen as more important now and in the future, as academic tenure demands and performance targets have become increasingly more rigorous. Also of interest is a later study by Hart in 2007, which examined a large number of journal articles with an academic librarianship focus in an attempt to determine whether co-authorship leads to a higher quality article as measured through rates of citation. No evidence was found to support this conclusion, which goes against his previous assumptions.

Yousefi-Nooraie et al (2008), however, in their analysis of three Iranian medical research facilities identified a clear link between the extent of the co-authorship network and the scientific productivity and scientific impact. In their study they discovered that the research centres with denser academic communities, which are more decentralized, and more open to outside connections networks, showed better scientific outputs. They stated that a lower mean number of authors per paper suggests the involvement of smaller number of researchers in common projects, and lower potential for team working (Yousefi-Nooraie et al, 2008). However, whilst this may be the case in the medical sciences, it may vary across different research disciplines. Newman (2004) showed that biological scientists tend to have significantly more co-authors (mean of 3.75 per paper) than mathematicians (1.45) or physicists (2.53). He believes this finding reflects the 'labor-intensive, predominantly experimental direction of current biology' (p5205), compared to the more theoretical and individual nature of mathematical sciences (Newman, 2004).

Within the radiography research fields, co-authorship is also accepted practice. For example, an analysis of five recent editions of the journal *Radiography* (Feb 2008 to Feb 2009) identified that 73% of papers excluding editorials were multi-authored, although the majority of these papers had a maximum of two authors. Within the field of radiology, however, multi-authored papers are much more common, with many papers having five or more authors. This practice has come under some criticism, with several radiology journals questioning the ethics of 'multiple authorship'. In a paper by Gilbert and Denison (2003) discussing research misconduct in radiology, they note that:

> The international committee of medical journal editors states that only those individuals who have made a substantial contribution to the research and who understand all aspects of the paper are entitled to authorship. Authors should have participated sufficiently in the work to enable them to be publicly accountable for the content. (p501)

Gilbert and Denison (2003) also comment on the notion of 'gift' authorship, whereby, for example, a Head of Department would expect to have their names in papers that their staff had produced, whether or not they had made an intellectual contribution to it. They argue that the relatively recent practice of the National Library of Medicine listing all authors in Index Medicus and Medline has done nothing to curtail the practice of 'gifting' co-authorship to increase individual publication outputs. In an attempt to ensure that gift authorship is reduced, a number of journals, including *Clinical Radiology*, require each author to sign a declaration that the work is original and has not been published or submitted elsewhere, and to identify their individual contribution to the article and the research underpinning it. Whilst the requirements for acknowledging the individual author contributions are not currently as stringent within the *Radiography* journal, publication ethics is nevertheless highly topical, with a forthcoming Editorial focusing upon this subject (Price, 2009). The order of authorship is always controversial, with different institutions and disciplines using different methods (Gilbert and Denison, 2003). Generally within radiography and radiology the culture attributes importance to the sequential order of the co-authors, with the 1st author having made the greatest contribution.

The published works presented within this thesis include ten journal articles, of which two are single authored, and eight are co-authored. Co-authors are drawn from within the author's institution and from partner clinical sites (Blackpool Victoria Hospital, South Manchester University Foundation Hospitals, Royal Preston Hospital, Countess of Chester Hospital), as well as from other higher education institutions (Canterbury Christ Church University).

Two books are presented which are jointly edited, bringing together a large number of expert co-authors from across the United Kingdom. PW5 was edited by three individuals with equal contribution (including one co-editor from Christchurch Polytechnic Institute of Technology in New Zealand). Within this book one single-authored chapter is presented within this thesis. PW12 was co-edited with a colleague from Bristol NHS Trust, collaborating with expert clinicians and health professionals from across the UK. One of two chapters written by the author is presented, bringing together authors from Australia and America who present a discussion related to the developments of advanced practice across the English-speaking world. An additional 1st authored book chapter from another edited and peer reviewed book is also presented (PW8).

The reasons for collaboration within the thirteen published works follow very closely the three primary reasons for co-authorship identified within Hart's study (2000), namely: a belief that co-authorship would improve the quality of the article; the perceived need for the additional expertise of the co-author; and the belief that the co-author would bring valuable ideas that may influence the direction of the research

and the subsequent article. The articles and their agreed contributions can be seen in Table 2. Confirmation about the author agreements can be seen in Appendix 3.

TABLE 2 CONTRIBUTORS TO THE PUBLISHED WORKS AND PERCENTAGE CONTRIBUTION AGREEMENTS

Code	Author (JN) position	Co-authors	Agreed (JN) contribution
PW1	Sole	-	100%
PW2	1st	Professor Peter Hogg	50%
PW3	1st	Professor Peter Hogg	70%
PW4	3rd	Andrea Owen Professor Peter Hogg	20%
PW5	Joint editor (book) Sole author (chap 6)	J. McConnell / Renata Eyres -	33% 100%
PW6	1st	Professor Peter Hogg	80%
PW7	2nd	Elaine Scarles	50%
PW8	1st	Professor Stuart Mackay / Ben Mollo	80%
PW9	1st	Professor Stuart Mackay	80%
PW10	Sole author	-	100%
PW11	3rd	Judith Kelly Keith Piper	20%
PW12	Lead editor 1st (chap 1)	Robert Law Myke Kudlas / Liza Ricote	60% 60%
PW13	1st	Roger Newman	60%

PART 2 – CRITICAL APPRAISAL OF THE PUBLISHED WORKS

2.1 REVIEW OF THE METHODOLOGICAL APPROACHES USED

This section outlines the range of methodologies used to underpin the published works, and explores examples of innovative practice or first use within the discipline.

Throughout the published works a wide range of methodologies have been used, including:

- literature reviews (PW2; PW3; PW6; PW7; PW11);
- qualitative interviewing and analysis (PW1);
- documentary analysis (PW4; PW9; PW10);
- survey methodology (PW8);
- action research (PW8).

Detailed accounts of the methods used and their justification within the empirical studies can be seen within the published works themselves. Increasing methodological sophistication has been a feature of the published work, with literature reviews being one example of this. The review articles (PW2, 3, 6, 11), and those published works with a review element (PW7) have benefited from a number of improvements in the author's understanding and increasingly elaborate use of technology and software, enabling literature searching to become faster and more sophisticated. An increasing awareness of the strengths and limitations of various

research methodologies has led to greater scrutiny of articles incorporated within the author's literature reviews, with an increasing emphasis on the analysis of the findings of meta-analyses and systematic reviews within more recent published works and works in press (eg. The Royal College of Radiologists, 2009).

One of the literature review articles (PW3) was placed under systematic external scrutiny when it was cited in a highly influential Royal College of Gastroenterology scoping document published by Williams et al (2007). Using strict review criteria, the article was assigned a score of 64% (where 45-65% was classed as being a reliable source of evidence, falling short in one or more areas) which resulted in inclusion within this report. The majority of articles reviewed fell short of even the 45% barrier (poor quality evidence). On reflection, PW3 falls short of the 65% threshold because of the lack of information related to the systematic search strategy – that is, it is not easily reproducible. This limitation will be addressed in the author's future review articles.

A number of examples of innovative application of research methodology can be found within the published works, including first application of a particular method within the discipline. Much radiography research, perhaps not unsurprisingly for a largely technical discipline, leans towards quantitative, positivist paradigms. Very few radiography researchers have employed true post-positivist paradigms within their research, with Murphy (2003) identifying PW1 as one of only two contemporary articles discovered to be sympathetic to this paradigm. PW1 was also acknowledged by Ng and White (2005) as the first article to be published within the radiography field

related to phenomenological enquiry. These authors, reviewing the use of qualitative methods within the radiography field, stated that:

> This study [PW1] is a good example of phenomenology as it provides a detailed description of the major themes and keeps with the phenomenologic method and terminology. (p223)

Many other studies reviewed were criticised by Ng and White (2005) for not being explicit regarding the methodology used, making it difficult to reproduce. Some studies were also noted to have selected an inappropriate qualitative methodology.

Documentary research, as used in PW9, is an example of an 'unobtrusive and non-reactive measure', in that the documents are created for a different purpose and therefore are not affected by the researcher's involvement (Robson, 2002). Documentary research methodology has also been applied in PW 4 and PW10. These are relatively rare examples within the discipline of the use of an unobtrusive methodology, and a search of Radiography journals only identified two other examples of empirical documentary analysis (Bentley, 2008; Caruana and Plasek, 2006).

Documents are often analysed by 'content analysis', which may have a quantitative approach such as counting the frequency of key words, or may have a qualitative approach concerned with the identification of key themes and messages within the documents. The latter approach has been used within four of the published works.

Whilst PW4, 9 and 10 examined existing documents (protocols and portfolios), a more common approach is to explore documents that are created for the purposes of the research, including interview transcripts, reflective diaries and questionnaires. Content analysis, used in this way, is considered an 'obtrusive measure', with the potential to alter participant behaviour. One example of this more traditional use of data analysis is found in PW1, where a well-established method of thematic content analysis developed by Bernard (1991) was used to analyse the transcripts from semi-structured interviews.

Several of the published works (PW1, 4, 9, 10) demonstrate methodological skill in a range of qualitative methods. Knowledge of survey methodologies has also been evidenced in PW8 (written questionnaires), being part of a multi-methods study. PW8 employed an action research methodology, involving identification of a problem, introducing a change, observing what happens following the change, reflecting on the consequences, then planning further action (Robson 2002). This methodology, used within the educational and learning technologies environments, aroused much interest when presented at a multi-professional education conference. The author was requested to submit the work as a chapter in a 'Best Papers' conference book edited by O'Doherty (2008).

In summary, a range of methodological approaches are evident within the published works. These include the application of a survey methodology, documentary analysis of existing documents as well as those compiled for the purposes of the research, qualitative interviewing techniques and observation studies as part of an action

research project. Some of these methodological approaches are noted to be the first to be published within the radiography field. The use of these research methods is supported by increasing sophistication in desk-based literature searching techniques.

2.2. THE IMPACT OF INDIVIDUAL PUBLISHED WORKS

This chapter explores the degree of impact of the individual published works, by presenting an analysis of both citation data and article download data. Further sections will explore the impact of the published works by analysing journal quality metrics, and book reviews.

2.2.1 CITATIONS

This section explores the number of citations received for the individual published journal articles, and offers a qualitative analysis of the source of the citations. The importance of citation data as one component of the assessment of article quality is discussed, including a comparison of the potential limitations of the different citation tracking databases.

Traditionally individual author citation data has been used in some fields to help to form a judgement of the quality and utility of the authors work. This data has been used alongside other measures such as the numbers of articles published coupled with the impact factors of journals in which the author publishes (Seglen, 1997). For many years the 'Web of Science', an electronic journal tracking database, had a monopoly on the provision of citation tracking (Bakkalbasi et al., 2006), but in 2004 two new competitors emerged – Scopus (supported by Elsevier) and Google Scholar. Whilst Web of Science can track citations back to 1900, Scopus analysis is limited to 1996 and beyond. A direct comparison of the three citation trackers highlighted that

all three versions have strengths and weaknesses, with all presenting some unique material (Bakkalbasi et al, 2006). Google Scholar is the only free subscription service and potentially accesses more non-traditional sources (eg. Government publications and online books). Bakkalbasi et al identified that for recent medical-related literature (2003 oncology articles), Scopus returned the highest number of citing references. The Web of Science is slightly more complex to use, and only returns one of the author's publications, as the journal *Radiography* is not ISI / Medline indexed and therefore none of the *Radiography* articles will feature in a Web of Science search. For this reason, as well as its ease of use, Scopus was selected as the initial analytical tool for identifying the author's citations, which were all published within the 1996 cut-off date. Google Scholar and Web of Science were used as a secondary search to identify any additional citations.

Analysis of Scopus data (www.scopus.com) enables a researcher to review their own performance in terms of citation rates. A search of PW1 (in the author's maiden name of Innes) identified two citations, both within the *Radiography* journal. Analysis of Scopus data under the author's present name identified nine articles, with six of them having citations. Further analysis of two articles (PW9-10) without citations identified that these were the most recent articles, only coming into print between December 2008 and February 2009 (although they were previously available online). Six of the articles have a publication date of 2007 or later, so are unlikely to have accrued many citations at this time.

A secondary analysis of the author's citations identified through Google Scholar (http://scholar.google.co.uk/) found additional citations for several articles. This phenomenon of unique material being highlighted within the different databases is also noted by Bakkalbasi et al (2006). The citations identified by the three media can be seen in Table 3.

TABLE 3 ARTICLE CITATIONS IDENTIFIED BY SCOPUS, GOOGLE SCHOLAR AND WEB OF SCIENCE

Published Works			**Citations in Each Database**			
Article	**Year**	**Brief title**	**Scopus**	**Google Scholar**	**Web of Science**	**Total Citations**
PW1	1998	Stress in postgrad	2	3	0	3
PW2	2003	Clinical pract adv level	9	8	0	10
PW3	2003	Gastrointestinal AP	10	12	0	13
PW4	2004	Analysis of protocol	4	4	0	5
PW6	2007	GI in USA	1	1	1	1
PW7	2008	Colorectal cancer	0	0	0	0
PW9	2009	Swallowing	0	0	0	0
PW10	2008	Protocols	0	1	0	1
PW11	2008	Facilitators for AP	0	0	0	0

As can be seen in Table 3, two articles published in 2003 have attracted ten and thirteen citations respectively. One article published in 2004 attracted five citations,

one attracted three citations, and a further two articles have attracted one citation each.

The citation data for the articles listed above can be re-formulated as an h-index, which is based on the highest number of papers included that have had at least the same number of citations. For example, if an author has an h-index of 6, then they would have six papers having at least six citations each. Calculation of the h-index for the published works presented within the thesis leads to a score of 3 – where three of the papers have at least three citations. This is found to be fairly similar to the Scopus h-index (www.scopus.com) of others working in the same field, including: Maryann Hardy (University of Bradford) h-index=5; Robert Law (Bristol NHS Trust) h-index=2; Beverley Snaith (Mid Yorks NHS Trust) h-index=4.

According to the Scopus Journal Analyzer, the *Radiography* journal has a maximum trend line score of 2.46 (2008), with an average score over several years of 1.15. This can be equated to a rough estimate of average number of citations per article (ie. 1.5 citations per article). Two of the author's articles (PW2 and 3) have 10 and 13 citations, more than six times higher than the average score for the journal. One of the articles (PW3) lies just outside the *Radiography* journal's 'Top 10' articles cited within Scopus, which range from 19-11 citations (Radiography homepage www.elsevier.com). Only one of these 'Top 10' articles is published more recently than PW3. For the later published works (after 2006) and those only recently available in print, it is understandable that citation rates will be minimal.

Whilst the citations rates for PW2 and 3 are good, and are clearly better than many authors publishing in the Radiography journal, nevertheless these scores are relatively low in comparison to those found in, for example, radiology related journals. Seglen (1997) cautions against the use of citation measures alone, as significant biases can be introduced within and between scientific disciplines. Higher citation rates are likely to be seen, for example, in authors using the English language, in generalist areas rather than specific or applied (eg. clinical) subjects, in review articles rather than original research, in cutting-edge articles tending to have a short life-span, and in longer rather than short articles (Seglen, 1997). He also notes that emerging research disciplines (such as radiography) are likely to have lower citation rates than established disciplines.

Interrogation of an author's citations can be done electronically within the ISI Web of Science (http://isiwebofknowledge.com), creating informative diagrammatic displays of citation mapping across the globe. These diagrams enable the wider citation networks to be visualised, working back through two generations of citations linked to institutions, countries, journals and subject areas. Unfortunately these analytical tools cannot be used for the author's published works due to the lack of ISI / Medline indexing of the *Radiography* journal. However a manual interrogation of the published works' citations identifies that the citing authors published in seven separate journals: *Radiography; Australian and New Zealand Nuclear Medicine; Journal of Radiotherapy in Practice, Learning in Health and Social Care, British Medical Journal (GUT online)*, *Breast Cancer Research* and *Radiologia* (a Spanish radiology publication). The majority of citations are found within the same journal in which the original articles were published (*Radiography*), a phenomenon noted

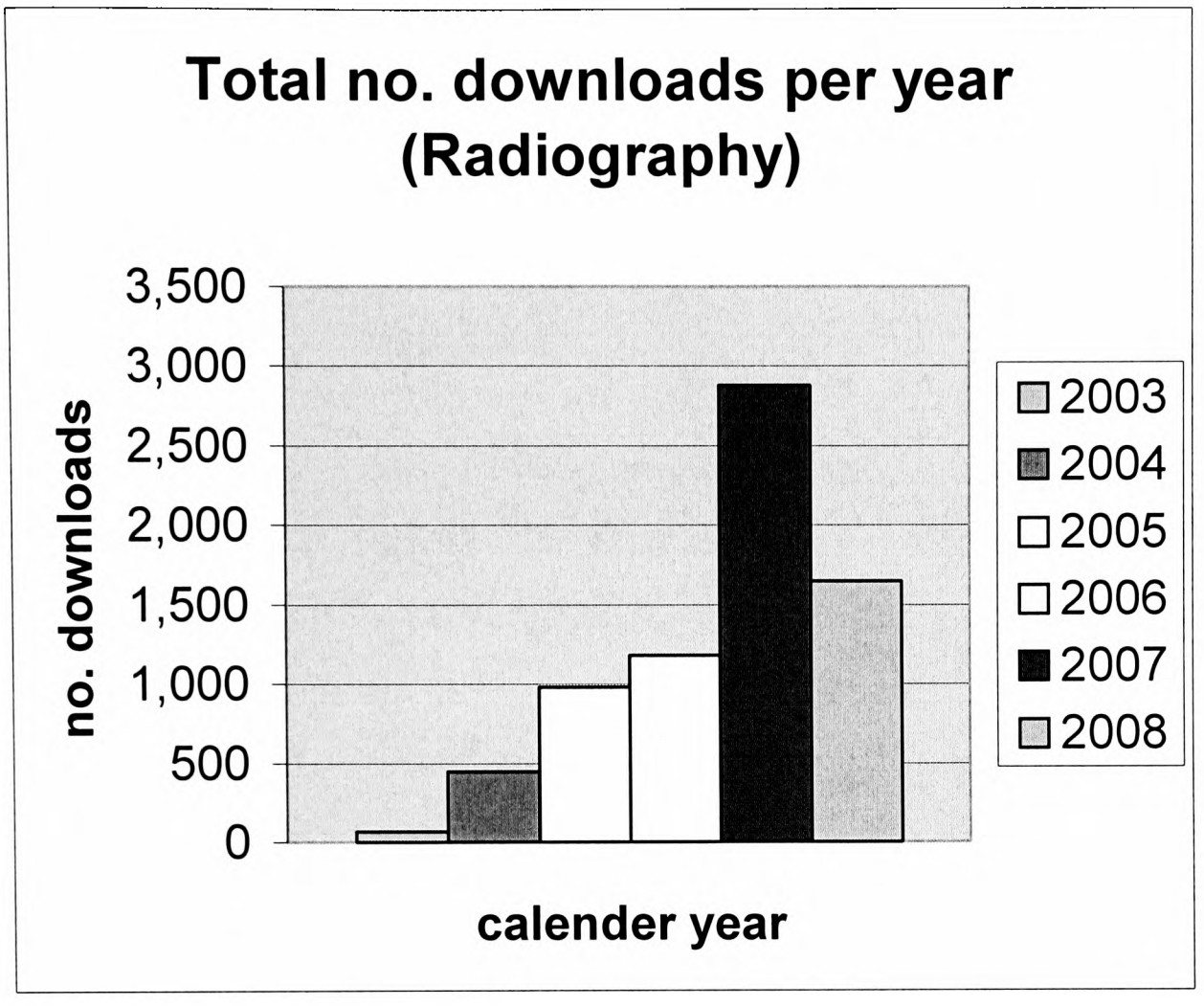
frequently by Seglen (1997). As well as UK authors, citations included an overseas research team from Hong Kong Polytechnic University (Ng and White, 2005), a research team from the Karolinska Institute in Sweden (Larsson et al, 2008), a team from Bergen in Norway (Hafslund et al, 2008) and a radiologist from Spain (Garcia Aguaya, 2008). The analysis of citing authors suggests that the articles are being used within the three different disciplines of radiography, radiotherapy and radiology, both within the UK and overseas.

One of the flaws in relying upon citation data is that most online analysis tools only register peer reviewed journal citations. A brief review of other 'grey literature' has identified a number of additional citations for the published works within book chapters, PhD Theses, MSc dissertations, professional body literature, professional (non-peer reviewed) journals, and hospital documents such as protocols. These have included, for example, seven citations within *Synergy – Imaging and Therapy Practice*, and a citation for PW3 in a highly influential Royal College of Gastroenterology scoping document published by Williams et al (2007), demonstrating that the research is being utilised by professions other than radiography.

2.2.2 DOWNLOAD DATA

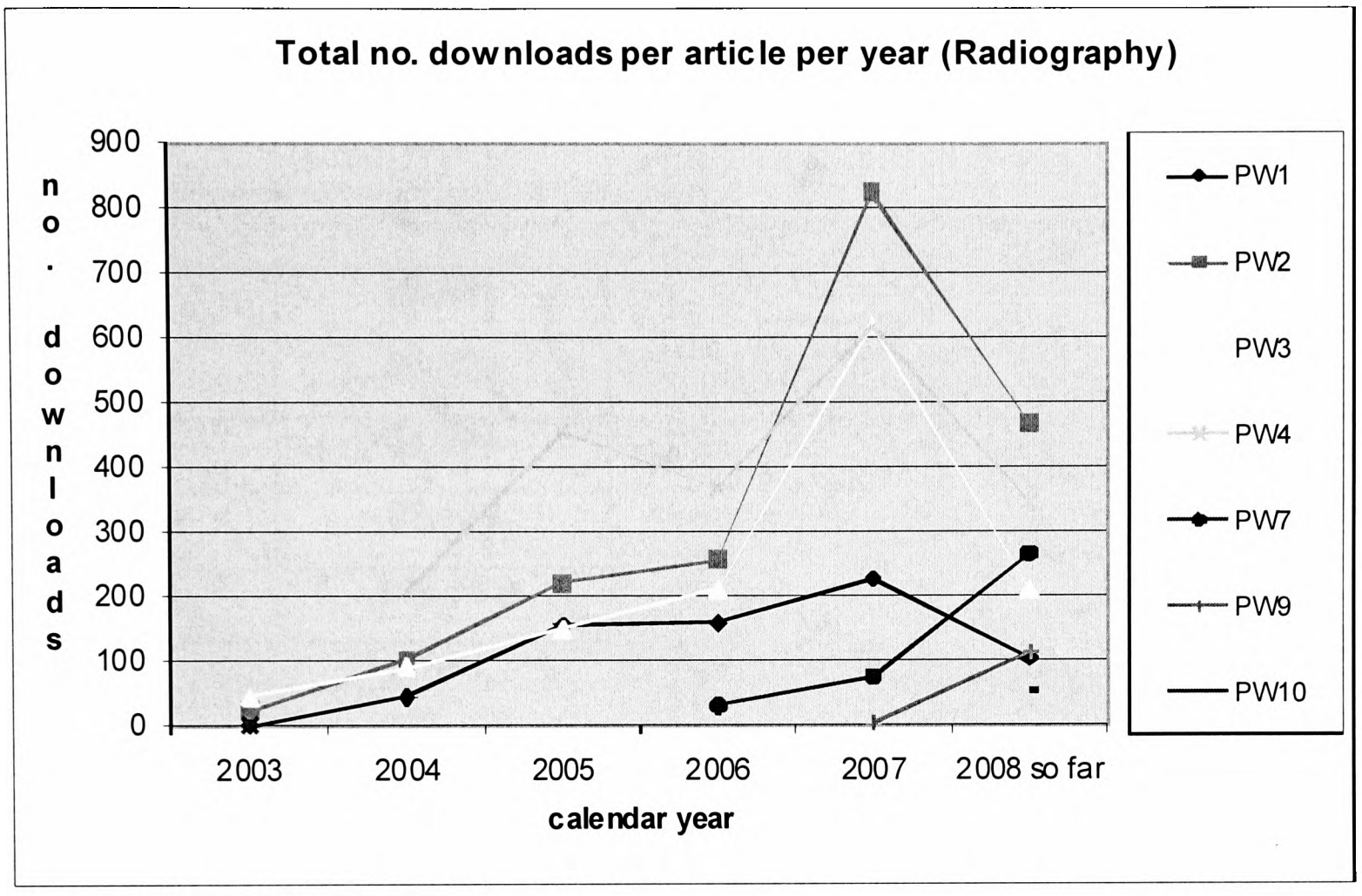
As journal publishers have moved increasingly towards online access to their articles, and online journal subscription services and search facilities have become more accessible, it is appropriate to consider individual article download data. Whilst no data is available for PW6 (*Radiologic Technology*), download data has been received from *Radiography* for each of the author's articles from 2003-mid 2008. This data was summated to give total download data for the author's published works per year. Chart 1 demonstrates that the total number of downloads of the author's articles have increased annually to reach a peak at 2,879 in 2007 (see Figure 1). Figures have dropped for 2008, but this was 'year to date' data based on only 8 months of the year, the census having been taken in August 2008.

FIGURE 1 TOTAL NO. DOWNLOADS PER YEAR FOR THE PUBLISHED WORKS (RADIOGRAPHY JOURNAL)



Further breakdown of this data has demonstrated the download trends for each of the author's articles (Figure 2). PW9 and PW10 have only recently been published in print, and whilst they were formerly available online, downloads are expected to be lower than other articles which have received greater publicity in print.

FIGURE 2 TOTAL NO. DOWNLOADS PER PUBLISHED WORK PER YEAR (RADIOGRAPHY JOURNAL)



The majority of the author's articles as seen in Figure 2 show an increase in the number of downloads year on year. Whilst this gives evidence of the longevity of the research findings, it also reflects the rapidly increasing access to the internet for most users of research, as well as the exposure and development of the *Radiography* journal. This tremendous increase in downloads can be shown with great effect when one accesses the total download data for the journal (Table 4). The download rate for 2008 (year to date to November 2008) is extremely high for a quarterly journal.

TABLE 4 TOTAL NO. DOWNLOADS PER YEAR FOR THE RADIOGRAPHY JOURNAL (ALL AUTHORS)

Year	Total downloads
2002	348
2003	4,792
2004	20,491
2005	50,759
2006	64,294
2007	97,128
2008	119,563

Dividing the total number of downloads for 2008 by the total number of articles published in the journal from 2003-2008 gives a mean download rate per article of 376. Three of the author's most downloaded articles (PW2, 3, and 4) compared favourably, achieved between 617 and 823 downloads in 2007 alone. These download rates can also be compared to the journal 'top 10' articles for 2007, which received between 700 and 1500 downloads each during that calendar year (information supplied by Ruth Beer, *Radiography* publishing editor). As PW2 and PW3 were published in 2003, it is pleasing to see that they are still achieving a relatively high number of downloads five years later.

More readily available through Scopus is information regarding the 'Top 25' articles of any journal or subject area. For *Radiography* the Top 25 are generally calculated every 3 months, with records beginning in October 2006. A number of the author's articles are included in the Top 25 (see Table 5).

TABLE 5 ARTICLES APPEARING IN THE TOP 25 DOWNLOAD LISTINGS FOR THE RADIOGRAPHY JOURNAL (DATA EXTRACTED FROM SCOPUS.COM)

Assessment period	Article	Position in Top 25
Oct - Dec 2006	PW2	24
Jan – Mar 2007	PW2	10
	PW4	20
Apr - June 2007	PW2	13
	PW3	22
	PW4	24
Oct - Dec 2007	PW2	18
	PW3	23
Jan – Mar 2008	PW2	19
Apr - June 2008	PW2	25

PW 2 and 3 were published in 2003, with PW4 in 2004. Unfortunately no Top 25 data is available from 2003-6 which is when most interest in these articles would have arisen (although access to the internet was perhaps less). Nevertheless it is clear that PW2 and 3 in particular have longevity, remaining within the Top 25 until the present day (5 years after publication). This longevity and continuing utility of the articles was also recognised by the *Radiography* journal, when PW 2 and 3 were both re-launched in an 'Advanced Practice' special on-line edition in 2007, four years after their initial publication.

2.2.3 SUMMARY

Whilst citation and download data has been relatively low for some of the articles published more recently, some of the earlier articles have frequently appeared in the Top 25 downloaded articles, even five years after publication. Qualitative analysis has demonstrated an interesting trend in terms of citations, with authors from a range of countries and disciplines choosing to cite the author's work in several different journals and publications. However the lack of Medline indexing and only recent inclusion on Science Direct is felt to have limited the possible citations from outside the UK radiography field. Whilst quantitative analysis of a researcher's portfolio is interesting, it does not necessarily equate to a measure of the quality of the research. As Seglen (1997) states, there is no substitute for peer review by experts in the field.

This section considers the quality and performance of the journals in which the selected articles have been published, as this is related to the potential impact of the articles. Journal quality is compared by analysing the number of articles published and citation rates.

The selected published articles, with only two exceptions, have been published in *Radiography*, an international peer reviewed journal. Whilst *Radiography* is not currently ISI impact rated or Medline indexed, the journal was submitted for indexing within Medline in 2008 (Price, 2008), although unfortunately this was unsuccessful. However this rapidly developing quarterly journal is believed by many to be the world leader in radiography research (Hogg 2008, pers. comm.). According to Hogg (2008), the previous editor in chief, the journal has a growing international reputation: the Australian Government have accepted it as a journal that can be used in their Research Assessment Exercise system, and the Chief Executive Officer of the American Society of Radiologic Technologists has stated that '*Radiography* has an excellent international reputation and it has a broad readership' (Hogg 2008: pers comm.). This growing international reputation is reflected in the journal statistics, which demonstrate that currently manuscripts received from outside the UK total 42.5%, with a 60% UK readership (Radiography Publisher's Report, January 2009). *Radiography* has a print circulation of approximately 20,000 copies (including e-copies over 23,000), plus average downloads of over 7,000 per month. The rejection

rate (often used as a measure of quality) is rapidly increasing, with a high of 48% in 2007 (Radiography Publisher's Report, January 2009).

One article (PW7) is published in *Radiologic Technology*, the primary publication of the American Society of Radiologic Technologists (the USA equivalent of radiographers). This is the only radiography-related journal to be indexed in Medline at the current time, and is single blind peer reviewed by the editorial panel (the reviewers see the author's names, but the authors do not see the reviewers' names). The *Radiography* journal has a double blind peer review system, which one could argue would be less prone to bias. Seglen (1997) makes a convincing argument for qualified experts judging article quality (i.e. the peer review process), and acknowledges that more time should be spent improving the peer review process rather than developing increasingly complex quality calculations (metrics).

There are only a limited number of journal alternatives in which to publish articles aimed primarily at a radiography audience. One such alternative was the *Journal of Diagnostic Radiography and Imaging (JDRI),* but this journal was only published from 2003 to early 2006. A conscious decision was made at that time for the author to submit articles to the 'tried and tested' *Radiography* journal. An Australian radiography professional journal entitled *The Radiographer* is available but has limited international readership, so would not be a suitable publication for many of the author's articles. More recently the *European Journal of Radiography* was launched in 2008, offering a peer-reviewed forum for (mainly) Southern European and

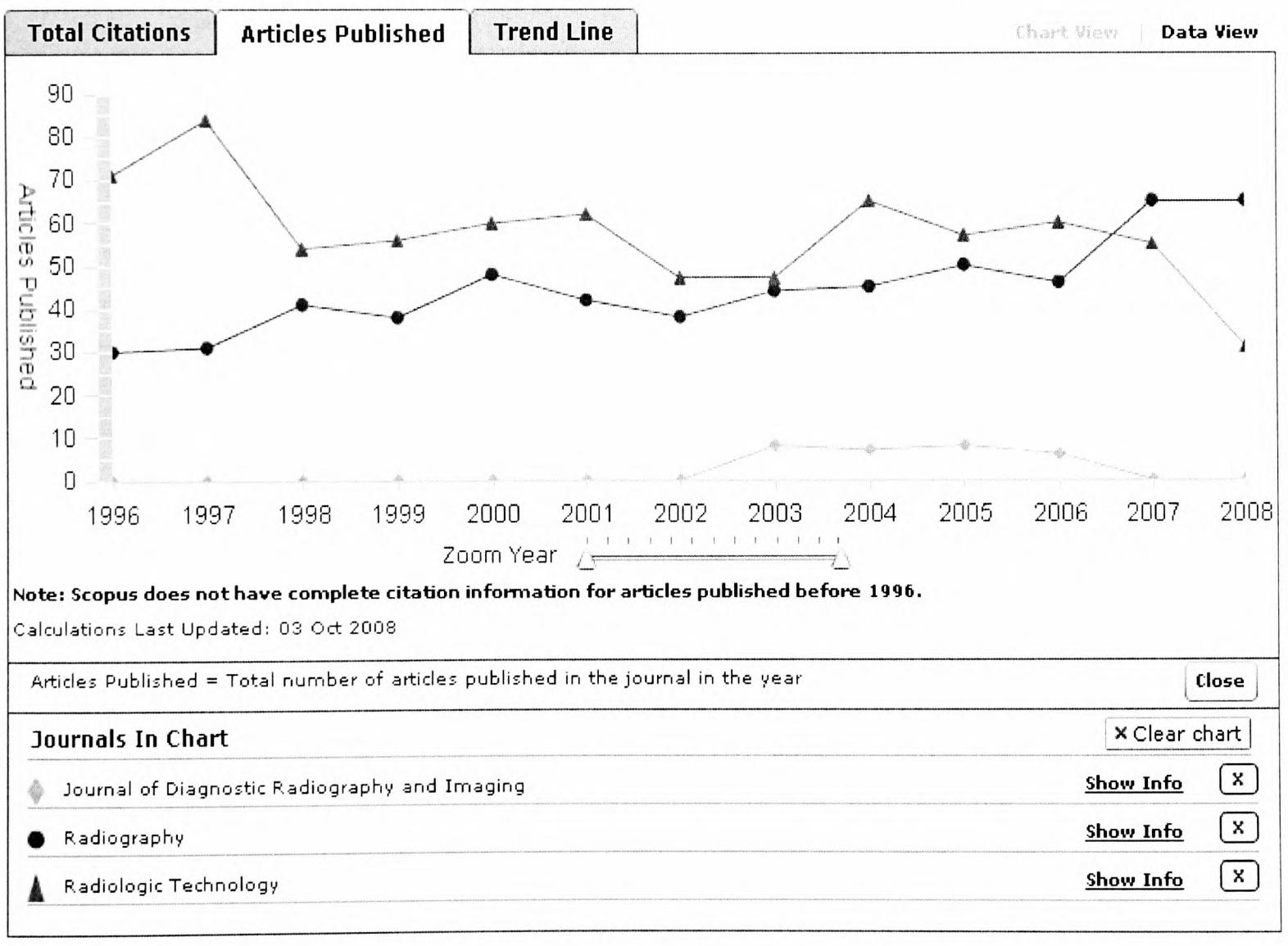
Mediterranean radiographers. Currently it has little copy, but once it is established this may be a possible publication option for the future.

PW13, alongside several other articles and editorials by the author not included within the thesis, has been published in *Synergy – Imaging and Therapy Practice*. This is the monthly professional journal for radiographers in the UK, and has a current print circulation of 19,500 copies. The journal is reviewed by the editorial panel, rather than being peer reviewed. Whilst the peer review process utilised within most academic journals can be seen as an indication of a quality process, some authors criticise the mechanism as being rather crude and lacking in rationality (Seglen, 1997). The author has published a number of scholarly articles for continuing professional development (CPD) within this journal, however only one recent example (PW13) has been selected to be included within this PhD submission. Whilst this professional journal is not impact rated or peer reviewed, it can still have a significant potential impact into 'real world' practice at a local and a national level, as will be evidenced later in Section 2.6.3.

The journals targeted within this PhD thesis have therefore been limited to two international peer reviewed publications: *Radiography* and *Radiologic Technology*, and one editorial panel-reviewed professional journal: *Synergy – Imaging and Therapy Practice.* Analysis and comparison of quantitative journal data is warranted as most education institutions and journal publishers rely heavily upon the findings. Further investigative work into the performance of radiography journals has uncovered some interesting trends. This work was undertaken using the Scopus

Analyzer, an online tool which offers a "quick, easy and transparent view of journal performance". (www.info.scopus.com/journalanalyzer/). The Scopus Analyzer holds data going back to 1996, and enables the researcher to compare up to ten journals in a specific field. The following charts demonstrate graphical comparisons between three selected radiography journals (*Radiography*, *Radiologic Technology* and the *Journal of Diagnostic Radiography and Imaging*, or JDRI), comparing the number of articles published per year (Figure 3), and the number of citations per year (Figure 4).

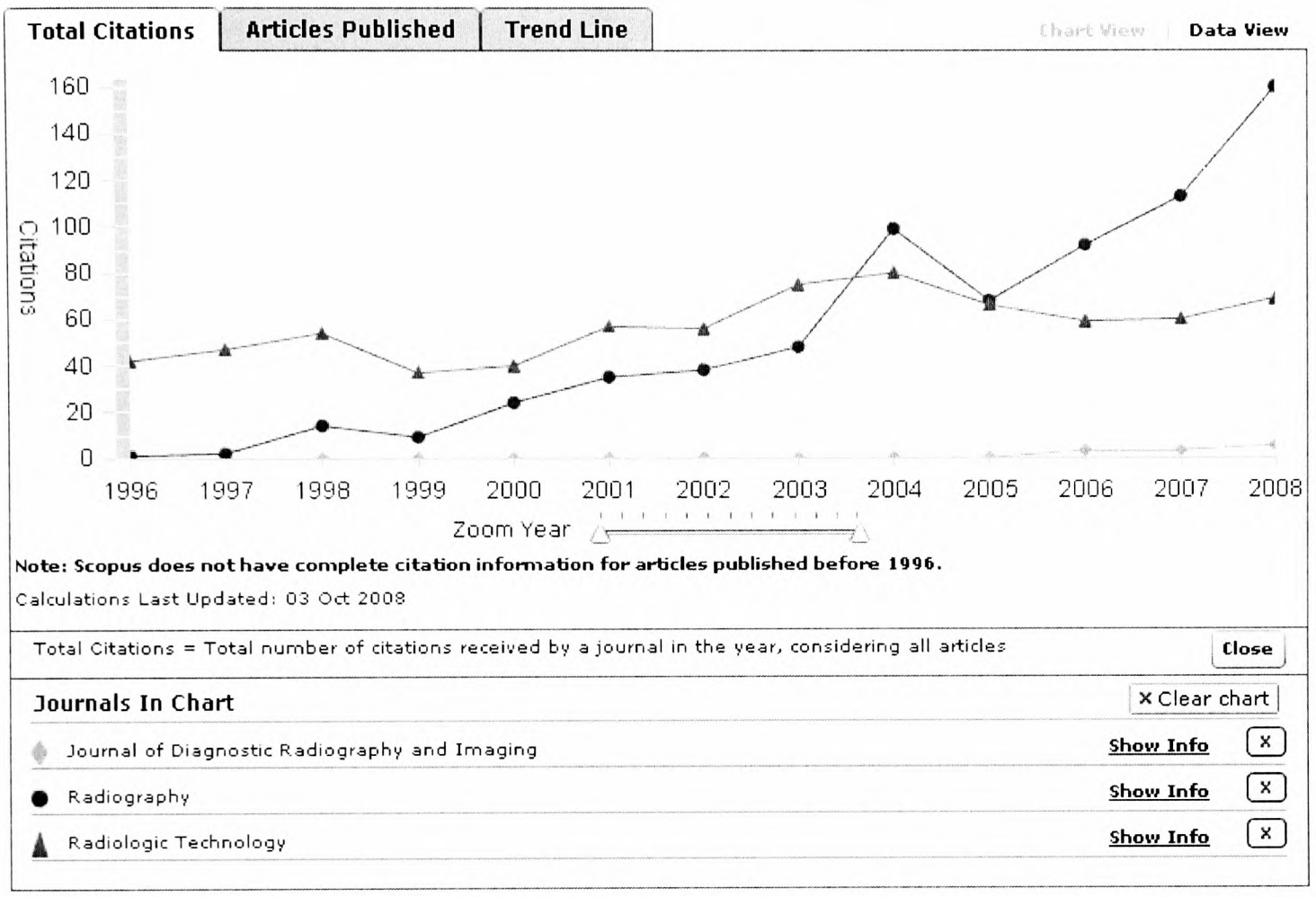
FIGURE 3 NUMBER OF ARTICLES PUBLISHED ANNUALLY PER JOURNAL (1996-2008)



As can be seen from Figure 3 above, the number of articles published by *Radiologic Technology* has been consistently higher than for *Radiography* until 2007. This is not

surprising as this journal has bi-monthly publication rather than quarterly. However it is interesting to see *Radiography* publications rising quickly from 2006 to the present. JDRI has limited output throughout the short life-span of this journal.

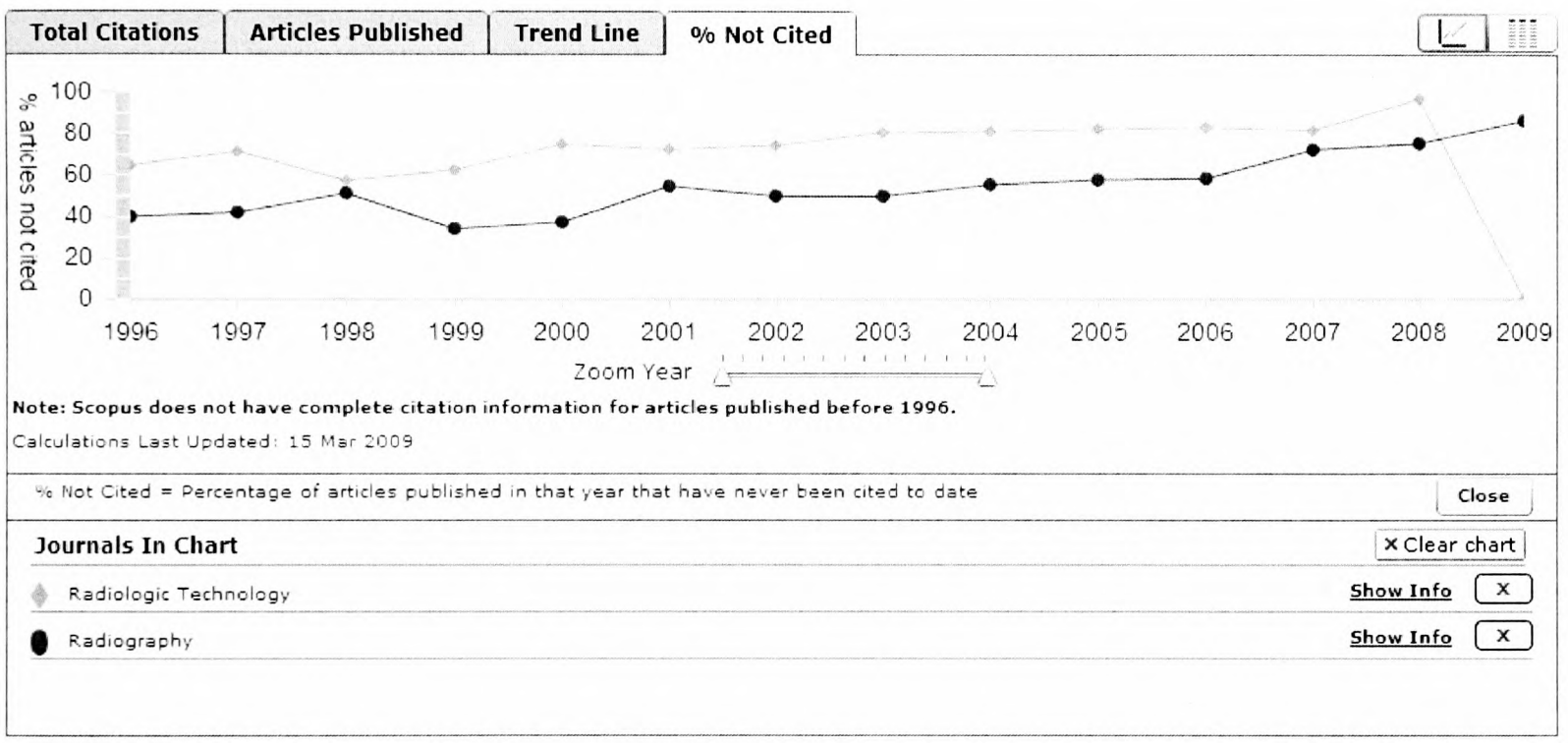
FIGURE 4 NUMBER OF CITATIONS ANNUALLY PER JOURNAL (1996-2008)



Whilst *Radiologic Technology* has had a slightly increasing trend for citations, *Radiography* citations have been increasing at a much higher rate, overtaking *Radiologic Technology* in 2004. This is an interesting finding which supports the decision to publish predominantly within *Radiography*, as citations are one of the indicators of quality and journal influence. However the lack of Medline indexing (primary medical search engine) is undoubtedly limiting the citation rate of this journal, as searches through Medline and Web of Science will not pick up these articles. Whilst mean article citations are potentially a measure of journal quality, the figures can be influenced by the inclusion of just a few highly cited articles. A perhaps

more potent measure of journal quality is the percentage of articles within a journal that have never been cited to date. Figure 5 demonstrates that, even considering the lack of exposure through Medline indexing, *Radiography* performs better than *Radiologic Technology* within this particular metric. The latter journal presents a fairly consistent picture of approximately 75-80% of articles never attracting citations, with *Radiography* performing considerably better at approximately 40-60%.

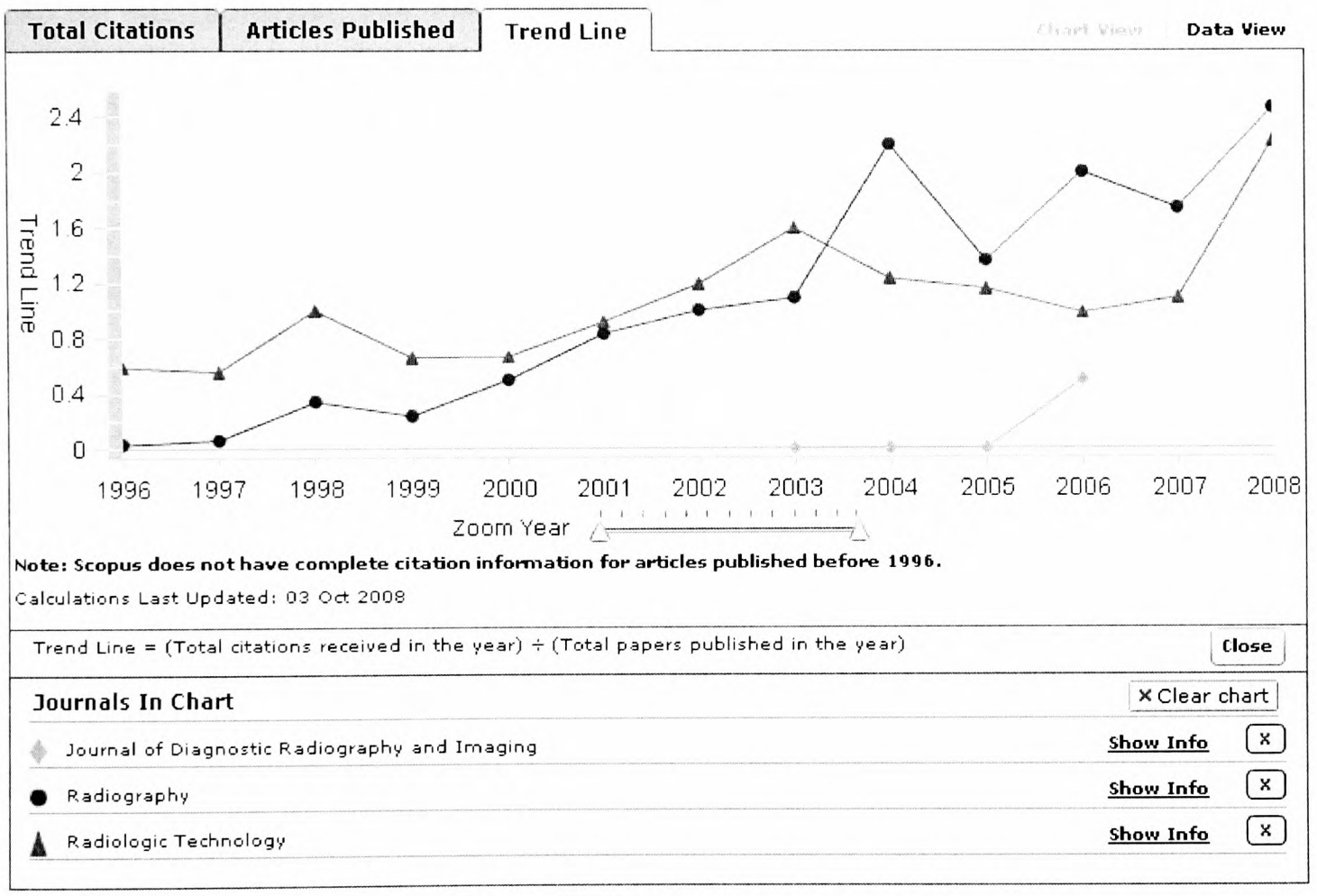
FIGURE 5 PERCENTAGE OF ARTICLES PUBLISHED IN EACH YEAR THAT HAVE NEVER BEEN CITED TO DATE (1996-2009)



Whilst *Radiography* is showing an increasing citation rate, spread across a large number of its articles, and the evidence shown here suggests that this journal is arguably superior to other radiography journals, it is nevertheless important to counter this data against that displayed by other, long-established Medline indexed international journals (which gain much greater exposure). If one considers the related discipline of Radiology, for example, there is a huge gulf between article and citations rates shown here in *Radiography*, and those for example in *Clinical*

Radiology and the *British Journal of Radiology*. This gulf can best be demonstrated in terms of 'trend lines' (essentially Impact Factor ratings taken over a longer time period). The trend line for the three radiography journals can be seen in Figure 5. This formula calculates the total citations per year, divided by the total number of articles published per year. A score for each year is then calculated, with the higher scores being more favourable in terms of journal influence. The score obtained can also be equated to an average number of citations per article.

FIGURE 6 TREND LINES PER JOURNAL (1996-2008)



As can be seen in Figure 6, *Radiography* has an increasing trend line with a maximum score of 2.46 (2008), and an average score of 1.15 (1996-2008). *Radiologic Technology* also has an increasing trend, with a maximum score of 2.2

and an average of 1.16. (N.B. Caution should be advised when interpreting 2008 figures as the full year was not complete at the time of checking the data).

However, when comparing the average scores to the radiology journals, a dramatic difference is acknowledged. *Clinical Radiology* (impact factor of 1.429, published monthly) has an average score of 17.66, with the *British Journal of Radiology* having a score of 20.41. These are highly respected impact-factor rated journals which reside within well-established scientific and research disciplines. The impact factor can be calculated as the mean citation rate of all the articles contained in the journal, and is regarded as a quality ranking for journals. However Seglen (1997) cautions against total reliance on impact factors, as they do not necessarily reflect the quality of the articles published, but rather their scientific utility.

The radiography journals, according to the criteria outlined by Seglen (1997), are unlikely to attract a high impact rating. Nevertheless, the aims and scope of the impact factor rated radiology journals has not been appropriate to the content and philosophical approach taken within the published works submitted to the radiography journals. The decision taken to publish within *Radiography* and *Radiologic Technology* is supported.

The author has co-edited two textbooks related to advanced practice, the first with Blackwell Publishing, published in 2005 (*Reporting Trauma Radiographs*), and the second with Elsevier (*Gastrointestinal Tract Imaging: an evidence based practice guide*). The latter publication has been accepted for publication, and is currently in press.

The earlier publication (McConnell, Eyres and Nightingale, 2005) brought together six authors from four different disciplines (radiography, radiology, medical law and psychology), and aimed to provide a core text for radiographers and other health professionals who were embarking upon a new advanced role (reporting of trauma radiographs). The three co-editors were all radiography educators and agreed to write a number of chapters in their specialist areas, with primary editorial responsibility handed over to Julie Nightingale. As well as the introduction and preface, the author wrote the foundation chapter, PW5 (Anatomy, Physiology and Pathology of the Skeletal System).

Since 2005, five separate book reviews have been published related to *Reporting Trauma Radiographs*. These reviews have appeared in the journals of *Radiography*, *Clinical Radiology*, *Synergy – Imaging and Therapy Practice*, *Pediatric Radiology* and *Shadows* (the New Zealand radiography professional journal). Four of the five reviews were very positive (see Table 6), with one review (Bates and Grainger 2007)

showing a balance between positives and negatives. This latter review was undertaken by one of the world's most eminent radiologists (A.J. Grainger), a prominent author of radiology reporting textbooks listed as core texts for radiologist training. Four out of five reviews highlighted the excellent overview of anatomy, physiology and pathology offered in the author's chapter (PW5). They acknowledged this chapter as being well written, well illustrated and valuable for developing new knowledge, working as a reference aid, and as a revision tool. The review by Bates and Grainger (2007), whilst offering specific praise for the author's chapter (PW5), criticised the physical size and quality of reproduction of some of the images in the book. This was a source of concern for the editors as well, who were assured by the publishers that the loss of resolution in the original proofs would be corrected when on print quality paper. Unfortunately for some of the images this was not the case.

As can be seen in Table 6, a number of the reviewers made recommendations that the book was of interest to not only radiographers, but also to radiology trainees, GPs, junior trauma specialists (doctors), emergency nurse practitioners and chiropractors. This demonstrates that there is high potential for the 'message' within the book to be spread widely beyond the boundaries of the base profession.

The second co-edited textbook (*Gastrointestinal Tract Imaging: an evidence based practice guide*) is a collaboration between the author and Robert Law, the first Gastrointestinal Imaging consultant radiographer in the UK, and one of only three radiographers to ever be offered a Fellowship of the Royal College of Radiologists.

TABLE 6 SUMMARY OF 5 REVIEWS FOR "INTERPRETING TRAUMA RADIOGRAPHS", EDITED BY J MCCONNELL, R EYRES AND J NIGHTINGALE, 1ST EDITION, BLACKWELL PUBLISHING, 2005

Review author(s)	Journal	Positive aspects	Negative aspects	Recommendations
Duncan 2005	Shadows (NZ)	1. Fundamental tool for MRTs (radiographers) wanting to improve or refresh their knowledge 2. Sets out what needs to be considered if the profession in NZ is to move into role extension 3. A+P chapter is an excellent overview and refresher for those not having studied recently. 4. Excellent, clear explanatory diagrams 5. Chapters with self-test answers	None	1. Excellent benchbook for MRTs in A+E setting 2. Useful reference for junior trauma specialists or GPs.
Sanford 2006	Synergy	1. Logical in layout and format 2. A+P chapter gives detailed descriptions of bone osteology 3. Radiographic images and clear diagrams used throughout 4. Comprehensive guide to the complex aspects of radiology reporting	Printed image quality of the radiographs, but pathologies can be seen adequately	1. Valid accompaniment for any postgraduate 2. Quick reference guide for anyone working with trauma radiology

Poynter 2007	Radiography	1. Unique among similar texts as aimed at the non-medically qualified health care practitioner (rather than doctors) 2. Interesting and informative opening chapter 3. Good overview of anatomy, osteology and bone pathology 4. Each chapter is well written with many good examples, numerous radiographs, line drawings and tables to illustrate the key points 5. Book offers excellent value for money	None	1. Recommend this book to any postgraduate radiography student undertaking a skeletal reporting course 2. It will also be of interest to medical practitioners, emergency nurse practitioners or chiropractors.
Hassan 2007	Pediatric Radiology	1. A bold work, and an original one 2. Specific anatomical and pathological patterns of injury are discussed and illustrated extensively... 3. Underlines that the traditional boundaries between different professional groups are no longer appropriate in the setting of 21st-century health care. 4. An invaluable companion for those who come around to this "new" concept [of skills mix]	A little repetition in Section 2. Some chapters in this section are a little lightweight and would benefit from correlation with CT findings. Books title is not sufficiently representative of the work's aim.	Valuable source for: radiographers; medical practitioners / casualty officers; physiotherapists; specialist registrars in radiology (especially section 1). Overall grade: Good
Bates and Grainger 2007	Clinical Radiology	1. Excellent chapters on the legal implications, and the anatomy, physiology and pathology of the skeletal system. 2. Anatomy chapter includes informative tables of non traumatic bone pathologies 3. Images supplied with useful self-test questions and answers 4. Line drawings and tables are clear and helpful 5. Overall, a well written and reasonably priced book	Quality of reproduction and small size of many of the radiographs is at best disappointing	1. Difficult to recommend the book on its own due to image quality 2. Raby et al (a competing text) has much better images, but lacks the excellent detail of Section 1 of this text. 3. Therefore for any professional contemplating trauma image interpretation it would be prudent to have access to both texts.

This text book has been submitted as a complete manuscript to the publishers and has now been accepted for publication and is currently in press. As the book is not yet in print there are as yet no independent book reviews. The author is sole author of one chapter (applied anatomy and physiology of the gastrointestinal tract), and is leading a team of overseas authors in the introductory chapter (PW12).

The final book chapter that is submitted as part of the thesis (PW8) is co-authored with Professor Stuart Mackay and Ben Mollo. This chapter was submitted for peer review for publication in a 'Best Papers' book entitled *Education in a Changing Environment*, edited by Eamon O'Doherty. The chapter was the first work that the author has had published outside of the radiography field. The book has not, as yet, been reviewed beyond the editorial team.

2.4.1 SUMMARY COMMENTS

Three book chapters have been submitted as part of this thesis (PW5, PW8 and PW12), and these have been published within two of the author's edited texts, and one independently edited text. All three chapters, whilst related to advanced practice, are different in their focus: PW5 offers a theoretical and practical insight into anatomy for advanced practice; PW8 discusses the role of learning technologies in advanced practice based on development and usability testing of software; and PW12 explores the facilitators and barriers to advanced practice both in the UK and overseas. Only PW5 has received independent reviews, all of them largely positive. PW8 has only recently been published (2008), with PW12 currently accepted for publication and in press.

2.5 ASSESSMENT OF ORIGINALITY OF THE PUBLISHED WORKS

This section demonstrates the originality of the published works by performing both a quantitative and qualitative assessment of similar material in the same field. The main focus will be on the journal articles, as search engines are more readily available. This analysis will be based upon review of key word searches on a range of journal databases. A review of related books will also be undertaken. These analyses demonstrate the relative paucity of material published in this field.

2.5.1 DATABASE SEARCHES OF JOURNAL ARTICLES

The review of originality of journal articles was undertaken via the Science Direct and Synergy databases. The Science Direct search engine (www.sciencedirect.com)/ was selected as an easily searchable database which incorporates many of the radiography and radiology journals. The online search facility of the journal '*Synergy – Imaging and Therapy Practice*', a monthly publication for radiographers in the UK, was accessed separately as this journal is not available on Science Direct. A range of key words were identified which had relevance to the published journal articles, and these were inserted into the search engine one at a time, and then in combination. No year or journal restrictions were used. The full results of the key word searches can be seen in Appendix 4. What quickly became clear was the difficulty in identifying appropriate key words, in the absence of any agreed national or international terminology for this area of practice. This is a consequence of publishing in a 'cutting edge' area of practice, and several of the published works (eg. PW3, 6, 10, 12) are helping to define future semantic classifications.

The published works within this thesis are original as (until 2008) they were the only articles found which addressed UK-wide and international aspects of advanced practice education. In particular, the published works related to gastrointestinal imaging are unique. For example, no other articles have been found, following an extensive search, which chart the development of this new field of radiography (eg. PW3), compare practice in this field to that of other nations (PW6, PW12), or discuss the educational aspects of GI advanced practice (PW8, PW9, PW13). Similarly, PW10 is the only article found which addresses the development of protocols across the advanced practice field, with other articles focusing on only one field of practice or reporting. The following paragraphs outline the findings of the main key word search categories (further analysis in Appendix 4).

'Advanced Practice' category

Searches using 'advanced practice' and 'advanced practitioner' key words identified 412 hits related predominantly to nursing, but when in combination with radiography-specific stems the numbers of hits were significantly reduced. What is very surprising from this set of searches is that PW 3 and 4 appeared only in certain combinations, and PW2 did not appear at all in any of these combinations. PW2 and 3 did not contain key words, resulting in reduced potential to be detected on database searches. These articles would only appear if the search terms are reflected within the article title, which may have influenced download and citation numbers for these articles (see following section). Similar authors appear on several of the search term combinations, with the following authors prolific in this field: Hardy and Snaith in

various combinations; Price with various authors; Brealey in combination with various authors.

'Role Development' Category

Search terms related to 'role development' surprisingly identified none of the published works, whilst many similar articles are listed. This again is a flaw in the article key words, as the author has elected to use the term 'advanced practice' when perhaps other radiography authors had not yet made the transition. In addition to those authors listed previously, Manning appears in various author combinations under these search terms. Most other authors have a single article published under these search terms, with most being discussion pieces. Only two authors appearing under these headings have concentrated their articles on the gastrointestinal field (Law et al, and Booth and Mannion). The latter article was a write up of a dissertation supervised by the thesis author.

'Radiographer Reporting' Category

Similar authors found in the 'advanced practice' searches were returned in Science Direct searches for 'radiographer reporting' (17 hits). Two of the published works (PW3 and 4) appear under 'radiographer reporting' but not 'radiographic reporting', again suggesting that the key words might have been too specific. The Synergy searches also showed a proliferation of articles under the search terms of 'radiographer reporting' (20 relevant hits) and 'radiographic reporting' (an additional 7 relevant hits). Of these articles, five of them were by the thesis author, but these

were additional articles that were purposefully not included within the PhD submission. Analysis of the other Synergy authors highlighted a dominance of the skeletal / plain film reporting field, followed closely by nuclear medicine, GI and breast imaging. Again authors such as Hardy and Snaith feature predominantly in the skeletal reporting field, with authors such as Waugh, Pearson and Hawke authoring professional development articles related to GI Imaging.

'Gastrointestinal Imaging' Category

The third combination of search terms considered terms related to practice in the gastrointestinal imaging field (see Appendix 4), including terms such as 'fluoroscopy' and 'GI radiographer'. Whilst PW9 appeared in several search combinations, these had to be very specific. Law (in combination with other authors) appeared under several search terms, with several different articles. Culpan and Chapman in varying combinations also appeared under several search terms. An interesting finding was that radiologist authors such as Chapman, Desai, and Leslie and Virjee only appeared under searches of 'barium enema radiographer', and not under 'GI radiographer' or 'advanced practice'. This possibly reflects the narrower view of the potential scope of radiographer advanced practice held by some members of the radiology profession.

'Protocols' Category

Search terms related to 'protocols' in radiography flagged up 121 articles that were very specific to an individual protocol, or mentioned protocols only in passing. PW4

and PW10 featured in other protocol-related search combinations. Jones and Manning featured several times (a single article). Out of the 121 initial hits, PW10, and to some extent PW4, were the only articles to focus specifically on what is a protocol, and what it should contain.

A number of authors were identified within the above key word searches as having written more than one article in the same field as the author. These authors are: Hardy and Snaith; Manning; Law; Culpan; Brealey; Price. A brief review of their work is shown in Appendix 5. This review outlined that all of the above authors are seen as complementary to each other within the advanced practice field. Each author has published articles related to a particular area of advanced practice, or has developed particular methodologies related to advanced practice. Each appears to have developed their own niche within this emerging field, and any overlap between their work appears to be generally beneficial in promoting advanced practice, rather than leading to 'territorial disputes'.

2.5.2 AMAZON SEARCH FOR OTHER BOOKS IN THE FIELD

A search of the Amazon books website (www.Amazon.com) was undertaken using search terms related to '*Interpreting Trauma Radiographs*' by McConnell, Eyres and Nightingale (2005). A search of 'radiographer reporting' had ten hits with only two relevant publications – the above text book and a UK policy guide by Paterson et al. Interestingly, a search for the subtly different 'radiographic reporting' had 29 hits. Again the only relevant hits were the McConnell et al text book, three professional

body documents, and a text book entitled '*Radiological Reporting in Clinical Practice*', which was much wider in scope than the McConnell text.

'Trauma reporting' had 282 hits, but most were not relevant to medical imaging. 'X-ray interpretation' had 924 hits. One text that was highlighted in a similar area of practice and in a similar price bracket was a text on lower limb reporting by Karen Sakthivel-Wainford (M+K Publishing, 2006). This was also highlighted in a search for 'Trauma x-ray interpretation', which interestingly did not feature the author's text book! This text had some value to radiography practitioners but the image quality and layout was generally poor, with insufficient background detail for postgraduate radiographers.

Other books which are known to be in the same field are, like Sakthivel-Wainford (2006) and Raby et al (2005), of insufficient background detail for the postgraduate radiographer audience (often aimed at emergency nurse practitioners and casualty officers), or are generally large and multiple volume, expensive core texts for radiologists. A book by Helms (2004), which is often recommended on postgraduate radiography courses, has a number of flaws including lack of detail for postgraduates and poor image size. Whilst the author's text suffered some similar problems with image quality, the text is clearly unique in this market. This was also backed up by the book reviews, with one author (Hassan, 2007) stating that PW5 was indeed "an original work". PW5 was the first book to address the educational needs of the reporting radiographer, going into much greater depth of underpinning knowledge and theory than other texts.

Similarly, the new text book which has been accepted for publication by Elsevier (Nightingale and Law, 2008), is original and unique. No other gastrointestinal imaging texts aimed at radiographers and advanced practitioners have been found in detailed database searches. It is the first text book to be aimed primarily at radiographers and other non-medically qualified practitioners engaged in GI practice, although it may find a secondary audience with medical trainees specialising in radiology, surgery or gastroenterology. The editorship of this book brings together twenty-two authors with a wealth of experience across eight different professions, including surgery, radiography, radiology, radiotherapy, speech therapy, gastroenterology, oncology and pathology. It also seeks an international perspective by working with authors from the USA and Australia. This multi-professional and international perspective on the role of gastrointestinal imaging within the patient pathway will assist practitioners and clinicians to develop a much wider knowledge and understanding of their own role, and the evidence base on which their practice is underpinned. The approach of this text book mirrors the drive for more effective skills mix and multi-disciplinary team working within the modern health service, unlike many additional texts which have a tendency towards a single disciplinary approach (eg. GI surgery, GI radiology etc). Whilst the author has written two of the chapters, only one chapter is presented within the thesis. PW12, co-authored with Myke Kudlas (USA) and Liza Ricote (Australia), is entitled 'Evolving practice and shifting boundaries in gastrointestinal tract imaging'. As the title implies, this chapter charts the historical development of GI radiology, both in terms of technological advances as well as changes in manpower and skills mix. Whilst the primary focus is on the barriers and facilitators to the development of UK advanced practice, it is contrasted with the changing professional landscape seen in the USA, Australia and New Zealand. This chapter is the first

published work to explore gastrointestinal advanced practice in Australasia, and builds on a previous article which explores advanced practice in the USA (PW6).

2.5.3 SUMMARY

It is clear from the preceding reviews that whilst a number of other book and article authors are writing within a similar field, all have adopted slightly different approaches. The published works are largely focused within a niche area: the developing scope of advanced practice and the underpinning education required to support it. Many of the published works have been the first to be published within this field (PW1, PW2, PW3, PW4, PW6, PW9, PW10, PW12) potentially influencing the direction of this branch of the profession ahead of other authors. The published works have been focused to the identification of barriers and facilitators, development of protocols for safe and effective practice, comparisons of UK practice to other countries, and a focus on the development and establishment of Gastrointestinal Imaging as a new radiographer specialty. The focus on educational elements of advanced practice and the development of the GI specialty has resulted in the work being considered distinctive and original.

2.6 COMMENTS ON THE SUBSTANTIVE CONTENT OF THE WORK

The following section outlines the themes and concepts that emerge within the published works. It demonstrates the potential influence of the published works on the development of advanced roles and the associated culture change within the radiography profession. The emerging themes will be explored under the headings for each substantive (discipline specific) research aim.

2.6.1 AIM 1

Analyse critically published literature related to the nature of radiography advanced practice, establish how it differs from standard practice, and determine the factors related to its successful introduction and dissemination.

The phenomenon of UK radiographer role development began in the 1970s, with a wider expansion to the scope of practice of radiographers emerging in the early 1990s (Price, 2006). Many of these developments resulted in the practitioner engaging in what could be termed extended roles (see Chapter 1.1.2 for a definition of terms). It was not until 2003 that the term 'advanced practice' was adopted, associated with the new career structure (Department of Health, 2003). Radiographers engaging in advanced roles potentially slotted in to three tiers of practice (practitioner, advanced practitioner and consultant practitioner), and this opened up a debate regarding the explicit requirements for each level of practice. For

example, is someone who is undertaking several extended roles necessarily working at an advanced or consultant practice level?

Whilst advanced and consultant practice had already been defined by the Department of Health (2003) in general terms, a thorough literature search identified that PW2 was the first review article to explore the concepts of clinical practice at an advanced level, and argue the subtle differences between advanced practice and role development. It pioneered the concept of a service development role for advanced practice – based on the fact that the rigorous audit of practice following delegation of roles may result in revised and improved departmental standards. When coupled with published evidence, this is pivotal in driving the standards of the whole profession. Hardy et al (2008), in an article discussing international perspectives of advanced practice, also argue that advanced practice roles, particularly where professional boundaries converge or intersect, are an essential ingredient in developing new models of care to meet future service needs.

PW2 was also the first to highlight the fluid nature of advanced roles – that the introduction of an advanced role is not a 'one-off' exercise, but is embraced within a constantly changing environment. For example, it questioned whether an extended role might in time become a normal expectation of professional practice. Roles such as intravenous injections and red dot commenting are recent examples of the fluidity of advanced roles, with their smooth transition from extended role into normal practice occurring within a relatively short time frame.

Fournier (2000), commenting on the 'un-making' of the health and social care professions, argued that professional boundaries are able to shift smoothly without damage to the profession as they are malleable, expandable and self-constituted. As boundaries between the professions blur, new ones are created, for example between radiologists and other clinicians such as surgeons and heart and chest specialists, between radiographers and other professions including nursing and physiotherapy, and between the four different radiography career grades. The latter phenomenon, first suggested in PW2, is currently being explored in a 2008 project commissioned by the College of Radiographers, looking at the new career structure and its effects on career progression.

PW3 also developed the theme of shifting boundaries, suggesting that as roles are delegated by one professional group to another, reduced exposure to practice will lead to a change in the baseline skills of the delegating profession. The 'expert' will shift from one profession to another, and radiographers must be prepared to shoulder this increased expectation. Halligan (2002), in an editorial regarding sub-specialty radiology, had warned radiologists to "*Be afraid, be very afraid*", when highlighting that a general radiologist accused of negligence would probably be confronted with a sub-specialist radiology expert witness in court. PW3 asked whether a general radiographer undertaking limited advanced sessions per week might be similarly judged by a 'specialist' expert radiographer. It also questioned whether, once the 'expert' has transferred from one profession to another, the expert witness of the future for radiologists could be a GI radiographer. The potential nuances of this debate are discussed further by Buttress and Marandon (2008), who attempt to

identify where the boundaries of legal responsibility lies within advanced practice, based upon wide-ranging case law.

Although other authors such as Mannion et al (1995), Loughran (1994) and Culpan et al (2002) had pioneered extended roles by publishing the results of small pilot studies (based on the performance of only two or three radiographers in very discrete areas of practice), it is surprising that a decade later there is still little empirical evidence available (based on larger studies) that can be generalised to the wider radiographic community. For many individual advanced roles that have been accepted into modern radiography practice (e.g. radiographer-managed small bowel studies, barium swallows, sigmoidoscopy and colonoscopy), currently no published empirical evidence is available, although several authors are making some moves to address this deficiency (e.g. Judson and Nightingale, 2009). The empirical evidence that is available is often focused to demonstrating that radiographers can perform and interpret at a high level in one individual examination (e.g. Law et al, 2002), rather than being concerned about the wider role of the advanced practitioner. PW3 was the first article to offer an in-depth discussion related to the potential impact of advanced practice within a wider arena (Gastrointestinal Imaging). This article built on PW2, documenting the specific drivers for change culminating in the development of an emerging speciality in radiography. Following a wide literature search it is evident that this article (along with its precursor Nightingale and Hogg, 2000) was the first to identify and define this new radiographic speciality, presenting an overview of current practice, and speculating upon potential new tasks that could be done in the future. PW3 contended that the commonly used term 'barium enema radiographer' to

describe a radiographer engaged in GI practice was inevitably self-limiting, arguing for a cultural shift towards the term 'GI radiographer'.

PW3 also introduced new concepts which were to be further developed in a subsequent professional journal article (Nightingale, 2004). This included the notion of a 'tiered' or hierarchical system of reporting. With reference to the clinical recommendation for double reporting of some complex procedures, the article contended that a radiographer contributing to a double reporting system should not in any way be treated as of less importance (in terms of financial, grading and career prospects) than someone who is independently reporting less complex examinations. Following the publication of PW3 and Nightingale (2004), the author was frequently contacted for advice in appeals against Agenda for Change career grading (Department of Health, 2004).

PW2 and 3 defined the scope of practice of advanced practice radiographers in a specific field, and attempted to outline the drivers for change as well as the potential barriers which restrict the dissemination of such roles across the UK. The drivers and barriers may differ from one branch of the profession to another. Over the last five years, as advanced practice has become embedded within the profession, a clearer picture has emerged with respect to the barriers and drivers for change, though this is mostly based upon speculation and opinion. Although there is a reasonable amount of empirical evidence to demonstrate the successful dissemination of advanced roles, certainly within the UK (Price and le Masurier, 2007; University of Hertfordshire, 2008), there is almost no published work available to identify and

investigate areas where advanced practice has not been embraced. This begs the question, is all advanced practice positive, or are the negative aspects being under-reported? Whilst many potential barriers to advanced practice have undoubtedly been overcome, it is clear that the introduction of consultant radiographer roles is not without problems. The author was invited to contribute to a paper on the facilitators and barriers for consultant practice (PW11). This enabled information from the previous articles to be brought forward and updated, and opened up a new area of debate regarding the reasons why there are still at present only thirty one radiographers in the UK who have reached consultant status (Kelly et al, 2008).

PW12 also presents a contemporary analysis of the factors which have driven change – identifying that the drivers for change in one examination within a specialty will not necessarily be the same for another. Whilst other research reports (University of Hertfordshire, 2008; Price and Le Masurier, 2007) have noted this differential uptake of extended roles within the GI field, PW12 is the first work to attempt to explain the variation in the success of skills mix by the application of objective criteria. PW12 also argues that the skills mix debate is constantly shifting, and warns of a potential backlash against radiographer advanced practice by sub-sections of the radiology profession. With more radiologists in training (potentially reducing workloads), the perceived drivers have changed, thus potentially altering the dynamics of the skills mix environment.

2.6.2 AIM 2

Evaluate critically published literature to determine the extent of, and reasons for, any variation in the scope of practice of radiographers working in the UK and in other international health care systems.

In PW2 (2003) we noted that the training for certain advanced practices (such as ultrasound) was being supported by workforce development confederations (precursor of Strategic Health Authorities) in the form of annual training commissions, yet education for other role developments had to be paid for out of a stretched radiology department budget. Whilst lack of funding could be a potential barrier to advanced practice, PW3 highlighted that Gastrointestinal Imaging was a rapidly expanding area of advanced practice, yet this field was not supported on a national level by commissioned training. So why was the GI field so ripe for change?

PW3 outlined the specific drivers for change in GI Imaging, which included extremely long waiting lists for some procedures, the advent of waiting time initiatives, and the relative lack of interest in traditional fluoroscopic procedures by the radiology profession. In contrast, highly technological modalities such as Computed Tomography (CT) and Magnetic Resonance Imaging (MRI) at that time offered very little opportunity for radiographer advanced practice, with the exception of performing intravenous injections (Price et al, 2002). This may have been as a result of a perceived lack of need for change, or because radiologists did not wish to relinquish their workload in such cutting-edge technology – indeed Price (2006) as part of a

PhD thesis, identified following interviews with eleven radiology managers that, at local level, radiologists were the key drivers in enabling radiographer role extension. Exploration of the reasons for some GI practices to be readily handed over to radiographers, whilst others appeared to be 'jealously guarded' by the radiology profession were addressed in PW12. However PW12, concurring with Price (2006), also noted that the introduction of new technology and software has increased the potential for new role developments, but this time crossing modality boundaries from fluoroscopy to CT and MRI. The author provoked a new debate within the profession, regarding which practitioners (GI or cross-sectional imaging specialists) are best-placed to manage gastrointestinal investigations based within cross-sectional imaging modalities. This led to an invitation to write an editorial on this subject, entitled 'The GI radiographer: fluoroscopist or a multi-modality specialist?' (Nightingale, 2008).

As advanced practice became firmly established within the UK, the author's interest turned to other English-speaking countries (whose radiography training was most closely aligned with our own), exploring the reasons why advanced practice had not yet gained a firm foothold overseas. Buchan and Dal Poz (2002), on behalf of the World Health Organisation, conducted a systematic review of the determinants of skill mix in the health care professions, identifying: skill shortages; cost containment; the need for quality improvement; technological innovation; new medical interventions; new health sector programmes; health sector reform; and changes to the legislative regulatory environment (Buchan and Dal Poz, 2002). Whilst a number of limitations are evident in this study, including potential publication bias and problems with the use of appropriate keywords when there is no standardisation of terminology (as

noted earlier in this thesis), nevertheless the catalysts appear to be mirrored within UK radiology environment, as identified within PW3 and PW4 (2003). However Cowling (2008), representing the International Society of Radiographers and Radiologic Technologists, argued that the countries which had progressed further along the role development continuum were those with a longer history of formal radiographer education and professional recognition through regulation. Cowling stated that the UK and the USA are at the forefront of role advancement, although it can be argued that there are a number of fundamental differences between the two country's approaches.

Following an invited presentation on GI advanced practice at the American Society of Radiologic Technologists conference in 2004, the thesis author took a much closer interest in the reasons for the restricted professional boundaries seen within America at that time. Subsequent research resulted in PW6, a co-authored publication in an American peer-reviewed journal, offering an insight into UK practice and identifying critical differences between UK and USA practice. For example, advanced practice radiographers in America (known as Radiologist's Assistants and Radiology Practitioner Assistants) were permitted by the relevant professional bodies to perform GI procedures, but were barred from reporting them. The spread of advanced practice across the USA was also hindered by the fact that each state has differing views on the permitted scope of practice of Radiologist Assistants, unlike the UK which works with a nationally agreed framework of laws and guidelines. However, since publishing PW6, significant advances have been made towards unifying the education, assessment, scope of practice and licensing of Radiologist's Assistants in

the USA, assuring their longer-term acceptance as a viable solution to skills shortages (May et al, 2008).

The variations in the scope of practice of UK radiographers and those of other English-speaking countries was further explored along with two international co-authors, comparing UK practice with the USA and Canada, and with Australia and New Zealand (PW12). The latter three countries are considered by Cowling (2008) to be 'second level' on the role advancement continuum, noting that the same drivers for change are in place but no significant implementation has occurred. Whilst the USA has made some initial moves towards establishing advanced practice, Australia and New Zealand are keen to follow. Based upon the research undertaken for PW12, the fee-per-report model is likely to be the most influential factor to hold back advanced practice within Australasia. This model has the potential to discourage radiologists from delegating certain tasks to radiographers as they are likely to reduce their income in the process. In the UK radiologists are paid a similar salary regardless of which profession issues the definitive report. Following separate professional body reports on radiographer advanced practice issued in 2006 (Smith et al, 2008), the Royal Australian and New Zealand College of Radiologists (RANZCR) and the Australian Institute of Radiography (AIR) are continuing to develop a framework for advanced practice, based partly on the UK model (the author is an international advisor for this project). Whilst the two professional body views are divergent in some aspects, they have nevertheless agreed to formalise and legitimise existing extended roles, with continuing education being paramount to the development of future roles (Smith et al, 2008). RANZCR have recently shown a keen interest in adopting a UK-written standards document related to the new

practice of CT Colonography. The document 'CT Colonography Standards for Europe, Australasia and Canada' is written by the author alongside a small team of radiologists and radiographers, and is currently open for consultation of various professional groups within these geographical areas (The Royal College of Radiologists, 2009 *under consultation*).

Within the European arena, the UK is unquestionably the leader in radiographer role development (Cowling 2008). The Scandinavian countries, for example, are relatively wealthy countries with a small population, possessing few of the drivers for change (such as a shortage of radiologists) as seen in the UK. George (2006), in a keynote presentation as president of the ISRRT, also demonstrated a large variation in the scope of practice across Europe, as well as a lack of agreement in what different countries acknowledge as advanced practice.

Whilst some moves towards defining the concepts and philosophy of advanced practice have been made simultaneously in many countries, with the UK arguably leading the field, Hardy et al (2008), commented that 'international collaboration in advanced practice has been minimal'. However it is reasonable to disagree with this statement, as several articles, all of a discussion or literature review nature, have been published recently related to the international perspective of advanced practice (May et al, 2008; Cowling, 2008; Hardy et al, 2008; Smith et al, 2008; Nightingale and Hogg, 2007 (PW7)). Whilst many of these articles have strengths in terms of multi-national co-authorship, some, by their own admission, rely upon anecdotal information to develop their debate in the absence of empirical research (Cowling,

2008). Nevertheless the proliferation of these discussion articles suggests that the international community is keen to share ideas, and indeed ideals, related to advanced practice.

2.6.3 AIM 3

Analyse critically the changing nature of knowledge required for safe and effective advanced radiography practice, and explore the influence of education on its' origin and evolution

As professional boundaries shift, the specialist knowledge and expertise required within the profession also changes. It is incumbent upon the profession, higher education and the individual to identify the new required knowledge and facilitate its acquisition. In the 1990s new roles were being introduced into clinical practice, often at a rapid rate, and the formal knowledge brokers were playing 'catch up'. According to Price and Edwards (2008), this is consistent with the observation of Moses and Mosteller (1985), identifying changes in the curricula as the last piece of the jigsaw in responding to changes in technology. With this in mind, the professional body produced guidance to assist higher education institutions to become more market-aware, facilitating education to drive advanced practice (The College of Radiographers, 2003a and b).

Early extended role developments were often introduced following in-house clinical training, sometimes supported by a short course of academic lectures. During the mid 1990s the first postgraduate programmes were introduced, but the first cohorts of students had not had the benefit of studying for an undergraduate degree. For this reason the author felt it was appropriate and timely to investigate the student experience, then, as now, an important research topic. PW1 explored the nature of radiography postgraduate study, and identified through phenomenological enquiry the sources of stress which such students encountered. Whilst previous literature had focused on academic stress associated with undergraduate or full time postgraduate programmes, none had identified and explored the unique situation in which part time postgraduate students found themselves. Significant stress was associated not only with academic study, but with 'spill-over' from home and work life, not surprising as the participants were mature students with families and responsible work positions. However the range of coping methods identified was illuminating, as was the tremendous increase in confidence and motivation towards the latter parts of their course. The findings of this study, having been externally reviewed by Ng & White (2005) as a sound example of phenomenological enquiry, have the potential to inform educational and hospital-based practice. They are strongly supportive of the benefits of postgraduate education for advanced practice radiographers, echoed by the College of Radiographers (2003a) who emphasised that Masters Level study was appropriate for this level of practice.

PW3 also challenged the trend of radiographers undertaking extended roles following in-house training rather than a formal education route. The lack of formal education had several potential consequences: lack of transferability between hospitals;

inequity between GI radiographers and other specialities where postgraduate education was the norm; potentially a barrier to becoming an advanced or consultant practitioner. PW3 encouraged radiographers to see postgraduate study as an essential component of advanced practice, as it attempted to embed an evidence-based culture into clinical practice.

The College of Radiographers also identified a role for both formal and 'on the job' education, outlining that in order to practice at an advanced level, the individual must have:

> ...acquired knowledge, training and experience, and a range of skills additional to that required for registration. These should include enhanced/advanced analytical, judgement, planning, organisational and patient care skills. They should also be able to communicate information that may be highly complex, sensitive or contentious.
> The College of Radiographers (2003a) p14

However one of the difficulties that those training to acquire the above knowledge and skills have faced is a lack of suitable educational materials. Books were often written with the expert radiologist in mind, and were too complex, too diverse, or too expensive (eg.Taylor and Resnick, 2000; Adam et al, 2008). Similarly books written for radiographers were often too shallow for a practitioner moving into advanced and consultant practice (eg. Raby et al, 2005; Sakthivel-Wainford, 2006). For this reason the author collaborated with other expert academics, practitioners and clinicians to edit and author two textbooks, one focused to '*Reporting Trauma Radiographs*' (PW5), and one to '*Gastrointestinal Tract Imaging: An Evidence Based Practice*

Guide' (PW12) (accepted for publication). In both of these books the author designed detailed chapters on applied anatomy and physiology, which have been acknowledged for their particular usefulness within several book reviews in the UK and overseas. These chapters take the knowledge and application of anatomy, physiology and patho-physiology to a higher level than would have been required within initial qualification. PW5, with a target audience of radiographers engaged in trauma reporting or in training for this role, has also been recommended within several book reviews as a valuable resource for a multi-professional audience, including casualty officers, radiology registrars, physiotherapists and trauma nurses. Since its publication in 2005, PW5 is likely to be adopted also within undergraduate radiography curricula, following the recent professional body steer towards inclusion of 'radiographer-commenting' pre-registration (The College of Radiographers, 2006). Again this is another example of role boundaries shifting and the baseline skills threshold raising.

PW12, currently in press, has been the result of a collaborative venture with Robert Law, a consultant GI radiographer, and honorary fellow of the Royal College of Radiologists. The author identified that there were no suitable books to recommend to either undergraduate or postgraduate radiographers on the subject of GI Imaging practice. PW12 offers a complete guide to the GI Imaging field, not only for radiographers, but also for clinicians training in the radiology, surgical and gastroenterology specialties, as well as specialist nurses. The style of the book has been written to accommodate information about the whole patient pathway, from the initial clinical examination, through imaging, endoscopic and pathology tests, to the various treatment options available. This truly multi-professional venture is reflecting

the changing knowledge required to work effectively across practice boundaries, and is a direct attempt to convey the '*enhanced/advanced analytical, judgement, planning, organisational and patient care skills'* required of an advanced practitioner (College of Radiographers, 2003a). The textbook is currently in press, so PW12 offers a preface, a table of contents, and one complete chapter from the book.

Whilst core text books and reference works are an important part of clinical training, peer reviewed and professional journal articles also have a vital part to play in encouraging evidence-informed practice and maintaining radiographer continuing professional development (CPD). A number of gaps in knowledge, caused by the rapidly changing professional boundaries, have been identified by the author in collaboration with GIRSIG (GI Radiographers Special interest Group) via member questionnaires. These gaps have included lack of sufficient knowledge of pathology, patient pathways, and the roles of other professions, and several of the published works attempt to address the deficiencies in knowledge. PW7, for example, uses a clinical case study as a vehicle to explore the potential link between breast cancer and colon cancer. This article was of importance to both GI and breast imaging radiographers, as if a link was proven, breast cancer patients would require more frequent bowel surveillance.

Gaps in underpinning anatomical, physiological and image interpretation skills were also evident following analysis of formative assessments of new postgraduate cohorts. Following the publication of PW5 in 2005, the author was invited to co-author a series of advanced practice CPD articles in a professional body journal (see CV).

PW13 is one such example, identifying the important role that radiographers can play in the investigation of dysphagia (difficulty in swallowing). This article was co-authored by Roger Newman, an experienced speech and language therapist, and this collaboration expounded the benefits of multi-professional team working – essential for practice at an advanced level. PW13 articulates the contemporary blurring of role boundaries with clear benefits for the patients, and whilst not a peer reviewed article, it nevertheless has attracted much interest and correspondence since its recent publication in January 2009. Most notable of the correspondents was the Chief Executive Officer of the Society and College of Radiographers, Richard Evans, who requested permission to send the article to the Chief Health Professions Officers in the four countries of the UK. In his email (Appendix 6), Richard stated that the article:

> ...refers to an excellent example of a model where AHPs [Allied Health Professions] of two separate disciplines collaborate to provide a clinical service without the requirement for routine involvement of medical personnel. This results in more timely and expertly delivered care...The development of professional roles amongst AHPs has progressed in the UK to the extent that innovations in practice [such as this] are accepted as of international importance. (Richard Evans, pers comm. 2009)

Whilst this practitioner CPD article (PW13) was not published within a peer reviewed forum, it is clear that, if well written and well researched, such articles have great potential to not only influence practice, but also to have an impact upon national (and international) policy.

A number of professional body publications have advised radiographers to work within agreed protocols for clinical practice (The College of Radiographers, 2006,

2007). However they offer little information regarding what constitutes a satisfactory protocol, and how it could contribute effectively to the medico-legal protection of the radiographer, delegating radiologist, and the patient. PW3 cautioned against the use of restrictive or overly-prescriptive protocols, often employed during the early stages of role development. This article outlined the benefits and potential dangers of a restrictive protocol, essentially placing the radiographer into a 'clinical straight jacket' with little or no professional autonomy. In medico-legal terms these can either deny patients the benefits of adaptation of practice, or where a radiographer does stray outside the protocol for the benefit of their patients, they could be open to potential litigation or disciplinary action. The concept of medico-legal issues and reporting errors was explored further in a subsequent article not part of this PhD thesis (Nightingale, 2004).

In 2004 the author was co-contributor to an article (PW4) which was the first within radiography publications to focus in depth on the subject of protocols, offering a critical analysis of a single protocol. This article highlighted the potential difficulties when there are no national standards against which to audit practice. PW4 defined what is meant by a protocol, and stated its medico-legal purpose, but it identified that 'there is limited literature readily available to guide how protocols are developed and managed'. PW10, a single authored article, subsequently filled this gap. PW10 took a much wider and more informed discussion based on newer available literature. It introduced a methodology for creating an evidence-informed protocol, which practitioners could adapt to their own needs. The author has used it extensively in a number of postgraduate programmes to assist postgraduate students who are in the process of developing their own protocols for clinical practice, and it is also used on

the undergraduate radiography programme to inform the advanced practitioners of the future. The contemporary and influential nature of the article was supported by the comments from the peer-review team, who accepted it with almost no revisions, having the fastest turnaround time from initial submission to acceptance for that journal (Hogg, Pers comm., 2008). Subsequent to the writing of PW10, the author has been involved in protocol development at an international level, defining standards and recommendations for the practice of CT Colonography in Europe, Australasia and Canada. The standards development team consists of four eminent radiologists and two expert radiographers selected by the two professional bodies. The document is currently in its consultation phase and is scheduled for publication in mid 2009 (The Royal College of Radiologists, 2009).

Whilst the majority of the published works have involved traditional publishing media such as books and journal articles, the author is also aware that more innovative methods of learning are available to us now. PW8 was the culmination of a project to develop an online learning package for radiographers training to report GI images. This package enabled radiographers to test their pattern recognition, image interpretation and report writing skills whilst remote from the university, and to undertake peer and tutor review of their reporting practice. This innovative formative assessment enabled students to be supported to develop their own report writing style based on comparisons of 'best practice', rather than feel they had to follow the colloquial example set by their clinical mentor. The development of the learning package was presented in a report to an international conference in 2007 and has now been published as a book chapter (PW8).

Innovative assessment practices have also been a feature of the author's academic and research interests. The potential value of portfolios in supporting advanced practice development was a particularly interesting aspect of research. Following several successful deliveries of a postgraduate module, training radiographers and speech and language therapists to undertake assessments of swallowing function and anatomy, an analysis of their assessment portfolios was undertaken. No research has previously been published to demonstrate the effectiveness of practitioners in this role, and PW9 was able to demonstrate that practitioners undertaking training within this field introduce a wide range of practice changes for the benefit of their patients. PW9 was also an example of how higher education is now more market-aware. As the only course for radiographers and speech therapists to train to perform barium swallows, it is clearly driving forward this new role into clinical practice. Having delivered the findings of this research at an international peer-reviewed conference, and subsequently published PW9, the author was approached by the President of the Irish Institute of Radiographers and Radiation Therapists to deliver a similar course in Ireland (scheduled for summer 2009).

Following a systematic review of evidence to support the introduction of extended roles for a range of allied health professionals, McPherson et al (2006) identified that there was little evidence as to '...how best to introduce such roles, or how best to educate, support and mentor these practitioners.' Collectively the publications presented within this thesis have attempted to address McPherson's concerns, identifying the gaps in knowledge and offering innovative educational solutions to support established and trainee advanced practitioners. They have contributed to the

setting of a new baseline for required professional knowledge, which is likely to continue to shift as the boundaries for practice expand.

PART 3 - CONCLUSION

A total of thirteen published works have been offered within this thesis as evidence of a sustained research and scholarship portfolio over the last decade. Whilst the total body of work by the author numbered over thirty five, the thirteen works were selected to represent the range and scope of the author's work within the radiography advanced practice theme, and include peer reviewed articles, books and book chapters, and professional journal articles.

Scrutiny of the published works via citation analysis, downloads and book reviews has demonstrated the utility of the works for the target audience. Whilst citation rates are low for some articles, research has indicated this is not a particularly useful measure within an emerging, niche field of study. Nevertheless the citation rates for several articles have been shown to be higher than the average rates for the journals in which they are published. Download figures have shown the continuing popularity of the articles, with figures remaining high several years after publication. Book reviews in a range of journals have been largely positive, and give excellent feedback for any future planned editions.

An assessment of the originality of the published works was undertaken by various key word searches to identify other authors publishing within the same field. Further review demonstrates that these authors can be seen as complementary to the author's published works, rather than competing or overlapping. The published works

have a number of areas of originality, with several being considered unique in their approach. A range of methodologies have been used throughout the published works, with some of these methods also being original or innovative because of their use within the radiography field.

Three 'discipline specific' research aims were identified within the early stages of development of this thesis. A number of works published over several years addressed each aim, enabling a series of concepts to emerge, which have the potential to form the basis of further exploration. In summary, the main concepts that emerged include:

3.1.1 DRIVERS AND BARRIERS TO ADVANCED PRACTICE IMPLEMENTATION

- The successful dissemination of advanced practice is facilitated by a number of drivers, and is held back by perceived or actual barriers
- Drivers for change in one specialty (and one examination) will be different to those seen in another
- The barriers to change can be lifted or further enforced over time, dependent upon the political and professional landscape
- Colloquial radiographer job titles can serve to either inhibit, or promote expansion of practice
- Whilst many barriers to advanced practice have been overcome, significant barriers exist in the development of consultant roles.

3.1.2 CONSEQUENCES OF ADVANCED PRACTICE

- There is a distinction between role development, extended role and advanced practice, although these terms are often used interchangeably
- An extended role can become part of 'normal' practice over time

- Individual advanced roles, grouped together within a theme, can define a new specialty of radiography practice
- Introduction of advanced roles may result in service improvements due to increased audit requirements, and may drive up professional standards
- As roles are delegated, the 'expert' can shift from one profession to another
- Double reporting, if recommended due to the complexity of the examination, should be considered equal in terms of status, to independent reporting.
- Boundaries are blurring between different professions, but may also begin to blur within the profession (between different tiers of practice)

3.1.3 DISSEMINATION OF ADVANCED PRACTICE WITHIN THE UK

- Role advancement is not universally embraced within all areas of the radiology department – highly technological modalities show relatively fewer role development opportunities than less complex modalities
- Tension may occur between established radiographic specialties when new technologies and new procedures emerge
- Whilst regional / national funding may have driven forwards some advanced practice initiatives, there is no evidence to suggest that absence of national funding is a barrier

3.1.4 DISSEMINATION OF ADVANCED PRACTICE OVERSEAS

- The UK is a world leader in advanced practice, with the USA making rapid headway towards this goal
- By contrast, European countries have few aspirations for advanced practice, and consider some of the UK traditional scope of practice to constitute advanced roles
- The 'fee per report' model is the single most important factor hindering role advancement in countries with a mixed public / private health care system
- A national steer for advanced practice is vital to its success, as has been seen within the UK, USA and more recently in Australia

3.1.5 THE INFLUENCE OF EDUCATION ON ADVANCED PRACTICE

- As professional boundaries shift, the required knowledge base also changes
- Historically education has responded to changes in clinical practice ('catch-up') but more recently the provision of suitable education has helped to drive clinical practice developments
- Radiographers are required to work within agreed advanced practice protocols, but overly restrictive protocols can deny patients appropriate care and may not protect the radiographer appropriately
- Radiographers undertaking advanced roles should be encouraged to attend formal postgraduate programmes of study where available
- Postgraduate part time study, whilst having the potential to increase confidence and career motivation, carries with it a potential for experiencing a high degree of stress
- In-house training can reduce potential employability and can have a negative impact in the status of the individual and specialism

3.1.6 THE KNOWLEDGE BASE, TEACHING, LEARNING AND ASSESSMENT FOR ADVANCED PRACTICE

- Individuals undertaking extended or advanced professional roles require new knowledge that is often not easily found within existing textbooks
- Gaps in the knowledge base of advanced practitioners include pathology, patient pathways, and the roles of other professions
- Different publishing media (books, articles and e-learning packages) all have a role to play in the education and continuing professional development of radiographers
- Peer review can have a valuable role in reducing the potential for inadequate or outdated practice
- Flexible portfolio assessment can encourage practitioners to question local practice and subsequently introduce new practices, thus improving the service

This thesis has demonstrated the influence of the published works on the development of advanced roles and the associated culture change within the radiography profession. It is clear that the concept of advanced practice has now

been embraced within the UK radiography workforce, and the benefits are being realised across a range of radiography specialties. Nevertheless, there are still some areas of the radiology department in which advanced practice has yet to gain a foothold, and more published evidence is needed to support practitioners who wish to develop their roles in these areas. Whilst some strides have been made towards introducing radiography advanced practice into other countries, with the exception of the USA, this development is still in its infancy. Within the UK the introduction of the Consultant Practitioner role has been rather measured in comparison to the Advanced Practitioner, with only thirty one consultants in post in late 2008. The importance of reliable evidence for the success (or otherwise) of these roles is essential if this top tier of clinical practice is to benefit patient care in hospitals around the country.

The published works presented within this thesis, alongside the work of other authors publishing in the same field, have gone some way to define and explain the concept of radiography advanced practice. By stating that the modern scope of radiographer practice is 'that which the radiographer is educated and competent to perform', The Society and College of Radiographers (2009) is making it clear that it sees no boundaries to the practice of a radiographer. Whilst this wholehearted support from the professional body for advanced and consultant practice is very welcome, nevertheless, the findings of McPherson et al (2006), following a wide-ranging systematic review, should be heeded:

> A range of extended practice roles for allied health professionals have been promoted and are being undertaken, but their health outcomes have rarely been evaluated. There is also little evidence as to how best to

introduce such roles, or how best to educate, support and mentor these practitioners. (p240)

A number of recommendations for future research and future policy are therefore important to ensure radiographers and their patients benefit from advanced, and indeed consultant practice:

1. Formal education is one of the keys to the success of the advanced and consultant practitioner role, and should be promoted within the profession. Masters level study is appropriate for advanced practitioner grades. However flexible on-going portfolio assessment also has a role to play and should be encouraged.

2. Consultant radiographers, and those training for this role, should be supported to gain greater research awareness, and should disseminate evidence of success of their role to the profession. Research partnerships between educators and consultant radiographers could be one way forward to achieving this goal.

3. Radiographers should be encouraged to continue to publish evidence of success in individual advanced roles (often assessed by audit of reporting accuracy, image quality, complications etc), as there is relatively little evidence to support some modern radiography practices. However it is essential that research is undertaken to explore the overall impact of advanced and consultant practice on the quality of patient care – do new pathways for care offer improvements in patient outcomes, patient satisfaction, and patient choice? Such investigations should embrace the wider aspects of the roles beyond expert clinical practice – including individual and collective

contributions to education and training, clinical research, expert resource contributions and team leadership. Further exploration of branches of radiography where higher level practice has not been readily embraced could shed light on the barriers and how they may be overcome.

4. Where new opportunities for advanced practice arise (eg. CT Colonography), work should be undertaken to identify the most appropriate training and skills mix combinations to best serve the interests of the patients. In emerging techniques, the professional body and relevant special interest groups should, where feasible, identify and disseminate best practice and evidence based protocols.

5. Educators and clinical staff have a responsibility to identify gaps in knowledge caused by shifting role boundaries, and should assist in creating new materials where relevant.

6. The UK, with its extensive knowledge of the effectiveness and implementation of Advanced Practice, should work with other countries which have a desire to introduce these roles, to assist them to make a smooth transition.

Following the relatively unique opportunity for personal reflection offered within the PhD by Published Works framework, the author of this thesis has now begun the transition from an academic scholar towards becoming a professional researcher. The next steps along the research career ladder involve greater participation in empirical studies, an increasing contribution to research leadership as principal investigator, an emphasis on seeking funding to support research, and facilitation of the developing research career of others, both as a research supervisor and as an

academic manager. Whilst the thesis contributes to the greater understanding of the nature, form and contribution of advanced practice, the next steps for the author include a greater emphasis on the creation of new knowledge via engagement in quality empirical studies. Increasing institutional expectations in preparation for the next UK Research Evaluation Framework, which is likely to have a heavier emphasis on citation analysis, suggests that publications in the future will need to be targeted to the highest impact factor journals which are ISI Web of Science / Medline indexed. Whilst this thesis has demonstrated the *Radiography* journal to be arguably world-leading in terms of radiography research, the lack of ISI / Medline indexing will potentially be a future barrier for publication for this researcher. However, as a current member of the editorial board of the journal, the thesis author is in a strong position to be able to encourage and support future indexing submissions.

PART 4 – APPENDICES

Total Body of Published Works by J Nightingale

i. Edited Books

McConnell J, Eyres R & **Nightingale J** (2005). *Interpreting Trauma Radiographs.* Oxford: Blackwell Publishing.

Nightingale J & Law R. *Gastrointestinal Tract Imaging: An evidence based practice guide.* Oxford: Churchill Livingstone. *In press.*

ii. Chapters in Books / Professional Body Documents

Nightingale J (2005). Anatomy, Physiology and Pathology of the Skeletal System. In McConnell J, Eyres R & Nightingale J (2005). *Interpreting Trauma Radiographs.* Oxford: Blackwell Publishing

McConnell J & **Nightingale J** (2005). Introduction. In McConnell J, Eyres R & Nightingale J (2005). *Interpreting Trauma Radiographs*. Oxford: Blackwell Publishing.

Nightingale J (2005). Preface. In McConnell J, Eyres R & Nightingale J (2005). *Interpreting Trauma Radiographs*. Oxford: Blackwell Publishing.

Nightingale J, Kudlas M & Ricote L. Evolving practice and shifting boundaries in GI Tract Imaging. In Nightingale J & Law R. *Gastrointestinal Tract Imaging: An evidence based practice guide*. Oxford: Elsevier. *In press.*

Nightingale J. Applied Anatomy and Physiology of the Gastrointestinal Tract. In Nightingale J & Law R. *Gastrointestinal Tract Imaging: An evidence based practice guide*. Oxford: Elsevier. *In press.*

Nightingale J, Mackay S & Mollo B (2008) Enhancing the learning opportunities of part-time postgraduate students using distance learning (p155-172). In O'Doherty E (Ed.) *The Fourth Education in a Changing Environment Conference Book 2007.* Volume 4. Informing Science. ISBN:1932886133, 9781932886139

Royal College of Radiologists (2009). *CT Colonography Standards for Europe, Australasia and Canada*. Currently under consultation. J. Nightingale co-contributor.

iii. Articles in Refereed Journals

Judson E & **Nightingale J** (2009). An evaluation of radiographer performed and interpreted barium swallows and meals. *Clinical Radiology,* 64, 807-814.

Kelly J, Piper K & **Nightingale J** (2008). Factors influencing the development and implementation of advanced and consultant radiographer practice: A review of the literature. *Radiography*, 14 (Supplement 1), e71-e78.

Nightingale J (2008). Developing protocols for advanced practice. *Radiography*, 14 (Supplement 1), e55-e60.

Nightingale J & Mackay S (2009). An analysis of changes in practice introduced during an educational programme for practitioner-led swallowing investigations. *Radiography,*15, 63-69.

Scarles E & **Nightingale J** (2008). Colorectal carcinoma in a patient with prior breast cancer: Is there a causal link? *Radiography*, 14(1), 2-7.

Nightingale J & Hogg P (2007). The role of the GI radiographer: A UK perspective. *Radiologic Technology,* 78(4), 284-290.

Krovak B & **Nightingale J** (2007). Radiation protection of female patients of reproductive age: a survey of policy and practice in Norway. *Radiography*, 13, 35-43.

Owen A, Hogg P & **Nightingale J** (2004). A critical analysis of a locally agreed protocol for clinical practice. *Radiography*, 10(2), 139-144.

Nightingale J & Hogg P (2003). The Gastrointestinal Advanced Practitioner: An Emerging Role for the Modern Radiology Service. *Radiography*, 9(2), 151-160.

Nightingale J &Hogg P (2003). Clinical Practice at an Advanced Level. *Radiography*, 9(1), 77-83.

Innes (nee) J (1998). A qualitative insight into the experiences of postgraduate students: causes of stress and methods of coping. *Radiography*, 4(2), 89-100.

iv. Refereed Conference Proceedings

Nightingale J & Mollo B (2007). Enhancing the learning opportunities of part-time postgraduate students whilst off-campus: periodic self-assessment of image reporting skills using Blackboard. *Proceedings of the Education in a Changing Environment: Meeting the Challenges Conference 2007*, p34, 12-14th September, 2007, Salford, UK

Nightingale J (2007). Role extension in gastroenterology: educational issues. *Proceedings of the United Kingdom Radiological Congress 2007*, p34, Invited review, UKRC, 11-13th June, Manchester.

Nightingale J (2007). The "swallowing disorders" service: changes in practice following practitioner attendance on a postgraduate programme. *Proceedings of the United Kingdom Radiological Congress 2007*, p4, Proffered paper, UKRC, 11th – 13th June, Manchester.

Nightingale J (2004). Multi-Professional Postgraduate Education: Challenges and Solutions, Invited presentation, Superintendent Managers and Radiography Teachers (SMART) Conference, Manchester, December 2004

Nightingale J & Owen A (2004). Advanced Practice in Gastrointestinal Radiology: A UK Perspective, *American Society of Radiologic Technologists Conference Proceedings 2004*, Invited key note presentation, Dallas Texas USA, June 2004

Nightingale J (2002). Radiographer reporting of the gastrointestinal system: Meeting the challenges of the modern NHS, Refereed Conference Invited Speaker, *United Kingdom Radiological Congress 2002 (Abstracts)*, Birmingham, June 2002

v. Articles in Non-refereed Journals / Professional Magazines

Eden J, **Nightingale J** & Meredith A (2009). The emerging role of Capsule Endoscopy in the investigation of small bowel disorders. *Synergy – Imaging and Therapy Practice*, Accepted for publication

Meredith A, **Nightingale J** & Eden J (2009). Retention during Capsule Endoscopy: What are the risks and how can they be minimised? *Synergy – Imaging and Therapy Practice*, Accepted for publication

Nightingale J & Newman R (2009). Practical Reporting: Interpreting swallowing function by videofluoroscopy. *Synergy – Imaging and Therapy Practice*, January 2009, 16-22.

Nightingale J (2008). The GI radiographer: fluoroscopist or a multi-modality specialist? *Synergy News* September 2008. http://synergynews.sor.org/node/491 Accessed 04.03.09

Nightingale J (2008). Embryology of the Gastrointestinal Tract. *Girsig Gazette.* Edition 18, Summer 2008, 10-13.

Martin A & **Nightingale J** (2007). Reporting on: Commonly encountered spine pathology. *Synergy.* Invited article, February 2007, 8-14.

Nightingale J, Martin A & McConnell J (2007). Reporting on: Thoracic and Lumbar spine trauma *Synergy.* Invited article, January 2007, 17-19.

Nightingale J, Martin A & McConnell J (2006). Reporting on: cervical spine trauma. *Synergy.* Invited article, December 2006, 12-17.

Nightingale J (2005). A Guide to Developing Protocols for Radiographer Reporting of Gastrointestinal Examinations. *GIRSIG Gazette*, Spring/Summer edition 2005.

Nightingale J (2003). Reporting Errors and how to avoid them. *Synergy*, February 2003, 16-23.

Nightingale J (2002). Continuing Education: Making the most of your regional meetings. *GIRSIG Gazette*, Spring 2002.

Nightingale J & Hogg P (2000). Gastro-intestinal imaging for radiographers: current practice and future possibilities. *Synergy*, December 2000.

vi. Conference Presentations

Nightingale J (2008). Advanced Roles in Gastrointestinal Imaging. *Annual conference of the Irish Institute of Radiographers and Radiation Therapists. Sligo, Ireland, November 2008.*

Nightingale J (2008). Effective poster design. Research workshop. *GIRSIG Conference - GI Tract Imaging: Present practice, future possibilities*. Bristol, October 2008.

Nightingale J and Booth A (2008). A brief history of radiology time. *GIRSIG Conference - GI Tract Imaging: Present practice, future possibilities*. Bristol, October 2008.

Nightingale J (2008). Approaches to evaluation of advanced clinical roles. *Irish Institute of Radiographers Advanced and Consultant Practice study day*, Dublin, Ireland, March 2008.

Nightingale J (2008). Advanced clinical roles explored: Gastrointestinal and Trauma Imaging. *Society of Radiographers Advanced and Consultant Practice study day*, Dublin, Ireland, March 2008.

Nightingale J and Fitzgerald G (2006). The specialist GI radiographer: results of a survey to assess progress. Invited presentation. *Advanced Practice in Gastrointestinal Imaging Conference*, November 2006.

Nightingale J (2006). Colorectal cancer screening: should women with breast cancer be offered medium / high-risk bowel cancer surveillance? Proffered poster, *Advanced Practice in Gastrointestinal Imaging Conference*, Blackpool, November 2006. 2nd prize winner.

Nightingale J (2003). Reporting Errors and How to Avoid Them! Invited Presentation, *Yorkshire Branch of the College of Radiographers Study Weekend*, Scarborough, October 2003.

Nightingale J (2003). Applied Anatomy of the Gastrointestinal Tract, *Study Force Radiographers Anatomy Course*, Warrington, February 2003 (Invited presentation).

Nightingale J (2002). Radiographer Reporting of Gastrointestinal Pathology: Advancing practice to meet service needs, Invited Speaker, *Society of Radiographers Annual Conference (Abstracts)*, Llandudno, April 2002.

Nightingale J (2002). Radiographer Reporting of Gastrointestinal Examinations: Reducing Reporting Errors, Invited Keynote Speaker, *GIRSIG National Conference*, Bristol, September 2002.

Nightingale J (2002). Medico-legal and Ethics Workshop, Invited Speaker, *GIRSIG National Conference*, Bristol, September 2002.

Nightingale J (2002). Advances in GI Role Development, *Radiographers CPD Study Session*, Oldham NHS Trust, July 2002.

Nightingale J (2000). Enhancing the Gastro-Intestinal Radiographer's Status: A Proactive Role for Education, Invited Review, *GIRSIG National Conference*, Sept 2000, York.

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Nightingale J & Norton S (2008). Book Review - Karen Sakthivel-Wainford, Self-assessment in Paediatric Musculoskeletal Trauma X-rays, M+K Update Ltd (May 2008) ISBN 9781905539345, 300 pages, paperback, price £29. *Radiography*, 14(Supplement 1), e93.

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Nightingale J (2004). Book Review - Radiology Core Review: A. Pitman, N. Major and R. Tello (Eds.); Saunders, Edinburgh, 2003, 490 pages, £49.00, ISBN 0-702-02619-0. *Radiography*, 10(1), 87-88.

Academic requirements for a PhD by Published Works

According to the University of Salford AQA (2008/09) Research Award Regulations, the PhD by Published Works thesis is required to offer (in addition to the published works) a critical review of up to 15,000 words stating:

- the aims and nature of the research
- wider disciplinary perspectives
- the inter-relationship between the material published and the main contribution and/or addition to knowledge of the works

"*The thesis should offer a critical appraisal of the work from a micro and macro perspective, to be undertaken to demonstrate that the candidate has subjected their work to scrutiny and review at the individual publication level and also within the wider boundaries of their specific discipline*".

University of Salford, AQA 2008/09 Section 10.20.

The regulations go on to state that the critical appraisal will provide evidence that the works are:

- embedding a coherent programme of research
- achieving a depth of scholarship and originality comparable to that required for the Award of PhD by thesis

Choice of selected published works should include:

- Works which are in the published domain
- Works that have been accepted for publication
- Works should normally have been submitted within last 10 years
- Books or book chapters should only be included if of comparable standard (research focus, theoretical depth or conceptual analysis)
- In theory, could include novel publishing media such as websites, videos and DVDs, music manuscripts etc.

Author Contribution Forms

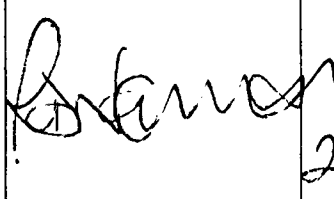
Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: **Roger Newman**

For the purposes of the above thesis for the award of PhD by Published Works at the University of Salford, Julie Nightingale will be including articles or book chapters that have been jointly authored with yourself. A requirement of the thesis is that the co-authors should agree to the contributions made by Julie Nightingale for each article. The article title and suggested contribution by Julie Nightingale is stated below. If you are in agreement with this percentage contribution then I would be grateful if you would sign the statement below and return it to me.

Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
2009	Nightingale J, Newman R (2009). Practical Reporting: Interpreting swallowing function by videofluoroscopy. *Synergy – Imaging and Therapy Practice*. Invited article, January 2009, 16-22.	60%		27/01/09

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: **Professor Peter Hogg**

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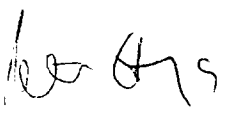
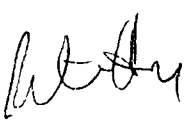
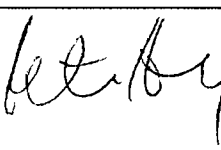
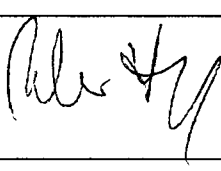
Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
Feb 2003	Nightingale J and Hogg P (2003), Clinical Practice at an Advanced Level, *Radiography*, Volume 9, Issue 1, February 2003, 77-83	50%		19/1/09
May 2003	Nightingale J and Hogg P (2003), The Gastrointestinal Advanced Practitioner : An Emerging Role for the Modern Radiology Service, *Radiography,* Volume 9, Issue 2, May 2003, Pages 151-160	70%		19/1/09
May 2004	Owen A, Hogg P and Nightingale J (2004), A critical analysis of a locally agreed protocol for clinical practice, Radiography, Volume 10, Issue 2, May 2004, 139-144	20%		19/1/09
March 2007	Nightingale J, Hogg P (2007), The role of the GI radiographer : A UK perspective, *Radiologic Technology*, March/ April 2007, vol 78, no 4, 1-7.	80%		19/1/09

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: **Renata Eyres**

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Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
July 2005	McConnell J, Eyres R, Nightingale J (2005) *Interpreting Trauma Radiographs*, Blackwell Publications, Oxford. July 2005. ISBN 1-4051-1534-3	33%	Renata D. Eyres	10/02/09

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: **Myke Kudlas**

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Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
2009	Chapter 1: Nightingale J, Kudlas M, Ricote L. Evolving practice and shifting boundaries in GI Tract Imaging In : Nightingale J, Law R (Eds) *Gastrointestinal Tract Imaging: An evidence based practice guide*. Elsevier. In press.	60%		1/21/09

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: **Professor Stuart Mackay**

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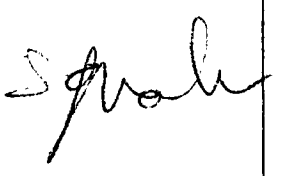
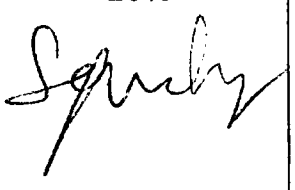
Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
2007	Nightingale J, Mackay S, Mollo B. Enhancing the learning opportunities of part-time postgraduate students using distance learning (p155-172) . *Education in a Changing Environment"* conference_book, Volume 4. Edited by Eamon O'Doherty. Informing Science. ISBN:1932886133, 9781932886139	80%	20% 	19.1.09
2007	Nightingale J, Mackay S (2009) An analysis of changes in practice introduced during an educational programme for practitioner-led swallowing investigations. *Radiography* Feb 2009, 15(1):63-69 doi:10.1016/j.radi.2007.10.001	80%	20% 	19.1.09

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: **Jonathan McConnell**

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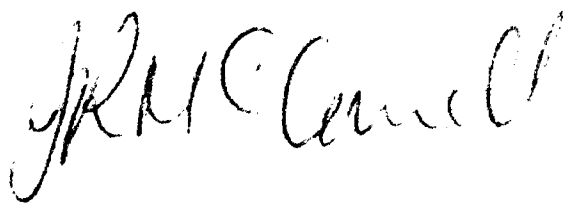
Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
July 2005	McConnell J, Eyres R, Nightingale J (2005) *Interpreting Trauma Radiographs*, Blackwell Publications, Oxford. July 2005. ISBN 1-4051-1534-3	33%		

I am happy to confirm the above contribution to the text given.



19/01/2009

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: Ben Mollo

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Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
2007	Nightingale J, Mackay S, Mollo B. Enhancing the learning opportunities of part-time postgraduate students using distance learning (p155-172) . *Education in a Changing Environment"* conference_book, Volume 4. Edited by Eamon O'Doherty. Informing Science. ISBN:1932886133, 9781932886139	80%	B Mollo	22 01 09

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: **Keith Piper**

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Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
2008	Kelly J, Piper K, Nightingale J. Factors influencing the development and implementation of advanced and consultant radiographer practice: A review of the literature, *Radiography* (2008), Vol 14 (Supplement 1) e71-e78. doi:10.1016/j.radi.2008.11.002	20%		20/1/09

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: Liza Ricote

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Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
2009	Chapter 1: Nightingale J, Kudlas M, Ricote L. Evolving practice and shifting boundaries in GI Tract Imaging In : Nightingale J, Law R (Eds) *Gastrointestinal Tract Imaging: An evidence based practice guide*. Elsevier. In press.	60%	(Liza Ricote)	20/1/09

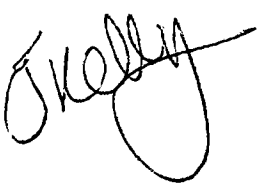
Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: Judith Kelly

For the purposes of the above thesis for the award of PhD by Published Works at the University of Salford, Julie Nightingale will be including articles or book chapters that have been jointly authored with yourself. A requirement of the thesis is that the co-authors should agree to the contributions made by Julie Nightingale for each article. The article title and suggested contribution by Julie Nightingale is stated below. If you are in agreement with this percentage contribution then I would be grateful if you would sign the statement below and return it to me.

Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
2008	Kelly J, Piper K, Nightingale J. Factors influencing the development and implementation of advanced and consultant radiographer practice: A review of the literature, *Radiography* (2008), Vol 14 (Supplement 1) e71-e78. doi:10.1016/j.radi.2008.11.002	20%	Judith F Kelly 	26/01/09

Developing the health care workforce through education: A case study in radiography advanced practice

Co-contributor: Elaine Scarles

For the purposes of the above thesis for the award of PhD by Published Works at the University of Salford, Julie Nightingale will be including articles or book chapters that have been jointly authored with yourself. A requirement of the thesis is that the co-authors should agree to the contributions made by Julie Nightingale for each article. The article title and suggested contribution by Julie Nightingale is stated below. If you are in agreement with this percentage contribution then I would be grateful if you would sign the statement below and return it to me.

Many thanks

Julie Nightingale

Date	Article Title	Suggested contribution by J. Nightingale	Signature of Co-contributors	Date of Signing
Jan 2008	Scarles E, Nightingale J. (2008) Colorectal carcinoma in a patient with prior breast cancer : Is there a causal link? *Radiography.* February 2008, vol 14, 2-7. DOI : 10.1016/j.radi.2006.08.002	50%	Elaine Scarles	22/01/09

Analysis of other competing and complementary authors using Science Direct searches of key words.

The review of originality of journal articles was undertaken via the Science Direct search engine (www.sciencedirect.com)/ A range of key words were identified which had relevance to the published journal articles, and these were inserted into the search engine one at a time, and then in combination. No year or journal restrictions were used. The results of search terms can be seen in the Tables below, identifying the number of hits, how often the author published works were included, and the other authors that were writing in the same field.

Table 1. Results of 'Advanced Practice' and 'Advanced Practitioner' search terms

Search terms	No. hits	No. hits by JN	Authors of note	Comments
"Advanced Practice"	412			Mainly nursing
"Advanced practice" radiographer	7	2 (PW3 and 4)	Hardy and Snaith (x4) Jones and Manning	
"Advanced Practice" radiography	6	1 (PW4)	Hardy and Snaith Smith and Yielder (Australia) Eddy (radiotherapy)	(1 nursing)
"Advanced Practitioner"	32			Nursing, midwifery, radiography
"Advanced Practitioner" radiography	6	0	Smith and Yielder Eddy	

			Hardy and Snaith Price and Le Masurier Brealey and Scally	
"Advanced practitioner" radiographer	4	0	Brealey and Scally Hardy and Snaith Ruffles and Strudwick	
"Advanced Practitioner" Gastrointestinal	1	1 (PW3)		
"Advanced Practitioner" GI or fluoroscopy	1	0	Ruffles and Strudwick	(dose levels)
"Advanced Practice" barium	1	1 (PW4)		
"Advanced Practice" fluoroscopy	0			
"Advanced Practice" GI	0			

Table 2. Results of 'role development' and 'radiographer reporting' search terms

Search terms	No. hits	No. hits by JN	Authors of note	Comments
"Role development"	126			Nursing and radiography
"Role development" radiography or radiographer	14	0	Smith and Yielder Hardy and Snaith Price and Le Masurier Brealey and Scally Forsyth and Robertson, Woodford Booth and Mannion Brady White and McKay	Booth and Mannion supervised by JN Brady and White and McKay focus on legal issues Role dev does not bring up any of JN articles!
"Role development" GI or gastrointestinal	2	0	Booth and Mannion	1 nursing
"Radiographer	17	2	Hardy and Snaith	Only 1 other

reporting" and "radiographic reporting"		(PW3 and 4)	Law et al Brealey and Scally x 2 Manning et al x 3 Elliot Rudd Price and Le Masurier Paterson et al Reeves Tennant Robinson	focussed on GI (Law et al). Most focus on plain film reporting, and are mainly discussion pieces JN articles did not feature under "Radiographic reporting"

Table 3. Results of search terms related to gastrointestinal imaging

Search terms	No. hits	No. hits by JN	Authors of note	Comments
"Swallowing disorder"	121			
"swallowing investigations"	1	1 (PW 9)		
Fluoroscopy and swallowing	26	1 (PW9)		Most very clinical / physiology based
Fluoroscopy and radiographer	7	0	Law et al (x4)	
"GI radiographer"	1		Ruffles and Strudwick	
"barium enema radiographer"	3	0	Culpan et al Law et al Vora and Chapman	
"barium enema" radiographer	18	1 (PW3)	Law et al McKenzie et al Leslie and Virjee Brown and Desai Culpan and Chapman Price and Le Mesurier Booth and Mannion	More radiologist authors seen – not using the terms advanced practice or GI radiographer

Table 4. Results of search terms related to 'protocols'

Search terms	No. hits	No. hits by JN	Authors of note	Comments
Protocols and radiography	121			
"Clinical protocols" radiography	2	1 (PW10)		Other article was about a specific protocol
"protocols" and radiographer	11	2 (PW4 and PW10)	Bewell and Chapman Brown and Henwood Jones and Manning Law et al	
Protocols "advanced practice radiographer"	3	2 (PW4 and PW10)	Jones and Manning	
Protocols "role development"	3	0	Jones and Manning	Nursing x 2

Brief Review of Competing and Complementary Authors identified in Science Direct

M Hardy and B Snaith – these authors are well known to the author, being associated with the University of Bradford (Senior Lecturer) and a neighbouring health Trust (Consultant Radiographer). Both authors have presented and written prolifically on the subject of role development, with a main interest in trauma reporting. Many of their CPD articles feature in *Synergy* (professional journal), with several articles also featuring in *Radiography*. Most of these articles have been discussion pieces, with one or two pieces of original research, although there does appear to be overlap in several articles. They have not presented any work in the Gastrointestinal Imaging field.

Professor D. Manning is based at the University of Cumbria, and has worked predominantly in the field of image perception. Many of his articles (often in combination with other authors) have been published in peer reviewed journals, and have evaluated the role of experience in perception, and concentrated on the use of technology to help novices learn reporting skills. This work is in a different field to the author's, although there are overlaps with advanced practice.

Robert Law had worked predominantly in the Gastrointestinal Imaging field, as a Consultant Radiographer. His publications appear mainly in *Radiography* and *Clinical Radiology*, and he has recently co-edited a text book with the author. Law's articles are generally presenting original research, or are based on discussions of his own practice, which is often pushing the boundaries of the radiographer scope of practice. These articles have often been used to inform the author's work, particularly in PW3 and PW7. Law presents to some extent a colloquial view of advanced practice (from the 'coalfront'), whereas the author's work often presents a more academic overview with a wider (across the UK and other countries) perspective of practice. One could argue that the two authors work is complementary, and this is one of the reasons for the collaboration on the textbook 'GI Tract Imaging: An evidence based practice guide'.

G Culpan has also authored within both the GI and the plain film reporting fields, often in collaboration with radiologist co-authors. Generally the work has been presenting original research findings which provide evidence to support the efficacy of advanced practice.

S Brealey has authored a number of articles which focus on the methodologies for assessing radiographer reporting efficacy. Whilst very useful, they do not particularly overlap with the author's current research foci.

R Price is the other author who features in a number of articles which present findings of a longitudinal study looking at how and where new roles have been established within the UK. This series of articles has been valuable in giving useful evidence of the role expansion. Price has also written a number of discussion pieces, predominantly related to radiographer reporting.

Email Correspondence from Richard Evans, Chief Executive Officer of the Society and College of Radiographers

Subject: FW: videofluoroscopy / swallowing article
Attachments:

From: RichardE@sor.org [mailto:RichardE@sor.org]
Sent: Tue 13/01/2009 17:45
To: Nightingale Julie
Subject: RE: videofluoroscopy / swallowing article

Dear Julie

I was pleased to see your "videofluoroscopy" article in Synergy this month. The following is an extract of the message I would like to forward on to the AHP policy makers along with the article:

Development of professional roles amongst the Allied Health Professions (AHPs) has progressed in the UK to the extent that innovations in practice are accepted as of international importance. The value of clinical contributions from this relatively small and very diverse group of professionals is frequently unrecognised. However the high degree of clinical expertise within their defined fields and the ability to contribute effectively and at an advanced level within multidisciplinary teams indicates that AHPs are particularly suited to providing first class clinical services in creative ways to the benefit of patient and client care.

The article published in Synergy: Imaging and Therapy Practice (the monthly professional practice journal of the Society and College of Radiographers) "Interpreting The Swallowing Function by Videofluoroscopy" refers to an excellent example of a model where AHPs of two separate disciplines collaborate to provide clinical service without the requirement for routine involvement of medical personnel. This results in more timely and expertly delivered care and ensures that medical staff (in this case Consultant Radiologists) are able to concentrate on other specialist work.

The authors, Julie Nightingale and Roger Newman have produced not only a practical guide to understanding the results of these examinations but also a clear description of the procedure and how the professionals involved bring appropriate skills to the process. As a result, the article provides for the professions an account of how inter-disciplinary working brings benefits to staff and patients alike and for the wider healthcare community an example of the possibilities for service improvement that AHPs can bring. For this reason, I believe that the article should be shared not only within the Speech and Language Therapy and Radiography communities but also more widely. As a start in this process, a copy is being sent to the Chief Health Professions Officers in the four countries of the UK.

Best wishes

Richard

Richard Evans | Chief Executive Officer | richarde@sor.org| Tel 020 7740 7202 | Fax 020 7740 7233

The Society and College of Radiographers | 207 Providence Square | Mill Street | London SE1 2EW

PART 5 – REFERENCES

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Changing professional landscapes:

The influence of education on the origin and evolution of radiography advanced practice

Volume 2 of 2

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PART 6 THE PUBLISHED WORKS

TABLE OF CONTENTS

OVERVIEW

The published works are displayed in full within this volume of the thesis. Each published work, listed in Table 1 overleaf, is accompanied by a one page summary sheet.

If readers of this thesis prefer to view the original PDF versions, enabling text to be enlarged and colour to be better displayed, an accompanying CD Rom is housed within this binding. Please note that PW12 is only available in a word document on the CD Rom.

Also housed within this binding is the textbook (PW5). Readers are particularly guided to read Chapter 6 (Section 1) of this book.

TABLE 1 PUBLISHED WORKS AND THEIR LOCATION WITHIN THIS VOLUME OF THE THESIS

Code	Date	Reference	Publication type	Location
PW1	1998	Innes J (1998). A qualitative insight into the experiences of postgraduate students: causes of stress and methods of coping. *Radiography*, 4(2), 89-100.	Peer reviewed journal	Vol 2 Page 7 CD Rom
PW2	Feb 2003	Nightingale J & Hogg P (2003). Clinical Practice at an Advanced Level. *Radiography*, 9(1), 77-83.	Peer reviewed journal	Vol 2 Page 20 CD Rom
PW3	May 2003	Nightingale J & Hogg P (2003). The Gastrointestinal Advanced Practitioner: An Emerging Role for the Modern Radiology Service. *Radiography,*9(2), 151-160.	Peer reviewed journal	Vol 2 Page 28 CD Rom
PW4	May 2004	Owen A, Hogg P & Nightingale J (2004). A critical analysis of a locally agreed protocol for clinical practice. *Radiography*, 10(2), 139-144.	Peer reviewed journal	Vol 2 Page 39 CD Rom
PW5	July 2005	McConnell J, Eyres R & Nightingale J (2005). *Interpreting Trauma Radiographs.* Oxford: Blackwell Publications. ISBN 1-4051-1534-3	Edited Book: 1 book chapter	Vol 2 Page 46 Book insert
PW6	March 2007	Nightingale J & Hogg P (2007). The role of the GI radiographer: A UK perspective. *RadiologicTechnology*, 78(4), 284-290.	Peer reviewed journal	Vol 2 Page 48 CD Rom
PW7	Jan 2008	Scarles E & Nightingale J (2008). Colorectal carcinoma in a patient with prior breast cancer: Is there a causal link? *Radiography*, 14, 2-7.	Peer reviewed journal	Vol 2 Page 56 CD Rom

PW8	2008	Nightingale J, Mackay S & Mollo B. Enhancing the learning opportunities of part-time postgraduate students using distance learning. In O'Doherty E (Ed.) (2008) *The Fourth Education in a Changing Environment Conference Book 2007* "Best Papers" Volume 4. (pp155-172) California: Informing Science Press.	Book chapter within edited work	Vol 2 Page 63 CD Rom
PW9	2009	Nightingale J & Mackay S (2009). An analysis of changes in practice introduced during an educational programme for practitioner-led swallowing investigations. *Radiography*, 15(1), 63-69.	Peer reviewed journal	Vol 2 Page 80 CD Rom
PW10	2008	Nightingale J (2008). Developing protocols for advanced and consultant practice. [Electronic version]. *Radiography* , 14 (Supplement 1), e55-e60.	Peer reviewed journal – electronic supplement	Vol 2 Page 88 CD Rom
PW11	2008	Kelly J, Piper K & Nightingale J (2008). Factors influencing the development and implementation of advanced and consultant radiographer practice: A review of the literature. [Electronic version]. *Radiography*, 14 (Supplement 1), e71-e78.	Peer reviewed journal – electronic supplement	Vol 2 Page 95 CD Rom
PW12	2008	Nightingale J & Law R (Eds.). *Gastrointestinal Tract Imaging: An evidence based practice guide.* Oxford: Churchill Livingstone / Elsevier. In press. Chapter 1: Nightingale J, Kudlas M & Ricote L. Evolving practice and shifting boundaries in GI Tract Imaging.	Edited Book: 2 book chapters, 1 submitted with preface and table of contents(in press)	Vol 2 Page 104 CD Rom
PW13	2009	Nightingale J & Newman R (2009). Practical Reporting: Interpreting swallowing function by videofluoroscopy. *Synergy – Imaging and Therapy Practice.* Invited article, January 2009, 16-22.	Professional journal	Vol 2 Page 125 CD Rom

Identification number / year	Published work 1 (PW1)	1998
Title	A qualitative insight into the experiences of postgraduate students: causes of stress and methods of coping	
Authors	Innes J (former name)	
Contribution	100%	
Full reference	Innes (former name) J. (1998) A qualitative insight into the experiences of postgraduate students: causes of stress and methods of coping. Radiography; 4(2);89-100	
Publication media	Peer reviewed international journal (quarterly)	
Abstract	Many radiographers enrol upon academic postgraduate courses as part of their Continuing Professional Development (CPD), working towards Postgraduate Certificates, Diplomas and Masters Degrees. Such study is generally undertaken whilst the radiographer continues to work full-time, and it has to be managed around the demands of their family and their social lives. This may result in the radiographer suffering varying degrees of stress. A qualitative analysis of data collected during semi-structured interviews with radiographers involved in this type of CPD has been undertaken. The results indicate that radiographers do experience considerable stress during their course, which results from a wide range of problems. Radiographers also highlighted the coping methods used to effectively manage the stress. A series of recommendations to assist radiographers considering such CPD opportunities is presented.	
Wordcount	6728	
Number of pages	12	
Thesis aims supported	Aims 1 and 3	

THE COLLEGE OF RADIOGRAPHERS

Radiography (1998) 4, 89–100

ORIGINAL ARTICLES

A qualitative insight into the experiences of postgraduate radiography students: causes of stress and methods of coping

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(Received 8 November 1996; accepted 3 October 1997)

Keywords: continuing professional development; semi-structured interview; thematic content analysis; anxiety; radiography education.

Many radiographers enrol upon academic postgraduate courses as part of their Continuing Professional Development (CPD), working towards Postgraduate Certificates, Diplomas and Masters Degrees. Such study is generally undertaken whilst the radiographer continues to work full-time, and it has to be managed around the demands of their family and their social lives. This may result in the radiographer suffering varying degrees of stress. A qualitative analysis of data collected during semi-structured interviews with radiographers involved in this type of CPD has been undertaken. The results indicate that radiographers do experience considerable stress during their course, which results from a wide range of problems. Radiographers also highlighted the coping methods used to effectively manage the stress. A series of recommendations to assist radiographers considering such CPD opportunities is presented. (This paper presents a summary of a dissertation submitted by the author for the award of Master of Science in Medical Imaging.)

Introduction

The College of Radiographers' 'Code of Professional Conduct' [1] recommends that radiographers engage in continuing professional development (CPD). This development, combined with changes to the structure of radiography education, has led to an increasing proportion of radiographers seeking enrolment onto postgraduate courses. Such radiographers are usually enrolled onto higher degree courses as part-time mature students, and therefore they may encounter unique problems in comparison to traditional full-time masters' level students. For example, they may not possess a first degree (with the associated study skills, writing styles and research experience) and it could be a considerable time since their last experiences of formal education. Similarly they may have significant professional, social and family responsibilities around which they have to incorporate their academic work. This additional burden of studying for postgraduate courses may result in radiographers experiencing a high degree of stress.

The concept of stress

Stress, as defined by Cox [2], is a:

> 'perceptual phenomenon arising from a comparison between the demand on the person and his ability to cope. p 25

The interactional model of stress discussed by Cox [2] implies that varying demands (commonly termed 'stressors') are made upon a person in any situation, and these may be physical, emotional or environmental in nature. However, the degree of stress experienced by different individuals in any single situation will vary considerably due to personal factors such as previous experience, education and training, as well as a range of

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personality traits. This intensely personal evaluation of the demands and the ability to cope is known as cognitive appraisal.

Following cognitive appraisal, any imbalance in demand and the ability to cope will result in the emotional experience of stress, including feelings of anxiety, guilt and frustration. The emotional experience of stress is accompanied by an organized set of responses aimed at reducing or removing the stress, including both physiological and psychological processes.

Physiological responses include the so-called 'fight or flight' response, initiated by the secretion of adrenocorticotrophic hormone from the pituitary gland and associated with stimulation of the sympathetic nervous system. This results in the body's resources, such as energy, being mobilized ready for immediate action. The physiological changes occurring under stress conditions include an increase in metabolism, heart and respiration rates, sweating and pallor, as well as a decrease in non-essential functions such as digestion. Such responses can therefore be seen as the facilitation of coping.

Psychological responses to stress also include the primitive responses such as 'fight' or 'flight'. However, modern man is rarely able to exhibit such behaviours when under stress, so he utilizes 'decisional control', entailing the selection of available options which lower the likelihood of harm [3]. These involve a range of coping responses—successful coping will restore any imbalance, whereas unsuccessful coping leads to the manifestation of stress symptoms [4], therefore increasing or prolonging the experience of stress. A diverse range of coping methods has been discussed in the literature, and these appear to reflect the population under study [5]. Emmons *et al.* [6], for example, identify several coping methods used extensively by professional working mothers which are all centred around the concept of time management. However, entirely different coping strategies are used to reduce the stress experienced during chronic illness. Wineman *et al.* [7], for example, in their study of chronically ill people discovered that coping methods were focused on dealing with emotional issues rather than time management.

The cost of stress

A degree of stress may be desirable to provide an individual with increased motivation to meet future challenges. However, an inability to cope with stress may adversely affect health and well-being.

Physical and mental ill-health has been previously linked to life-events stress such as bereavement or divorce [4], but recently much attention has been paid to the adverse effects of chronic long-term stressors [8] such as financial hardship, family conflicts and academic stress. Physical stress symptoms include colds, infections and migraine headaches [9], and long-term stressors may influence the manifestation of more serious illnesses such as cardiovascular disease and bronchial asthma [2]. Mental stress-related disorders include irritation, anxiety and concentration difficulties leading to tension headaches and stomach disorders [9].

The concept of anxiety is often classed as being a signal that the stress response has been activated, and is therefore the focus of much attention in stress research. Anxiety is described by Spielberger *et al.* [10] as an intervening variable in the stress–illness relationship, and is characterized by:

> 'subjective feelings of tension, apprehension, nervousness and worry' [10]. p 4

Prolonged anxiety may lead to clinical depression, associated with feelings of gloom and inadequacy [10]. Health workers in particular have been shown to be susceptible to depression and to the state known as burnout, characterized by extreme tiredness combined with feelings of failure and frustration [11]. Such individuals have a negative self-image and a lack of concern for themselves or their work and frequently succumb to absenteeism [12]. Indeed a study conducted at a Manchester hospital [13], identified that 1 in 12 health workers were suffering from mental ill-health which required treatment. This supports the widespread view that the health care service presents a stressful environment, and it is interesting to note that radiographers were included amongst the participants of the Manchester study.

Stress and the radiographer

Every profession has potential stress associated with it, and there is evidence to suggest that stress occurs most often in those with higher levels of education and a higher rank [12].

In her study of American radiographers, Polworth [14] identified physical stressors that included working in cramped conditions with poor lighting and ventilation. Particularly stressful was shift work involving irregular sleep periods and

working alone where feelings of personal safety may be compromised. Polworth [14] also identified role conflict with superiors and role ambiguity (responsibility without authority) as important stressors. She found that working with patients was not a stressful aspect of the radiographers' work. This finding is in direct conflict with work by Casselden [15], who discovered that most stressful situations in diagnostic radiography occurred when communicating with patients.

Radiographers also have to cope with stress in their family situations which may affect their capacity to work effectively from time to time. This is known as spillover and can occur from home to work and *vice versa*. Similarly, the effects of the additional burden of studying may also result in spillover into the working environment and the home situation.

Academic stress

Several academic stress-researchers have identified two main areas that are intensely stressful. These are examinations and course workload [16] and social stressors such as financial hardship and lack of time for family and friends [17]. Abouserie's [18] study of university undergraduates found that 8 out of 10 students suffered moderate stress levels, whilst 1 in 10 suffered severe stress levels with associated physical and emotional strain. Applying academic knowledge in the clinical situation has also been found to be particularly stressful within health care education [12, 19, 20].

However, few studies have concentrated specifically upon mature, part-time students such as postgraduate radiographers. This group may have unique problems confronting them relating to the integration of their home, work and course of study. It is therefore pertinent to identify these issues and address them appropriately.

Methodology

The aim of the study was to investigate the experiences of postgraduate radiography students in order to highlight any difficulties and problems which may have resulted in stress. Any coping strategies used and their perceived effectiveness was also investigated.

The method

In order to achieve the aims of the study a qualitative methodology (phenomenology) was selected. Phenomenological enquiry attempts to achieve a psychologically rich, in-depth understanding of the individual [21], and is effectively achieved by semi-structured interviewing. Interviewing is a powerful and flexible tool which may be used to open up new areas of research which have previously been little explored [22], and which will often encourage unexpected information to surface.

Semi-structured interviewing was used, where the interviewer followed a schedule of topics identified within the literature, but was free to adjust the actual order and emphasis of questions to suit the individual informant. The interviews lasted between 30 and 60 minutes, and were audiotaped and then later transcribed in their entirety.

The sample

A convenience sample of 13 postgraduate radiography students was chosen. Thirteen interviews was felt to adequately reflect the views of such students, and was a feasible number for a single researcher within the time frame available. The informants were enrolled upon five different courses organized by three radiography education establishments, and they were approached initially by either the researcher or their respective course leader. The diversity of courses were chosen to provide a wide cross-section of views. Informed consent was obtained from the students, and their privacy, confidentiality and anonymity was assured. The characteristics of the sample can be seen in Fig. 1.

Data analysis

The method selected for data analysis of the transcribed interviews was that of *thematic content analysis* as described by Burnard [23]. This method is a 14-stage process adapted from literature on grounded theory and content analysis, and provides the researcher with a systematic yet flexible structure within which to work. The aim of this analytical approach is to:

> 'produce a detailed and systematic recording of themes and issues addressed in the interviews and to link the themes and issues together under a reasonably exhaustive category system.' [23] pp 461 462

Gender	11 females/2 males	
Marital status/ dependants	4 married with children	
	3 married with no children	
	1 divorced single parent	
	5 single	
Age	7 aged 36 years and above	
	2 aged 31–35 years	
	4 aged 26–30 years	
Professional grade	6 Senior 1	
	3 Senior 2	
	4 Radiographer grade	
Course of study	2 BSc. (Hons)	
	11 MSc /PgD —	2 ultrasound
		2 nuclear medicine
		7 general science or sectional imaging

Figure 1. Sample characteristics.

The stages of analysis used in this study can be seen in Appendix 1.

Comments on methodology

The rigour of qualitative research methods has been much debated. Beck [24] suggests that there are inherent difficulties regarding the application of reliability and validity concepts in qualitative enquiry, as both were developed for use in quantitative methodologies. It is for this reason that several researchers have suggested new concepts which more accurately reflect the qualitative process (e.g. [25, 26]), and the following have been adopted for consideration within this study.:

Objectivity

Semi-structured interviewing may inevitably introduce an element of researcher bias into the line of questioning—whether it is a conscious or a subconscious act involving tone of speech, affirmation or body language. A list of research topics identified in the appropriate literature was therefore used with each informant to try to reduce bias in the line of questioning. As the researcher was also a postgraduate student, it was recognized that a set of preconceived ideas may be held already. A reflective field diary was therefore introduced to try to record in writing any such beliefs and to comment on particular worries regarding bias which arose during the enquiry. The aim of such a diary was to attempt to increase researcher self-awareness, and this was found to be a particularly useful tool.

Credibility

A study is credible when it presents descriptions which readers, previously confronted with the experience, may recognize as truthful. It was essential to refer back to full interview transcripts at many stages of the data analysis to ensure that any conclusions were firmly 'grounded' in the data [27], and that no information was manipulated or taken out of context. To try to increase credibility, three of the informants were asked to consider the themes which emerged from the analysis of the interviews and how these themes fitted in with their own interview transcript. Any areas of disagreement were discussed with the researcher.

Transferability

Likened to external validity, this allows the reader to make a judgment regarding the transferability of the findings into a different situation. The original context of the study should therefore be described. The relatively small sample size (n=13) makes it difficult to transfer findings to a wider population. However, the additional depth of insight achieved using this methodology can easily be applied to those in very similar circumstances, including other health care workers engaged in part-time study.

Dependability

This considers the replication of the study under similar circumstances (reliability) and is achieved by analysing data in a rigorous and well-documented manner (see Appendix 1). As the same researcher was used for all data-collection and analysis, inter-researcher reliability was not an issue (although the trade-off is an increased risk of bias). Although a range of individuals with differing personal circumstances were interviewed, the findings appeared to show meaningful 'parallels' across the informants, suggesting that the study is dependable [26].

Findings and discussion

A brief review of the findings is presented which includes reported stress levels, effects of stress and

the causes of stress identified in the study. In addition issues raised concerning the theme entitled personal discovery and methods of coping with stress are also reported.

The researcher's commentary is used to link together verbatim extracts (in italics) taken directly from the interview transcripts. Where appropriate the commentary is discussed alongside the literature reviewed previously. This method of combining findings and discussion is used to improve the 'readability' of qualitative research [23].

Reported stress

The radiographers interviewed all experienced a high degree of perceived stress at some time during their course, a finding which links closely with research by Abouserie involving undergraduate full-time students [18]. Stress levels fluctuated mainly with respect to academic deadlines, being higher both at the start of the semester (due to unclear objectives) and at the end (due to high workload and imminent deadlines). Such high workload related to assessment has been much reported [16] and is an anticipated source of stress. Several informants suggested that their stress levels would be reduced if assignment deadlines were staggered across the semester, although end-of-semester deadlines appear to be a common theme across university courses. Uneven workload was also a feature of clinical education modules, where the early clinical experience was seen by the student as a foundation:

> *'You had to get that under your belt before you could start writing about it . .'*

However stress at the beginning of the semester due to unclear objectives was underestimated by the researcher, and indeed was so pronounced that it became a stressor theme in its own right.

The degree of perceived stress appeared to vary from one individual to another, which probably related to a range of personality traits, previous experience, gender and social circumstances [2], although the causes of stress were consistent across the informants. Therefore any individual component of a course can only be labelled as 'potentially stressful'.

The radiographers recognized that stress experienced in their course was in addition to the stress encountered in their daily lives:

> *'Stress is all accumulative isn't it? It's been another stressful factor that I could have done without!'*

Perceived stress was reduced for all radiographers as the course progressed and those interviewed in the early stages of their course reported particularly high anxiety levels. As familiarity with the course increased, radiographers appeared to be exerting decisional control over the situation [3] by using the experience gained to introduce successful coping mechanisms:

> *'The second part I didn't really feel under stress . . but then again I felt by that time I was on a roll.*

Indeed some students interviewed in the latter stages of their course recognized that stress could actually be a positive phenomenon, creating the impetus for them to 'kick harder' and put into place appropriate coping mechanisms.

Effects of stress

Most radiographers experienced both physical and emotional effects of stress during their course, resulting in direct psycho-physiological effects upon their health. Physical signs included minor illnesses, intense fatigue and one possible example of 'burnout'. One female radiographer who may have been exhibiting signs of 'burnout', described a catalogue of distressing events which affected her during the 3-year course, including a distressing illness affecting a close family member, collapse of the family business and emotional problems affecting her young child. In her attempts to 'hold the family together' the radiographer ignored her gradually increasing stress levels resulting in complete exhaustion, frustration and deepening depression. This culminated in a lengthy period of absence from work. This particular scenario appeared to match closely the description of the state of burnout by Duquette *et al.* [11]. Surprisingly this radiographer did not approach any lecturer involved in her course to discuss the problems which were adversely affecting her academic performance. This is a worrying finding for lecturers, who are unable to offer support if they are not aware of the seriousness of such problems.

Several previous studies have also correlated student stress with ill-health, including O'Meara *et al.* [12]. In this study, however, few of the radiographers required time off work to cope with such stress-related illness, supporting the findings of the Polworth study [14] which indicated that

there are low percentages of absenteeism in radiography.

Physical signs of stress were undoubtedly related to the more commonly reported emotional signs including anxiety, guilt, worry and tearfulness, all previously noted to be maladaptive coping behaviours [28]:

> *'I was tired. I tried studying till all hours at the beginning but with working full-time as well I was exhausted.'*
>
> *'When I have got something on my mind I don't sleep at all well . . .'*

Anxiety was described in relation to course work and examinations, but was also linked to learning new clinical skills and dealing with new emotional situations. One ultrasound student, for example, found dealing with abnormal scans particularly stressful. This finding was reflected in the study by Casselden [15] in which she identified that the most stressful situations encountered by radiographers were concerned with dealing with patients. Dealing with 'bad news' is perhaps one area of course content which could be further developed.

Feelings of tension, apprehension and worry experienced by the radiographers in the study can be linked closely to the concept of anxiety developed by Spielberger *et al.* [10]. Anxiety was described in many different ways, most often the symptom was an inability to relax:

> *'It's uncomfortable . . . at the moment this feeling is just there all the time.'*
>
> *'There seems to be a big weight hanging over you.'*

More overt emotional signs of stress were discussed by several radiographers, and these included panic attacks, outbursts of anger and tearfulness. These were also noted in a previous study as being examples of mental stress-related disorders which often lead to tension headaches and stomach disorders [9]. Although the radiographers were aware that they were suffering from significant levels of anxiety, most were unable or unwilling to seek help:

> *'It seems that the further you get down the slippery road of stress, the more difficult it is to actually go out and get somebody to help you.'*

The reason why radiographers do not appear to be able or willing to seek help is uncertain, but it was raised on several occasions during the interviews. Previous studies have identified that professionals may believe that to seek help would reveal signs of weakness [9], or may even be unaware of the extent

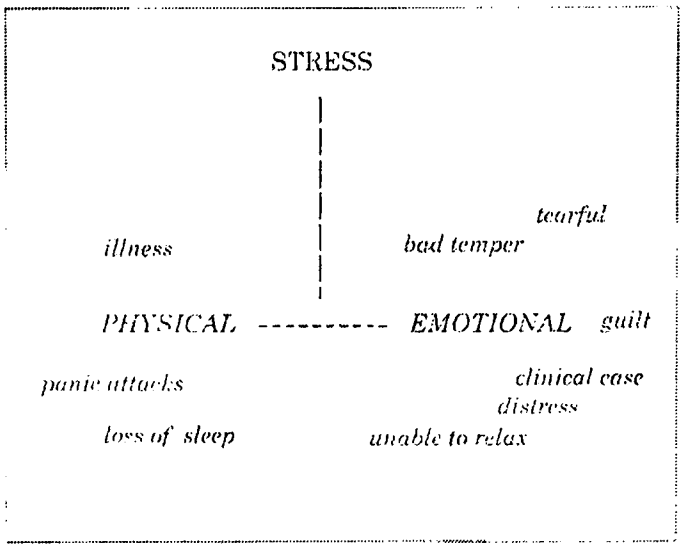

Figure 2. Summary of reported effects of stress.

of their problems [13]. A summary of the effects of stress reported by the radiographers is shown in Fig. 2.

Causes of stress

Several causes of stress emerged from the interviews, and were repeatedly highlighted by most of the radiographers. Three causes related directly to the academic course (financial drain, inadequate resources and unclear goals), but two had origins in the home and work situation (spillover and lack of support).

Financial drain was a problem particularly for those students receiving partial or no funding for their course, as this indirectly affected other family members. This resulted in feelings of guilt:

> *'In my first year I had to fund half of it . . . that's five hundred pounds out of your bank, which is a lot of money . . .'*

Most radiographers, even those receiving regional training grants for ultrasound or nuclear medicine training, noted that they would not be funded for the dissertation if they were to embark upon it. This seems a short-sighted approach by radiology managers, as it may hinder the development of research skills within their staff. It is also at odds with the Code of Professional Conduct (1994) [1], which states:

> 'It is the duty of radiographers to develop the practice of radiography and as such engage in research and *support the research of others.*'
>
> (Section 4.4, p 10)

Reducing on-call earnings (due to lack of time) and the purchase of a computer also had a considerable

impact upon students, as well as other hidden costs such as petrol for travelling, text-books and journals. Although financial hardship has been cited as a stressor by other researchers [17, 18], most relate to undergraduate student populations. The postgraduate students in this study had differing financial problems because although they were salaried workers, several had a mortgage and dependants to take into consideration. The additional financial burden created by the course resulted in some radiographers experiencing difficulties.

Inadequate resources included inappropriate access to computing and library facilities due to inadequate opening hours and inequity of access in some hospitals. However, most radiographers admitted that the problem lay in their inability to make the best use of such facilities due to a lack of previous education and training. This related particularly to literature searching, referencing and computing, though this may become less of an issue as more radiography graduates enter postgraduate education.

Unclear goals within the academic course was found to be a particularly important cause of stress, correlating well with role ambiguity described by Polworth [14]. Uncertainty regarding the level of work required was apparent particularly in the early stages of the course, as students were struggling with the concept of masters degree level study. A general lack of information throughout the course was noted by several radiographers, particularly with regard to the presentational aspect of assignments and format of examinations. A lack of previous examination papers increased their examination anxiety, a finding previously reported by several authors [12, 16, 19]. The 'usefulness' of modules was frequently questioned, implying that radiographers are 'goal-oriented', although students begin to understand the relevance of most aspects of their course as time progresses:

> *'I've realized that perhaps my interpretation of the course wasn't from a very good standpoint.'*

This is an interesting finding, and points towards the possible advantages of new students seeking information from previous students, who appear to have a more appropriate holistic view of their course.

Spillover was also reported as being an important cause of stress, where academic stress was taken into the family home and vice versa. Academic stress resulted in poor communication, badtemperedness and lack of time for other family members. One radiographer, for example, told how his studying had affected the early part of his marriage:

> *'We should have been learning about each other and we weren't—and there was not a bond—not the sort of bond that there is now. It really stressed and stretched our marriage during that first year.'*

One of the most difficult spillover situations occurred when radiographers realized that their children were being affected by their studying, resulting in intense feelings of guilt:

> *'I was short of temper with the kids—unfortunately they bore the brunt of it . . my little girl has been having abdominal problems as well which I think is psychosomatic—it seems as though she wasn't getting enough attention at the time . . .'*

> *'I wonder if I'd have been a different mum if I hadn't had this course?'*

In their study of professional working mothers Emmons *et al.* [6] highlighted similar feelings of guilt and frustration regarding the limited time that was available to spend with their children.

Negative spillover of stress from the home into the academic course was far more common than initially anticipated. Difficult home circumstances compromised the academic ability of the student, and this was found to be one of the most important and influential stressors. Most of this spillover had origins in acute life events [9] affecting the radiographers, including bereavement, divorce, marriage and family illness. Indeed 9 out of the 13 radiographers interviewed had experienced at least one major life change during their course, leading to incidences of failed course work and examinations and a general loss of motivation. Considering the large number of major life events affecting the radiographers in this study, lecturers should attempt to remain responsive to the changing circumstances of such students, as their support requirements may also alter throughout the course.

Not all spillover had a negative impact however, with several instances of positive effects being recounted. This challenges the commonly held belief that all spillover must inevitably be negative. One example of positive spillover was where the challenge of a course increased the self-worth of the student which positively affected other family members:

> *'Doing the degree really helps you when you have personal problems because you shut off those problems*

and you focus on your work for that period of time to get you over it. It certainly helped me focusing on my studying.'

This finding concurs with social research [6] suggesting that the occupancy of multiple roles (wife, mother, student, radiographer) enhances feelings of personal worth and security.

The final cause of stress reported was lack of support from any significant individual or organization during the course of study. Lack of support, though often interchangeable with the giving of support on other occasions, was perceived to originate from many sources including the professional body, the academic institution, the clinical department, colleagues and occasionally fellow students and family. Inadequate support was frequently the result of poor communication, resentment and jealousy from colleagues, and a lack of trust among fellow students early on in the course. Lack of support from clinical colleagues caused much concern amongst the radiographers interviewed. A common example of lack of support described by the informants was a sense of 'false' politeness, where colleagues felt obliged to enquire how the radiographer was progressing on the course, but appeared to become disinterested if they received a reply from the student other than 'fine'. Lack of support also included casual indifference by colleagues, and in its more severe forms provoked resentment, jealousy and anger. Those studying for clinically-based degrees were frequently reminded by some colleagues (generally those who had not studied for some time) that it was:

'An easy way to a Senior 1 post.'

Such lack of support and poor communication with colleagues was identified by Casselden [15] as being inherently stressful.

Although most radiographers felt that they had received adequate support from academic staff, all could relate stories where such support failed. In many cases this was due to problems with timetabling, where not enough time was set aside to discuss problems with tutors. This problem was often exacerbated with large class sizes, creating difficulties for individual informal discussion with course tutors. However, some radiographers felt that lack of support was attributed to personality clashes with lecturers:

'Personally I find her a bit unapproachable, and a bit unhelpful, and she has very fixed ideas . . .'

One disappointing finding was the suggestion by some radiographers, who had failed assessments, that they believed the onus was on the tutors to drive the recovery of failures, and not on themselves. This does not appear to sit comfortably with the self-directed ethos of studying at Masters degree level.

A perceived lack of support from the professional body provoked disillusionment in some radiographers, who described how they felt 'let down' by the radiography profession. Two radiographers who were nearing completion of a first degree were concerned that if they had been aware earlier of the impending introduction of masters degree radiography courses, they may not have chosen to study at undergraduate level. Similarly, several radiographers who had previously embarked upon, or completed the Higher Diploma of the College of Radiographers (HDCR), were left feeling disillusioned due to the lack of accreditation and respect that they felt this award had received from universities:

'I had got the HDCR which, because of all the changes to degree education, meant absolutely nothing. So I was stuck with a higher qualification that wasn't recognized anywhere.'

'We had the rug pulled from under us, so we had to look for something else.'

Personal discovery

A vast amount of information collected from the interviews did not appear to fit in the effect or cause of stress category. The radiographers in this study appeared to undergo a process of 'personal discovery' during their course, enabling them to become reflective about themselves and to be able to evaluate their performance. This cycle assisted them in assessing the potential harm emanating from the many different stressors that they encounter. Personal discovery appeared to correlate closely with the cognitive appraisal of stress described by Cox [2]. The process involved a degree of personal doubt and worry as stressors were confronted, but by using their previous experiences the radiographers were able to find an individual coping style that worked for them.

Personal discovery involved making preparations prior to the course and drawing upon previous experiences. Finding an individual style of writing and studying which was 'comfortable' to

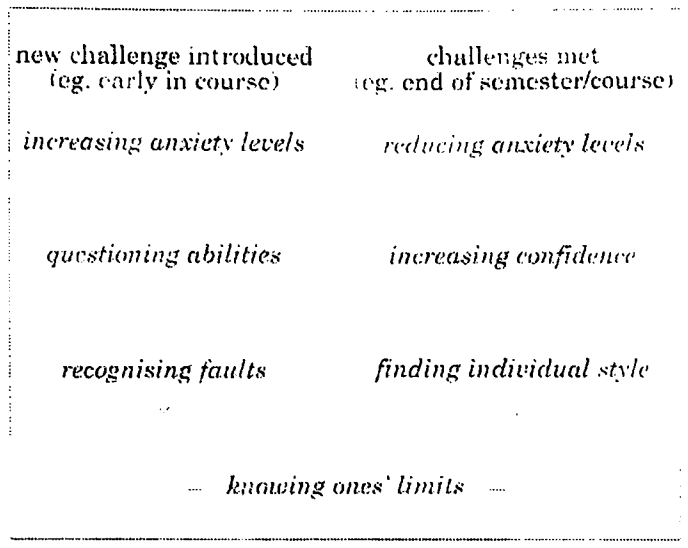

Figure 3. The process of personal discovery.

them was also part of this process. Students began to question their own abilities:

'If I have done the best I can and it's not good enough, then I have to sit back and think well am I cut out to do this?'

Personal discovery inevitably resulted in some minor changes of personality, with most students remarking that they had become more confident and more assertive, and appeared to be moving towards a strengthening of self-esteem.

'Now I know what I'm talking about . . . so nobody can just come and try it on with me.'

Most students were enjoying the challenge of their course, highlighting that they were seeking a greater challenge in their professional role. However, one additional worry recounted by several of those interviewed was that of an uncertain future in a rapidly evolving profession, promoting feelings of 'losing control':

'When everyone has got all these extra qualifications and they are still in exactly the same positions because there aren't any promotion prospects—doing more responsible things for the same money . . . there is going to be more dissatisfaction.'

This may be a problem in the future with more radiographers reaching postgraduate status, requiring possible innovative and flexible grading structures in order to tackle this issue.

The cognitive appraisal process found in the personal discovery category is demonstrated diagrammatically in Fig. 3. This process commences with increasing anxiety experienced in the early part of the course and progresses along several stages until ultimately a level of personal confidence is reached which will enable anxiety levels to reduce. This is an on-going process which will begin again when new challenges are encountered.

Methods of coping with stress

The coping methods used by the radiographers were varied and were placed into a number of categories, though it is acknowledged that several incorporated overlapping aspects of time management. The majority of the coping methods used were similar to those found in the study of professional working mothers by Emmons *et al.* [6], presumably because both populations under study had similar characteristics. These included the well-known coping strategy of 'planning and time management', and 'reappraisal', which was described as 'a need to step back' in times of turmoil such as failed examinations:

'You have to think it's not the be-all-and-end-all . . .'

'Divesting oneself of unimportant activities' was also described by Emmons *et al.* [6], and is a time-creating strategy whereby cutting back on leisure activities and 'on-call' commitments became the norm during term-time. However a worrying trend appeared to occur under intensely stressful periods, when radiographers admitted to cutting back on lecture attendance.

The 'superwoman' strategy which Emmons *et al.* [6] described as a response to role conflict involving using all available time creatively, was also highlighted in this study. This involved cutting back on break times, lunch hours and sleep:

'If I could get to bed before midnight and do the housework in the evening, I could then work off less sleep and get up early and do a couple of hours of study before the boys woke up . . .'

The consequence of the above was physical exhaustion after a period of time, so this is not necessarily a successful long-term strategy. However, many felt that there was little choice, as the burden of caring for children still rested on their shoulders.

Three other coping strategies outlined by the radiographers had previously been described by Folkman and Lazarus [7]. 'Taking a break' linked well with time management, and involved carefully protecting leisure time:

'I am a firm believer in making time to relax, because you can't work all the time, and it improves your work because you don't get stale.'

'Seeking social support' was generally a most successful coping strategy, though some were initially reluctant to seek help, preferring to work through problems individually. Support from fellow students and colleagues was much valued throughout the course. Support from family was generally unquestioning though there was some evidence that this support was slowly withdrawn towards the end of a long course, where family members were possibly suffering from 'support burnout'.

The final coping strategy related by the radiographers was that of 'avoidance'. Although this may seem an inappropriate strategy, for some radiographers avoiding confronting a particularly stressful aspect of their course did result in reduced anxiety levels. This is in agreement with Neufeld [3] who suggested that successful avoidance measures result in minimal energy expenditure, and therefore lead to little or no stress. Avoidance could be a short-term measure such as procrastination (for example 'putting off' a particularly difficult assignment until a later date), or total, including two examples reporting complete avoidance of the use of a computer. This involved asking family members to type up hand-written notes for assignments and projects or paying external agencies. Although avoiding confronting the obvious lack of expertise, resultant stress levels were reduced. In the long-term there is some concern regarding this strategy because it may ultimately be detrimental to the educational development of the radiographer.

Not all coping was successful initially, requiring re-evaluation during the personal discovery cycle. Unsuccessful coping necessitated seeking support from significant others such as tutors and fellow students, though radiographers usually attempted to confront problems alone in the first instances. Unfortunately for some radiographers advice was sought too late resulting in an accumulation of stress. Encouraging radiographers to seek support at an appropriate stage may be an interesting challenge for academic lecturers.

As suggested in the literature review, the coping strategies used by the radiographers appear to be similar to those identified in studies using similar populations [5, 6]. However they rarely reflected the coping strategies identified in dissimilar populations, such as chronically ill patients [7]. Coping, although a highly individual process, can therefore be assumed to be relatively consistent across groups with similar characteristics. This enables identified individuals (such as lecturers) to be able to offer constructive support and guidance regarding what may be successful and unsuccessful coping strategies regularly used by the target population.

Conclusions and recommendations

Postgraduate radiography students suffer varying degree of stress during their course, mainly as a result of the difficulties of combining a demanding academic course with the responsibilities associated with a full-time health service career. Being mature students they also have to integrate their studies into the demands of family life. A range of stressors was related by the radiographers in this study, most of which were a response to both quantitative and qualitative work overload. The spillover concept appears to be a previously underestimated source of stress, particularly in the direction of home to course. The process of stress appraisal labelled 'personal discovery' in this study, was used by the students to assess the potential harm from different stressors and to select appropriate coping strategies. Various strategies were initiated to deal with the stressors, though not all were initially successful in reducing or removing the stress. The personal discovery process eventually led to a strengthening of self-esteem in most students. The entire process can be seen diagrammatically in Fig. 4.

This research has attempted to provide an insight into the potential 'life-world' of the postgraduate radiography student, and from this research a series of recommendations for radiographers interested in embarking upon postgraduate study can be made:

- Prepare well in advance prior to embarking upon postgraduate study, ensuring that adequate time is allowed for improving computer literacy and investigating hardware and software purchasing or leasing options. For those who have not engaged in academic study for some time, it may be advisable to seek to improve writing skills by attending evening classes or similar. This time will not be wasted as it will strengthen the student's application for the course.
- Select a course carefully, ensuring that it is entirely relevant to individual and departmental needs. Seek further information regarding

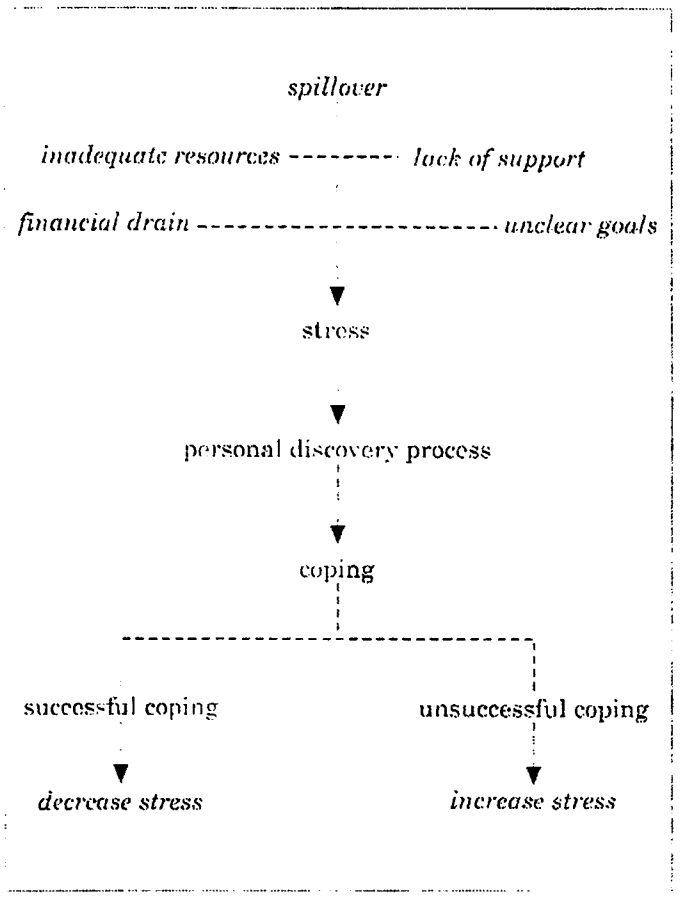

Figure 4. Stressors experienced by the postgraduate students in this study, and the coping methods and support networks available to them.

appropriateness from academic staff and previous or existing students.

- Approach clinical managers well in advance for funding and time allocation for study. Agreements should preferably be in writing. Where partial funding is available, it is worthwhile investigating alternative arrangements to help spread the cost. These can include direct debit, as well as bursaries from health trust funds and charities.
- Discuss implications of the course openly with family, friends and colleagues, explaining the time commitment and support required.
- Attempt to make course work relevant to the needs of the clinical department where appropriate in order to increase the interest and support from staff and managers. Involve staff by feeding back results when appropriate.
- Approach the course leader or personal tutor for advice regarding any significant spillover or academic issues which may be interfering with progress on the course. They may be able to offer alternative solutions to facilitate the student's progress.
- Be prepared to seek and accept support when it is available. Participation in student support groups is often found to be a useful exercise.

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Appendix 1

Stages of data analysis

(adapted from Burnard, 1991).

1 Notes and memos made in the field diary following each interview. Transcripts made in full.

2 Transcripts read through and notes made on general themes which arise.

3 Headings made which describe all aspects of the content of the transcripts, other than those unrelated to the topic in question. The headings or 'categories' should account for all or most of the data—at this stage this is known as open coding.

4 List of categories is grouped together under higher-order headings, in order to reduce the number of categories (collapsing similar headings under broader categories).

5 New list of categories is surveyed to remove repetitious or similar headings.

6 An experienced qualitative researcher is invited to review a transcript and generate their own category system. This is then discussed with the researcher, and adjustments are made as necessary.

7 Transcripts are re-read alongside the final list of categories to establish the degree to which they cover all aspects of the data.

8 Each transcript is reviewed with the list of headings and is coded accordingly. Coloured highlighting pens will be used to identify parts of the transcript which fit with each category.

9 Each coded section is cut out of the transcript, and all items of each code grouped together. Multiple photocopies of the transcripts are used to ensure that the context of the data are maintained, and meaning is not altered.

10 Cut out sections are pasted together under appropriate headings and sub-headings.

11 Three informants are asked to check the appropriateness of the category system, by showing them parts of their interviews and allowing them to decide whether the heading allocated was appropriate.

12 Sections filed together ready for writing, alongside complete transcripts for reference.

13 Writing up process begins, taking each category in turn, and identifying any further links between them.

14 Data examples are linked with commentary from the literature. Although writing a separate section which links the findings to the literature may be considered more pure, to consider the two together is felt to be more practical and readable.

Identification number	Published work 2 (PW2)	2003
Title	Clinical Practice at an Advanced Level	
Authors	Nightingale J and Hogg P	
Contribution	50%	
Full reference	Nightingale J and Hogg P (2003), Clinical Practice at an Advanced Level, Radiography, Volume 9, Issue 1, February 2003, 77-83	
Publication media	Peer reviewed international journal (quarterly)	
Abstract	Excerpts from the Introduction: The way that healthcare is developing in Great Britain is unique because of the way the advanced clinical practice of the so-called 'non-medical' professions (e.g. nursing, radiography, physiotherapy etc.) has advanced at a phenomenal rate. At a local (hospital) level, radiographers are being encouraged to take on new roles; although in some sub-specialties of radiography, the rate of change has been more sedate. .....On examination of the literature, one will find many articles and comments in journals, professional magazines and conference abstracts books on the various aspects of advanced practice. However, there is a lack of systematic documentary evidence that takes into account the current and future states of practice. Many of the publications and presentations on the advanced practice are often specific in nature—addressing a focused aspect, and often such valuable work adds to the general body of knowledge. In this series of articles, an attempt will be made to summarise and document generic (e.g. legal issues) and specific (e.g. the role of the gastro-intestinal (GI) specialist) themes on the advanced clinical practice.....This article commences with a review of the current position of advanced radiographic practice, which is followed by an examination of some catalysts that may have contributed to the current state of affairs.....	
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Thesis aims supported	Aim 1	

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REVIEW ARTICLE

Clinical practice at an advanced level: an introduction

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INTRODUCTION

The way that healthcare is developing in Great Britain is unique because of the way the advanced clinical practice of the so-called 'non-medical' professions (e.g. nursing, radiography, physiotherapy etc.) has advanced at a phenomenal rate. At a local (hospital) level, radiographers are being encouraged to take on new roles; although in some sub-specialties of radiography, the rate of change has been more sedate. For example Holmes and Hogg [1] and also Huggett and McClellan [2] nicely illustrate this on the subject of *image interpretation* by non-medical staff or personnel in nuclear medicine. Nonetheless, it is well recognised that local variations exist, but the overall ambition (both politically and professionally) is for a greater engagement in advanced practice to improve patient care and management. One must accept that, for a variety of reasons, there will always be resistance to change; and perhaps in a future article, this topic could be the subject of a debate.

On examination of the literature, one will find many articles and comments in journals, professional magazines and conference abstracts books on the various aspects of advanced practice. However, there is a lack of *systematic* documentary evidence that takes into account the current and future states of practice. Many of the publications and presentations on the advanced practice are often specific in nature—addressing a focused aspect, and often such valuable work adds to the general body of knowledge. In this series of articles, an attempt will be made to summarise and document generic (e.g. legal issues) and specific (e.g. the role of the gastro-intestinal (GI) specialist) themes on the advanced clinical practice. There is a dual purpose to this exercise: to formally record summary information for historical record; and to address more contemporary issues—such as the sharing of experience and knowledge in a bid to help meet common educational needs.

Although most articles on the advanced practice are specific in nature, it is important to note that some review and debate articles do exist. In particular, we draw the attention to Hay's [3] article. This article gives an excellent overview of skill mix and advanced practice in 1998. Then there is the more specific work of Price [4], a seminal piece, documenting how reporting for radiographers evolved throughout the ages. The work of Paterson [5] helps us to understand the need for publications addressing not only the current situation, but also the future development of the profession.

This article commences with a review of the current position of advanced radiographic practice, which is followed by an examination of some catalysts that

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Table 1 Examples of advanced 'radiographer' competencies

1. Justifying (and 'prescribing') the need for drug intervention as part of a radiological procedure (e.g. diuretics and smooth muscle relaxants)
2. Reading images/data and writing formal clinical reports (e.g. ultrasound, mammography and plain radiographs)
3. Conducting and/or managing complex invasive procedures (e.g. contrast angiography, GI studies and biopsies)
4. Performing therapeutic procedures (e.g. counselling)
5. Informing patients of the examination results, including breaking 'bad news'
6. Leading clinical research projects; teaching in universities and hospitals
7. Requesting radiological procedures ('Referrer') and justifying radiological procedures prior to conducting them ('Practitioner')

may have contributed to the current state of affairs. We then examine some advantages of advanced practice, and offer some 'what next' scenarios. In the next edition of *Radiography*, we shall explore one particular aspect of advanced practice—the GI-specialist radiographer. Suggestions for the future articles or the write-ups on the subject are welcomed.

THE CURRENT POSITION OF ADVANCED CLINICAL PRACTICE

The National Health Service (NHS) is rapidly moving towards an institution that is focused around the needs of the patient; in some respects, this is at variance with a traditional approach to service delivery. This patient-focused approach is well articulated in the document 'A Health Service for all the Talents—Developing the NHS Workforce [6]':

> The traditional demarcations between staff have held services back ... the provision of health services should depend on the ability of staff, not their job title.

To help advance the patient-focused delivery of care, a four-tier structure is being introduced within the health professions. In particular, the upper two grades (Consultant and Advanced Practitioner) could be seen as catalysts that will encourage clinical professionals to engage at an advanced practice level, whilst simultaneously rewarding them for the additional benefits they bring to patient management and care.

Table 1 illustrates some of the current advanced practices in which the radiographers engage. As can be seen, the scope of advanced practice could embrace a wide variety—from conducting highly invasive complex-imaging procedures to the management of sensitive and highly emotional patient issues. It is clear that the job of a radiographer can be very demanding, it requires personal attributes ranging from practical and intellectual skills to highly developed inter-personal abilities.

On examination of the literature, one identifies that most radiographers specialise and become skilled in particular niches; a niche might have a technology focus (e.g. a specialist in the application of ultrasound) or a body 'part'/pathology focus (e.g. breast cancer—the 'mammographer'). Occasionally, a radiographer may have a broad base of skills, as illustrated in Table 2. Table 2 presents the notes taken from one of the ten interviews performed on radiographers practising at an advanced clinical level. The interviews were used to help inform an invited review conference presentation in America in 2002 [7]. It can be seen from Table 2 that an individual radiographer can develop a wide range of advanced practices. Furthermore, and quite interestingly, on examining the job outline in Table 2, it becomes very difficult to distinguish between a radiographer and a radiologist. The traditional demarcations between staff groups are indeed becoming blurred.

The value of radiographers practising at an advanced clinical level is well recognised in numerous audit and professional reports, so much so that some workforce-development confederations have started to place post-basic/post-graduate education and training commissions for particular areas of

Table 2 Specialist Radiography Practitioner and Honorary University Lecturer (extracts from interview notes 2002 [7])

Qualified 15 years; approximately 70% of the time the job role is at an advanced practice level. Examples of responsibilities include:

1. Barium swallow and enema management, including reporting
2. Conducting sialography and peripheral venography
3. Reporting X-rays of the axial and appendicular skeleton (accident centre films)
4. Teaching radiologists and radiographers in university and hospitals

advanced practice (most noticeably for medical ultrasound). This is promising because until now radiographers or individual hospitals have had to pay for post-basic/post-graduate education and training. It is quite encouraging to see that advanced practice for radiographers is becoming commonplace and is being supported at many levels.

SOME CATALYSTS THAT HAVE LED TO THE CURRENT STATE OF AFFAIRS

It is difficult to pinpoint any one particular incident that resulted in the current situation; however, many inter-relating and mutually supportive events have combined to have an augmented effect. The development of roles at an advanced level is not unique to radiography and it would be hard to identify which profession was first performing advanced practice (simply because not all working practices have been documented in the literature). However, it would be fair to say that the real push came from the nursing professions. The relationship between the nursing and medical professions developed to a point to enable role and task delegation, and consequently, practice evidence was published. Around this time, radiographers commenced advanced level clinical activity, mainly starting with reporting ultrasound images. At some point, the health ministers began taking an interest, and we are now seeing a major shift in policy, ultimately allowing for more latitude in working practices and the blurring of professional boundaries. Discussed subsequently are the examples of some critical catalysts that have led to advanced practice for radiographers.

Professional body and legal support

Policy statements, national guidance and the law fully support radiographers (and others) to engage in clinical practice at an advanced level. The Society and College of Radiographers have made clear statements of their support (e.g. Ref. [8]), as have the Royal College of Radiologists in conjunction with the Society and College of Radiographers [9]. In addition to this, the General Medical Council clearly supports the delegation of medical responsibilities to other profession groups. For instance:

> Medical practitioners may delegate medical care to non-medical health care staff—but the medic must be sure that such staff are competent [10].

and

> such health care staff must be accountable to a statutory body (i.e., state registered) [11].

However, support from professional bodies is only a part of the story, and without legal backing, advanced practice could be breaking the law. Fortunately a number of pieces of new legislation and guidance have helped facilitate the implementation of advanced clinical roles. Two examples, derived from the same piece of law, are discussed subsequently.

IRMER 2000 [12]: Like many new pieces of legislation and guidance, this makes specific reference to a competence/skill base rather than a named professional group. As such, radiographers and other professional groups may be allowed to take on new responsibilities—such as Referrer (and Operator) and Practitioner.

A Referrer is a healthcare worker who requests a medical exposure. An Operator is a healthcare worker who performs a medical exposure. A Practitioner is a healthcare worker who justifies the medical exposure, thus allowing the examination to take place. It is clear that radiographers are working at all the three levels; for instance, two of these levels are illustrated by Holmes and Hogg [1].

IRMER 2000 [12]: All the radiological examinations must be reported, this is a professional requirement of the Royal College of Radiologists and also a legal requirement (Ref. [12], Regulation 7). Since there is a national chronic shortage of radiologists it is likely that the combination of law [12] and the professional requirements will help reenforce the development of reporting skills in radiographers. It is worth noting the 2002 Royal College of Radiologists publication [13] entitled 'Clinical Radiology: A Workforce in Crisis'—it estimates that the number of UK radiologists posts 'needs to double just to match existing workloads, let alone take into account future service pressures'.

A range of factors confounds the shortages of radiologists. Technological advances within radiology have resulted in time and effort of radiologists being diverted away from certain well-established activities (e.g. barium work and plain film radiography reporting) towards more complex procedures (e.g. magnetic resonance imaging and interventional

therapies). There is also a year-on-year increase in the overall numbers of examinations performed [14]. Improvements in the delivery of services, for example cancer, have been driven through the introduction of National Service Frameworks, the NHS Cancer Plan (2000) being such an example [15]. This document outlined the role of the new Cancer Services Collaboratives, which were tasked with re-designing services, cutting waiting times and improving the patient experience. It also identified the central role of radiologists in cancer care, requiring their presence at all multi-disciplinary meetings. Such transparent government initiatives have led to increased patient expectations and have added to the roles, which radiologists are expected to perform. Radiologists are also expected to meet additional supervision requirements of specialist registrars and medical-student teaching, and also an increased out of hours and research expectation [13].

Not surprisingly, the 2002 Radiology Audit Report [16] suggests that the traditional separation of roles between radiographers and radiologists has changed, as ways are being sought to increase productivity. This report clearly suggests that staff need to be given the opportunity to develop beyond their existing roles.

The evidence base

For the development of professional roles, the answer to the question, 'Do radiographers use evidence to inform clinical practice?', is unarguably yes. Radiographers, radiology service managers and radiologists most certainly generate and subsequently use evidence to inform the strategic and operational direction in which the radiographers are becoming involved in day to day service delivery. Let us examine two examples to support this view.

Example 1: A number of publications demonstrate that radiographers can perform certain delegated tasks to a very high standard [17–21]. In the ability to report X-ray films, Cassidy *et al.* [22] illustrated that there was no statistical difference between the third-year registrars and radiographers; however, a significant difference between second-year registrars and radiographers existed ($P < 0.02$)—radiographers were better. There are a lot of published studies asserting similar outcomes. On the basis of this type of research, informed arguments have been posed to justify hospital business cases that argue a need for greater involvement of radiographers in the reporting process. However, one should be cautious while assessing the evidence base of such advanced practices, for example Brearley *et al.* [23] questioned the validity of the methodologies used in some radiographer-reporting audit and research studies.

Example 2: Several studies have demonstrated that multiple reading of barium enema images reduces errors significantly (both in statistical and clinical terms), [24, 25]. For this reason, double reporting of the double-contrast barium-enema examination is said to be the 'gold standard'; though in practice, shortages of radiologist result in many departments falling short of this ideal. To address this shortfall, radiographers are now formally engaging in double-reporting processes, both within fluoroscopy and mammography.

The published evidence base is of growing value nationally and internationally. Nationally, it helps to influence policy and, therefore, define scope of practice and standards. Internationally, it helps other nations see that professions other than medical practitioners are capable of managing and delivering care and treatment beyond their normally accepted scope of practice.

POTENTIAL ADVANTAGES OF PRACTISING AT AN ADVANCED LEVEL

There are a number of values of practising at an advanced level, and these values can be loosely classified under four headings: (1) value for the patient; (2) value for the radiographer; (3) value for the profession; and (4) value for the radiology service.

The patient

Does radiographer advanced practice lead to improved patient outcomes? We know that the interests of the patient are paramount [26]; and before any advanced practice role is introduced, a risk assessment must be undertaken to ensure that at the very least, the patient experience will not be adversely affected, and will hopefully be improved. There is much evidence that points to improved patient experiences as a result of advanced practice [27, 28]. For example, radiographer reporting may result in reports that are available to the referring clinician immediately (hot reporting), or at least soon enough to allow more timely patient management.

Radiographer-led fluoroscopy or urology often results in better continuity of the service (the so-called 'seamless' approach), with patient and referring clinician queries dealt with directly by those who will perform the examination. Involvement in audit of advanced practice will result in the identification of areas for improvement, and may result in a new approach to departmental standards and protocols.

The radiographer

For many years, there has been a view that radiographers have been working below their potential in both specialised and general radiographic roles [29]. Advanced practice enhances the role of the radiographer by offering new career pathways and new opportunities for professional development, in line with the CPD expectations of the professional body and likely requirements of registration. These opportunities include a greater role in patient management and care, and a greater emphasis on collaborative multi-disciplinary working. The additional responsibilities associated with advanced practice are key elements to the new Advanced Practitioner role and, most certainly, to a Consultant Practitioner role. The advanced practice radiographer is taking a step towards becoming a more autonomous practitioner, which should be reflected in salary and grading terms.

The profession

Participation in advanced practice roles, particularly those involving greater multi-disciplinary working, will enhance the status of the radiography profession [30]. Radiographers who develop their role can contribute to clinico-radiological meetings in a better way and are well placed to collaborate in multi-disciplinary audit and research. The status of radiographers is also likely to increase amongst existing radiologists and radiology trainees—particularly, if registrar training is part of the radiographer's role. There is evidence to suggest that radiographer-role developments are readily accepted by other health professionals, especially when they witness the holistic benefits that advanced practice may bring.

The radiology service

The main drive for the introduction of advanced practice roles is to improve in some way the efficiency and/or quality of the radiological service. For example, the introduction of trauma reporting by radiographers has usually been a response to films going unreported or reported too late to influence patient management [31]. Reports issued at or near the time of the examination will undoubtedly be less likely to invite litigation. Similarly, the introduction of radiographer-managed barium-enema lists has often been a response to unacceptably long waiting lists for fluoroscopic procedures, particularly in the light of cancer waiting list initiatives. The introduction of other roles such as radiographer-managed intravenous urography lists have reduced the actual examination time per patient, as the intervention of a radiologist has not been necessary for injecting contrast agents or assessing images. As radiographers have taken on a greater number and range of advanced practice roles within the service, a greater amount of radiologist time has been released. This additional time has potentially enabled greater emphasis on complex procedures and interventional radiology, as well as on the requirements of clinical governance and research.

It is beyond the scope of this article to present the balanced view—i.e. the limitations of and barriers to advanced practice. However, as suggested in the section 'Introduction', it might be worth our while writing a full article on this topic for a future edition of Radiography.

WHAT NEXT?

There are at least three obvious 'what next' scenarios. First, a pragmatic approach—'what can radiographers take on next to provide a better service to their patients?' A whole list could be drawn up. Second, another pragmatic approach—'what can other professional groups do in terms of medical imaging and radiotherapy?' Third, a philosophical approach—'when does an advanced practice role become a basic requirement of the job?'

In some respects, this latter philosophical issue has been tacitly creeping up on us for years, but we may not have recognised it. For instance, one could argue that sonographers must report images as a basic job requirement. If this is true, then is it fair to say that image interpretation is part of a normal sonographer's role? In which case, what is advanced practice in sonography–biopsy perhaps? A similar issue could affect mainstream radiography too. Currently, writing reports by radiographers is considered an advanced clinical role. However, in

the light of subject-benchmark statements and also professional advice, some undergraduate curricula have recently moved to the inclusion of image interpretation skills in the qualifying award. Presumably, it would only be a matter of time before reporting the radiograph would be a basic job requirement for radiographers; in which case, like sonography, would not reporting the image become the norm and routine. This again raises the question 'what will advanced practice constitute for such radiographers in the future?' This argument demonstrates that nothing stands still, and it is true that the goal posts will change—particularly for career progression. Perhaps this current state of change may be followed by a period of stability, where roles will again become entrenched within a new sub-culture of professional demarcations. Albeit this time, the subdivisions might be between the 'medical profession and the others' and also between the 'various levels within the proposed four-tier structure'. Comments on this discussion are invited.

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FURTHER-READING

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Abstract	INTRODUCTION Radiographer role development in the field of gastrointestinal (GI) imaging is a flourishing sub-specialty, with radiographers in many National Health Service (NHS) Trust hospitals performing a range of examinations that were formerly in the province of the radiologist. The emergence of this advanced role has been rapid and sustained, with practitioners continually pushing the traditional practice boundaries within this specialty. The purpose of this article is threefold. Firstly, it is important to document the historical context and justification for this change in practice; secondly, to provide an overview of the scope of practice currently seen across the UK; and finally, to consider the potential opportunities afforded to GI practitioners and their patients in the future.	
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REVIEW ARTICLE

The gastrointestinal advanced practitioner: an emerging role for the modern radiology service

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INTRODUCTION

Radiographer role development in the field of gastrointestinal (GI) imaging is a flourishing sub-speciality, with radiographers in many National Health Service (NHS) Trust hospitals performing a range of examinations that were formerly in the province of the radiologist. The emergence of this advanced role has been rapid and sustained, with practitioners continually pushing the traditional practice boundaries within this speciality. The purpose of this article is threefold. Firstly, it is important to document the historical context and justification for this change in practice; secondly, to provide an overview of the scope of practice currently seen across the UK; and finally, to consider the potential opportunities afforded to GI practitioners and their patients in the future.

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HISTORICAL PERSPECTIVE

For the last four decades, the national shortfall of radiologists required to cope with an expanding NHS has provoked a heated debate centred around the possibility of radiographers undertaking some of their work. Swinburne [1] is often quoted as being one of the early catalysts, suggesting boldly in 1971 that "certain radiology tasks could be devolved to radiographers." However, only relatively minor role changes were introduced in the 1970s and 1980s, and it was not until the 1990s that the pace of radiographer role development accelerated.

In 1995, a highly critical Audit Commission report of radiology departments identified the major difficulties in offering an effective service [2]. In particular, attention was drawn to long waiting lists for complex examinations, and many examinations being unreported or reported too late to influence patient management. In part, this report provided impetus for a range of role development initiatives in the latter half of the 1990s.

The double contrast barium enema (DCBE) examination was one such case in point—extensive waiting lists were the norm, with some suspected cancer patients waiting weeks or months between referral and diagnosis. In 1981, the DCBE was

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considered by Somers *et al.* to be a potential area for role delegation, as it could be 'easily described within a pre-defined standard protocol' [3]. This is not to say that it is an 'easy' examination to perform; on the contrary, the protocols often require adaptation to accommodate a wide range of anatomical and patho-physiological variations. Although this (Canadian) study demonstrated the delegation of the barium enema to be feasible, it was not seriously considered in the UK until the results of a pilot study for a barium enema training programme for radiographers were published in 1995 by Mannion *et al.* [4]. The success of Mannion's pilot study was assessed by comparing radiographers' and radiology registrars' performances on several aspects of the DCBE role. The pilot study concluded that delegation of performing barium enemas to radiographers was both safe and effective [4].

A barium enema training course was subsequently introduced at St. James's Hospital in Leeds in 1993, comprising a 1.5-day theoretical course combined with clinical training by a supervising radiologist, followed by a 1-day refresher course 6 months later. This training course proved to be very popular, offering radiology departments a low-cost, fast-track solution to lengthening waiting lists and radiologist shortages. More importantly, it added weight to the argument that radiographers could play a much greater part in patient management [1], and provided a springboard for many radiographers to move into a more challenging role.

The Leeds short course has continued to be a leading provider of initial barium enema training. On completion of this course, many radiographers have continued their education at universities offering related Masters degree level courses. The opportunity to study at a higher level has provided practitioners with some of the underpinning skills and knowledge necessary to critically evaluate their role and practice at an advanced level.

Recent estimates suggest that at least 1000 radiographers have been trained to perform barium enemas; not surprisingly, the practice is now widely accepted. The percentage of NHS Trust hospitals participating in this role has been estimated between 82% [5] and 69% [6]. A preponderance for non-teaching hospitals has been noted, with lower rates of uptake in Scotland, Wales, Northern Ireland and London [6]. Many teaching hospitals have, perhaps, been reluctant to introduce GI role development because of the perceived effect on radiology registrar training, or perhaps because there is less need due to higher radiologist staffing ratios [5].

JUSTIFICATION FOR RADIOGRAPHER-PERFORMED DCBE

The development and acceptability of the GI radiographers role has been influenced by a range of published research and audit, related particularly to safety and efficacy of the delegated role.

Several studies have noted positive service improvements because radiographers have been available to perform a greater number of barium enema sessions, thus reducing waiting times [5, 7]. There is also a positive knock-on effect for other waiting lists, as radiologists are available for other duties.

The cost-effectiveness of such delegation is also evident, with radiographer hourly rates being significantly less than those of a radiologist [8].

The technical quality of the radiographer-performed DCBE examination has been extensively studied, with much literature reporting a high-quality examination [3, 5, 9] that is indistinguishable (or better) than that of radiologists or registrars [4, 10, 11].

Linked to the technical aspects of the examination is the diagnostic value. This has been studied by several authors by cross-checking histologically proven cancers with previous barium enema reports. Such studies have reported that radiographer-performed studies compare favourably with radiologist-managed procedures [9, 12, 13].

Before any role development can be introduced, a risk assessment should always be performed to ensure that patients would not be unduly harmed by the change of practice. In terms of the DCBE, assessment of patient radiation dose, and also of complication rates is essential.

Crawley *et al.* [12] undertook a comparative study of radiologist- and radiographer-performed barium enemas, which identified an increase in effective radiation dose to the patient in the radiographer studies. Although an increase in fluoroscopy times could be excused during early fluoroscopy training, there was grave concern that radiation doses were higher when experienced GI radiographers were conducting the examination. Crawley *et al.* identified that the radiographers were obliged within their protocol to take a greater number of hard-copy images than the radiologists, and this contributed to the

extra dose burden. This practice (which was commonplace in the 1990s) was difficult to justify. The authors concluded that a revised protocol was essential; and in 2002, they reported that no dose penalty was incurred while following their new digitally based protocol [14].

Other studies have found either no difference in radiographer's or radiologist's fluoroscopy times and radiation doses [4], or statistically significant reductions in radiographer-performed enemas [10]. However, there is a need to avoid complacency in this issue, as the barium enema examination contributes one of the highest doses in the radiology department. Certainly, much can be done to optimise the fluoroscopy technique, but equipment factors have been found to influence dose to a much greater degree [15]. For example, the introduction of digital spot images may give only 10–20% of the radiation dose of a conventional film/screen combination [15], and removal of the antiscatter grid during fluoroscopy might also lead to a significant reduction in doses [16, 17].

Crawley *et al.*'s article [12] highlights one of the problems that many radiographers experience when first undertaking the DCBE role development—that of restrictive and overly prescriptive protocols. During the initial introduction of radiographer-performed enemas into a department, both radiologists and radiographers may feel more comfortable with such prescriptive protocols. Such protocols may require referral to the radiologist for the administration of antispasmodics, or to check films prior to allowing the patient to leave the department, and even to routinely re-screen the patient. Such practices are indeed restrictive, but perhaps understandable. However, as individual practitioners have gained experience, the protocols must be relaxed to enable the radiographer to minimise radiation dose, and to facilitate more autonomous and patient-specific practice.

The barium enema is an invasive procedure not without risks, and reassurance that patients have not been adversely affected by radiographer participation in this examination, has been welcomed. Complication rates are reported to be similar to those of radiologists' [7, 18], with a mortality rate of 1 in 44,900 [18] compared with 1 in 56,786 for radiologists [19]. Care must be taken when interpreting these figures because, although radiologists may perform the more difficult cases in some trusts, the radiographers' practice is likely to be audited more frequently [5], and complications, therefore, are identified more readily. In the early implementation of this role development, the range of patients examined by radiographers was often restricted to relatively fit and younger outpatients, with the clinical indications also being restricted. However, as experience was gained, radiographers commonly accepted those patients onto their lists who were likely to include the very frail and elderly, and more complex examinations, such as postoperative checks and colostomy studies. When such patient groups are examined, there will inevitably be a rise in reported adverse events, such as perforation and cardiac complications.

In summary, radiographer-performed barium enemas have been shown by many studies to be an efficient, cost-effective and safe delegated role. Early opposition from some radiologists and radiographers appears to have dwindled, as the role has gained acceptability. However, despite the obvious successes, barium enema radiographers in many trusts began to feel isolated and somewhat undervalued, believing that they had much more to offer. For this reason, amongst others, a national special interest group was launched in 1998 to offer support and encouragement to such radiographers, and to act as a link with the professional body. The GI Radiographers Special Interest Group (GIRSIG)[1] had the foresight to define their members as GI radiographers, rather than the traditionally accepted 'barium enema' radiographers. At the time of GIRSIG's launch, few would have predicted the expansion of other GI radiology investigations that would be incorporated into the role of many GI radiographers.

THE CURRENT POSITION

Influencing factors

A wide range of factors have led to the continuing development of the GI radiographer's role; these are indicated in Table 1. In particular, the continuing radiologist shortage has been highlighted by the Royal College of Radiologists publication entitled 'Clinical Radiology: A Workforce in Crisis', estimating that the number of UK radiologists' posts 'needs to double just to match existing workloads, let alone

[1] For further information about GIRSIG, please contact the Chairman Jon Pearson, GI radiographer practitioner, Norfolk and Norwich Hospital. E-mail: jonp2319@aol.com, telephone: +44-01603-286103.

Table 1 Some factors leading to the development of the role of the GI radiographer

Shortage of radiologists
Increasing radiology workload
Ageing population, with expanding patient referrals
Support from professional bodies for role development
Changing political climate supportive of role development
Potential introduction of national colorectal screening
Cancer target waiting periods and waiting lists initiatives
Radiographer (and radiologist) enthusiasm
Technological advances in CT/MR re-directing the GI radiologist from traditional barium workload
Greater number of referrals for time-consuming GI interventional services
Encouraging and supportive research and audit results

take into account future service pressures' [20]. Although recent intakes of radiologist trainees have increased, the GI speciality will, arguably, not be the first choice of many.

Radiology is indeed under pressure from an ageing population with its associated greater utilisation of clinical imaging. The GI radiology service is acutely affected, as most GI cancers have a higher incidence with advancing age. Colorectal cancer, for example, has a median age at presentation of just under 70 years. Barium studies in the elderly, although employing similar techniques, frequently take longer to perform and to interpret [20]. With demand for such techniques rising, and pressures for radiologists to offer more complex interventional examinations increasing, radiographers are stepping forward to maintain an effective service. These developments have been facilitated by professional body support [21, 22], the introduction of enabling legislation such as IRMER 2000 [23] and a changing political agenda. Key Department of Health documents [24, 25] have identified a need for modernisation, and see the allied health professions as pivotal to this process. In particular, government-set targets such as waiting list initiatives in the NHS Plan [26] and cancer standards have provided the impetus for new ways of working across the GI field. Improvements in the delivery of cancer services have been driven through the implementation of the NHS Cancer Plan [27]. This document outlined the role of the new Cancer Services Collaboratives, which were tasked with re-designing services, cutting waiting time periods and improving the patient experience [28]. It also identified the central role of radiologists in cancer care, requiring their presence at all multi-disciplinary meetings. Such initiatives have been focussed, in particular, on the colorectal service, as colorectal cancer is the second most common cause of cancer deaths in the UK [29], with a very low overall survival rate of only 35% when compared with that in most other European countries [28]. The prognosis is highly dependent upon early detection, and the government has, therefore, commissioned two pilot trials for colorectal cancer screening, which, if taken up nationally, will be likely to have an even greater impact on the GI imaging service.

The GI advanced practitioner

The traditional demarcations between radiologist and radiographer roles in the GI field have become blurred, with radiographers now extending the scope of their practice well beyond the restrictive protocols of early barium enema delegation. Current practice has developed in three ways: radiographers have accepted greater responsibility within the management of the DCBE examination; they have expanded the scope of their practice to include a range of other examinations; and they have developed their role to incorporate a greater teaching and research focus.

Greater responsibility within the barium enema role

Many GI radiographers have accepted greater responsibility for a wider and more complex group of patients, and in doing so have become well-respected members of the multi-disciplinary team. Regular attendance at relevant clinico-radiological meetings has afforded them greater opportunity for collaboration in cross-service audit and research initiatives to improve the patient experience. The majority of radiographers have increased their contribution to the reporting process, providing a provisional report, offering a formal report as part of a double reporting system or issuing the definitive report in some centres.

Implicit within advanced practice is an expectation that the GI radiographer should regularly audit their own practice to ensure their continuing competence, and there is much evidence of such audit activities taking place [9, 30]. It is interesting to note that the radiologists who delegated this role were rarely subject to the same rigorous audit cycle.

Table 2 Development of DCBE practice

1993	2003
Two radiographer lists per week	Nine lists per week (75% fluoroscopy workload)
Prescribed film series (all over couch)	No restrictions on imaging
No antispasmodics given	Choice of antispasmodics (within an approved protocol)
No patients over 65 years	All patients except colostomy enemas
No input to the reporting process	All radiographers trained to write a provisional report as part of double reporting system. One radiographer is independently reporting (PGC in GI reporting)
Dependent practitioner, with regular referral to radiologist (e.g. all films shown to radiologist before patient gets off table)	Independent practitioner working within a relaxed protocol, little reference to radiologists
No input to clinical meetings	Weekly attendance at gastroenterology and surgical meetings
Radiologist training for all staff (radiographers and registrars)	Radiographers train other staff including registrars

The practice has been developed in York Hospital over a 10 year period. York was one of the first trusts in the country to introduce radiographer-performed barium enemas.

Table 2 illustrates how responsibility and autonomy within barium enema practice have developed at one district general hospital over a 10-year period. However, still of concern is that the enhancement of the DCBE role has been hindered in some hospitals by a lack of resources (particularly staff time to report or attend meetings). GI radiographers should expect to be afforded the same opportunities as radiologists, including working with support staff to perform hard-copy films and assist with patient care. They should also expect similar educational opportunities to maintain and enhance their continuing professional development.

Expanding the scope of practice

The success of the barium enema delegated role coupled with the enthusiasm of radiographers has led to a wider range of examinations being delegated. In a number of centres, radiographers routinely perform other GI studies, particularly barium swallows and meals. A limited number of training programmes are available to support this role. Most training is, however, 'in-house', with radiographers undertaking a wide range of other contrast studies including proctograms, T-tube cholangiograms and small bowel examinations. Although there is limited published literature on the success of such initiatives, conference presentations have proved promising [31, 32]. Table 3 demonstrates the expanded scope of practice undertaken by the lead GI radiographer at one teaching hospital.

Several centres have now introduced new radiology services as a direct consequence of the enthusiasm and availability of the GI radiographers. Such services include videofluoroscopy for speech and language therapy, and 'same day' endoscopy and radiology clinics. These afford radiographers a greater opportunity for true multi-disciplinary work and increasingly autonomous practice.

Development of a strong teaching/research focus

It is now a common practice for experienced GI radiographers to undertake the training of colleagues

Table 3 Wide scope of practice within the GI role

Double contrast barium and water-soluble enemas. colostomy enemas
Barium- and water-soluble swallows, meals and follow throughs
Colonic transit studies
Small bowel enteroclysis
Ileostomy studies
Intubations and wire placement for oesophageal and rectal stent insertions; jejunostomy tube replacement
Venography
Diaphragmatic screening
Percutaneous endoscopic gastrostomy checks
T-tube cholangiograms and cholecystograms
Fistulograms and sinograms
Cystograms

Example of the Frenchay Hospital, Bristol, where radiographer role development in GI work has been an accepted practice for many years. The studies are performed by the lead GI radiographer.

new to the barium enema role, without recourse to a radiologist. In many teaching hospitals, this practice has been expanded to include radiographer-led training programmes and assessment for radiology registrars. This is a considerable accolade for radiographers, and sets the scene for improved working relationships between the professional groups in the future.

Many GI radiographers are also involved in formal teaching and assessment activities, including in-house tutorials and input into university undergraduate and postgraduate programmes. The value of such activities to both the practitioner and the profession has been recognised, with some radiographers holding honorary lecturer appointments.

The proportion of GI practitioners who have been involved in research, presentation and publication is still low, and there is scope here for improvement. In teaching hospitals, in particular, there will be opportunities for multi-professional research, and these must be seized. In the future, education up to and beyond Masters degree level for advanced GI practitioners will be essential to provide a proper understanding of the research process.

Table 4 shows how one GI radiographer at a Teaching hospital has developed teaching and research to be a significant proportion of the role. Many of the activities undertaken by this GI advanced practitioner arguably resemble consultant-level practice, and this debate will be continued in the following section.

Table 4 Developing the teaching and research focus of the GI role

Approximately 50% time practical teaching and mentorship:
Radiographer GI training (clinical)
Student radiographer fluoroscopy experience (including assessment)
Registrar practical training programme
Approximately 5–10% teaching within higher education:
Postgraduate GI reporting course: reporting skills
Undergraduate programmes: GI technique and pathology, student radiography awareness days
Member of GI reporting course team
Involvement in multi-disciplinary research and audit, resulting in peer-reviewed publications and presentations
Member of the national committee for GIRSIG
Completed PGC in GI reporting, now double reporting 75% of all enemas (including registrars). Nearing completion of a Masters degree
Give results to patients in conjunction with GI nurse practitioner
Manages the fluoroscopy suite, performs barium swallows, meals, enemas and videofluoroscopy
Performs a number of studies on private patients, for which she is paid

Example of roles performed by a GI advanced practitioner at South Manchester University Hospitals Trust.

FUTURE CHALLENGES

It is difficult to predict confidently what the future may hold, but, certainly, there are some areas of the GI role that will undergo change.

Radiographer reporting

Perhaps one of the most immediate service needs is to provide an effective barium enema reporting service that meets the challenges laid down by the NHS Cancer Plan [27]. Reporting at or close to the time of the examination is essential for appropriate patient management and to alleviate patient anxiety [2]. The pressures of increasing radiologist workloads may result in delays in the reporting process, and may impact on diagnostic error levels. Markus *et al.* identified the relatively high level of perception error in barium enema studies, resulting in up to 30% false negative decisions [33]. Indeed 'missed' colon cancers have been categorised by the Royal College of Radiologists as a serious reporting error that should have mandatory critical incident reporting and investigation [34].

Several studies have demonstrated that multiple reading of the images will significantly (both in statistical and clinical terms) reduce such errors [33, 35]. For this reason, double reporting of the DCBE examination is said to be the 'gold standard', though in practice, radiologist shortages result in many departments falling short of this ideal.

A survey by Price *et al.* indicated that approximately 20% of radiographers in the surveyed hospitals interpreted their barium enemas [6], but it was not indicated whether these were definitive reports. A recent article by Murphy *et al.* [36] presented a comparison of radiographer and radiologist reports over a 2-year period, following a period of 'in-house' training. They concluded that "radiographers

with specialised training can report barium enemas to a high standard" and recommended double reporting by two radiographers in 'normal' or 'diverticular disease only' cases [36]. This study was very encouraging; however, problems can arise with in-house training, as it can be highly variable and lacks rigorous assessment, creating problems of transferability between trusts. It might be worth noting that at the time of writing this article, at least two higher education institutions were offering training programmes for barium enema reporting/interpretation.

As radiographers perform greater proportions of the fluoroscopy workload in many trusts, the question must be raised as to whether the abilities of the radiologist to perform *and* report the examination diminishes with sustained lack of practice. This phenomenon is known as 'deskilling' [37]. There is also a potential for new recruits to the radiology profession to find difficulties gaining sufficient experience in fluoroscopic procedures; similarly, contributing to the 'deskilling' of the radiology profession. For these reasons, there is ample justification for trained radiographers to offer a formal report as part of a double reporting system, and this is supported by the 1997 College of Radiographers' document 'Reporting by Radiographers: A Vision Paper' in which it is stated that "Reporting by radiographers is not an option for the future. . .it is a requirement" [38].

Accountability

Advanced practice roles and, in particular, independent reporting bring with them significant medico-legal issues, as the radiologist has a lessening contribution to particular patient-care pathways. Radiographers must acknowledge that the courts do not recognise the existence of team liability, meaning that each practitioner is responsible for his or her actions and cannot blame the team for their negligence [39]. In a court of law, there is no defence for inexperience due to age, junior status or being delegated a role from another profession [39]. The patient expects a reasonable standard of care, no matter who performs the examination or who reports it. In the event of a medico-legal investigation being instigated, the competence of the GI radiographer would be judged by applying the 'Bolam' test [40], where the claimant would be obliged to prove that there was a failure to follow the reasonable standard expected from a competent practitioner [39]. Such competence would normally be judged against the expected standard of peers, but, in the case of the delegated role, the 'peers' may in fact be GI radiologists. There is an increasing trend towards specialisation within radiology, and this is mirrored within radiography (GI radiographers being a prime example). Halligan [41] expressed serious concerns that there may be a growing patient (and medico-legal) expectation that their care is only delivered by such 'experts', leading to the demise of the general radiologist. Could this be the future of our profession? It is clear that specialisation implies greater experience and practice within a smaller field with, at its heart, resultant benefits to both patients and staff. However, what is not yet clear is whether a general radiographer who performs one or two fluoroscopy sessions each week is likely to be at greater risk from medico-legal claims than a specialist 'full time' GI radiographer?

The problem remains, however, in determining what constitutes 'acceptable' competence in the absence of national performance standards. The drive to create national standards may gain impetus if a national colorectal cancer-screening programme is introduced, much as happened in the breast-screening service. The formulation of appropriate national standards undoubtedly presents an opportunity for collaboration between the Royal College of Radiologists and the College of Radiographers, along with their associated GI special interest groups. Currently, work is underway within GIRSIG to develop user-friendly guidelines for protocols for both performing and reporting the DCBE.

The demise of the DCBE?

A number of studies have highlighted the potential demise of the barium enema as a first choice investigation for many GI patients [42]. This is particularly poignant in the wake of new 2-D and 3-D techniques, such as virtual colonography and CT colonography, which offer patients less invasive and more comfortable procedures. Is the end of the barium enema in sight? The answer is probably not for some time yet, as the new procedures require spare capacity on a high-speed CT scanner and, currently, lengthy postprocedural re-construction and reporting times. Additionally, if a national colorectal-screening programme is introduced following the two current pilot trials, barium enema requests are likely to rise where colonoscopy is difficult or incomplete.

However, radiographers need to continue to push the boundaries of their role if they are to keep themselves rewarded and motivated. There are potentially no limits, as the Government has committed to removing unnecessary demarcations and introduce more flexible working practices [26] for the benefit of the patient. One example of exciting cross-boundary working has been seen at the Royal Cornwall Hospital, where an experienced GI radiographer has now developed her role to become the first UK radiographer endoscopist. Similarly, other GI radiographers are routinely performing invasive and interventional (therapeutic) radiology studies as part of their role, including pre-stenting guide wire insertion at the Frenchay Hospital in Bristol, and placement, management and removal of gastrostomy feeding tubes at Salisbury District Hospital (see Table 5). Such practices may be the future of the GI speciality and, although such possibilities may appear remote for many radiographers, it should be remembered that radiographer-performed enemas would also have appeared ludicrous in the 1980s.

Table 5 Advancing practice to include interventional and therapeutic procedures

Example 1: The Royal Cornwall Hospital, Truro
A radiographer has trained to perform sigmoidoscopies and colonoscopies, including therapeutic/interventional procedures. She regularly combines sigmoidoscopy with barium enema (one stop clinic), thus offering the patient continuity of staff. She is the first radiographer endoscopist in the UK, and has shared her experiences in both publications and presentations around the UK.

Example 2: Salisbury District Hospital
A radiographer performs a wide range of GI examinations, and assists with interventional procedures (scrubs up routinely). Works closely with the interventional team, including doing joint ward rounds for pre-interventional counselling and follow-up. She has developed a lead role in the placement of gastrostomy tubes, including performing the incision and administering lignocaine. She is the key worker for the gastrotomy service, offering advice and support to patients, GPs and nursing staff. She has built up extensive knowledge in complications of such procedures including scarring.

Example 3: Frenchay Hospital, Bristol
Lead GI radiographer performs and reports invasive procedures including enteroclysis. He is also responsible for inserting guide wires through oesophageal lesions prior to stent insertion and deployment.

The new four-tier structure

We are living in rapidly changing but exciting times. Pay and reward have traditionally not kept pace with increasing responsibility, with many experienced GI radiographers still working at Senior two grade (or less). The newly proposed grading structure for the health professions has at its heart a requirement to carefully map the skills of a practitioner and reward them for what they do, regardless of their professional background. It is clear that many GI radiographers are currently working at an advanced practice level, and many are now seeking re-grading. Participation in formal reporting, education and research will strengthen their case, but is there a glass ceiling?

The implementation of consultant posts in the allied health professions was announced in a Department of Health Advance Letter [43], and the first of these posts should be implemented by 2004. A consultant will be a leading specialist in their field, and will bring "clinical leadership and strategic direction to their particular area of expertise" [43]. A consultant practitioner will be expected to perform four core functions, with 'expert practice' as the main element of their post. The other functions will vary from post to post, and comprise: professional leadership and consultancy; education, training and development; and practice and service development, research and evaluation.

The GI consultant practitioner will probably be performing and independently reporting a complex caseload of examinations, and will have a strong multi-professional focus to their work. They will be working within the GI speciality, rather than within radiology per se. They will probably be educated to at least Masters degree level, and in the future may be expected to hold a professional doctorate or PhD degree. They will, undoubtedly, be recognised as a national expert in their field (having links with the professional body and higher education), and will contribute to the training and education of a wide range of professionals. They will ultimately drive service improvements based on a strong evidence base.

Do we have such radiographers currently working at this level of practice? The GI field offers opportunities for autonomous practice and multi-disciplinary

work, not easily accessed in many other areas of radiography. There are certainly a number of individuals whose work closely resembles the job description outlined previously (see Tables 2–5), and many others who are developing their career in this way.

However, Price and Paterson [44] caution that the Advance Letter (2001) states that the consultant positions will only apply to new posts, and should not be "conferred on individuals in recognition of innovative or excellent practice" [43], thus presenting an apparent obstacle to radiographers who are currently fulfilling the consultant criteria. This could be perceived as a major de-motivating factor, which is likely to have the opposite of the intended effects. Steps are being taken at national level to challenge this statement.

SUMMARY

The GI specialist radiographer contributes to the successful delivery of GI radiology services in many ways. The performing of barium enema examinations by radiographers is now established and widely accepted across the UK, and many radiographers have successfully advanced their practice to incorporate a range of other GI investigations. GI radiographers will, in the future, be presented with many challenges and opportunities as they embark upon advanced and consultant-level practice, and theoretically, there should be few limits to the roles that they can successfully undertake. The driving force behind such role development must ultimately be effective GI service delivery and improved patient outcome. Although GI radiographers are a relatively new addition to the radiology team, they have, without doubt, proved their effectiveness; and it is certain, that they will be maintaining and improving the GI service for the foreseeable future.

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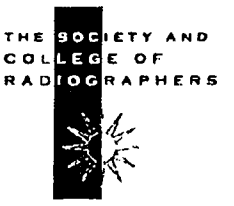

REVIEW ARTICLE

A critical analysis of a locally agreed protocol for clinical practice

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Abstract Within the traditional scope of radiographic practice (including advanced practice) there is a need to demonstrate effective patient care and management. Such practice should be set within a context of appropriate evidence and should also reflect peer practice. In order to achieve such practice the use of protocols is encouraged. Effective protocols can maximise care and management by minimising inter- and intra-professional variation; they can also allow for detailed procedural records to be kept in case of legal claims. However, whilst literature exists to encourage the use of protocols there is little published material available to indicate how to create, manage and archive them.

This article uses an analytical approach to propose a suitable method for protocol creation and archival, it also offers suggestions on the scope and content of a protocol. To achieve this an existing clinical protocol for radiographer reporting barium enemas is analysed to draw out the general issues. Proposals for protocol creation, management, and archival were identified.

The clinical practice described or inferred in the protocol should be drawn from evidence, such evidence could include peer-reviewed material, national standards and peer practice. The protocol should include an explanation of how to proceed when the radiographers reach the limit of their ability. It should refer to the initial training required to undertake the clinical duties as well as the on-going continual professional updating required to maintain competence. Audit of practice should be indicated, including the preferred audit methodology, and associated with this should be a clear statement about standards and what to do if standards are not adequately met. Protocols should be archived, in a paper-based form, for lengthy periods in case of legal claims. On the archived protocol the date it was in clinical use should be included.

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Introduction

This article analyses an 'existing' clinical protocol for radiographer reporting barium enemas, to draw out general issues related to the creation, management and archival of protocols on which the practice is based; this 'existing' protocol had been used to guide routine radiographic practice in a large teaching hospital. The purpose of this article, using the barium enema reporting protocol as a vehicle, is to suggest practical advice on the development, use and on-going appraisal of clinical protocols. This article has value to radiographic practice at consultant, advanced practitioner, assistant practitioner and practitioner levels. Since standards should be set for the responsibilities, rather than for any one professional group, the protocol would have universal value to professions other than radiographers. Notwithstanding this, 'radiographers' will be referred to throughout the text because this article is focused to radiographic practice.

A protocol may be described as an *official formality of etiquette*—put more simply, *an agreed [documented] system under which 'something' is conducted.*[1] For clinical purposes, a protocol should describe a detailed framework within which a patient is managed. Furthermore, given the research-based climate in which we operate, the framework should be based upon good quality evidence.[2] Typically, in imaging and therapy, the protocol is likely to apply to a 'category' of patients—for barium enema reporting this is clearly the case. Thus, in the context of imaging and therapy, the primary purpose of the protocol is to provide a clear indication of how, certain categories of, patients will be managed and by whom. Consequently, if the protocol is based upon good research evidence, and the radiographer adheres to it, then one should be assured of the best available management and care. If all professionals work to the same protocol then all patients should be assured of the same quality of service, reducing inter- and intra-operator variability.

In the context of clinical negligence claims, it is essential that practice is based upon best evidence and peer practice.[3,4] Some argue that such practice need not be documented (ie presented in a written form), and it is known that in a number of clinical centres this is the case. However, given that clinical negligence claims may arise some 21 years after the patient's examination has been conducted (ie for children) it becomes difficult, even impossible, to construct a legal defence when what was actually done, and also why it was done, was not remembered.[3] In this context alone the argument for not having written protocols is refuted. The value of evidence-based written protocols is therefore established.

The main body of this article is presented in three sections. First, in the section 'Description of the 'existing' barium enema reporting protocol', there is an explanation of how the 'existing' clinical protocol for radiographer reporting barium enemas was created; the protocol will then be presented. Second, in the section 'Analysis of the protocol', there is a critique of the protocol and the approach taken to its creation and review/management. Finally, in the section 'Development and ingredients of a clinical protocol—a suggestion', a proposal is made to indicate how a protocol might be created and managed effectively. At the end of the process, suggestions are made as to what YOU need to think about when developing your own protocols.

Description of the 'existing' barium enema reporting protocol

The protocol to be discussed can be seen in Fig. 1.

The protocol for radiographer reporting of barium enema examinations was developed from an existing protocol for Radiology Registrar reporting of the same examination. (The consultant GI radiologist developed the original protocol.) This was augmented by a new protocol on report content following the RcR audit of 2003 recommendations.[5]

The Gastrointestinal (GI) Radiographer wrote the protocol, who then passed it to the consultant radiologist and Radiology Business Manager for comment. It is marked with a creation date, and review date, however no names or signatures appear on the protocol document itself.

The protocol sets out to say how and when examinations are to be reported. How significant findings should be communicated to the referrer and wider GI team. What to do in the case of inpatient reports, and how to deal with examinations where there is doubt as to the presence of pathology.

At the time the protocol was developed, several other hospitals in the region were contacted in an attempt to acquire copies of their protocols, to look at peer practice, however none were available. This may have been due to the fact that radiographer reporting of barium enemas was in its infancy at that time, with the first cohort of students on the GI reporting course having just

The Protocol

1. The person who performed the barium enema should sign the request form
2. All images must be 'double read'. The names of both reporters should appear on the final report.
3. Significant findings (eg carcinoma) must be communicated immediately to the referring physician and also the GI nurse practitioner.
4. All in-patients must have a preliminary report placed into their case notes on a blue sticker.
5. The second report (ie the double report) will be done daily between 08.00 and 08.45. The first report must be available in this reporting session for the second person to check
6. Double reporting must be completed within 48 hours of the barium enema examination being performed.
7. Only radiographers who have undertaken and passed a recognised training programme will be allowed to participate in the reporting process.
8. If there is doubt as to the presence of pathology a further opinion must be sought, ideally from the specialist GI radiologist.
9. Audit of radiographer [double] reported examinations should be carried out every 3 months. Audit should comply with 'IRMER 2000'
10. The following should be indicated within the report.
    - Patient history
    - Technical quality of the examination, for example completeness (eg did the barium flow throughout the required regions and bowl preparation)
    - A comment on pathology - indicating the most serious first
    - Sizes and positions of polyps and tumours
    - Malignancy for tumours should be indicated
    - Recommendation of further examinations, if required
    - Name of the people who [double] reported the examination
11. Radiographers can check only barium enemas at the present time.

Figure 1 The protocol.

qualified. A similar exercise carried out now would undoubtedly yield more information.

Analysis of the protocol

As already suggested, there is limited literature readily available to guide how protocols are developed and managed. Given this it becomes difficult to perform a fully evidence-based analysis of the above protocol. Nonetheless, the approach taken here will be to use the limited available evidence, from the professional bodies, special interest groups, peer-reviewed papers on best practice and the website national electronic library for health, combined with some examples of existing clinical practice. For the purpose of analysis, the items from the above protocol will, where possible, be taken sequentially to assist with information assimilation.

Authorship

Two professional groups (a radiographer and the radiologists) developed the protocol. Literature suggests that *all* stakeholders should be involved.[6,7] The Special Interest Group in Radiographic Reporting (SIGRR)[8] supports the view that a team should be set up to develop reporting protocols. Ideally, in addition to the radiographer and the radiologists, the stakeholder group might have been broader. Thus the development team may have included professionals such as the GI nurse specialist, secretaries, receptionists, radiographer aids, assistant practitioners and the surgical and medical teams.[7] The difficulty in this approach is that widening the development team would almost certainly lead to difficulty in reaching a consensus of opinion. NICE[7] suggest that a team of 6–10 is the optimal number for such a group. This document also suggests ways of selecting team members.

A quite important point not explicitly stated on the protocol is the authorisation of its use. Again SIGRR[8] provides valuable information. At 4.5 this document indicates that

> The scope of reporting is defined in the protocol and must be agreed by reporting radiographers, the professional head of radiography within the trust, and the clinical director of the clinical radiology department. It must also be authorised at trust board level.

The National Electronic Library for Health gives an example of an X-ray protocol where there is provision for all of the above to authorise its usage.

Dates

The date the protocol was implemented was indicated on the protocol, which complies with Alderson and Hogg's suggestion,[3] this is also supported by SIGRR.[8] However, on the protocol itself there was no indication of what should happen when it is updated; similarly there was no indication of what should happen to the 'old' protocol when the original protocol has been updated and it is no longer used. As suggested earlier, particularly for clinical negligence claims, Alderson and Hogg[3] suggest that once a protocol is

updated the 'old' protocol should be archived in a suitable place, marked to indicate when it was in force—ie 'start date' and 'end date'. Ideally, archived protocols should be paper-based, rather than stored on digital media. This minimises significantly any possibility of the prosecution suggesting tampering with the protocol after it had been archived. Perhaps in the future read only CD-Roms may have a part to play.

Double reporting

Within the trust double reporting is the norm for all barium examinations, and this is taken to mean that the person who undertakes the examination reviews the images and hand writes a report. This report, along with the images, is then taken to a set session with either a consultant GI radiologist or the GI advanced practice radiographer for review. This is specifically written into the protocol. However, it would be useful here to state how other hospitals in the area were reporting their barium enemas, so that the protocol was in line with local peer practice.

Literature supporting double reporting and the different methods of double reporting could be made reference to within the protocol. When a protocol is updated the literature should be 're-searched' in case more up-to-date reference material has become available. This would ensure that current best practice was being followed.

Time scales

The protocol indicates that the report must be ready within 48 h, with In-patients having a provisional report placed in the medical notes at the time of the examination. The National Audit of Radiographic Reporting Services,[5] the Royal College of Radiologists, standard for turnaround of reports on GP, and In-patients was set at 24 h, however the audit showed this to be unachievable, particularly in large acute hospitals. Thus the setting of a lower turnaround time, particularly for an examination where two individual reports are produced is not unreasonable. However, the protocol does not say if this target is to be audited. Within section 3 of the same audit report, it is suggested that:

> [4.3.7] It is good practice to write a report directly into the patients records (though this advice indicates it applies when a radiologist carries out the examination)

Thus the protocol complies with the principle of this report.

The Cancer Plan[9] also sets time scales for treatment of cancer patients from initial diagnosis. To ensure that these are adhered to, the protocol makes a suggestion as to how this category of patients' reports should be communicated back to the referrer.

Training for radiographer reporting

The protocol states that only radiographers who have undertaken and passed a recognised training program will be allowed to double report. This complies with statements made by the College of Radiographers.[12] Similarly SIGRR[8] reflects the need for adequate training and education. The Royal College of Radiologists states that reporting should be carried out by an accredited radiologist or properly delegated. In stating that radiographers should have attended a recognised training course the protocol is reflecting the views of both professional bodies.

Within the protocol a procedure is highlighted as to the path to follow when the [radiographic] reporter is unsure—in this case they are advised to approach a specialist/senior member of staff. Alderson and Hogg,[3] exploring case law,[10] make clear the legal value of including this within a protocol. Similarly the Society and College of Radiographers also recognise that radiographers, as professionals, must acknowledge their own limitations and scope of practice, as reflected in statement 5 in the Statements for Professional Conduct.[11] The SIGRR emphasis this point too.[9] Being encouraged to acknowledge ones own limitations, and thus seek help and advice as required, may also engender a culture of learning and team working which in turn may improve service quality even further.

Audit

Although the protocol states that audit will be carried out on a regular basis, there is no definition indicated within the protocol as to what audit is, or indeed what should be audited and why. However, within the protocol reference is made to 'IRMER 2000'[13] and within this Statutory Instrument is a definition of [clinical] audit:

> A systematic approach or review of medical radiological procedures, which seeks to improve the quality and outcome of patient

> care through structured review. Whereby radiological practices, procedures and results are examined against agreed standards for good medical radiological procedures, intended to lead to modification of practices where indicated and the application of new standards if necessary.

The aim of the audit therefore becomes clearer, however precisely what should be audited is not obvious. One might consider that accuracy of the 'reporters' should be examined, and this would be quite appropriate. However, the [double] reporting process sits within a broader context, such as patient satisfaction, financial and human resource implications, national targets, patient outcomes (including survival rates and quality of life), waiting times and report turnaround time. These might be audited too. Returning to audit of the reporting process itself—exact details of what is to be audited should be indicated.

In 2003,[14] a national audit was conducted to assess the sensitivity of double contrast barium enemas (DCBE) in the diagnosis of colo-rectal carcinoma. This sort of report might prove a valuable resource for [reporting] standard setting against which performance can be measured. Similarly, work by Murphy and Loughran[15] give some insight about the standards of radiographers' performance on lesion detection in barium enema studies. Similarly, Halligan et al.[16] have conducted work to assess observer variation and suggest a methodology to assess this.

When developing a method for audit/analysis of performance, care should be exercised regarding the limitations of the approach. For example, Shrovon[17] notes deficiencies in Halligan et al.'s[16] work. In academic circles this is common not least because nothing is perfect and intellectual debate is encouraged regarding information in the public domain. Variation in the quality of published material highlights the importance of discriminating, in a scientific fashion, between good and bad evidence. Another important [audit] information not included within the protocol is a definition of what an acceptable level of performance is. This is particularly important here because there is currently no nationally agreed standard. The SIGRR[9] notes that there is an absence of national standards or performance measures, consequently suggesting that local standards may need to be agreed and implemented. The SIGRR[9] goes on to suggest that audit may assess reports for accuracy, structure and effectiveness of communications to referring healthcare practitioners. SIGRR[9] indicates that the outcome of such an exercise 'should be fed back into the process'. Also, and quite importantly, should performance fall below the locally (or nationally) agreed standard of performance then there should be a clear statement included on what action(s) should be taken to remedy the situation. It might be worth noting that some X-ray departments operate within recognised quality frameworks (eg ISO 9000) and the quality assurance of department protocols falls within this kind of overarching quality framework.

It is evident that the protocol met many of the published suggestions regarding the general approach to developing a protocol and its contents. However, there were several points on which it failed. Nonetheless, the process of analysis does suggest areas in which the protocol could be improved. That said, it is worth noting that if a protocol is too detailed it may significantly restrict practice—this may be particularly restrictive for 'experienced' staff. Conversely, if the protocol is not adequately detailed then it may not be sufficiently supportive for 'less experienced' staff.

Development and ingredients of a clinical protocol—a suggestion

Reflecting on the protocol for radiographer reporting barium enemas and through examination of the literature whilst taking into account known clinical practice, the following might be seen as a good starting point for the development and management of a clinical protocol and also what could be addressed within it.

Protocol development and management and points that should be addressed within a protocol:

- Precise details of what should be done and when during the [clinical] procedures should be indicated.
- An indication that the protocol has been 'approved' for clinical use with 'appropriate' authorities.
- Stakeholders should be included in the development (and review) process.
- National standards, where available, should be included.
- Good quality relevant literature (ideally peer-reviewed) should be used, and cited.
- The people responsible for creating it, including names as well as designations (ie job titles), should be included on the protocol.
- The date it was implemented, and also the date by which it should be reviewed/revised, should be indicated.

- The date it ceased to be used in clinical practice should be written onto 'old' protocols. Old protocols, in a paper version, should be suitably archived.
- The audit process for the clinical activity, paying 'adequate' detail to methodology and also how data are processed and reported, should be included.
- If the protocol sits within other guidance, rules or protocols they should be clearly stated on the protocol.
- The required level of training and education including continual professional development for staff should be stated.
- Definitions of 'new' words and terms *or/and* definitions of words and terms used in a new context should be included.
- What to do/who to seek help from, when an unsure situation is reached, should be outlined.

Finally, considering the need to evidence peer practice and also meet the need to share good/best practice we would suggest that you consider placing your protocols into forums for use by other professionals. Additionally or alternatively, we welcome written comments about your protocol in relation to this article. Such comments should be directed to the Editor in Chief of this journal.

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Identification number	Published work 5 (PW5)	2005
Title	Interpreting Trauma Radiographs	
Authors	McConnell J, Eyres R, Nightingale J	
Contribution	33% (edited book) 100% (Chapter 6)	
Full reference	McConnell J, Eyres R, Nightingale J (2005) Interpreting Trauma Radiographs, Blackwell Publications, Oxford. July 2005. (Editor and co-author) Part 1 Chapter 6: Nightingale J (2005), Anatomy, Physiology and Pathology of the Skeletal System : seen in McConnell J, Eyres R, Nightingale J, (2005), Interpreting Trauma Radiographs, Blackwell Science, July 2005, Oxford	
Publication media	Edited book.	
Abstract	Excerpt from Chapter 6: Successful image interpretation of musculo-skeletal plain film images is founded upon an extensive underpinning knowledge of anatomy and physiology, coupled with a detailed understanding of the pathophysiology of related injury and disease processes. The following chapter will revise and expand upon basic anatomical and physiological concepts, and will direct the reader towards supplementary texts where appropriate. It will discuss the concept of mechanisms of injury and resulting trauma patterns seen in both the adult and paediatric patient, as well as outlining some of the more common bone and joint pathologies.	
Wordcount	7421	
Number of pages	296 total 44 pages Chapter 6	
Thesis aims supported	Aim 3	

PW5

Please see accompanying text book. Please pay particular attention to Chapter 6.

Identification number	Published work 6 (PW6)	2007
Title	The role of the GI radiographer : A UK perspective	
Authors	Nightingale J, Hogg P	
Contribution	80%	
Full reference	Nightingale J, Hogg P (2007), The role of the GI radiographer : A UK perspective, Radiologic Technology, March/ April 2007, vol 78, no 4, 1-7.	
Publication media	Peer reviewed international journal	
Abstract	Context: Since the 1990s radiographers in the United Kingdom have expanded their role in gastrointestinal (GI) radiology, first by performing double-contrast barium enema (DCBE) examinations independently and later by interpreting and reporting the results of these exams. Objective: This article will trace the evolution of GI radiographers in the United Kingdom, evaluate their success and explore how the U.K. experience could apply to American radiologist assistants. Methods: The authors surveyed the professional literature to determine the historical context in which GI radiographers emerged and assess how their performance on DCBE exams compares with radiologists' performance. Results: DCBE exams performed by GI radiographers have been shown to be efficient, cost effective and safe. In addition, GI radiographers have helped reduce waiting and turnaround times for DCBE exams. Summary The success of GI radiographers in the United Kingdom offers assurance that radiologist assistants can benefit American patients, radiologists and radiologic technologists.	
Wordcount	3922	
No.pages	7	
Thesis aims supported	Aim 1 and 2	

The Role of the GI Radiographer: A United Kingdom Perspective

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Context *Since the 1990s radiographers in the United Kingdom have expanded their role in gastrointestinal (GI) radiology, first by performing double-contrast barium enema (DCBE) examinations independently and later by interpreting and reporting the results of these exams.*
Objective *This article will trace the evolution of GI radiographers in the United Kingdom, evaluate their success and explore how the U.K. experience could apply to American radiologist assistants.*
Methods *The authors surveyed the professional literature to determine the historical context in which GI radiographers emerged and assess how their performance on DCBE exams compares with radiologists' performance.*
Results *DCBE exams performed by GI radiographers have been shown to be efficient, cost effective and safe. In addition, GI radiographers have helped reduce waiting and turnaround times for DCBE exams.*
Summary *The success of GI radiographers in the United Kingdom offers assurance that radiologist assistants can benefit American patients, radiologists and radiologic technologists.*

Gastrointestinal (GI) imaging is a flourishing subspeciality of radiology. Air-contrast barium enema examinations, known as double-contrast barium enema (DCBE) exams in the United Kingdom, have long been a mainstay of GI imaging. Today DCBE exams are complemented by, or in some cases replaced by, more complex procedures such as computed tomography (CT), magnetic resonance (MR), ultrasound, nuclear medicine and endoscopy. Although DCBE eventually could be supplanted as the gold standard examination by CT-based techniques, for many patients DCBE remains the initial investigation. There are various reasons for this, including cost, availability and risk factors.

Until quite recently DCBEs were performed by a radiologist with a radiographer assistant. This "master and assistant" relationship was upheld in the United Kingdom for many decades.[1] The traditional role of the radiographer entailed preparing the room, pharmaceuticals and barium; setting exposure factors; and ensuring that images were appropriately captured, developed and prepared for reporting. The traditional role of the radiologist entailed operating the fluoroscopy equipment, positioning the patient, and capturing and reading images. Typically, physical and emotional care was offered by the radiographer, with the radiologist usually obtaining informed consent from the patient, explaining the procedure and, if appropriate, offering the patient a verbal interpretation of the images.

In the early 1990s several "pioneers" started to perform DCBEs without radiologists present in the examination room, and during the 1990s the number of radiographers doing this increased dramatically.[2] Radiographers now undertake DCBEs in many hospitals with little or no supervision by a radiologist. It is fair to say that within the United Kingdom the management of DCBE has become the radiographer's domain.

This article examines the current role of radiographers in the United Kingdom who have specialized in gastrointestinal imaging procedures (known as GI radiographers) and explores the historical context of how and why the GI radiographer's role expanded. American radiographers also have started to develop their clinical responsibilities through radiologist assistant programs and may be considering establishing similar GI services.[3-6] The introduction of radiographer-led services can be justified only if the efficacy of these services can be established, and we believe that the insights gained from evaluating these practices in the United Kingdom will benefit American radiologists and radiographers who are involved in GI imaging.

Literature Review

An overview of literature related to the historical development of the GI radiographer role up to the present day is presented, followed by justification for the introduction of radiographer-led DCBE services.

Historical Context

For many years, a chronic shortage of radiologists has existed within the United Kingdom. This human resource problem has been confounded by the expansion of health and medical imaging services coupled with an increase in nonclinical radiologist roles. The implementation of the European Working Time Directive, which reduced the number of hours junior doctors are legally permitted to work, and the introduction of government health targets also affected the shortage of radiologists.[7-9] These targets focused on maximum waiting times for consultations with medical staff, appointments for diagnostic procedures, diagnostic report turnaround time and, more recently, total waiting time from initial referral to treatment and discharge. Diagnostic radiology departments were noted as a significant barrier to hospitals achieving these targets, which resulted in financial penalties ultimately being applied.

During the 1990s it became clear that radiologists could not cope with the increasing demands being placed upon them.[10] Not surprisingly, alternative ways of delivering radiology services were sought, and early literature about the capability of radiographers was re-examined.[11] In the early 1990s new roles for radiographers started to emerge in a wide range of clinical areas. Such roles were supported by a highly critical national audit of the radiology service,[12] which determined that waiting times for examinations frequently were unacceptably long and radiological reports often were issued too late to influence patient management. The DCBE examination was particularly problematic, mostly because it had extensive patient waiting lists. Given that colorectal carcinoma has a better prognosis when treated at an early stage and any delay in treatment can result in metastasis, the DCBE examination became an area in which advanced competencies for radiographers were rapidly implemented.

In 1981 a Canadian study by Somers et al[13] suggested that the DCBE was a potential area for role delegation from radiologists to radiographers, as it could be easily described within a written set of instructions (ie, a protocol). However, it was not seriously considered in the United Kingdom until the results of a pilot study for a DCBE training program for radiographers, frequently referred to as the "Leeds Course," were published in 1995.[14] This pilot study was evaluated by comparing radiographers' and trainee radiologists' performances in several aspects of the DCBE examination. The pilot study concluded that delegating performance of DCBEs to radiographers was both safe and effective.[14] The DCBE training course commenced in 1993, and over time proved to be very popular, offering radiology departments a low-cost, fast-track solution to patient waiting lists and radiologist shortages. Subsequent studies demonstrated the efficacy and wide uptake of radiographer-performed DCBE.[15,16] This added weight to the argument that radiographers could play a much greater part in patient management, as well as providing a springboard for many radiographers to move into more challenging roles.

For many years the Leeds Course continued to be a leading provider of initial DCBE training for radiographers. On completion of this course, some radiographers pursued master's degree courses in their specialist field. The opportunity to study at a higher level provided radiographers with some of the underpinning skills and knowledge necessary to critically evaluate their GI role and therefore improve the radiology service.

It is estimated that more than 1200 U.K. radiographers have been trained to perform DCBEs. The percentage of hospitals where radiographers participate in this role has been estimated between 69%[2] and 82%,[16] with the majority being nonteaching hospitals and fewer located in London. This could be because teaching hospitals in the capital city have more trainee radiologists and consequently shorter waiting lists for DCBEs. Concern has been expressed regarding the potential effects on radiologist trainees when radiographers perform DCBE examinations because of the suggestion that radiologist trainees will have less access to barium enema training.[15] However, in hospitals where radiographer-performed DCBE is the norm, qualified radiologists tend to delegate the training role to radiographers.

Justification for Radiographer-led DCBE

Radiographers now have performed DCBE examinations in the United Kingdom for more than 10 years. The development and acceptance of this practice has been influenced by research regarding the following aspects of the care pathway:

Service Delivery

Although a wide range of published literature exists regarding radiographer-performed DCBE examinations, surprisingly none has focused on patient acceptability. In practice, however, many unpublished patient surveys

have suggested that patients are happy to be cared for by a radiographer without recourse to a radiologist. Several studies have noted positive service improvements because radiographers have been available to perform a greater number of DCBE sessions than qualified radiologists, thus reducing waiting times.[15,16] There is also a positive effect on other waiting lists, as radiologists are available for other duties. This is important because the British government has placed significant emphasis on reducing the length of time a patient waits for diagnostic tests and treatment within the publicly funded health care system.[8,9] The cost effectiveness of radiologist-to-radiographer delegation is also evident in that radiographers' hourly pay rates are significantly lower than radiologists'.[17]

Technical Quality and Diagnostic Accuracy

The technical quality of radiographer-performed DCBE examinations has been studied extensively, with much literature reporting a high-quality examination that is indistinguishable from or better than that of radiologists or trainee radiologists.[13-15,18-20] Technical quality refers to factors such as quality of barium coating of the bowel, density and contrast within the images and adequate demonstration of the appropriate anatomy in double contrast. Closely associated with technical quality is diagnostic accuracy. Several authors have studied accuracy by comparatively assessing histologically proven cancers with DCBE reports. Such studies have noted that radiographer-managed studies compare favorably with radiologist-managed procedures.[18,21,22]

Radiation Dose

In 1998 Crawley et al[21] published a comparative study of radiologist- and radiographer-performed DCBEs; this is a particularly interesting study because of the debate that arose within and from it. Crawley et al found that radiation dose to the patient was higher for radiographer-performed DCBEs compared with those performed by radiologists. Increased fluoroscopy times, and therefore radiation doses, can be explained as a byproduct of the radiographer training period. However, there was grave concern that radiation doses were also higher for experienced GI radiographers. Crawley went on to explain that radiographers were required by the radiologists to take more hard-copy images than the radiologists. This requirement was documented formally in a written protocol that radiographers had to follow meticulously. This inequitable practice, which was commonplace in many U.K. hospitals in the 1990s, was difficult to justify. Not surprisingly, it was concluded that a revised protocol was essential, and in 2002 Crawley and Booth reported that radiographers' doses were as low as the radiologists' doses when following the new protocol.[23] The revised protocol required radiographers to take fewer films than previously, thus creating more consistency between radiologist- and radiographer-performed exams. In addition, digital equipment was introduced, which further reduced radiation dose.

Other published studies have found no difference in fluoroscopy times or DCBE radiation doses for exams performed by radiographers or radiologists[14]; however, one study determined them to be statistically significantly lower in radiographer-performed examinations.[19] Much can be done to optimize fluoroscopy techniques, and equipment-related factors have been found to have a major influence on dose.[24] For example, the introduction of digital spot images may give only 10% to 20% of the radiation dose of a conventional film-screen combination, and removing the antiscatter grid during fluoroscopy also can lead to a significant dose reduction.[24-26]

The debate on overly prescriptive written protocols highlights one of the problems that many radiographers experience when first undertaking DCBE management. Initially, both radiologists and radiographers felt more comfortable with very clearly demarcated boundaries for practice, as indicated in the protocols. For instance, in the 1990s these protocols often required radiologists to administer smooth-muscle relaxants and antispasmodics, check films prior to allowing the patient to leave the department and routinely rescreen the patient to check for missed pathology. However, as radiologists' and radiographers' confidence increased and radiographers' capability improved, protocols evolved accordingly to permit greater professional latitude for radiographers. This lessened the requirement for radiologist involvement.[1]

Complication Rates

The barium enema exam is not without risk, and reassurance that patients have not been affected adversely by radiographer-performed procedures is vital. Several studies with similar methodologies reported that complication rates were similar to the rates for radiologist-performed exams.[15,16,27] Mortality rates for radiographer-performed DCBE were identified in Culpan and Chapman's 2002 study as 1 in 44 900.[27] However, mortality rates were identified as 1 in 69 687 in their 2004 study.[28] The only study with a similar methodology on radiologist-performed DCBE noted a mortality rate of 1 in 56 786.[29] Although the low mortality rates for radiographer-performed DCBE

examinations are reassuring, concern has been raised regarding the frequency of cardiac complications — 1 in 8000 for radiographers compared with 1 in 46 000 for radiologist-performed DCBE.[28,29] The discrepancy is suggested to be a result of heightened radiographer awareness of arrhythmias, which frequently go unnoticed and unreported. The authors also discussed the potential anticholinergic effects of routine administration of antispasmodics (ie, Buscopan) by radiographers.[28] Many U.K. radiologists do not administer Buscopan routinely, possibly resulting in the lower cardiac complication rates. The authors also pointed out that the use of this drug is prohibited in North America. In spite of the concerns raised, the cardiac complications were generally mild. Such adverse events must be anticipated when radiographers are performing examinations on the whole spectrum of patients, including the very frail and elderly, and a risk assessment should be performed to ensure that patients will not be unduly harmed by any change of practice. Within the United Kingdom's health care system, the risk assessment process is a formal and mandatory prerequisite in such situations.

In summary, performing DCBEs has been shown by the published studies outlined above to be an efficient, cost-effective and safe role for radiographers. This is reflected by the widespread national uptake of radiographer-performed DCBEs.[2]

Discussion

Early experiences of radiographer-performed DCBEs have been highly encouraging, and in the past few years GI radiographers have developed their clinical role significantly — well beyond that described in the early protocols. It is helpful at this point to consider the possible similarities and differences between the U.K. situation as outlined previously and that emerging within the United States.

The Drivers for Change

This article outlines a number of factors that led to the emergence of the GI radiographer, including the long-standing shortage of radiologists in the United Kingdom, which resulted in long waiting lists for examinations and diagnostic reports. The United States also is beginning to experience similar problems, with a widening gap between the increase in demand for radiology services and the slowly growing supply of radiologists.[3] Adding to this problem are limits on hours that residents may work (also imposed on U.K. radiology trainees) and increasing patient expectations regarding availability and choice of location for services.[3]

In the United States, work force shortages also are noted for radiologic technologists, with high vacancy rates and an aging work force.[3,4] May noted that radiologic technologists historically have been limited in their clinical career, with the "best" technologists moving out of clinical practice to advance their careers in education, management and sales.[4] Until recently, this was the experience in the United Kingdom as well.

Solutions to the Problems

As previously documented, the United Kingdom's solution has been to develop the role of the GI radiographer to take over responsibilities formerly undertaken by radiologists. GI radiographers willingly have accepted greater responsibility for managing DCBE examinations, examining a more complex group of patients and becoming involved in multidisciplinary collaboration, auditing and research.[18,30]

In a number of hospitals, GI radiographers routinely perform a broad range of studies, including barium swallows and meals, proctograms, T-tube cholangiograms and small bowel examinations.[31,32] Compared with DCBEs, however, there is limited published evidence of their efficacy. A small number of radiographers also have been trained to perform sigmoidoscopy, colonoscopy and CT colonography examinations. New services have been offered in many hospitals, including radiographer-led videofluoroscopy for speech and language therapy and same-day endoscopy.

Experienced GI radiographers are responsible for fluoroscopy training of radiographers new to the DCBE role, and in some centers GI radiographers are responsible for training trainee radiologists.[33] Many GI radiographers also are involved in formal classroom teaching and associated assessment of GI radiography and radiology students.[33] The proportion of GI radiographers who have been involved in formal research, conference papers and journal publications is still low, but this is expected to change as more radiographers become educated at the master's degree level.

A consequence of the change in roles is that pay and career structures have had to be revised to reflect more adequately the higher levels of responsibility. A GI radiographer who performs DCBE examinations has an elevated position within the structure; one who performs and interprets a wide range of GI examinations has every chance of being at the pinnacle of the career structure.

In the United States the concept of the radiologist assistant (RA) was proposed to address the issues of

radiologist shortages and rising workloads. The first cohort of RAs — radiologist extenders who work under the supervision of a radiologist — recently graduated and is set to change the way radiology is practiced in the United States.[5] Their scope of practice includes a range of patient management and fluoroscopy procedures and could arguably be considered similar in scope to the United Kingdom's GI radiographer. The RA is an experienced, registered radiologic technologist who has successfully completed an advanced academic program at either the baccalaureate or postbaccalaureate level encompassing both nationally approved curricula and a clinical preceptorship.[5] This is not dissimilar to the education of some GI radiographers in the United Kingdom; however, there is no legal or professional requirement for U.K. radiographers to have attended an accredited postgraduate program. Most radiographers attend short, ungraded courses for initial DCBE training, coupled with in-house clinical training. However, to attain the higher levels of the career structure (what are known in the United Kingdom as advanced and consultant practitioner positions), there is an increasing expectation that GI radiographers will have completed relevant studies at the master's degree level.

The Debate Surrounding Image Reporting and Interpretation

GI radiographers usually are involved in image reading, either providing a formal, independent report or a provisional report as part of a double-reporting system.[2]

DCBE procedures usually are performed with both pulsed and real-time (continuous) fluoroscopy, with images captured as appropriate. This demands considerable operator skill, as the operator not only needs to be able to capture high-quality double-contrast images covering the whole area of interest, but also must react quickly to the appearance of potential pathology, taking additional images as necessary. All GI radiographers must develop advanced pattern-recognition skills so they can identify normal and abnormal anatomy with confidence. This is not straightforward; the DCBE is known for a potentially high level of perceptual error, resulting in up to 30% false-negative findings.[34]

Not surprisingly, the importance of double reading of DCBE images starts to emerge. Several published studies have demonstrated that multiple or double reading of DCBE images significantly reduces such errors.[34,35] Therefore, double reading of DCBE examinations is considered the "gold standard." In practice, however, lack of time results in many hospitals only offering single image reading. Because the DCBE examination is highly operator dependent and is imaged in real time, the person who performs the procedure is in the best position to contribute to the reporting process.[36] When this person is the radiographer, it makes sense that he or she should, at the very least, make a written comment on the findings used to inform the definitive report.

Image interpretation and report-writing skills can be developed in GI radiographers, thus enabling them to contribute to double reading.[36] GI radiographers with specialized training can read DCBE images to a high standard, although most published studies have involved GI radiographers who underwent in-house reading training.[37] Such in-house training can be variable and can lack assessment rigor, creating problems of role transferability between hospitals. To offer a solution to this problem, 4 U.K. universities offer master's level education and training for DCBE image reading. The Society and College of Radiographers, the U.K. radiography professional body, added support to this argument by stating, "Reporting by radiographers is not an option for the future . . . it is a requirement."[38]

The position regarding reporting by radiologic technologists in the United States is very different than in the United Kingdom. At an early stage during the development of the scope of practice of RAs, decisions were made to exclude image interpretation from their role; thus, RAs will not be able to practice independently of radiologists.[3,4,6] This could be, in part, a response to financial penalties for radiologists if RAs were to read the images. This is not a factor in the publicly funded U.K. health service, where radiologists' pay remains largely unaffected by their workload. However, it should be reiterated that, arguably, the best-placed person to report on dynamic, real-time images is the one who performs the procedure.[36] Even if RAs are prevented from interpreting images and issuing the definitive report, they still could offer an informal opinion to the radiologist, thus following best practice by offering an efficient method of double reading the examination.

Medicolegal Issues

When GI radiographers perform and read DCBE and other fluoroscopy examinations independently, the related medicolegal issues must be considered. In the United Kingdom, each radiographer is responsible for his or her actions and there is no defense for inexperience due to age, junior status or being delegated a role from another profession.[39] The patient expects a reasonable standard of care, no matter who performs the examination or who interprets it. Therefore, GI

radiographers must ensure they work within a protocol agreed upon by the supervising radiologist and the employer. Additionally, GI radiographers should have relevant and sufficient medicolegal insurance, gained through membership in the trade union body. In the event of a medicolegal or negligence claim, radiographers must be able to demonstrate that they received appropriate initial and ongoing training for the role and that they worked within agreed-upon protocols and schemes of work. They also must demonstrate continuing competence through a clinical audit of their work.

In the United Kingdom, GI radiographers work within national laws and professional guidelines. The situation in the United States is perhaps more complex, as different states have different views on the scope of practice that is acceptable for radiologic technologists.[3] This might limit adoption of the RA role in some areas of the country and could hinder qualified RAs from seeking employment in states other than the one in which they were trained. The RA concept is still in its infancy, and there undoubtedly will need to be a number of important changes if the role is to be used to maximum effect.

Conclusion

Radiographer-performed DCBE examinations now are well established in the United Kingdom, and an expanding evidence base has shown that GI radiographers can perform and read such examinations successfully to an adequate standard. Radiographers can adapt their skills to perform both existing and new techniques, such as CT colonography, that may replace the DCBE in the future. In recognition of their expert clinical abilities, they can be rewarded with elevated status and pay within a new career structure.

The lessons learned from the United Kingdom's experience with GI radiographers have the potential to be transferred to the newly introduced RA role in the United States. As this role takes shape in the near future, radiologists and radiologic technologists should be reassured that the transition of roles from one professional domain to another can be relatively smooth and painless. The RA role has the potential to be of maximum benefit to both professions and, more importantly, to the patients that they serve.

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Abstract	A 70 year-old female patient with prior breast cancer was diagnosed with a transverse colon adenocarcinoma. Both primary cancers were discovered within 6 years, and at a stage where potentially curative surgery was performed. The patient's long-term prognosis was expected to be good. This article questions whether the two primary cancers were independent oncological events, or whether they were related, by exploring a range of cancer risk factors associated with lifestyle, genetics and medication. Factors such as smoking, alcohol consumption, genetic predisposition and the use of contraceptives and Tamoxifen may increase the relative risk for both cancers, and although tenuous the links between the two cancers cannot be completely ruled out. Various studies have offered conflicting data regarding the relative risk for developing the second cancer, but long-term cohort studies will continue to add to the evidence base. The outcomes of these studies should be closely monitored as they may have implications for follow up of breast cancer patients within the colorectal cancer screening service.	
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Colorectal carcinoma in a patient with prior breast cancer: Is there a causal link?

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Abstract A 70-year-old female patient with prior breast cancer was diagnosed with colorectal carcinoma six years following the original breast referral. The cancers were both discovered at an early stage enabling potentially curative surgery to be performed, with an associated good long-term prognosis. This article explores a range of cancer risk factors associated with lifestyle, genetics and medication to ascertain whether the two primary cancers were independent oncological events, or whether they were related. Factors such as smoking, alcohol consumption, genetic predisposition and the use of contraceptives and Tamoxifen may increase the relative risk for both cancers. Various studies have offered conflicting data regarding the relative risk for developing the second cancer, but long-term cohort studies will continue to add to the evidence base. It is possible that the outcomes of these studies may have implications for the follow up of breast cancer patients within the colorectal cancer screening service.
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Introduction

A 64-year-old female patient was diagnosed with a Grade 2 duct carcinoma in her left breast. She underwent a left mastectomy and axillary node clearance, and was prescribed Tamoxifen drug treatment. Five years later there was no evidence of recurrence so the Tamoxifen was discontinued and she was discharged to routine monitoring via the breast-screening programme.

Six years following the diagnosis of breast cancer the patient was referred by her GP for urgent investigation of symptoms suggestive of colorectal carcinoma. A double contrast barium enema examination demonstrated an eight centimetre shouldered stricture in the transverse colon. This was confirmed by histology and computed tomography to be a moderately well differentiated adenocarcinoma of the colon (Dukes B, T3, N0, M0) (Table 1).

Although the patient had a good prognosis, she had presented with two metachronous primary tumours in different anatomical sites within a relatively short timeframe. This article outlines the aetiology of breast cancer and colorectal cancer, and explores whether women with

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Table 1 Staging of colonic tumours

Stage	Description (TNM)			Modified Dukes'	
0	Tis	N0	M0		Tumour in situ (mucosa)
I	T1, T2	N0	M0	A	Tumour invades submucosa (T1) or muscularis propria (T2), no nodal spread or metastases
II	T3, T4	N0	M0	B	Tumour invades beyond muscularis (T3) or into adjacent organs (T4). No nodal spread
III	Any T	N1, N2	M0	C	Tumour invades 1–3 local nodes (N1), 4 or more regional nodes involved (N2). No metastases
IV	Any T	Any N	M1	D	Tumour metastasises to other organs (M1)

Traditionally colorectal tumours were staged using the Dukes' system, but clinicians have now generally adapted the TNM staging system. T, tumour stage; N, lymph nodes affected; M, presence of metastases.

prior breast cancer are at increased risk for developing colorectal cancer.

Discussion

Breast cancer and colorectal cancer are the two most common cancers to affect women in the United Kingdom,[1] and at presentation she was in the high risk age bracket for developing both cancers.[2] Research has investigated possible links between these cancers and whilst there may be a connection, factual proof seems tenuous. A proven link would have implications for the colorectal cancer screening services: should it be proven that women who have had breast cancer are more susceptible to colon cancer then they will need to be included in a regular colorectal monitoring programme.

Lifestyle

The statistical chance of developing cancer can be influenced by lifestyle. For colorectal and breast cancers common risk factors are obesity and a sedentary lifestyle.[3–5] The risk of colon cancer increases by an estimated 15% in overweight and 33% in obese people.[6] Whereas little is known regarding the activity levels of the patient, she had a Body Mass Index of 22 so was not obese.

Bowel cancer incidence is generally lower in populations with high fibre, low fat diets. However, prospective studies following people with high-fibre diets have reported variable results ranging from a lower risk of bowel adenomas and of carcinoma, to no association with colorectal cancer.[6] An inverse relationship between fruit and vegetable intake and colorectal cancer has been noted in some studies, and a significant increase in colorectal cancer has been found in people with a high fat and a high red or processed meat consumption.[3]

Smoking and breast cancer

Prior to the diagnosis of breast cancer, the patient had been a regular smoker. The link between smoking and breast cancer is complex, and is founded on 3 main theories:

1. carcinogens in tobacco may elevate the risk of breast cancer;
2. an anti-oestrogenic effect of smoking may actually protect women from breast cancer; and
3. smoking is associated with dietary patterns (such as alcohol intake) that may elevate breast cancer risk.[7]

Experimental evidence demonstrates that carcinogens in tobacco smoke induce neoplastic transformations in breast epithelial tissue;[8] however, the likelihood of cancer induction appears to be related to the rate of differentiation and proliferation of epithelial cells. In other words, young nulliparous females are much more susceptible to the effects of smoking carcinogens on the breast than females following pregnancy and lactation (when the cells have differentiated) and after the menopause.[8] With an increase in females smoking at an early age in the UK, it could be postulated that there is likely to be an associated increase in breast cancer in younger women. However, breast cancer is undoubtedly hormone dependent, and there is evidence to suggest that smoking may have an anti-oestrogenic effect in women.[8] Therefore, to some extent there is a potentially protective effect of smoking at younger ages.

One of the largest studies re-analysing worldwide data on 58,515 women with breast cancer found that smoking had little or no independent effect on the risk of the disease.[9] However, they noted that smokers tend to drink more alcohol than non-smokers, and the risk of breast cancer is clearly linked to alcohol consumption. (The patient's alcohol consumption was 14–21 units per week; 14 units is the maximum limit recommended for women.) Chaturvedi[10] argues that in populations where smoking is highly prevalent, even a modest positive association would result in a substantial increase in the number of breast cancer cases.

Smoking and colon cancer

Colorectal carcinoma is not normally considered to be a tobacco related cancer, although D'Avanzo et al.[11] outline a number of clinical studies demonstrating a link between smoking and the development of colorectal adenomas (benign, but potentially malignant polyps). Experimental work has also identified that cigarette smoke extract promoted in-vitro angiogenesis in colon cancer growth, and adenoma formation in mice.[12]

The large case-control study by D'Avanzo et al. indicated that smoking was not a strong risk factor for colorectal cancer, even after a long induction period.[11] They point out, however, that smokers tend to have a diet poor in fresh fruit and vegetables, and higher intakes of fats and alcohol, thus explaining an apparent association with smoking and colon cancer. This finding is also supported by Emmons et al. in their study of patients

diagnosed with colorectal adenomas,[3] but other studies have been unable to support a hypothesis of a common diet-related causal mechanism for both breast and colon cancer.[7]

Oral contraceptives and HRT

Oral contraceptives and Hormone Replacement Therapy (HRT), used by many women at the time of the menopause, should be considered within the aetiology of colon cancer. Female hormones protect against colon cancer, possibly because of changes in bile synthesis and secretion, leading to a reduced concentration of bile acids in the colon. Previous studies suggest that the overall risk of colon cancer halves with 5–10 years of HRT use, and is reduced by 18% following the use of oral contraceptives at any time,[6] although the effects significantly decrease after stopping treatment.[13] Oestrogen-only HRT appears to have no effect on the risk of colon cancer, whereas combined oestrogen–progestogen therapy HRT appears to reduce the risk.[13,14] Kmet et al.,[5] however, found that the risk for colon cancer is unrelated to prior HRT, or indeed menopausal status or hormone receptor status of breast cancer. It is not known if the patient in this case study had been prescribed HRT.

Tamoxifen treatment

For post-menopausal women with oestrogen-receptive cancers and an absence of metastases, Tamoxifen (which blocks the effects of cancer-promoting oestrogen) has been shown to reduce recurrence by 40–50%.[15] The patient was prescribed Tamoxifen for 5 years after her mastectomy, and its use has been implicated in increasing the risk of colorectal cancer. In 1995 a joint analysis of three major Scandinavian studies found that there was a significant increase (almost doubling) in the relative risk of developing colorectal cancer for patients undergoing Tamoxifen therapy.[16] An American epidemiological cohort study by Newcomb et al.[17] concluded that Tamoxifen therapy modestly increases the risk of colorectal cancer, but only after 5 years following initiation of therapy.[17]

More recent research, however, seems to be contradicting these results. Various studies have found no additional colon cancer or second cancer risk following Tamoxifen use.[18,19] Data collated from all Tamoxifen-related randomised trials prior to 1990 (involving a total of 37,000 women from 55 randomised trials) found that Tamoxifen had no apparent effect on the incidence of colorectal cancer.[20] These clinical findings have been opposed by experimental data, demonstrating that Tamoxifen and gonadal steroids can inhibit the growth of colon cancer cells.[21]

At the present time the research does not conclusively prove whether or not there is a possibility of the patient having increased susceptibility to colon cancer after Tamoxifen therapy, but whilst conflicting evidence still exists, clinicians need to be aware that any bowel symptoms should be viewed suspiciously.

Genetic links

Three classes of genes have been implicated in carcinogenesis (oncogenes, tumour suppressor genes and DNA repair genes), with gene mutations leading to altered cellular growth and the potential induction of cancer (see Table 2). Specific gene mutations that follow a relatively consistent pattern have been identified in the development of colon cancer (Fig. 1).[22]

The evidence for specific genetic links for cancer is particularly strong when one considers familial breast and bowel cancers. Familial cancers are those that the patient has an inherited genetic susceptibility to developing. The genetics of familial colon cancer has been extensively investigated and genes linked to Familial Adenomatous Polyposis (FAP) and Hereditary Non-Polyposis Colorectal Carcinoma (HNPCC) have been discovered. In the case of this patient, she did not have the numerous polyps associated with FAP, and her family history did not meet the criteria for HNPCC. It is therefore likely that her colorectal carcinoma was sporadic (random events).

The hereditary breast cancer syndrome accounts for about 5–15% of all breast cancers, requiring a strong family history of breast cancer, particularly at a young age, with

Table 2 Genes implicated in cancer development

Gene classification	Examples	Role
Oncogenes		Mutated form of proto-oncogenes, which play an essential role in controlling cell proliferation and encoding growth and transcription factors
Tumour suppressor genes (TSGs)	p53 tumour suppressor gene; APC tumour suppressor gene	Negative regulators of cell growth. Their inactivation results in loss of growth inhibition, hence the cell gains a growth advantage. Recessive genes so both copies must be inhibited for the malignant characteristics to occur. (50% of all tumours carry a p53 gene mutation)
DNA repair genes	Mismatch repair gene, MMR	These genes repair DNA damage incurred due to numerous factors (such as spontaneous mutation and exposure to radiation). Mutations within DNA repair genes tend to result in a genetic instability leading to additional mutational events, such as inactivation of TSGs

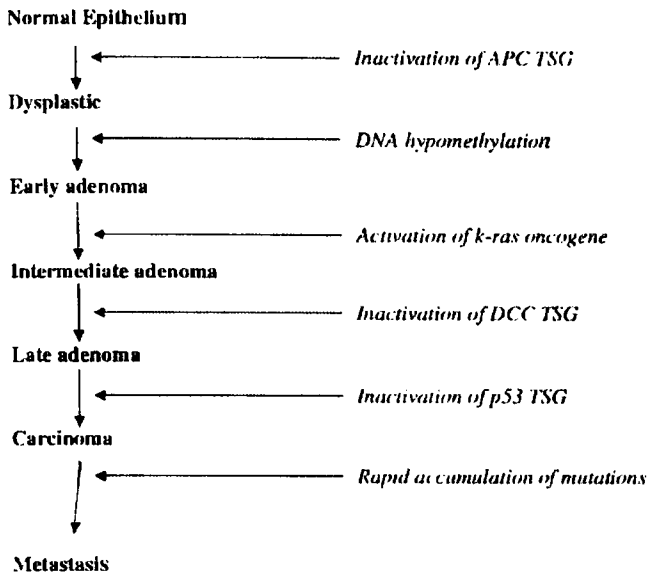

Figure 1 Development of colorectal cancer (Cassidy et al.[28]).

bilateral cancers and multiple affected members.[23] Again it appears that the patient did not fit into the hereditary category, more likely having a sporadic breast cancer. In sporadic cancers both copies of the genes involved need to undergo mutation, and as yet no definite genetic link between different sporadic cancers has been proven.

The genetic role of cancer is beginning to be unravelled, and some genes have been found to be common to several different types of cancers. Some studies suggest an underlying genetic predisposition linking breast cancer with some other cancers such as uterine serous cancer,[24] but no links with colon cancer have yet been identified.

Statistical chances of having a second cancer

Having considered some of the risk factors for both breast and colon cancer (Table 3), what are the chances of developing these two separate primary cancers? A study by Fowble et al.[25] followed up 1253 women with early breast cancer who had received conservative treatment followed by radiation with or without adjuvant therapy. The 10-year cumulative index of a second cancer was found to be 16%, with 167 women developing a second cancer at a median interval of 6.1 years from their initial breast cancer diagnosis.[25] The patient in this case study also had an interval between her two cancers of 6 years. Excluding skin and contralateral breast cancer, the most common sites of second cancer were colorectal, endometrial and non-Hodgkin's lymphoma. The factors associated with a statistically significant increased cumulative incidence of a second non-breast cancer malignancy was age over 65 years, postmenopausal status, and the use of Tamoxifen as the only adjuvant therapy.[25] Once again, this reflects closely with the patient in this case study.

A German study by Ochsenkühn et al.[26] used colonoscopy to investigate the frequency of colorectal adenomas

Table 3 Possible risk factors for breast and colorectal cancer

Risk factor	Breast cancer	Bowel cancer	Relevant to this patient?	Comments
Age over 65	↑	↑	Yes	
Obesity/sedentary lifestyle	↑	↑	No	
High fat/red meat diet	–	↑	?	Some studies unable to support diet related hypothesis
Low fruit/vegetable consumption	↑	↑	?	
Smoking	↑	?	Yes	Menopausal women less susceptible to breast risks than young women. Some studies say smoking has little effect on breast. Smoking and colon cancer risk confounded by poor diet of some smokers
Alcohol	↑	↑	Yes	Increased alcohol intake often associated with smoking
Oral contraceptives	–	↓	?	Effects decrease significantly after stopping treatment
Combined oestrogen–progesterone HRT	–	↓	?	Much debate surrounds effects of HRT on colon. Oestrogen only HRT less likely to have any effects
Tamoxifen use	↓	↑	Yes	Reduces recurrence of oestrogen receptive breast cancer—most studies suggest small increase in colon cancer risk
FAP and HNPCC	–	↑	No	Familial colon cancer syndromes increase risk significantly
Hereditary breast cancer syndrome	↑	–	No	

↑, increased risk of cancer; ↓, decreased risk of cancer; –, no evidence either way/not studied.

and carcinomas in women with breast cancer. Women with breast cancer were found to have a higher risk of adenomas than the age-matched controls, particularly in the 65–85 age group. Although colorectal carcinomas were found infrequently in both groups, the colonic adenomas do have a risk of malignant transformation.[26] Ochsenkühn et al. recommend that women with breast cancer should be encouraged to participate in colorectal cancer screening programmes. These are offered in most countries for average risk individuals over the age of 50,[26] although there is an argument to suggest that they should be accessing more comprehensive high-risk programmes offered to some other client groups.

However, a large retrospective cohort study based on 17,415 breast cancer women in the United Kingdom by Srinivasan et al. 2005 reported that women with prior breast cancer are not at an increased risk of colorectal cancer, and they recommend that they can follow average risk colorectal screening programmes.[27]

Conclusion

Risk factors for the two primary cancers have been identified, and some of these (such as obesity, sedentary lifestyle, diet and alcohol intake) are common to both cancers. The evidence regarding tobacco smoking as a risk factor is debatable, with several studies suggesting that it is the associated alcohol consumption and poor diet of many smokers that is of greater significance.

Many cancers are influenced to some degree by female hormones, and much controversy surrounds the potentially protective effect of HRT and contraceptive use on the colon, and the potentially harmful effect of Tamoxifen use.

The genetics of cancer are only just beginning to be understood, and some genes are common to different cancer types. Although hereditary links have been associated with some types of breast and colon cancer, as yet no direct genetic link between sporadic breast and colon cancers has been shown.

Large cohort studies following women diagnosed with breast cancer have offered variable results regarding the relative risk for developing colon cancer. Although a definite link between the two primary cancers has not been shown, all the research indicates that one must not be ruled out. Long-term follow-up studies of breast cancer patients continue to offer additional information regarding the risks, trends and patterns of second cancers, such that appropriate surveillance and screening strategies can be implemented.

Evidence presented in this review is not conclusive in determining whether the probability of developing colon cancer was higher for the patient in the presented case history. Whilst two metachronous primary cancers developed within 6 years, it is possible that these cancers were sporadic (chance) events, as the patient did not meet the criteria for a hereditary cancer. She did, however, have a number of potential risk factors for the development of colorectal cancer (Table 3), including age over 65, postmenopausal status, smoking and alcohol use, and Tamoxifen treatment. Similar risk factors have been identified in breast cancer follow-up studies where patients have gone on to develop a second cancer,[25] although a large retrospective study suggested that there was no increased risk of colon cancer.[27] With such contradictory evidence it is inappropriate to postulate that the probability of developing the second cancer was indeed raised for this patient.

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Abstract	Extract: The PgCert Advanced Practice (Gastrointestinal Imaging) programme was the first in the UK to prepare radiographers to write a diagnostic report on x-ray examinations of the lower gastrointestinal tract (colon and rectum), a task traditionally undertaken by specialist doctors known as radiologists. This 12-month postgraduate programme comprised blocks of university study with intervening periods of clinical practice. In module evaluations previous students reported feelings of isolation and loss of motivation during these lengthy clinical periods away from the university. This project aimed to enhance learning and on-going support whilst off-campus, utilising Blackboard, the university's virtual learning environment, to host an interactive study package for the development of image interpretation and report-writing skills.	
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Chapter 9

Enhancing the Learning Opportunities of Part-time Postgraduate Students using Distance Learning

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Abstract

The Post-Graduate Certificate in Advanced Practice (Gastrointestinal Imaging) programme was the first in the UK to prepare radiographers to write a diagnostic report on x-ray examinations of the lower gastrointestinal tract (colon and rectum), a task traditionally undertaken by specialist doctors known as radiologists. This 12-month postgraduate programme comprised blocks of university study with intervening periods of clinical practice. In module evaluations previous students reported feelings of isolation and loss of motivation during these lengthy clinical periods away from the university. This project aimed to enhance learning and on-going support whilst off-campus, utilising Blackboard, the university's virtual learning environment, to host an interactive study package for the development of image interpretation and report-writing skills.

In the initial phases of this project a database of carefully selected and verified examples of gastrointestinal x-ray examinations (cases) was sourced and housed within Blackboard, and these were released to students at set intervals. The students analysed each case and then reported their findings into an online forum known as the Blackboard discussion board, enabling students to view and compare differing report-writing styles. A facilitator guided the students, feeding back the verified definitive (actual) report and encouraging self and peer review. An initial campus-based training session was evaluated to explore both student and facilitator perceptions of the ease of use and educational value of the study programme. This was then followed by off-campus delivery of the study package. Whilst initial difficulties were encountered during the development of the database of examinations, the students valued the regular formative assessment and feedback from their peers and facilitator. In the next phase of the project the study package will be evaluated as a tool for auditing the reporting skills

of already-qualified practitioners as part of their lifelong learning/ continuing professional development obligations.

Context

Radiographers are registered health care professionals who are responsible for the production of high quality medical images such as x-rays. Traditionally these images were then transferred to a radiologist (specialist doctor) who "interprets" the images and issues a diagnostic report to the referring clinician. Over the last decade radiographers have developed their practice to include the interpretation and reporting of a range of medical images. This was partly in response to a national shortage of radiologists, but was facilitated by the enhanced educational status of radiographers, with graduate-level entry to the profession introduced approximately ten years ago. The reporting of medical images by radiographers is now well established in several radiological specialties including medical ultrasound, skeletal trauma, mammography (breast imaging), and gastrointestinal radiology.

Examinations of the lower gastrointestinal tract (colon and rectum) are often undertaken in patients with suspected cancer. Bowel cancer is the second most common cancer in the UK, yet if it is identified and treated at an early stage it can have an excellent outcome. This has prompted the recent introduction of a bowel cancer screening programme into the UK and several other countries. However x-ray examinations of the colon and rectum have been identified in the literature as being problematic to interpret due to a high level of perception errors (Hassan 2005; Halligan, Marshall, Taylor, Bartram, Bassett and Cardwell 2003; Markus, Somers, O'Malley and Stevenson 1990), where a pathology is present but not identified on the images by the radiologist. These "false negative" errors may include missed cancers or pre-cancerous polyps which have potentially serious consequences for the patient (RCR 2002). This has prompted a number of authors to recommend a "double reporting" system to overcome this (Leslie and Virjee 2002; Markus et al. 1990), whereby two trained individuals report on the images separately and then reach consensus agreement. This follows the principle that "two pairs of eyes are better than one". Several studies have suggested that radiographers could contribute to double reporting (Booth and Mannion 2005; Murphy, Loughran, Birchenough, Savage and Sutcliffe 2002), but these lack transferability as they are based on individual in-house training courses.

The Postgraduate Certificate in Advanced Practice (Gastrointestinal Imaging) programme provided by the University of Salford was introduced to overcome these limitations, and was the first course in the United Kingdom to offer combined academic and clinical training for this role. The programme has been taught successfully since 2001, using block release over twelve months with intervening periods of clinical practice. Students attend the University for one week every three months, where they gain the underpinning skills and theory necessary for the report-writing role. When they return to their employing hospital for clinical practice they apply this knowledge under the guidance of a clinical mentor. The innovative and flexible method of delivery attracts students from across the UK, but is not without problems. The clinical blocks are lengthy, and in this time it is easy for the student to experience feelings of isolation and loss of motivation, a problem also identified by Harun (2002). The clinical experience offered within each placement is also variable, with some students experiencing a wide range of pathology, whilst others encounter a very limited range. Similarly there were concerns that the students became "entrenched" within the particular ways of working encountered within their base hospital, rarely having the opportunity to explore image interpretation and report writing styles adopted by people other than their own mentor. This could potentially produce a parochial inward-looking practitioner.

Whilst on clinical placement the students were supported through email and had access to the Blackboard virtual learning environment (VLE). However it became apparent that interaction with Blackboard was rather passive in nature, and there was huge potential for Blackboard to be used in a much more innovative way. Examples might be to provide on-going e-learning and support for the students, offer feedback on progress, and prepare students for their summative (report-writing) assessment. A review of relevant literature suggested that e-learning and the use of virtual environments in radiographer / radiology education, although in its infancy, is becoming a popular adjunct to traditional learning methods (Scarsbrook, Graham and Perriss 2005a; White and Cheung, 2005)). Indeed the relevant professional bodies for radiographers and radiologists are strongly recommending a move towards online learning and self-assessment for their trainees (Scarsbrook, Foley, Perriss and Graham 2005b; College of Radiographers 2006) underpinned by the development of an associated national verified case archive (Ibid. 2005b). Recently a small-scale

project at the University of Salford demonstrated the potential of the Blackboard VLE for linking clinical and academic learning, making some strides towards encouraging regular student participation off campus (Newton-Hughes and Robinson 2005). In other health disciplines this has been taken a stage further, with some academic programmes being completely transformed into e-learning packages (Avery, Ringdahl, Juve and Plumbo 2003; Mulholland 2003). An internally funded project was therefore launched with the aim being to enhance the learning opportunities of part-time postgraduate students whilst off-campus, by introducing periodic self, peer and tutor assessment of image interpretation and report writing skills using Blackboard.

The Project Outline

In order to meet these aims, the project sourced a database of carefully selected and verified gastrointestinal radiology cases, and housed them within Blackboard. The cases were released to students at set intervals of time. The students analysed each case and then reported their findings into the discussion board, enabling students to view and compare differing reporting styles. A facilitator guided the students, feeding back the verified definitive report and encouraging peer review. An initial campus-based training session was evaluated to explore both student and facilitator perceptions of the ease of use and educational value of the study programme. This was then followed by off-campus delivery of the study package, and subsequent evaluation. The project was broken down into several distinct phases as shown in Table 6:

This article will explore only the results of the pilot phase (phase 1-4), including the evaluation of a campus-based training session. Two weeks after this session the first off-campus session took place, with further cases released to the students at four weekly intervals. Two independent clinical experts are scheduled to evaluate the learning package to see whether they feel that it has transferability to other similar situations.

Table 6. An outline of the five phases of the project, and method of evaluation.

Phase	Focus	Outline	Evaluation	Comments
1	Case acquisition	Acquire a bank of 30 suitable gastrointestinal cases (10 for pilot). Accompanying diagnostic report and clinical indications.	30 cases acquired by end of project.	Images must be in a suitable digital format, thus limiting the potential sources. Cases may involve up to 16 images (data storage problems).
2	Case Verification	The accompanying diagnostic reports were compared to reports written by a panel of "experts", to ensure that a consensus was reached (reduces ambiguity). Where consensus agreement was not possible, alternative cases were sourced.	All cases verified and agreed report stored on a database.	The methodology used to verify the appropriate cases (3 separate reports which reach consensus) follows traditional, quality assured practice within radiology.
3	Developing the teaching package	Framework identified for uploading and displaying cases on Blackboard. Each case was to be linked to the Blackboard Discussion Board. Students were to interpret the images and then write their findings within the discussion board. This would enable students to view and compare differing reporting styles.	Feedback from project team and clinical facilitators	Large image file sizes encountered in medical imaging may result in long download times, particularly if accessing without Broadband connections. Finding a small file size with excellent image resolution was potentially the greatest challenge within this project.

4	Piloting	Campus-based training session delivered by the project co-ordinator during the third week of university attendance (approximately half way through the year long programme). The purpose and layout of the on-line package was explained, and students were guided through the first of four cases. Minimal assistance was then offered for completion of the remaining cases. Following completion of the 4 cases, a facilitator re-visited each case with the students, placing the definitive (verified) report onto the discussion board. The facilitator encouraged participation of all students to explore the different report writing styles, highlighting examples of good practice.	Student questionnaire Observation of usability Statistical analysis of softwareExternal usability assessment	A campus-based session was delivered to familiarise the students with the training package, and to ensure that staff were on-hand to assist with any technical problems as they arose. It also provided an excellent opportunity for evaluation of both the ease of use of the software and the learning experience.
5	Delivery and external assessment	Off-campus delivery of the study package. Consider potential for use as an audit tool for qualified reporting radiographers.	External assessment by 2 clinical experts	Selected cases were subsequently released to the students at intervals whilst on clinical placement. A facilitator fed back the definitive report and promoted debate. The external assessors will evaluate the complete learning package (assessment of subject relevance / suitability) at the end of the project.

The Pilot Phase Methodology

The sourcing of images in Phase 1-3 was particularly problematic during the initial stages of the project, as image file sizes were too large to enable fast downloading times. A JPEG configuration with lossless compression was adopted, but the physical image sizes were found to be too small for image interpretation (covering less than 1/3rd of the screen). A compromise solution was found, with minimal loss of resolution and images covering approximately half of the screen. Once the format had been agreed, a number of cases were sourced and loaded onto Blackboard ready for verification, although it took longer than anticipated to reach the required number of cases. The panel of experts viewed each case and verified the diagnostic reports which accompanied the cases with few exceptions or amendments, and the agreed reports were stored on a database (not visible to students). An image display format was agreed, whereby the case clinical details were placed at the top of the screen, the individual thumbnail images down the left hand side, and the selected image occupying the rest of the screen (Figure 7). A hyperlink was provided to the Blackboard

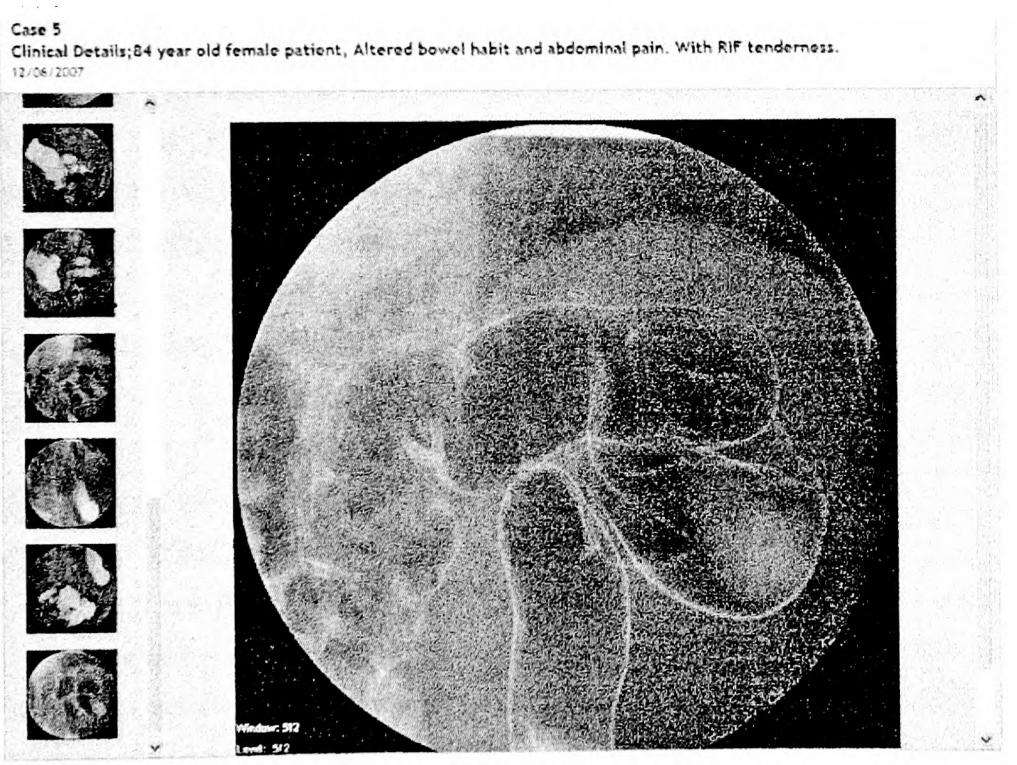

Figure 7. A screen shot demonstrating one case.
Clinical details are posted along the upper screen. Thumbnail images from the case are positioned in the left hand column. Clicking on a thumbnail image demonstrates the full size image.

Discussion Board, enabling students to write their report / findings into the appropriate discussion forum. A facilitator then posted the definitive report and any appropriate comments to the group or to individuals.

The piloting of the tool involved a campus-based training session, enabling both observation of the tool in use, as well as an opportunity for student and facilitator feedback. Whilst methods such as nominal group technique and interviews were considered for the student evaluations, a questionnaire was felt to be the most appropriate means of gaining the relevant information, as different questions could be administered at various points within the training sessions. It also ensured anonymity of the student responses. A number of existing validated usability and learning technologies questionnaires were considered (eg. QUIS Questionnaire for User Interaction Satisfaction), but these were often focussed on evaluation of a larger entity such as a complete website or virtual learning environment. A bespoke questionnaire was therefore designed based upon some of the principles of software evaluation (Neilson 2005) underpinning the validated questionnaires, but enabling much more focussed evaluation of the software package as a learning experience. The questionnaire explored prior experiences of using IT, evaluation of the software, and evaluation of the learning experience. Section 1 of the questionnaire (completed before the training session) aimed to discover the student's previous experience of, and access to IT, to identify whether this may influence their perceived ease of use of the learning package. Section 2 was focussed towards evaluation of the ease of use of the software, and was developed following additional background reading into the general principles (heuristics) of user interface design and usability testing (Nielsen 2005; Dix, Finlay, Abowd and Beale 2004). Section 3 was focussed towards an evaluation of the software tool and the training session as a learning experience, and asked questions related to the next "off campus" phase of the project. To increase the validity of the questionnaire it was piloted using two clinical experts who had also recently been introduced to the learning package. Only minor changes to layout were suggested.

Results: Project Co-ordinator Feedback

During the campus-based training session, the project co-ordinator observed the students working through four cases, and identified one

or two specific problems during this session. These included poor viewing facilities caused by insufficient black-out curtains which interfered with image interpretation. Poor image quality reported to the co-ordinator by one student was easily improved by changing the monitor brightness and contrast. A number of "repetitive" errors being made by the students caused some frustration, including clicking on the wrong buttons. Statistical analysis of the package showed that students required an average of thirteen minutes to view, interpret and write their report on each case. This was useful information as it guided the project team in terms of the numbers of cases that should be released at any one time (no more than five cases), and the potential timeframe that students would need to set aside to complete the task "off campus".

Questionnaire Results

Eight students completed the questionnaire. Section 1 identified that the respondents (seven females and one male) were all mature students, evenly split between the age groups 21-40, and 41-50. All had access to computers both at home and at work, and these included broadband internet connection and email access. Two students commented that internet access was limited to certain sites at work. The results show that they have all had at least some experience in a range of IT packages such as using Microsoft word and sending emails, but limited experience in using the Blackboard Virtual Learning Environment and online discussion forums or bulletin boards.

Section 2 focussed on evaluation of the software. All students felt confident to use the software unaided after completion of 2 cases, with minimal input from the tutors for the 3rd and 4th cases. Five students identified that navigating around the system did "not too difficult", with 3 students perceive the system as "quite easy" or "easy". However, six students had made mistakes such as pressing the wrong keys, although seven out of eight students noted that it was easy to rectify such mistakes. Two of these mistakes were commonly occurring and were also identified by the project co-ordinator during the observation period. These included a tendency for the cases to automatically "minimise", and for students to select the wrong box when viewing reports in the discussion board, resulting in an unwanted attempt to email the report author. Seven of eight students noted that writing reports into the discussion board was "straight-forward", and none

found that moving between the cases and the discussion board to be problematic.

Seven of eight students found that the layouts of the images were appropriate and consistent, but only 2 felt that the images were laid out in an order which mimics their clinical practice. However two respondents noted that there is no single way of viewing images in clinical practice, and that whilst the images were not presented in their preferred sequence, they felt that the images were still negotiable. Students were asked whether the image quality (contrast, resolution, physical size) was acceptable, and there were mixed responses. However most students did appreciate that there was sufficient image quality to enable them to make a reasonable judgement in a "formative" setting.

Six of eight students felt that there was sufficient clinical information (patient presenting symptoms) present to make a judgement on the images, and they considered these cases to be either "quite difficult" (5/8) or "straight-forward" (3/8).

Section 3 focussed upon the evaluation of the learning experience. Students were asked whether they felt uncomfortable allowing their reports to be viewed by their peers. Five of the eight students were not worried about this, with three of the eight stating that they felt a little uncomfortable. However all felt that this uncomfortable feeling would reduce over time. All believed that it was useful being able to view other student's reports, citing a range of reasons. All students had found the facilitators comments useful. When asked whether they would be interested in continuing the reporting exercises off campus, all said yes, with one requesting that it was on a voluntary basis. The students were divided over the length of time they would need to complete four cases in clinical practice, with the majority suggesting 1-2 weeks would be adequate. Most of the students stated that they would complete the cases at home rather than at work, as they would not be interrupted.

In a "free comments" section at the end of the questionnaire, several students noted that the session had been very helpful, and that they are now more confident accessing Blackboard and the cases. Two students noted that they must remember to check their Blackboard and emails more frequently when in clinical practice, as between academic blocks they had tended to "switch off" from their studies. Several students

noted that comparing the reports with each other, and the debate that ensued between the students and the facilitator was valuable.

Discussion

Whilst the evaluations have been generally very positive, students and facilitators have noted that some cases do not appear to have optimum contrast and resolution. As anticipated, image quality is unlikely to rival that found within the clinical placement when dedicated image viewing software with high-resolution monitors are used. The appearance of any image will always be limited by the quality and resolution afforded by the computer monitor, and those used in university computer laboratories and students' personal computers will generally not have the resolution to rival those used in the clinical setting. Similarly students have commented that the software package does not enable the use of important image manipulation tools (such as zoom and edge-enhancement). Whilst these issues are not a significant problem for these formative exercises, the programme team wish to develop online summative reporting assessments in the future. With the current limitations, we do not feel it is appropriate to assess students on sub-optimal images. However, as radiology departments increasingly switch over to fully digital (filmless) operation, we will be able to begin importing images without any loss of resolution. Recently DICOM (digital imaging and communications in medicine) standardised image display and compression tools have been adopted by x-ray equipment manufacturers (Graham, Perriss and Scarsbrook 2005), enabling easier transfer of images from one site to another. Recent purchase of computed radiography equipment by the University of Salford will facilitate such image transfers, and a new free software package (K-PACS) is currently being explored which will offer a range of image manipulation tools. The learning package evaluated within this project should be seen therefore as one that is in transition as new technology becomes available.

Students also commented on several "repetitive" errors being made, including clicking on the wrong buttons and minimising the screen. As five of the eight students had indicated that they had no previous experience of using online discussion forums or bulletin boards, the concept of writing reports into the discussion board was being introduced to many of them for the first time, so some errors were to be expected. However a recent Blackboard software upgrade has

reduced the potential for these mistakes, and a help file will be created to guide students to "undo" any mistakes. A help file could also be useful to guide students and facilitators in optimising the effectiveness of the learning package. For example, some students had noted poor viewing conditions due to insufficient "black-out" conditions during the training session. Glare on the computer monitor can make image viewing difficult, and this could also potentially be a problem when working through the cases at home and at work. Again this should be incorporated into a help file, ensuring that viewing conditions are optimised before commencing the cases. For one student who alerted the facilitator to the fact that brightness and contrast were too poor to report on the cases, this was easily resolved by altering the contrast and brightness dials on the monitor. Again, a reminder on a help file to check monitor controls, particularly where equipment is shared with others, would be valuable.

Whilst the pilot evaluations have identified some areas where improvements could be made, the opportunity to participate in these e-learning opportunities have been welcomed by both the students and the project team. Although three of the eight students indicated they felt initially self-conscious when entering their reports onto the discussion board, they all acknowledged the benefit of being able to view and evaluate different reporting styles. Two student's comments indicated that peer and self assessment was indeed being put into action:

> It was helpful to see other people's wording and then compare to your own report.
>
> People phrase things differently; some people use many words but come to the same conclusion with no additional information.

Similarly, following a tutor's posting of the actual report and some additional feedback, statistical review of the Blackboard site showed that all students had re-visited the cases and each other's reports, with several posting further comments and queries. The facilitator has therefore an important role as a catalyst in ensuring that students make the most of the learning experience, and they must be vigilant in checking for further postings and queries. Feedback from the facilitators has also suggested that they need to develop new skills to manage the process effectively. In particular, encouraging mature

students who are qualified professional health workers to post their "answers" onto an open discussion forum is something that is new and potentially intimidating to many tutors and students alike. Facilitators need to be mindful of the individual students who may have made an incorrect report, giving constructive and supportive comments which will encourage them to keep trying and will reduce any feelings of embarrassment or inadequacy. With tactful feedback, the benefits of this form of distance learning and self, peer and tutor support are potentially wide-ranging.

Following the campus based training session, all students indicated that they would like to continue with these sessions "off campus", with one student noting that this should not be mandatory. The first "off campus" session provided students with a further 4 cases to complete, with 7/8 students posting a report on the discussion board. Due to anonymity of the questionnaires, it is not clear whether the one student who did not take part in this session was the one who felt it should not be mandatory, but this did raise several questions for the project team. If these sessions were not mandatory, then some students could opt out from contributing a report, but could still access the cases and the other students' reports and tutor feedback. This could be perceived as unfair, as they could reap the benefits of the other students' hard work. At this stage we do not have an answer to this difficult question, but it is one that is often encountered in different types of group work such as problem-based learning, where the minimal contributor may still have access to the work undertaken by the group. We therefore will be vigilant in monitoring and encouraging participation over the following 12 months.

Conclusion and Recommendations

Whilst this project has not yet come to its conclusion, it is clear from the pilot phase facilitator and student comments that it does have value in enhancing learning and support to students whilst off-campus. Prior to this, project students rarely engaged with their tutors and each other during the clinical blocks, and this has the potential for students to suffer from isolation and loss of motivation. By encouraging them to actively engage with Blackboard at intervals within the clinical placement, we are introducing more effective distance learning, which enhances the link between academic and clinical learning objectives. The interaction with facilitators will better prepare students for their

summative reporting assessments, as they will not only be able to assess themselves against the "definitive" report, but they will also have access to viewing other student's strategies for report writing. This formative feedback will enable areas of strength and weakness to be identified.

Following an external assessment of the learning package by two clinical experts, we hope to expand the case bank further for this programme of study. Information gained from this project can be directly transferred to other radiography programmes, as setting up a similar case database will be easier now that we are aware of some of the pitfalls and problems that may arise. Similarly there may be transferable outcomes to other academics interested in developing work-based and distance learning to include online delivery, using visual images to prompt discussion and participation by students.

Previous students have expressed an interest in gaining access to this new case bank, in order to "test" their image interpretation and report writing skills against a validated case archive. This opportunity does not currently exist in the UK within this particular speciality. Qualified reporting radiographers have a requirement to engage in lifelong learning and audit their practice at regular intervals, and this may be a more transferable audit tool than the "in-house" mechanisms that they currently use.

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Abstract	With an expanding elderly population, demand for radiological evaluation of dysphagia is likely to grow. Radiographers and speech and language therapists (SLTs) have been encouraged to advance their role and they now perform swallowing studies in some hospitals.....This study aimed to investigate the nature of any changes in practice that were introduced by practitioners as a consequence of attendance on the module. Documentary analysis was undertaken of the portfolios of 16 radiographers and 8 SLTs, to identify any changes in practice initiated by the students..... Practitioners .....introduced between 4 – 19 practice changes (mean of 9), which could be categorised into 3 main areas of potential service improvement: communication; protocols and safety; quality assurance and audit. New services were introduced, including the introduction of practitioner-led services in 15/24 (62.5%) individuals. Without the academic underpinning knowledge and critical evaluation of practice promoted within the module, it is improbable that these practice changes would have been introduced as quickly, if at all. Practitioner-led swallowing services clearly have a place in the changing health service, and attendance on an academic programme of study can facilitate service developments by encouraging practitioners to engage in evidence-based practice.	
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THE SOCIETY AND COLLEGE OF RADIOGRAPHERS

An analysis of changes in practice introduced during an educational programme for practitioner-led swallowing investigations

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KEYWORDS
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Abstract *Aim:* With an expanding elderly population, demand for radiological evaluation of dysphagia is likely to grow. Radiographers and speech and language therapists (SLTs) have been encouraged to advance their role and they now perform swallowing studies in some hospitals. An academic programme was designed to support practitioners to develop their role in swallowing evaluation, evidenced by a clinical portfolio. This study aimed to investigate the nature of any changes in practice that were introduced by practitioners as a consequence of attendance on the module.

Materials and methods: Documentary analysis was undertaken of the portfolios of 16 radiographers and 8 SLTs, to identify any changes in practice initiated by the students. Practice changes were coded and grouped into themes.

Results: Practitioners had a mean of 15.2 years post-qualification experience (range 5–37), and a mean of 4.5 years working in the gastrointestinal field. Practitioners introduced between 4 and 19 practice changes (mean of 9), which could be categorised into three main areas of potential service improvement: communication; protocols and safety; quality assurance and audit. New services were introduced, including the introduction of practitioner-led services in 15/24 (62.5%) individuals.

Conclusion: Without the academic underpinning knowledge and critical evaluation of practice promoted within the module, it is improbable that these practice changes would have been introduced as quickly, if at all. Practitioner-led swallowing services clearly have a place in the changing health service, and attendance on an academic programme of study can facilitate service developments by encouraging practitioners to engage in evidence-based practice.

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Introduction

A wide variety of patients with symptoms of oropharyngeal or oesophageal dysphagia (difficulty in swallowing) may be referred to the imaging department for evaluation by videofluoroscopic swallowing assessment (VFSA) or barium swallow. The evaluation of dysphagia is facilitated by a multi-disciplinary approach, often requiring collaboration between radiologists, gastroenterologists, speech therapists and head and neck surgeons.[1] Fluoroscopic evaluation of dysphagia is likely to continue to be the most sensitive technique available for the foreseeable future,[1–3] and with an expanding elderly population demand is likely to grow.[4] Swallowing studies in the United Kingdom are traditionally performed by radiologists with radiographer support, usually in conjunction with a speech and language therapist (SLT) for VFSA. The well-documented shortage of UK radiologists coupled with an expanding radiology portfolio has already resulted in the widespread introduction of radiographer-led barium enema services in the UK,[5,6] with the transition towards swallowing studies being a logical expansion of their role.

However, a 2006 survey of 113 UK radiologists and SLTs engaged in VFSA procedures by Power et al. has raised concerns regarding the apparent lack of evidence-based practice in swallowing examinations.[7] They noted an absence of any consensus in the approaches taken and a lack of consistency in protocols used, with 41% of respondents employing potentially "unsafe" practices. Radiologists in this study had received little or no training to perform VFSA effectively, with 50% of SLTs receiving a maximum of one day's training. The majority of respondents performed VFSA on an "ad-hoc" basis, with only 32% participating in more than six assessments per month.[7] Concerns such as these have resulted in the Royal College of Speech and Language Therapists recently issuing guidance on the practice of videofluoroscopy for their members, which strongly endorses the development of specialist VFSA training opportunities including short courses and masters level programmes.[8]

Whilst the Royal College of Radiologists and the College of Radiographers have not issued specific guidance on performing swallowing examinations, they have noted that where possible any clinical "in-house" training should ideally be complemented by an accredited academic programme,[9] which will encourage a questioning and evidence-based approach. With this in mind a 30-credit Masters Level module was developed at the University of Salford to support radiographer and SLT practitioners to develop their VFSA and barium swallow practice, and a portfolio-based assessment method was selected. Brown describes two distinct types of professional portfolio.[10] The personal portfolio is a private collection of evidence of skills, knowledge and personal achievements over the full breadth of the practitioner's work, gathered over a long period of time. This ongoing portfolio is then used as a reminder or prompt to help to build the second type of portfolio, the clinical profile.[11] This is a detailed collection of evidence which is selected for the attention of a particular audience for a particular purpose[11] – in this case the audience is the academic staff and employers, and the purpose is to demonstrate developing competence in swallowing disorders studies. The portfolio in this module followed the clinical profile model, comprising a log of cases, a reflective commentary and supporting evidence. This format is recommended as an appropriate tool for assessing components of practice at advanced levels.[12]

The "swallowing disorders" portfolio directed students to provide evidence to demonstrate that they could meet a range of learning outcomes. These learning outcomes required students to demonstrate not only their clinical expertise but also to explore the underpinning theory and evidence on which their practice is based. Students were expected to reflect upon their service, but were not required to introduce subsequent changes within this module. Portfolios are said to be of high potential when used in certain learning environments, such as competence development modules.[13] This is because in reflecting on practice the students are provided with feedback to guide their own learning. Where they perceive themselves as weak in a particular area, they will put some activity in place to develop their skills, and then evidence this. The portfolio therefore encourages self-directed learning.[13] However, during the marking of the first cohort portfolios, it became apparent that the students were not only identifying weaknesses, and making recommendations, but that they were also affecting a number of changes in practice. This finding follows the theory developed by Tillema, who suggests that a well-designed portfolio may lead to focused interventions regarding the goals that are to be evaluated.[13] The researchers proposed that it would be a valuable exercise to investigate the changes in the service to help to inform future course developments and to disseminate any relevant findings to others. The aims of this study therefore were to document and explore the nature of any changes in practice that were introduced by practitioners as a consequence of attendance on the module.

Methodology

To address the research aims, a combination of case study and a limited evaluation methodology was selected. Case studies involve the development of detailed knowledge about a single case, studied in context and involving mainly qualitative data collection methods including documentary analysis.[14] This study scrutinised the portfolio of evidence compiled by practitioners whilst undertaking the Masters level swallowing disorders module, in order to obtain detailed knowledge of case studies relating to their practice. Evaluation methodologies adopt an approach seeking to establish the value or effectiveness of a programme or service to the recipients.[14] In this example, the programme is the intervention in the form of the swallowing disorders module, and the recipients are the educators, the students and the swallowing disorders service.

A convenience sample of students in two separate cohorts of the module was selected for review, comprising a total of 24 practitioners (16 radiographers and 8 SLTs). Students gained approval within their hospitals for any service developments initiated, and permission was sought to source their portfolios for data relevant to this study only after the work had been assessed. This was essential to ensure that

the research was unobtrusive and did not influence the development of the portfolios. Confidentiality of both students and their patients/employers was assured. This fulfilled current data protection and ethical requirements.

Documentary analysis of the portfolios was undertaken using a proforma to record information relevant to the study. This involved collating demographic data as well as gathering information about the nature of any documented changes in practice. Only changes that had actually occurred or were going through a formal approval process were included in the data collection, and evidence had to be provided to demonstrate that the change had occurred, or that it was in progress. It is acknowledged that documentary analysis has inherent difficulties when the "documents" have not been written for the purposes of the research study, introducing potential biases or distortions.[14] However in order to reduce these weaknesses, a number of checks were initiated during the data collection and analysis phases, including the use of more than one researcher for data collection and analysis, reliability checks, and involvement of the students in a "peer review" capacity. Whilst one researcher was involved in the delivery of the programme, potentially introducing bias, a second researcher, experienced in the dysphagia field, was not involved in programme delivery.

Once information about the changes in practice had been collated for each student, a review of all the changes documented across the 24 portfolios was undertaken. Similar types of practice developments were collated and then grouped together into themes. These themes, which encapsulated a number of practice changes, were named appropriately. The researchers then tested the reliability of the proposed coding system and themes[14] by returning to two randomly selected portfolios, ensuring that all practice changes could be suitably linked with one of the themes. The researchers discussed any discrepancies and amendments were made. The agreed themes and research findings were then sent to a sample of the students for their comments, to ascertain whether they felt that any assumptions made based upon the findings were valid and applicable to their own experiences.

Results

Twenty four portfolios were assessed in total, including 8 submitted by SLTs, focussing upon VFSA competency. Of the 16 portfolios submitted by radiographers, 7 were focussed towards VFSA and 9 towards barium swallow competencies. The practitioners had a mean of 15.2 years post-qualification experience (range 5–37), and had an average of 4.5 years experience working in the gastrointestinal/dysphagia field (range 0–10). The SLTs were generally more experienced in the field than the radiographers. Thirteen percent of students noted the Diploma of the College of Radiographers (DCR) as their highest academic qualification prior to attending the postgraduate module, with the remainder holding either a B.Sc., Postgraduate Certificate, or in one case, a Postgraduate Diploma.

Each portfolio that was examined demonstrated evidence of a number of changes in practice. These practice changes were categorised into three main themes, entitled communication; protocols and safety; and quality assurance and audit. Each theme had a number of sub-categories, in which "issues for concern" had been raised by the students, providing a focus for changes in practice. The main sub-categories are identified below, accompanied by the number of students who initiated related changes in practice.

1. Changes in communication (see Fig. 1)
   - patient information leaflets (22/24)
   - referral systems (16/24)
   - appointment systems (9/24)
   - groups with impaired understanding (photographic communication) (6/24)
2. Changes in protocols and safety (Fig. 2)
   - examination protocols (23/24)
   - reporting procedures (19/24)
   - contrast agents used (9/24)
   - image sequences (7/24)
   - objectivity in reporting (penetration–aspiration scales) (7/24)
   - early termination of the procedure (when to stop) (3/24)
3. Changes in quality assurance and audit (Fig. 3)
   - practice audit (13/24)
   - dose monitoring and dose reduction (saving) (11/24)
   - QA testing (9/24)
   - equipment selection and tendering (9/24)
   - Referrer training (IR(ME)R 2000) (4/24)

As the themes emerged, it was evident that a range of new services had been introduced, and the practitioner's role was subject to rapid role redesign and expansion (Fig. 4). This included active participation in the relevant multidisciplinary (MDT) meetings, thus strengthening links with

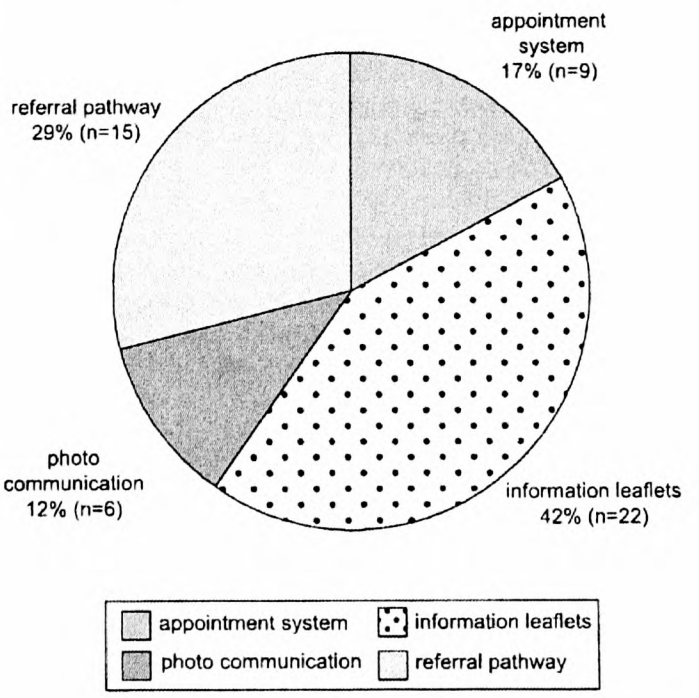

Figure 1 Changes in communication identified within the portfolios.

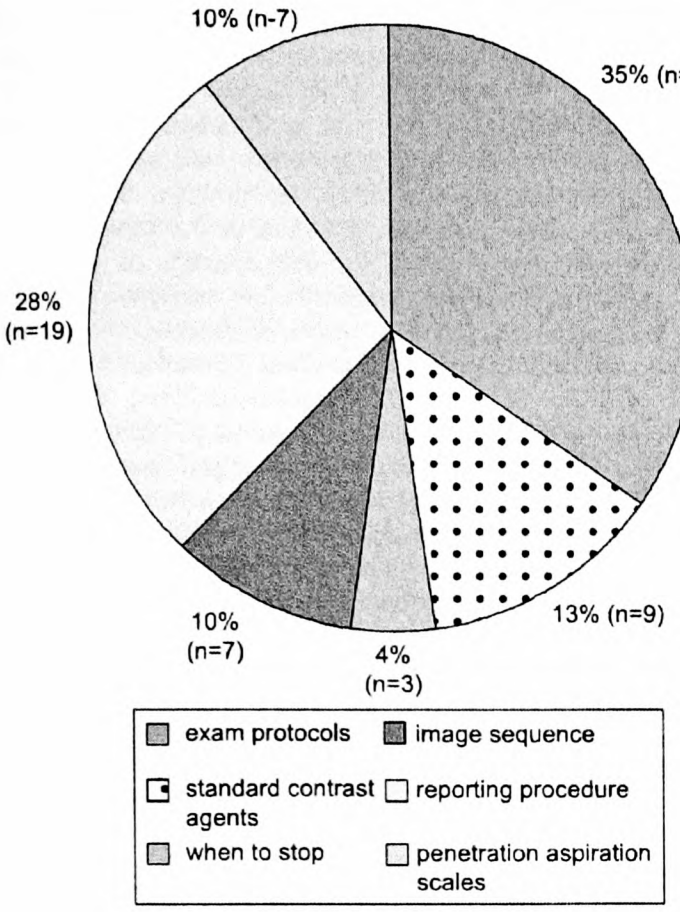

Figure 2 Changes in protocols and safety identified from the portfolios.

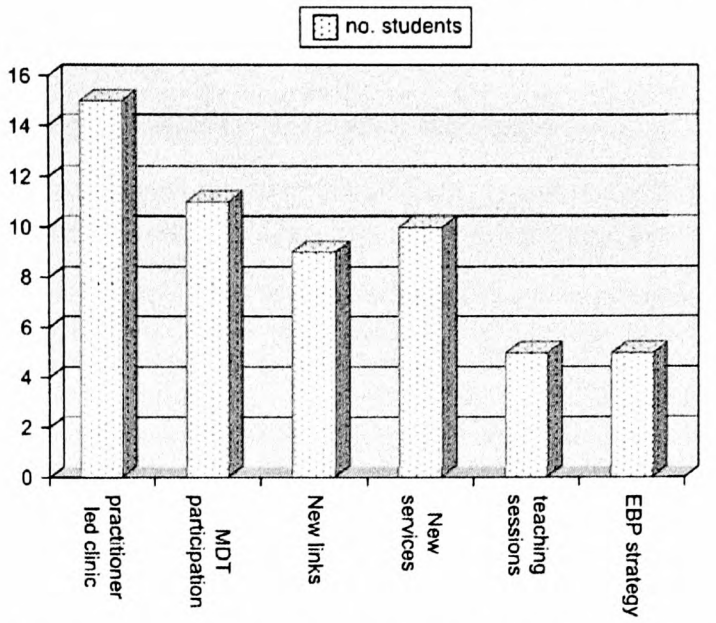

Figure 4 Main areas of service and role redesign identified from the portfolios.

other disciplines, and often leading to new services. Several practitioners increased their engagement with teaching as well as their involvement in research and audit projects. For most practitioners, the outcomes listed within the three themes combined to facilitate the introduction of a practitioner-led swallowing service.

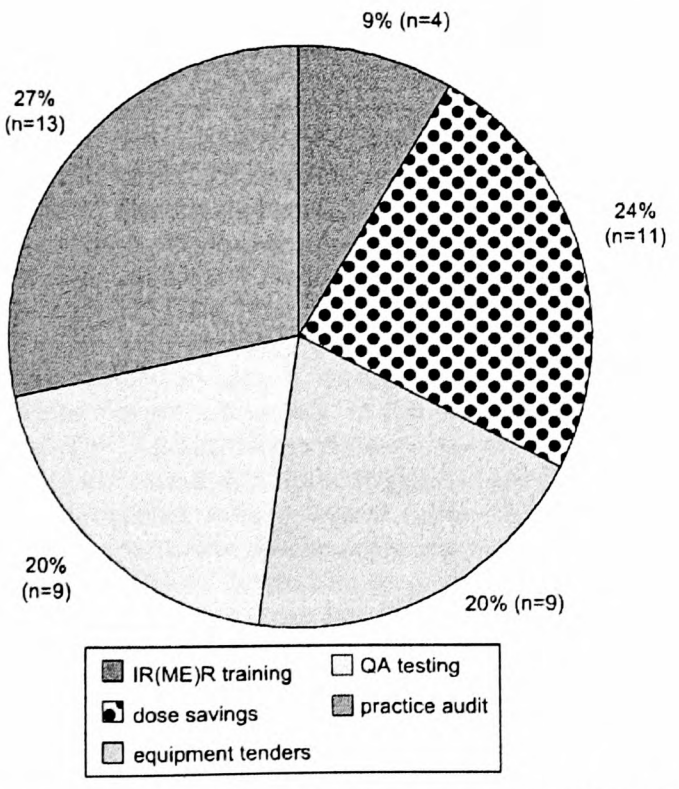

Figure 3 Changes in quality assurance and audit identified from the portfolios.

Discussion

During the timeframe of the module, all practitioners had introduced a number of practice changes, ranging from 4 to 19 with a mean of 9. Those with fewer changes usually had a non-medical colleague already performing swallowing examinations, who had previously initiated service improvements. However, the implemented changes did not appear to be related to the length of experience in GI work, or prior experience in performing swallowing disorders studies. This suggests that the training intervention has had a positive effect, encouraging practitioners to share their practice with peers and base their own service on the best available evidence. The number and range of practice changes did not appear to be related to the previous qualifications or academic mark obtained, as the academic mark is based on a number of additional criteria. However, this also suggests that the academically less able students have still benefited from attendance on the programme, justifying and initiating a number of important changes in their practice.

Changes in communication

Changes in communication were related to both patients and staff. The most frequent issue to be identified within the portfolios (22/24) was inadequate or out of date patient information leaflets and appointment letters. Practitioners commented upon incorrect contact details, reliance on professional jargon, small fonts and confusing layout, and conflicting information offered within the patient leaflet and the appointment letter. A number of practitioners also commented on the "reading age" of the documents being too high. The practitioners created new "patient-friendly" documents using NHS guidelines,[15] frequently combining

the information leaflet and the appointment letter. A number of practitioners (6/24) also created additional information documents based on a photographic "storybook", suitable for paediatric or learning disabilities patients, as well as large font documents (for visually impaired patients) and information about a translation service for patients whose first language was not English. This was in response to documented incidents where the students had encountered insufficiently prepared patients who were unnecessarily anxious. Appropriate and accessible patient information leaflets have been found to reduce anxiety in previous studies.[16]

The referral pathway for swallowing examinations was seen in many Trusts as unnecessarily unwieldy, with SLTs required to contact a doctor to refer the patient following their positive clinical swallowing assessment. 15/24 practitioners designed new referral protocols to speed up the process, identifying potential referrers and ensuring they had completed IR(ME)R (2000) training.[17] 9/24 practitioners also negotiated a more streamlined and flexible appointment system, facilitating more time per patient. Such changes can help to ensure appropriate referrals,[18] as well as aid in achievement of maximum waiting targets imposed by the Department of Health.[19]

Changes in protocols and safety

23/24 practitioners had identified important weaknesses within their existing examination protocols. For some, particularly the SLTs, no written protocols existed. Where they did exist, they were either unnecessarily over-prescriptive, or more commonly contained insufficient detail for guidance and for medico-legal purposes.[20,21] In particular, many of the practitioners mirrored the concerns of Power et al.[7] in identifying that there was no standardisation of the use of contrast agents and materials within the protocol – essential if follow-up studies are to be undertaken. An agreement to standardise the consistency of materials used, the quantity and the sequence administered by all practitioners in their hospital was reached in 9/24 practitioners, as recommended by professional body guidelines.[8] Patient safety within the procedure was given more emphasis within the protocol, with 3/24 practitioners inserting an additional clause regarding the ethics of the procedure, including how to ensure informed consent is given (when patients may have learning disability or other physical disabilities such as dysphonia), and also when to terminate the procedure (e.g. in the event of aspiration).

A number of practitioners revised their imaging sequence following discussion with other students, for example starting the procedure with a lateral rather than an antero-posterior projection to enable small degrees of aspiration to be identified (7/24). Revised imaging sequences also led to radiation dose savings, as has been noted in previous research studies.[22] The majority of practitioners (19/24) developed or amended their examination report proformas, to enable greater standardisation of reporting by different practitioners and therefore improve communication with the referring clinicians, as recommended in a 2007 National Patient Safety Agency safer practice notice.[23] For 7/15 practitioners engaged in VFSA reporting, their report proforma was revised to include the Rosenbek et al. penetration–aspiration scale,[24] a more objective measure of assessing and recording the examination findings.

Changes in quality assurance and audit

For many practitioners, even those experienced in the swallowing disorders role, little attention had been given to quality assurance and audit of their work. For 4 SLTs, attendance on the course encouraged them to undertake IR(ME)R 2000 training,[17] to enable them to refer patients safely and assist in managing the procedure.[18] Experienced SLTs in particular had previously given little attention to radiation dose and dose saving procedures, seeing that as a radiographer role. However, following the course 11/24 practitioners introduced a number of changes including the wearing of a radiation dose monitor by the SLTs, recording and auditing the patient doses incurred, and introducing recognised dose saving measures (such as grid removal and screen capture).[25–27] 9/16 radiographers identified inadequate quality assurance testing of their fluoroscopy equipment, and often no testing regime for ancillary equipment such as DVD or video machines. They introduced regular equipment testing sessions into the fluoroscopy working week. 9/24 practitioners identified deficiencies in their equipment compromising the quality of the swallowing examination, and they became involved in equipment tendering and purchase for more suitable equipment. Examples included specialist patient chairs, DVD recorders, and suitable C-arm equipment.

Perhaps the most positive change in the view of the authors, introduced by 13/24 practitioners, was the introduction of a regular audit cycle, including a review of screening times and radiation doses, reporting accuracy and turnaround times, patient satisfaction surveys and review of attendance rates and waiting times. Other students already had some form of audit in place, but these were often irregular or not documented or disseminated. Ongoing audit, regular reviews of practice and formal critical incident and error reviews are essential to assure clinical governance standards where practitioners extend their scope of practice.[8,9,28] Indeed a number of elements of the VFSA service have been identified as suitable for regular audit and future research by the Royal College of Speech and Language Therapy.[8]

Service and role redesign

For many of the practitioners, attendance on the course enabled them to gain sufficient knowledge and expertise to eventually develop a practitioner-led swallowing service. For 15/24 practitioners, this change was introduced towards the end of the module, although for some there was still radiologist involvement in terms of writing a definitive report.

Attendance on the programme had encouraged 11/24 additional practitioners to regularly attend relevant multidisciplinary team (MDT) meetings, and in so doing 9/24 fostered important clinical links with other specialties and professions, resulting in documented evidence of improved services and communication. 5/24 practitioners were invited to deliver regular "in-house" teaching sessions, including radiology registrar practical training, radiographer

and SLT CPD sessions, and student training, this increasing educational involvement being previously identified by Nightingale and Hogg as an important role of a gastrointestinal advanced practitioner.[5] Several practitioners noted that they had developed enhanced literature searching and computer skills whilst undertaking the module, and that this enabled them to ensure that they were updating themselves with the latest research. For 10/24 practitioners, attendance on the programme led them to develop new and innovative services within their hospital. Such services included:

- VFSA services where previously these were sent to additional hospitals;
- "same day" acute stroke assessment VFSA;
- dedicated paediatric and learning disabilities services;
- additional patient lists to reduce waiting times.

The assessment method chosen for this module was a clinical portfolio. With the ability to assess both breadth and depth of knowledge and expertise, yet still remain highly flexible, the portfolio has demonstrated clear links between theory and practice. Whilst the authors acknowledge the time-consuming nature of portfolio development, the reflection on practice and critical evaluation of the service is clearly evident. Practitioners appear to identify weaknesses in themselves or the service, and initiate rapid changes, which may lead to improvements. It might be considered that such service improvements would not have been introduced so quickly in the absence of the impending academic assessment submission. For a portfolio assessment to be successful the learning outcomes must be clearly matched to both the desired academic objectives and to the required clinical skills and abilities. These learning objectives must be clearly articulated to the students, as guidance is essential to enable the students to complete their portfolio within the available timeframe.

There are a number of potential limitations within this study. Whilst it could be argued that such changes may have occurred anyway following local audit, for many of the practitioners who had been working in this field for several years, attendance on the module still appeared to promote service changes. This study has only attempted to conduct a simple numerical count of the evidenced changes in practice, with exploration and discussion surrounding the types of changes and their possible justification (as evidenced within the portfolios). What this study did not seek to demonstrate is the level of service quality provided within the practitioners' base hospitals before the educational intervention, or to categorically state that the service quality has improved after the programme. Similarly, the study does not attempt to compare outcome or performance data between practitioners and radiologists.

Conclusion

A wide range of important changes in practice were introduced as a consequence of attendance on this module, leading to the subsequent introduction of practitioner-led services in the majority of cases. It appears from the portfolio evidence that the practice changes positively impacted not only on the student, but also on the radiology/speech and language therapy department, referring clinicians, and their patients. These research findings support the work of Storey and Haigh, who also identified that portfolio assessment improves the quality of care provided for patients by encouraging the development of reflexive practice skills.[29] This research has identified clear benefits to support the introduction of practitioner-led swallowing services. Attendance on an academic programme of study has been shown to facilitate changes in practice and potential service improvements by encouraging practitioners to engage with evidence-based and peer practice.

Although not included in this paper, an extension of this study is to be undertaken to identify whether such role redesign is embraced over the longer term. As similar courses are introduced at other institutions, it would also be of interest to compare service outcomes from the different programmes. The strongest recommendation to emerge from this research is, however, to encourage these practitioners to audit their practice and disseminate the results, thus strengthening the evidence base in support of practitioner-led swallowing disorders services.

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Abstract	Radiographers engaged in advanced and consultant roles are advised to base their work within an agreed framework of practice, commonly known as a protocol. A protocol is an agreed and documented system which outlines how certain categories of patients are to be managed, and by whom. Whilst many variations in the terminology and layout of protocols may cause confusion, scrutiny of a range of protocols from different clinical centres suggests that they often adopt a similar approach to their content. This article explores the vital "ingredients" that make up a protocol for advanced practice, highlighting a range of good practice to minimise the risks to both the radiographer and patient.	
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Developing protocols for advanced and consultant practice

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Abstract Radiographers engaged in advanced and consultant roles are advised to base their work within an agreed framework of practice, commonly known as a protocol. A protocol is an agreed and documented system which outlines how certain categories of patients are to be managed, and by whom. Whilst many variations in the terminology and layout of protocols may cause confusion, scrutiny of a range of protocols from different clinical centres suggests that they often adopt a similar approach to their content. This article explores the vital "ingredients" that make up a protocol for advanced practice, highlighting a range of good practice to minimise the risks to both the radiographer and patient.

Protocols in clinical practice

Radiographers in the UK have been encouraged to expand and develop their roles to meet service needs, with many now engaged in what are termed advanced practices, performing roles and managing services traditionally undertaken by a medically-qualified radiologist. Radiographers engaged in advanced practices are strongly advised to develop (and work within) an agreed set of guidelines, commonly termed a protocol. However this terminology is not universally applied across healthcare practice, potentially creating confusion. A number of terms are used interchangeably when referring to practice guidelines, including clinical protocols, clinical guidelines, operational policies and schemes of work. A brief interrogation of the internet suggests that a "clinical protocol" tends to refer to the methodological framework within which research studies such as randomised controlled trials are designed. The term "clinical guideline" tends to refer to national guidance on the appropriate pathway for diagnosing and treating particular medical conditions, for example those produced by the National Institute of Health and Clinical Excellence (NICE) or the Scottish Intercollegiate Guidelines Network (SIGN).[1,2] "Schemes of work" and "operational policies" normally discuss roles and responsibilities of different workers in different settings. Within healthcare the term "protocol" commonly refers to a set of "best practice" guidelines for performing a particular procedure. In simple terms, a protocol is an agreed and documented system which outlines how certain categories of patients are to be managed, and by whom.

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Protocols are valuable in radiography and the wider healthcare setting for many reasons. These include:

- providing a detailed framework within which patients can be managed;
- standardising medical care, based upon research evidence;
- raising quality of care to a minimum level;
- reducing levels of risk;
- documenting the normal course of action for a particular group of patients.

The factors documented above are evidence of "good" clinical practice. The protocol is a method of ensuring that practitioners are working with practices that are evidence based, and thus is potentially a method of driving up standards. This view is supported by the NHS Modernisation Agency, who state that a protocol can improve care in almost any setting, including practitioners who are delivering care across a department, as well as those working in a small, discrete team.[3]

In the event of a complaint about standards of care or indeed litigation for alleged negligence, the information contained within a well-written protocol can help in defending a claim. It is essential for medico-legal purposes that such protocols are written down and are based on the best research evidence of the time. Claims for medical negligence, for example, can be submitted several years after the actual episode of care, so one cannot rely upon the practitioner's memory of the practice at that time.[4]

Whilst variations in terminology do exist between different hospitals, "protocol" is the commonly adopted term to describe the set of guidelines within which radiographers can undertake advanced roles. The requirement for protocols supporting radiographer advanced roles has been outlined previously in professional body publications,[5,6] and has been expanded further in articles by Paterson et al (2004)[7] and Owen et al (2004).[8]

The process of protocol development from its initial conception through to piloting and delivery is clearly outlined by the NHS Modernisation Agency in a publication entitled "A step-by-step guide to developing protocols".[3] The key stages of this process are outlined in Table 1. However, even though such guidance exists, review of several working protocol documents related to advanced practice demonstrates a wide variation in protocol design and content. Before embarking on the design of a new protocol, or evaluating an existing one, it is helpful to look at the content and layout of as many different protocols as possible, both from within and outside one's own hospital. In this way, one can identify "best practice", and avoid having to re-invent the wheel. Whilst different hospitals undoubtedly have their own guidelines for protocol development, a number of suggestions are offered below which will assist in ensuring that, from a medico-legal viewpoint, best practice is followed.

Table 1 Key steps to developing protocols

Stage in protocol development cycle	Description
Stage 1	Select and prioritise a topic
Stage 2	Set up a team
Stage 3	Involve patients and users
Stage 4	Agree on objectives
Stage 5	Build awareness and commitment
Stage 6	Gather information
Stage 7	Baseline assessment
Stage 8	Produce the protocol
Stage 9	Pilot the protocol
Stage 10	Implement the protocol
Stage 11	Monitor variation
Stage 12	Review the protocol

Adapted from the NHS Modernisation Agency, 2002.[3]

Ingredients of a protocol

Whilst variations undoubtedly exist, protocols for advanced practice commonly include a number of different elements related to the practices and procedures to support either performing a particular procedure, and/or writing a diagnostic report. These elements are listed in Table 2, with each element being explored in more detail in the following sections. These suggested elements are based upon previous literature, as well as extensive review of examples of working protocols. Examples of suggested wording are enclosed in italics.

Background section

This details the general title and purpose of the protocol (eg. *to enable suitably trained radiographers to issue clinical reports on barium enema examinations performed within xxx hospital*), and briefly sets the scene regarding the evidence base for this practice. Having the evidence base discussion placed at the beginning of the article shows the reader (eg. the hospital management and potentially a plaintiff's lawyer) that the protocol has been well-researched, and suggests that the practitioners using the protocol will also use an evidence based approach to their practice.[4] This section must, therefore, include references to national standards (where available), professional body publications and current research evidence supporting the practice. It should explore a brief history of the development of such practices at the particular hospital, and the justification for this. When developing a new protocol it is valuable to justify how the new advanced role will meet a particular service need, thus helping to convince the hospital authorities to support the protocol. The results of any previous departmental audits supporting the practice may be referred to in this section.

Education and training

This section should outline the minimum requirements for the training and education of the practitioners involved. This may include reference to the initial qualifications and/or clinical training required to *perform* the procedures (eg. *to have completed a professional body accredited course and*

Table 2 Elements of a protocol for advanced practice

Section of protocol	Description of contents
Title	Clearly identifies the contents
Background section	Documents current evidence base to support the practice Historical development of the role at the hospital Explores local service need
Education and training	Minimum requirements (formal and in-house education) to perform or report the examinations Special requirements for those in training
Scope of practice	Particular examinations and patient categories that can be managed by the radiographer Degree of autonomy enabled by protocol
Procedures for performing or reporting examinations	Steps involved in performing or reporting the procedure Minimum facilities required Standards to which radiographers should conform Contraindications and unusual/emergency scenarios when the normal protocol is not followed
Report structure	Elements of the report, including possible reporting codes used
Clinical audit	Detailed outline of audit procedures and standards
Continuing professional development	Minimum (and recommended) CPD expectations of radiographers to maintain and document their competence
Verification section	Approval of the protocol at all levels
References	Key references including peer reviewed and professional body/Department of Health literature

clinical training programme for mammography practice), the pre-requisites for *training to report* the procedures (*must have been undertaking independent barium swallow examinations for at least 12 months*), and the qualifications/training necessary to enable the practitioner to *report* the examinations. For some reporting practices (barium enema, mammography, CT head, skeletal reporting, nuclear medicine) this would include a professional body accredited postgraduate programme in conjunction with in-house clinical training and mentorship. Successful completion of the programme implies "competence" to report. However in niche and emerging areas of practice masters level reporting programmes may not be readily available. In this case there should be emphasis upon the requirements of any in-house clinical training programmes, with documented information on how initial competence has been ascertained (eg. through audit). The protocol may, for example, specify a minimum number of training cases that should have been completed, with a required accuracy threshold.

Whilst the protocol is developed to facilitate performing or reporting an examination on completion of the above training, mention can also be made here of any procedures that should be followed by those undergoing training for this role. For example, the protocol may stipulate that those in training cannot issue independent or definitive reports. This section may, in some circumstances, outline any grading or remuneration for the new practices.

Scope of practice

This section outlines the particular examinations and patient groups to be performed or reported by the radiographer under this protocol. This may include and exclude certain categories of patients. For performing barium enemas, for example, this may exclude those under 16 years of age, and any post-operative checks. For reporting barium enemas, this may include any barium enemas performed within the hospital, or may be restricted only to those performed by the radiographer.

The scope of practice and reporting must be agreed upon by the reporting radiographers, the professional radiographer lead for the department, the clinical director (usually a radiologist), as well as the hospital management. This must be indicated on the protocol (see verification section).

This section will also identify the nature of the reporting process – for example, whether there will be single or double reporting of the above procedures. There is evidence to suggest that double reporting helps to reduce perception errors in some procedures, particularly mammography[9] and the barium enema,[10,11] and potentially also in CT colonography. For such procedures double reporting may be accepted as "best practice". If radiographers are contributing to a double reporting system for the above reason, this does not mean that they are not "independently reporting", providing that the examinations are viewed independently by the two reporters, who are equal partners in the exercise, and a consensus is then reached.[12]

Procedure for performing or reporting examinations

This section should outline the actual steps taken in the procedure or the reporting process. This may include the requirements for performing the procedure. These could include the staff required in the examination room, associated documentation, and procedures to be followed (which may refer to other guidelines such as for checking patient identification, ascertaining pregnancy status, and seeking informed consent).

The indications and contraindications for a radiographer-performed study must be outlined. In some delegated roles there is a stipulation that the radiographer cannot proceed unless a supervising radiologist is available within the department for advice if necessary. With any advanced practice, knowing when one has reached the limits of competence and experience is essential,[13] and in such cases advice from a consultant colleague should be sought.

The actual examination procedure guidance (also often called a protocol), documenting the patient positioning, pharmacology administered and images taken, may be attached to the protocol within an appendix. At this point the protocol could refer to any occupational standards or required competencies for performing aspects of the procedure, such as those recommended by Skills for Health.[14]

Where the protocol relates to reporting, it is advisable to document the facilities that should be available to the radiographer – (eg. *radiographers can make an initial comment on the request card immediately following the procedure, but the definitive report must be made in a suitable reporting environment*). It may be worth here documenting what is meant by "suitable" – the minimum requirements of a quiet room with blackout facilities, high quality workstation or viewing boxes with bright light facility, magnifying glass and dictaphone. It may also be useful to specify access to particular resources such as key radiology textbooks or online resources. Radiographers cannot expect to produce accurate reports without these facilities, and must have protected time for their reporting (documented in the protocol). A suggested maximum number of cases to be reported in any particular session could also be documented (to avoid mistakes caused by fatigue).

The reporting timeframe should also be included. All reports must be issued in time to affect patient management[7] but the actual stipulated timeframe may vary for different categories of patients (eg. urgent suspected cancer versus non-urgent work-up). However it is useful to be specific here – within 1 day, 3 days etc., as this forms a basis on which to audit the service (and possibly argue for more resources in future). Also contingency plans could be noted, such as what will happen during annual leave weeks or in the event of staff sickness.

The protocol should document the different steps in the reporting process. For example, how is the report produced – hand-written, typed directly onto a radiology information system, or dictated? If there is double reporting, how and when do the two reporters discuss the examinations? How is any conflict or discrepancy resolved? What administrative support is available? What is the responsibility of both the reporters with regard to checking the final report?

The protocol should also identify potential unusual or emergency circumstances in which the suggested pathway is not followed. For example, if during a barium enema examination an obstructing lesion or cancer is identified, the report may be made verbally to the surgical team before the patient leaves the department, so that an urgent appointment and counselling can be arranged. Equally if a pneumothorax is spotted on a routine GP chest referral, urgent referral to the accident and emergency department may be made. Further examples where it may be recommended to deviate from the normal protocol are included in Table 3.

Table 3 Examples of emergency or unusual situations where adaptation to the normal processes may be recommended in the protocol

- What should the radiographer do in a potential examination emergency, such as a suspected perforation, anaphylactic reaction or frank aspiration?
- When might the radiographer be advised to write a provisional report in the patient's notes?
- When might the radiographer give results directly to a referring clinician or a patient?
- When would consultation with a radiologist be necessary, prior to completion of the examination (eg. inadequate demonstration of pathology, or confusing findings?)
- When would consultation with a radiologist be necessary, prior to the report being issued (eg. incidental findings that may be significant)?
- When should a radiographer terminate a procedure prior to its completion?

Report structure

This section may suggest a layout for a report, and may refer to the use of reporting codes that have been agreed (and understood) by both the radiology department and the referring clinicians. In some cases the report may also include some form of diagrammatic representation of the findings as happens in most endoscopy reports. The report would normally include:

- patient details;
- examination details, including completeness of the study and possible limitations (eg. sub-optimal study);
- pharmacology used, including any adverse incidents;
- findings, which may include a description of radiological appearances, followed by a diagnosis or relevant differential diagnoses;
- conclusions, important particularly if the report had multiple findings of variable significance;
- recommendations, particularly advice about further investigations or referral;
- signatures and designation of the reporting radiographer, and both people involved in a double reporting system. For example, in some hospitals the preferred wording is *"reported by x, verified by y"*.

Clinical audit

This section often has inadequate detail in many protocols. It is of little value to say *"performance will be audited"*, without stating the detail of how often, when, how, by whom, and against which standards. The audit practices of radiographers engaged in plain film reporting, for example, have been noted to be inadequate in some cases, and non-existent in a sizeable proportion,[15] so it is essential for guidance to be offered within the protocol.

In a single reporting system, it may be of use to be specific and say *"10 consecutive skeletal reports will be double reported and audited by the supervising radiologist during the first week of every month"*. For double

reporting, it may be useful to maintain a reflective log of reports (beyond initial training) where the levels of agreement with the second report are documented, and discrepancies followed up. This "portfolio" can then be used for clinical audit as well as CPD purposes.[15]

It is well known that the reporting of barium enema examinations in particular is not always accurate due to confounding factors such as a tortuous bowel, faecal loading and barium pooling. One reasonably effective strategy for assessing accuracy in GI reporting is to audit against the surgical and pathology department results,[16,17] alongside monitoring of re-referrals to assess false negative diagnoses. This requires a commitment by the radiology department to following up patients for several months beyond their initial presentation. The protocol should document how and when this audit is to be undertaken.

In skeletal (plain film) reporting, achievable sensitivity and specificity rates of 95% are often quoted,[7,18] which give radiographers a standard against which to audit themselves. In the breast screening service those engaged in reporting are commonly audited annually, by assessing individual performance against a national test set of validated images, known as PERFORMS.[19] However in many other examinations it is much more difficult to define a minimum accuracy level for clinical competence, as there are often multiple findings, rather than findings which may be categorised into a yes/no answer (ie. a fracture is present or it is not). If, for example, a radiographer reporting a barium enema examination identifies two polyps, but misses the third, is this classed as a false negative? In these circumstances it is best to avoid stipulating an actual percentage figure of accuracy rate against which to audit, and instead formulate a system of grades of concurrence with the radiologist or second radiographer report where double reporting is in operation. One example of a grading system is seen in Table 4. As categorised within this table, the rates of non-significant errors can help to identify the need for further training or tutorials. The rates of significant non-concurrence should be closely monitored and followed up.

An alternative approach is the one suggested by Nakielny (2002).[20] In this system cases are assessed for the "grade" of the discrepancy, which takes into consideration any change of management and prognosis of the patient. Table 5 outlines the categories within this grading system. Any report assigned a Grade 3 listing would require a critical incident form to be completed.[21]

Whilst reporting performance audits have been considered in this section, the protocol should also address audit of the performance of a procedure, where relevant. The audit section could include within its remit the diagnostic quality of the images, patient dose audit, the report turnaround times, and referring clinician satisfaction surveys.

Continuing professional development

This section should outline the minimum requirements for radiographers to be able to maintain and enhance their skills as required as a condition of on-going registration. Not only should this put some onus upon the radiographer to seek all available opportunities for relevant CPD, but it should also outline what support will be given from the department. For example, this section may include:

- a minimum number of cases that should be performed or reported per month to maintain competency;
- a commitment to releasing radiographers from other duties to attend relevant multi-disciplinary team meetings/case conferences/discrepancy meetings;
- a commitment to identifying sufficient study time for radiographers to attend relevant special interest group meetings, study days and short courses (a minimum number of days and funds available could be outlined here);
- a requirement for radiographers to evidence their CPD activities within a portfolio;
- a requirement for radiographers undertaking advanced practices to support the professional development of others. The protocol may outline any teaching activities, such as radiographer or Specialist Registrar training.

Table 4 A comparative method of audit of radiographer performance using the radiologist as a "gold standard"

Degree of agreement with the radiologist report	Example	Level of significance of error
Concurrence	Full agreement with radiologist report	Not significant
Non-concurrence (1)	General agreement, but: • minor pathology missed • extent of disease incorrectly identified	Low significance
Non-concurrence (2)	Disagreement – false positive or false negative in which patient management would have been affected	Significant

Table 5 A method of grading reporting performance using perceived theoretical significance of errors, based upon patient outcomes[19]

Grade	Level of discrepancy	Significance
0	No discrepancy	None
1	Minor	Minor (incidental to treatment/management)
2	Significant	Significant (affects treatment/management, not outcome)
3	Major	Major (affects outcome)

Grade 3 errors should be considered significant/critical incidents.

Verification section

At some point in the protocol (most commonly at the beginning), the signatures and designations of those involved in creating and approving the protocols must be evident, including the relevant dates of creation and modification. Signatures without designations are meaningless from a medico-legal viewpoint (especially as several years later a particular person may have left the department). The date of initial approval should be included, with the approval procedure mentioned (eg. *approved by Radiology Clinical Governance Committee on 01/02/05, approved by hospital management board on 28/02/05*).

The date and procedure for reviewing the protocol must be clearly stated, and this must include whose responsibility it is to do this (this person is therefore the "owner" of the protocol). The date for review is often annually, although it could be sooner for a recently introduced protocol.

The protocol must be clearly identified with a computer file name and heading as "Version 1" or "2004 protocol". On review, even if no changes are made, it should be renamed as a new version. Old versions should be suitably and safely archived (in hard copy format), so that they are accessible in the event of medico-legal claims, but cannot be mistaken by practitioners as the current version. When a new protocol has been approved, an implementation date must be appended and a copy distributed to all relevant staff.

Summary

As stated at the beginning of this article, there is no one correct way of designing a protocol, and these guidelines are only suggestions. Every hospital will have its own unique requirements, which will necessitate some adaptation of the standard protocol or policy. However, whilst protocols and procedures for individual examinations need to give the practitioner a suitable guidance framework within which to work, there is a danger that some protocols can be overly restrictive. This prevents radiographers from being able to use their experience to adapt their practice to an individual situation.[22] Such prescriptive protocols have been identified as working against patient care rather than improving it,[23] particularly where a cautious approach has been taken when introducing an advanced role for the first time. As practitioners gain experience and their professional scope of practice widens, it is important to ensure that they are still working within the boundaries of the protocol. Review at least annually will identify when the professional latitude within the protocol needs to be revisited.

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Publication media	Peer reviewed article	
Abstract	United Kingdom (UK) government policy, which has focused on modernising the NHS and making it more responsive to patients' needs, has, in fact, created significant service demand. The Department of Health (DoH) committed itself to changing and improving the organisation and delivery of health care through professional role development and blurring of traditional professional boundaries. In 2000, the DoH announced an intention to create consultant allied health professional posts to facilitate career development opportunities for expert and experienced staff. There are currently 31 consultant radiographers in the UK who have been appointed to new posts, and 2 trainees. Such posts are created subject to a formal approval panel process as laid down by the DoH. This paper will begin by outlining the current scope of radiographic consultant practice and advanced clinical roles in the UK. Key factors that have facilitated the development and implementation of such roles will then be explored and discussed. It will also consider what specific factors can inhibit innovative change and whether there appears to be any perceived threats to the current momentum of change.	
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Factors influencing the development and implementation of advanced and consultant radiographer practice – A review of the literature

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Abstract United Kingdom (UK) government policy, which has focused on modernising the NHS and making it more responsive to patients' needs, has, in fact, created significant service demand. The Department of Health (DoH) committed itself to changing and improving the organisation and delivery of health care through professional role development and blurring of traditional professional boundaries. In 2000, the DoH announced an intention to create consultant allied health professional posts to facilitate career development opportunities for expert and experienced staff.

There are currently 31 consultant radiographers in the UK who have been appointed to new posts, and 2 trainees. Such posts are created subject to a formal approval panel process as laid down by the DoH.

This paper will begin by outlining the current scope of radiographic consultant practice and advanced clinical roles in the UK. Key factors that have facilitated the development and implementation of such roles will then be explored and discussed. It will also consider what specific factors can inhibit innovative change and whether there appears to be any perceived threats to the current momentum of change.

Introduction

Major changes in United Kingdom (UK) healthcare delivery have occurred over the last 10–15 years, particularly in relation to the personnel undertaking this care. A climate of change was created by the introduction of the National Health Service (NHS) and Community Care Act[1] which moved to a system of internal markets. Traditional methods of care provision were challenged, causing some blurring of professional boundaries. Many Trusts facilitated the creation of new roles for nurses and allied health professionals in order to meet ever increasing healthcare demands. Workforce

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reconfiguration was believed to be strategic in enabling Trusts to meet targets for treatment and waiting times, whilst simultaneously dealing with skill shortages and pressures for change from patients[2] and commissioners.

It was accurately predicted that the fundamental changes being introduced into the NHS would influence radiographic role developments.[3] The key professional bodies, namely the Royal College of Radiologists (RCR)[4] and the College of Radiographers (CoR)[5–7] realised that significant role changes were necessary to cope with the dynamics of change and future NHS developments. Consequently, during the 1990s, restrictions on radiographer reporting were gradually relaxed and the Statement of Conduct of the Radiographers' Board of the Council of Professions Supplementary to Medicine[8] was modified. This, along with guidance produced by the CoR,[5–7] enabled radiographers to write reports and perform certain procedures (such as barium enemas, swallows and intravenous injections), which were previously undertaken by radiologists. Furthermore, the RCR[4] acknowledged that certain tasks could be delegated to radiographers, provided the change was,

> '*proper, agreed, planned and monitored so as to avoid prejudicing the outcome for the patient or increasing the likelihood of complaint and litigation.*' (page 7)

There is now an emerging body of published literature demonstrating that, with appropriate education and training, radiographers are capable of reporting on images with acceptable accuracy, that is, equivalent to the standard of a consultant radiologist.[9–13] The CoR recognises that this is a demanding role[14] (it is noteworthy that radiologists themselves frequently make interpretational errors[15–17]), and that the reporting radiographer requires a high level of comprehension of clinical issues as a basis on which to approach this task.[14]

Interestingly, it was recognised in radionuclide imaging that practitioners undertaking reporting were seen to take greater pride in acquiring and processing scans, ultimately resulting in increased job satisfaction.[18] If this was to be generalised to all other aspects of imaging then significant patient benefits could be realised. Indeed, the CoR envisages that by 2010, some form of clinical reporting will become a core radiographic competence.[14] Similarly, the Special Interest Group in Radiographic Reporting (established in 1996, now renamed the Special Interest Group in Medical Image Interpretation) envisaged that reporting will, at some point, become a core radiographic skill.[19]

Wholehearted approval of these changes has not been universal, with some authors maintaining that image interpretation should only ever be the domain of the medically trained consultant radiologist who can contribute a *medical* opinion on the significance of the findings.[20] Still others state that radiographers will always be limited to 'certain well-circumscribed tasks' because of their lack of medical training.[21]

Nevertheless, a consultant radiographer is described as an autonomous practitioner and an '*expert in a specialist clinical field,*' requiring, '*exceptional skills and advanced levels of clinical judgement*'.[22] Furthermore, the national profile for diagnostic consultants'[23] states they must possess,

> '*skills for interpreting, reporting on patient conditions, diagnosis from a range of options. Possibly conflicting interpretation, recommending further action, changing practice.*' (page 11)

This implies far more than the performing of 'well-circumscribed tasks,' indicating this conservative view is now considered to be outdated for such practitioners, though it may be the case for many advanced practitioners. Concern has also been expressed that skill mix can have a detrimental effect on junior radiologist training, due to consultant radiologists having to spend additional time training radiographers to take on advanced roles.[24]

This paper will begin by outlining the current scope of radiographic consultant practice and advanced clinical roles in the UK. Key factors that have facilitated the development and implementation of such roles will then be explored. It will also consider what specific factors can inhibit innovative change and whether there appears to be any perceived threats to the present momentum of change.

Current scope of practice

There are currently 31 consultant radiographers in the UK who have been appointed to new substantive posts, with 2 trainees. Such posts have been created subject to a formal approval panel process as laid down by the Department of Health (DoH).[22] These are posts which are known to the Consultant Radiographers Group (CRG), a network established in 2006 to provide peer support and direction for consultant radiographers, under the guidance of the Society and College of Radiographers (SCoR).

The range of specialties and the areas of expert clinical practice are shown in Table 1.

In order to demonstrate consultant level practice, job descriptions *must* include aspects of four elements of practice, as indicated in the published generic guidance for the creation of such posts.[22] These are

- expert clinical practice, minimum 50% time;
- professional leadership and consultancy;
- practice and service development, research and evaluation; and
- education, training and development.

Table 1 Range of consultant practice.

Specialty	Number of consultants in post
Breast	9 and 1 trainee
Emergency care and trauma	3
Gastrointestinal imaging	5
MRI	2
Musculoskeletal and chest	1
Musculoskeletal	3
Neuro endovascular	1
Oncology	5
Palliative care	1 trainee
Ultrasound	2

Time allocated to these elements varies from post to post in accordance with local needs and circumstances.

As Table 1 indicates, there is currently a preponderance of consultants in breast imaging. This is probably due to a number of factors, including a direct link to the NHS Cancer Plan[25] which announced an extension to the National Health Service Breast Screening Programme (NHSBSP), with a projected increase in workload of 40%. This led to the development and piloting of the four tier career structure which facilitated the development of consultant roles.[26] Breast imaging is a relatively discrete, specialty, and highly experienced radiographers have successfully been trained to a standard that compares well with consultant radiologists.[11] This has enabled consultant breast radiographers to carry their own caseloads and work autonomously. In recent years there has been a great expansion in cross sectional imaging services and this may well have been a reason for fewer radiology trainees being available to undertake breast work. (Nationally the number of computed tomography (CT) scans has been increasing by 15% each year; magnetic resonance imaging (MRI) by 11% a year; and ultrasound scans by 5% a year[27(p3)]). Interventional procedures have also imposed an additional burden on an already overstretched radiological service.

Table 1 also shows that five consultant oncological posts have now been established. Prospects for further such appointments have increased following a report published in 2007 from the National Radiotherapy Advisory Group (NRAG).[28] This was established by Professor Mike Richards in June 2004 to ascertain the current situation in radiotherapy and advise on the future provisions required to deliver a world class radiotherapy service. The report states that the incidence of cancer is set to increase with the ageing population and advises further reductions in the time patients wait to receive radiotherapy treatment. This may lead to more role development opportunities.[29] Short term recommendations to achieve this include the production of timetabled plans for implementing the four tier structure in *all* radiotherapy departments. Furthermore, the report states,

> *'In particular, strategic health authority commissioners and service employers should fund the new roles in the model at advanced and consultant level in non-medical radiotherapy professions – where these roles have been introduced they have demonstrated the potential to drive efficiency, reduce waiting times and refocus radiotherapy services around the needs of patients.'* (page 6)

This appears to give an emphatic endorsement of new radiotherapy roles and presents a challenge to those in diagnostic advanced clinical posts to ensure the benefits of their roles are *demonstrated* to all stakeholders, particularly those who carry influence at a managerial or strategic level.

Advanced clinical roles and radiographer-led teams are also well established in gastrointestinal imaging,[30] plain film, accident and emergency, chest, nuclear medicine and CT head reporting. Further examples involve administration of contrast media in CT, MRI, urographic and angiographic studies and injections of radiopharmaceuticals. (This list is not intended to be exhaustive.)

Factors influencing advanced and consultant practice development

Government policy and service need

To a great extent, Government policy, which has focused on modernising the NHS and making it more responsive to patients' needs, has, in fact, created significant service demand. A number of DoH papers[25,31] outlined Health Service modernisation plans to meet healthcare demands into the 21st century. Innovation and change are now viewed as integral to improving the NHS which depends on the development of a workforce capable of delivering high quality, patient centred care. A key objective of the Calman Hine Report[32] and the NHS Plan[25] was to make cancer and health services more responsive to patients' needs by enabling staff to renegotiate their roles and practice across traditional professional boundaries, ensuring seamless care delivery. Radiographers have benefitted from this, resulting in significant advanced practice developments taking place in recent years. Obviously the converse is true in the absence of a specific service demand, and clinical departments are not obliged to develop such roles if the need does not exist.[33]

In late 2007, the NHS Cancer Reform Strategy[34] announced plans for a major expansion of cancer screening programmes, coupled with 'fast tracking' of suspected cancer cases. This will inevitably further increase the demands on imaging and radiotherapy departments, which have experienced an ever increasing volume of examinations in recent years, exerting severe pressure on services. The strategy also undertakes to support workforce development and training in order to fulfil these stated commitments. Once more the challenge to radiography is to engage with these opportunities and drive forward advanced practice developments.

Further (though currently unknown) innovative opportunities for radiographers may arise following the publication of the National Stroke Strategy,[35] also in late 2007. Considerable emphasis is placed on the importance of timely imaging and interpretation (MRI, CT and vascular ultrasound) in the management of stroke patients (pages 24–28). Once diagnosed with a stroke, patients will need to be screened for swallowing before eating or drinking, at least within the first 24 h. Again, this may facilitate advanced practice opportunities.

Radiological skill shortages

The momentum for change within the NHS coincided with the fact that in recent years a massive growth in applications of radiological imaging, interventional procedures and image-guided treatments has occurred. This caused a worldwide shortage of radiologists as the numbers being trained failed to keep pace with this greatly expanded workload. In 2002, the RCR[36] estimated that the number of posts,

> *'Needs to double just to match existing workloads, let alone take into account future service pressures.''* (page 5)

This situation also provided radiographers with role development opportunities, which many embraced enthusiastically. In 2002, an Audit Commission report[37] on NHS hospitals in England and Wales described the traditional separation of roles (with radiographers producing images and radiologists interpreting them) as changing, as departments sought ways to increase productivity. The RCR and DoH have responded to the demand for increased radiologist numbers, recognising that rapid access to diagnostic services reduces waiting times. Furthermore, delays in diagnostic tests can contribute to costly 'bed blocking' in hospitals. Training places have been greatly enhanced by the establishment of Radiological Academies at three training schemes, offering innovative learning opportunities. Despite this, a recent joint RCR/SCoR publication indicated that a shortage of consultant clinical radiologists still persists.[38] Theoretically then, role development opportunities for motivated radiographers should continue, at least in the immediate future.

Key stakeholder support

A decade ago (1997) the CoR's policy was,

> *'that all radiological examinations carried out by radiographers, irrespective of the imaging modality used, should receive a radiographic report and that the report should be produced in time to assist in patient management.'*[7]

Both relevant professional bodies (SCoR and RCR) have played a key role in the advancement of radiographic role extension. Since 1999 the RCR has advocated role extension where significant patient benefit is realised[39] and again in 2002, the organisation expressed the view that clinical radiologists have a responsibility to support skills mix.[36] However, a more recent RCR[40] document published the following statement in relation to non-medically qualified personnel providing imaging reports.

> *'The types of investigation which may be suitable for primary reporting by healthcare professionals without the benefit of a medical degree are those where there is a single organ investigation, with a single suspected pathology and a yes/no answer.'* (page 6)

And,

> *'It should be appreciated, however, that in these circumstances unexpected or unrelated pathology may not be diagnosed.'* (page 6)

These statements seem to be at variance with the CoR's vision for radiographer reporting[7] and indeed with current training programmes and actual practice. However, interpreted literally, they appear to place a ceiling on the extent to which the RCR currently seems willing for radiographers to progress. The influence the RCR confers on radiographic role developments cannot be overestimated.

Studies have found that some developments have been linked to individual medical consultants and confined to specialised areas.[41,42] Evidently, some consultants within radiology favour advanced practice more than others[43–46] for a variety of reasons (the most extreme negative opinion being a claim that supporting it amounts to 'professional suicide'),[47] and this will probably always be the case. These differences of opinion inevitably affect role developments, given the close working relationship between radiologists and radiographers, and perhaps partly explains the ad hoc nature of progression to date. Of course, support of other health professionals within the multidisciplinary team is also vital. Many hospital doctors and their colleagues have supported such changes,[48,49] once convinced of a service need and the competence of advanced practitioners.[50] Managers too, have the capability to facilitate or stifle change, and a major aspect of their role should be the professional development of their staff.[51] The same applies to *existing* advanced and consultant practitioners as team leaders, to collaborate with managers and identify potential future opportunity for development amongst their respective colleagues and staff.

As far as patients themselves are concerned, it has been found that they generally accept health care professionals extending their role, provided they possess the necessary skills and experience to care for them.[52]

Legislation and the ionising radiation [medical exposure] regulations 2000 (IR[ME]R 2000)

As indicated earlier, some significant legislation came with the NHS and Community Care Act,[1] granting considerable autonomy for hospital Trusts to configure their staffing arrangements. This led to the blurring of traditional professional boundaries and proved to be a major catalyst for the rapid growth of advanced roles.

A decade later, further legislation regarding new ionising radiation regulations (IR[ME]R), published in 2000,[53(p11)] stated that a clinical evaluation of the outcome of each medical exposure must be recorded as a legal requirement. This increased the reporting workload and it was suggested this would assist in re-enforcing the development of radiographic reporting skills.[54]

Development of educational and training programmes

The Higher Education Institutions (HEIs) have responded to the need for education and training necessary for role developments by collaborating with health care organisations and professional bodies to establish postgraduate educational programmes. These are tailored to equip radiographers with the necessary clinical and academic skills to underpin their practice.[55] The SCoR recommends that future educational requirements for advanced and consultant roles will include skills development in patient assessment, clinical reasoning, and decision making.[14] Other issues requiring to be addressed are that pre-registration undergraduate programmes embed image interpretation and clinical reporting and assessment knowledge. Practitioners will then possess skills to provide informed comment on plain film and standard contrast agent examinations.[14] It is envisaged that radiographic clinical reporting will become a core competence by 2010. This should provide the ground-work to facilitate future transition and development to advanced practitioner

status and beyond, for those who wish to progress in this way.

National career structure

As mentioned previously, an innovative model of service delivery based on team working called the 'Four-tier Structure' was developed and piloted by the NHSBSP in 2002[26] in order to meet the increased workload caused by the expansion of breast screening, announced in 2000.[25] This formed the basis for new roles and facilitated radiographic career progression to advanced and consultant status (the third and fourth domains of the Structure). However, whilst this model *theoretically* heralded the solution to address the augmenting scope of radiographic practice, there appears to have been a greater initial focus on assistant practitioner developments,[56] with the highest number of staff (excluding practitioners) being advanced practitioners.[57] Price and Le Masurier[57] found that much less attention was being paid to establishing consultant posts and suggested that research would assist in investigating why consultant numbers are so low.

Effective leadership

Without doubt, the radiography profession would not have evolved to its current position within healthcare, were it not for the role leaders have played, particularly within the last 15 years.

Much of the literature pertaining to advanced practice and consultant level skills emphasises the importance of key personal attributes such as self-belief, motivation, commitment, intellect[48,49] and particularly the need to demonstrate effective clinical and professional leadership in order to motivate and inspire others.[22,33,54,58] Such individuals are often clinical experts but the role may also encompass management as well as research and education.[59] It is obvious that fulfilment of job expectations in advancing practice, engaging with other professionals to modernise services (sometimes at a national level) and initiate research, requires highly developed leadership capabilities. Leadership training may not have been prioritised for some individual consultant radiographers in preparation for their role but many local Trusts now provide in-house courses and a number of other educational programmes are accessible to NHS employees. Indeed, it has been emphasised that adequate leadership training is necessary for research activity to succeed[60] – an important aspect in the fulfilment of a consultant radiographer's role. Furthermore, Hogg et al.[61] stated that,

> '*excellence in professional leadership will be critical to support the need to develop the profession yet further.*' (page 60)

Resources

Studies have shown that the radiography profession appeared to be disadvantaged compared to the nursing profession in terms of Continuing Professional Development provision.[62–64] More recently, radiographers attempting to advance their role have also indicated the need to carry out some reporting tasks, audits and presentation preparations using their own time and resources.[46,65]

Provision by employers of resources such as internet access, journals, books, studying accommodation, funding and human resources (the latter to backfill posts, enabling training to take place and attendance at clinical governance/multidisciplinary team meetings) are all key requirements that facilitate role developments within the clinical environment. In times of financial crisis, these vital resources are often the first casualties in NHS organisations seeking to reduce costs. However, if these roles are to be sustained and effect real improvements in services, it is vital that appropriate long term investment with supporting infrastructures is established, to ensure this occurs.[54,59]

Lack of professional research base

Historically the radiography profession has not developed a strong research base, a fact that has been lamented by a number of authors this century and they have exhorted radiographers to engage in research activity.[66–69] Had this been the case, there is no doubt radiographers would have been better placed to gain the respect of the medical profession, whose support is so vital for advanced practice developments. It appears that a reluctance to undertake primary research persists and a large number of graduates lack confidence in using university-acquired research skills in practice.[70] This gives cause for concern in relation to the future development of the profession. Research deficits may well restrict career progression and therefore the chance to improve services.[33]

The SCoR acknowledged this gap[71] and established a designated research group in order actively to support research amongst its members. All consultant radiographers' job descriptions should include contribution to research as a mandatory activity[22] and it is important for post holders to be supported adequately in the workplace to facilitate this. Employers' priorities may sometimes focus on clinical activity, but failure of its clinical leaders to fully engage in the research process will inevitably stall the further professional development of radiography.

Lack of standardised accreditation and transferability of skills in hospital Trusts and Higher Education Institutions

There is perhaps a significant caveat for the radiography profession from the Government's granting of increased autonomy for Trusts to determine their own staffing arrangements: role developments have not occurred systematically but have frequently been opportunistic, pragmatic and championed locally.[42,62,72,73] This has enhanced local service provision but failed to assure standardised accreditation and transferability of the extended roles.[41] The absence (until recently) of clearly defined advanced practice criteria was criticised as a barrier to developments.[74] Consequently, some practitioners who have acquired skills 'in house' in one Trust may not be permitted to practice them in another, indicating that this strategy has been somewhat short-sighted. Work is

currently ongoing to remedy this unsatisfactory situation, and the SoR has published a consultation document on the accreditation of advanced practice.[75] The proposal is that those who seek accreditation at advanced practice level will need to possess a portfolio encompassing education and practice. Reference to the Knowledge and Skills Framework,[76] (a key aspect of the Agenda for Change system[77]) which provides a tool for describing the knowledge and skills staff need to apply in their posts, and Skills for Health,[78] who develop and manage workforce competences, may also assist in ensuring standardisation of in-house training.

The development of potential consultant practitioners has similarly been hampered by a lack of clearly defined clinical and educational pathways to date.[70] Some Trusts have sought to circumvent this by establishing their own career development programmes. However, it has been suggested that only the establishment of a true career pathway, underpinned by an appropriate education and research strategy will produce individuals capable of leading and progressing radiographic practice, in turn fulfilling the aspirations of practitioners, the profession, and the NHS.[70]

A further unhelpful situation has occurred occasionally between HEIs, whereby some universities have not been able to recognise modules obtained at another due to guidance issued in relation to accreditation of prior learning. Anecdotal evidence has indicated that some individuals have had to repeat modules (or only been granted half the credits) if they wish to pursue a particular qualification which suits their chosen advanced practice pathway. This is likely to frustrate those motivated professionals who are not only attempting to find career fulfilment, but also (presumably) meet an identified service need within their organisations. Accreditation of advanced practice modules by the SoR could be a major facilitator in leading to increased transferability from one university to another.

Limited understanding from stakeholders regarding the expected scope and breadth of function for consultant/advanced roles

Consultant posts are new and, as such, not yet fully embedded within existing NHS culture and hierarchical structures. Some influential stakeholders may not be familiar with the government generic guidance regarding the creation of such roles and the fact that each post actually commands four key elements, as indicated earlier.[22] This guidance also indicates that post holders should receive employer support in order to fulfil all the expected functions. The roles are not meant to be purely clinical, merely to plug a radiological gap, nor are they primarily managerial in nature. In addition to the primary objective of improving patient services, the intention was to provide career development opportunities for experienced and expert staff[31] which would also, in turn, assist with recruitment and retention of skilled professionals.

Recent discussions at the Consultant Radiographers Group have alluded to the fact that some radiologists believe a 50% clinical commitment represents poor value for money compared to other staff and there is generally a limited appreciation of the potential benefits of the three other role elements. In fact, there is considerable variation amongst post holders in terms of time allocated within job plans to the clinical component. Current workloads within Trusts have meant that a number carry a 70% clinical weighting, with pressure to devote even more time to that element, risking the other elements of the post not being given sufficient attention.

It is therefore incumbent upon current post holders to *demonstrate* and *justify* the benefits of their existence and title from a holistic perspective (assuming this is the case). This can be achieved through comprehensive role evaluation and professional leadership and the Consultant Radiographers Group has recently been devising a strategy to raise the national profile of the consultant radiographer role. It is believed that there is currently at least one study in progress, specifically aimed at evaluating the impact and effectiveness of the consultant role within the healthcare arena. This is: 'Quality Impact of the Consultant Radiographer', with principal investigator Lesley Forsyth, on behalf of the Robert Gordon University, Aberdeen.

Agenda for change (AfC) – facilitator or barrier?

AfC[77] was an UK government initiative that all NHS organisations were committed to implementing (from October 2004) and designed to,

> '*enable staff to give their best for patients by working in new ways and breaking down traditional barriers.*'

And,

> '*pay fairly and equitably for work done, with career progression based on responsibility, competence and satisfactory performance.*' (page 2)

Reliable data outlining the full impact of this major innovation is difficult to obtain, though much anecdotal information has emerged. Many organisations have taken far longer to implement AfC than was probably anticipated initially and this has no doubt exacerbated the situation. However, the following quotation from the Department of Health National Imaging Board[79] gives a reasonably accurate indication of the current situation.

> '*We particularly highlight the inconsistencies in implementation of Agenda for Change. This is particularly notable in connection with advanced practice, clinical leadership roles and in terms of preventing attrition from the profession in general. It would be difficult to over-state the detrimental effects on staff morale that have resulted from woefully inconsistent and in some cases poor practice in introducing the new pay and conditions arrangements.*'

This appears to be an admission that the government's original vision of the benefits that AfC would deliver has not yet been realised. Furthermore, it is possible that full implementation of the Knowledge and Skills Framework[76] could prove difficult, due to current pressures such as waiting time targets, identifying sufficient funds for training, and staff shortages. The actual cost of employing

advanced and consultant practitioners may also prove prohibitive under the current financial constraints that many organisations are facing.

Summary

There is no doubt that very significant progress in clinical practice has been made for the radiography profession in recent years, facilitated by a multiplicity of factors. Perhaps only the most optimistic of those within the profession could have imagined 10 or 15 years ago that a significant number of consultant posts would exist by 2008. Despite this, however, progress in consultant appointments has still been relatively slow (only 31 consultants appointed out of a registered SoR membership of approximately 18,000). The intention to create allied health professional consultant posts was first announced in 2000, nearly 8 years ago.[31] In addition, the profession requires evidence that adequate succession planning is ongoing, ensuring that when current consultant post holders vacate their posts, they are replaced by other consultant radiographers.

The onus is therefore particularly on those who are, or aspire to be, consultant/advanced practitioners, continually to demonstrate role and cost effectiveness through rigorous practice and performance evaluation. It is vital that the beneficial impact of such roles is shared locally, regionally and nationally. The RCR/SCoR has jointly indicated that there is a 'demand for a coherent national approach to skills mix and role development in clinical radiology services'.[38] The imperative for consultant practitioners is to exercise professional leadership and political awareness, through involvement and contribution to such strategic initiatives, currently and in the future. Furthermore, the initiation of research and audit, directly contributing to evidence based care must surely be given a higher profile if the profession is to gain further recognition amongst the Medical Profession and other health professionals.

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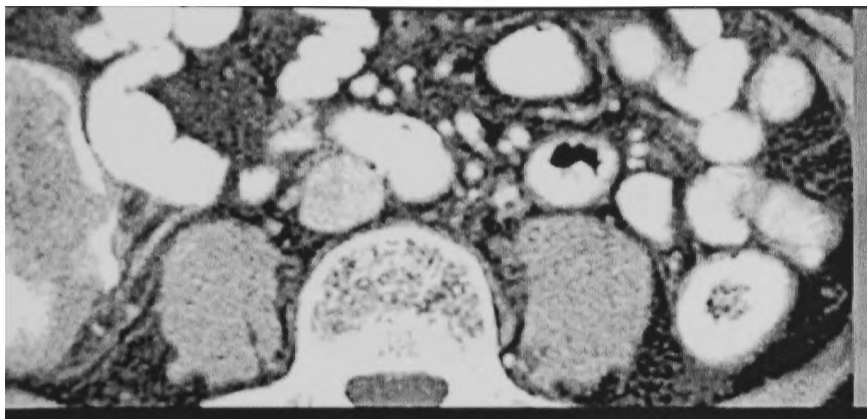

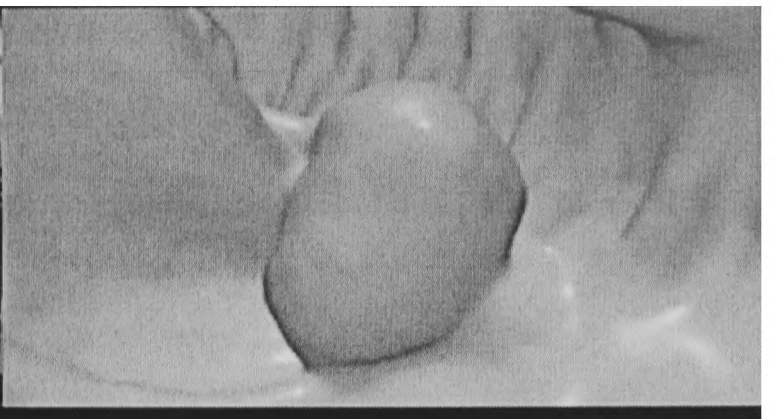

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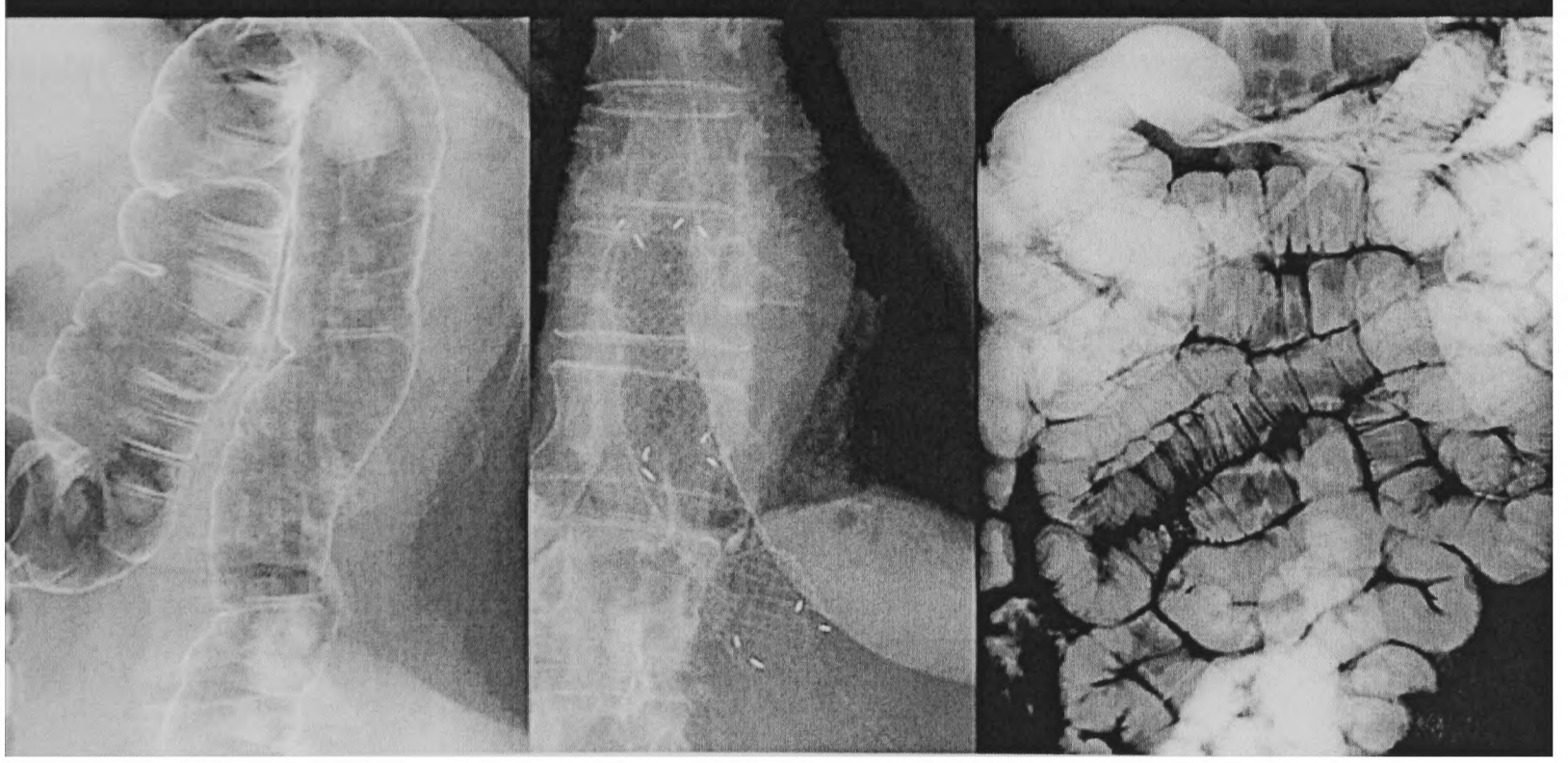
AN EVIDENCE-BASED PRACTICE GUIDE



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Foreword by **Giles Maskell**

Gastrointestinal Tract Imaging: An Evidence Based Practice Guide

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c0005 CHAPTER 1

Evolving practice and shifting boundaries in Gastrointestinal Tract Imaging

Julie Nightingale, Myke Kudlas, Liza Ricote

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s0010 Advances in GI imaging

p0275 Fluoroscopic techniques to image the gastrointestinal (GI) tract have been available since the early 20th century, although it was not until the 1970s (with the introduction of image intensification and double contrast techniques) that their effectiveness as a diagnostic tool was firmly established. While some fluoroscopic procedures have remained dominant as the method of choice for investigation of particular pathologies, a number have been replaced by alternative procedures, or are experiencing challenges to their position as a first line investigation. The barium meal, for example, has largely been replaced by endoscopy, with the double contrast barium enema (DCBE) being challenged by colonoscopy and computed tomography (CT) colonography. While fluoroscopic investigations have always been the examination of choice for investigating the small intestine (being difficult to access endoscopically), they also are being challenged by CT and MR enteroclysis techniques, as well as direct visualization by capsule endoscopy.

p0280 CT has been the mainstay of staging for most GI cancers, although we are seeing an increasing role for ultrasound and magnetic resonance (MR)

imaging, particularly in peri-rectal imaging. PET (positron emission tomography) and hybrid scanning methods are also likely to have an expanding role in the assessment of more complex cases, particularly in the investigation of cancer recurrence or identification of an unknown primary cancer.

p0285 Many radiology departments have also introduced an increasing array of interventional and therapeutic GI procedures, especially for palliation of cancer. These have included esophageal and colonic stenting and balloon dilatations for different types of stricture. More recently, fluoroscopic guidance and radiological expertise for gastric banding is being used to assist in the management of patients with obesity, demand for such involvement being likely to increase in developed nations. While being time consuming and resource intensive for the radiology department, such procedures provide hospitals with the ability to support effectively those unsuitable for major surgery.

p0290 Throughout the 20th century, the GI radiology service has involved a multiprofessional team of radiologists, radiographers, radiology nurses and health care assistants. During the 1980s, the skills mix within the fluoroscopy department began to change and the following section will consider how this affected radiology departments within the UK.

Shifting professional boundaries

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p0295 The gradual refinement of fluoroscopic techniques, coupled with the progressive exploration of new imaging modalities, has resulted in a much wider contribution of radiology to the gastrointestinal (GI) patient care pathway. Over the last three decades, there has been a huge shift in the role of the professions that are involved in providing the GI radiology service, particularly in the UK (Nightingale and Hogg, 2003a, 2007). However, the UK is not alone in this, with gradually shifting professional boundaries being seen within other English-speaking countries, including the USA, Australia, New Zealand and Canada.

p0300 The health services of the world are highly complex organizations, often being among the largest national employers. Introducing radical change into such organizations is challenging, as they often have many stakeholders with different needs to satisfy. Analysis of a number of historical role developments, both within and outside radiology, suggests that a range of overlapping drivers is necessary to implement the changes effectively (Box 1.1) (Nightingale and Hogg, 2003b). In the early 1990s, a major shift in professional roles began to take place within UK radiology departments. One of the

BOX 1.1 Drivers promoting successful introduction of new roles

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u0165 ■ A perceived deficiency in the service
u0170 ■ A proposed solution
u0175 ■ A legal framework within which to introduce the change
u0180 ■ A 'champion' of the change, at national and local level
u0185 ■ Evidence (research) that the change will be effective
u0190 ■ A benefit ot stakeholders (interested parties)

most rapid to be adopted was the introduction of radiographer-performed double contrast barium enema (DCBE) examinations (known as the air contrast barium enema examination in the USA). The introduction of this role will be explored further, considering the relevant drivers that came together to result in successful implementation on a national scale.

A perceived deficiency in the service

p0305 According to the UK professional body, The College of Radiographers (2006), diagnostic imaging and interventional services have increased by 2.5–5% per annum over the last 10 to 12 years. This continuing rise in demand for imaging services, coupled with a shortage of radiologists, led to UK radiology services being severely over-stretched. The shortfall in radiologists was estimated by the Royal College of Radiologists in 2002 to:

> Need to double just to match existing workloads, let alone take into account future service pressures.

p0310 Not surprisingly, perceived deficiencies were noted within the service. These included excessively long waiting times for complex examinations (including the DCBE) and radiological reports turned around too slowly to affect patient management, or not reported at all (Audit Commission, 1995). The DCBE examinations were often single reported, even when double reporting was considered to be best practice (Markus et al., 1990; Leslie and Virjee, 2002; Halligan et al., 2003). This raised serious concerns for patient care and the impact upon their prognoses, particularly where cancer was suspected. The shortage of radiologists also inevitably held back the further development of the service at that time, with less time available for audit, research and the introduction of new services.

A possible solution

p0315 Radiographers had expanded their pre-registration education to degree level (from a 2-year diploma course) and experienced radiographers had begun to explore postgraduate masters level opportunities. Radiographers have long been perceived to be working below their potential (Swinburne, 1971), often moving into managerial or education positions due to a lack of challenging opportunities in clinical practice. One solution, to train radiographers to undertake DCBE examinations, as these had unacceptably long waiting lists in many hospitals, offered an important new challenge and yet could be 'easily described within a protocol' (Somers et al., 1981).

A legal framework within which to introduce the change

p0320 A number of changes to legislation and professional body guidance was introduced within the 1990s, some acting as a catalyst to encourage role development and some, inevitably, being brought about in response to what was already happening at a local level. These included the introduction of the Ionising Radiation (Medical Exposure) Regulations (Department of Health, 2000a) and Department of Health publications such as the NHS Cancer Plan (2000b). The professional body and trade union for radiographers (the Society and College

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of Radiographers) was very supportive to radiographers wishing to develop their roles, issuing a series of guidance documents between 1996 and the present day (e.g. The College of Radiographers 1996, 1997, 2006). In essence, these documents suggested a framework in which radiographers could potentially develop any role, as long as they were appropriately trained, worked within agreed protocols, audited their practice and maintained their competence through continuing professional development (CPD). Protocols have been found to be appropriate frameworks within which radiographers can safely and effectively practice advanced roles (Nightingale, 2008). The Royal College of Radiologists (RCR; the UK radiologists professional body) has also been supportive towards radiographer role development, although with a slightly more cautious approach (RCR 1996, 1999, 2007). This is understandable when their members are delegating existing tasks and may still bear the ultimate responsibility for the delegated role.

A 'champion' of the change, at national and local level

There has to date been no direct professional body steer to introduce a particular role development across the UK. However, as with most new roles, there is often a champion at national level. For the introduction of radiographer-performed DCBE, this champion has arguably been the national gastrointestinal radiographers special interest group (GIRSIG), which has both promoted and supported radiographers involved in these roles for several years (Nightingale and Hogg, 2000). However, it is not clear if the role would have been introduced so successfully across the UK if it had not been for the presence of radiologist champions, promoting radiographer role development both within and beyond radiology (e.g. Chapman, 1997; Robinson et al., 1999; Thomas, 2005b). The radiologists appeared at that time to be the 'gatekeepers' to service development and this largely appears to be the case today. The radiologists provided clinical training and supervision for the radiographers, who had access to a short course or Masters level module for theoretical underpinning.

National drivers for role development have also emerged in the wake of a series of government targets, most notably the introduction of a maximum waiting target of 2 weeks from referral to diagnosis for suspected cancer (NHS Executive, 2000) and, more recently, the 18 week maximum from referral to treatment (Department of Health, 2006). With medical imaging being heralded by the Government as the primary bottleneck resulting in failure of hospitals to meet these targets (Department of Health, 2005), it is little wonder that modernizing services and new ways of working are being championed in political circles.

Evidence (research) that the change will be effective

Published evidence that the role change is effective is vital to promote the widespread introduction of a new service. While UK radiographers have been rather reticent to engage in research, where the DCBE examination has been concerned, one finds a wealth of literature supporting the new role. This has included a number of studies comparing radiographer performance in performing and/or reporting DCBE examinations with trainee radiologists (Mannion et al., 1995; Schreiber et al., 1996; Davidson et al., 2000) or with

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consultant radiologists (McKenzie et al., 1998; Culpan et al., 2002; Murphy et al., 2002; Vora and Chapman, 2004). It also includes performance against pathology databases (Law et al., 1999, 2008) and national surveys of practice (Bewell and Chapman, 1996). While most of these studies have concentrated on small numbers of individuals in single-center studies, they nevertheless provide very useful and plausible performance data across large numbers of patients.

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A benefit to stakeholders (interested parties)

p0340 However, without their being a clear benefit to the relevant stakeholders, it is unlikely that a new role will be introduced. The benefits to radiology departments have been clear, with vastly reduced waiting lists for DCBE and, where radiographer reporting has been introduced, quicker turn-around for report writing. There are potential cost savings, with the hourly rate of a radiographer being considerably less than that of a consultant radiologist (Brown and Desai, 2002). Surprisingly little published literature is focused upon patient acceptability, although in practice many unpublished patient surveys have suggested that patients are happy to be cared for by a radiographer without recourse to a radiologist. The patient benefits directly from these improvements, reducing anxiety with shorter waits and having a potentially better prognosis associated with a shortened referral to diagnosis timeframe. The benefits to the radiologist are clear, in that they have more time to fulfil their other duties or to introduce new services. Anecdotal evidence would suggest that, for most radiologists, the rather unglamorous aspects of the DCBE procedure have not been missed from their portfolio of duties!

p0345 So what about the radiographers? Again anecdotal evidence would suggest that performing these complex procedures has given them a great deal of satisfaction, in particular in relation to improved patient care and team working. For many who have continued their training to include reporting on the images and the performing of other GI procedures, they have increased their confidence and esteem, becoming highly valued members of the multidisciplinary team. This has led to re-grading and increased salaries for many radiographers within the new career framework.

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Beyond the DCBE

p0350 The radiographer-performed DCBE role has been so well received that radiographer-led services are now the norm across the UK National Health Service (NHS), with recent estimates suggesting that over 1200 radiographers have been trained to perform DCBE (Nightingale and Hogg, 2007); 82% of hospitals surveyed by Price and Le Masurier (2007) had implemented a radiographer led DCBE service. Many such radiographers have gone on to undertake postgraduate training to enable them to write an official report on the DCBEs, with published data supporting this practice (Law et al., 1999; Murphy et al., 2002). While most of the available courses prepare and assess radiographers to report independently, in practice, many will report as part of a double reporting system, whereby two people view the images independently and then compare reports. Double reporting is recommended in the

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UK for the DCBE procedure, as it is associated with a high level of potential perception errors (Markus et al., 1990; Leslie and Virjee, 2002).

p0355 Some radiographers have further expanded their role to perform and report barium swallows and meals, videofluoroscopy swallowing assessments, small bowel studies, proctograms and other non-GI fluoroscopy (e.g. hysterosalpingography) (Law et al., 2005; Nightingale and Mackay, 2008). While most DCBE radiographers have further developed their role within the confines of the fluoroscopy room, increasingly GI radiographers are crossing traditional imaging modalities to run a CT colonography service, often in conjunction with a CT radiographer. Some are not only working across imaging modalities, but have also crossed professional boundaries to work with teams outside radiology. Although nurse-performed endoscopy is far more common (Maruthachalam et al., 2006, Kelly et al., 2007), a handful of UK radiographers have trained to undertake sigmoidoscopy or colonoscopy, with the potential advantage over nurses of being able to offer continuity of care with combined DCBE and direct visualization on one day.

p0360 However, despite the exciting opportunities presented, relatively few UK radiographers have developed their role beyond the DCBE examination (Price and Le Masurier, 2007). This may be because the required drivers for effective role changes (see Box 1.1.) are not firmly in place. In Table 1.1, we present possible reasons, based upon both published and anecdotal evidence, regarding the apparent stalemate in the adoption of further role developments and advanced practices.

p0365 Clearly from Table 1.1, a number of drivers for effective implementation of widespread role changes are not currently in place. While a clear service need for other GI advanced practices may exist within any given hospital, the role is unlikely to be adopted as national standard practice without there being a perceived service deficiency, coupled with a champion at national level.

p0370 At the time of writing, it appears that we are once again on the threshold of a new role change for radiographers, which may well be implemented on a national basis. CT colonography (CTC) (alternatively known as virtual colonoscopy), a relatively new technique to examine the bowel, has been extensively researched around the world. Advocates of this procedure are proposing that it will eventually replace the barium enema for symptomatic work and may have an important role to play in bowel screening. For this reason, the government and professional bodies have also taken a keen interest, with a national working party currently developing a framework for implementation. A UK wide study (SIGGAR 1 trial) comparing CTC to barium enema and colonoscopy for bowel cancer in older symptomatic patients is soon to report its findings (Halligan et al., 2007). Nevertheless, hospitals around the UK have already introduced this procedure to varying degrees, with many proposing that radiographers play an important part in both performing the procedure, managing the scanning protocols and, in some way, contributing to the reporting process. Table 1.2 considers the presence or absence of drivers for implementation of radiographer involvement in CTC.

p0375 While CTC presents an exciting opportunity for radiographers (and possibly radiology nurses) to expand their role beyond the DCBE, a number of radiographers have already developed a 'package' of expertise that has enabled them to attain the highest level of clinical speciality in the UK – that of consultant radiographer status. At the time of writing, there are 26 consultant

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t0010 **Table 1.1** Criteria for effective implementation of role changes beyond the DCBE examination since 2000

Driver for change	Evidence for the presence of the driver
A perceived deficiency in the service	The waiting lists for other GI examinations and their report turnaround times are reasonably short The shortage of radiologists is no longer as acute as in the 1990s Additional funded radiology training places results in competition for training sessions in some hospitals
A proposed solution	Radiographers could take on new roles.
A legal framework within which to introduce the change	There are concerns about the greater risks involved in some procedures (e.g. endoscopy)
A 'champion' of the change, at national and local level	Some examinations are not attracting interest from the government, compared to others which are seen as high priority (e.g. examinations for colon cancer screening) While special interest groups and professional bodies still support role development, there is a lack of appropriate education and training for new roles
Evidence (research) that the change will be effective	There is a lack of published evidence that radiographer performed studies other than the DCBE are safe or effective
A benefit to stakeholders (interested parties)	Radiologists do not want to give up these procedures Radiographers already rewarded within the career structure for doing an advanced role (advanced practitioner level) are unlikely to receive any additional payment for taking on a new role (and new responsibility)

radiographers in the UK, five being GI sub-specialists. While the ethos of the consultant practitioner role should be applauded, 5 years since their introduction, the actual numbers achieving this accolade are still woefully low (Price and Le Masurier, 2007). Their roles vary depending upon local needs, but predominantly their post is concerned with service development, including aspects of expert clinical practice, research and involvement in education (Table 1.3). They often work alongside GI advanced practitioners, radiographer practitioners, assistant practitioners and radiology nurses within the GI service (see Table 1.3), with several crossing professional boundaries to work within the gastroenterology or endoscopy departments. It is likely that the numbers of advanced and consultant GI practitioners will grow in the next few years, although funding such posts will always be a major issue.

p0380 Inevitably, the role of the radiologist will also continue to evolve, with medical imaging always being central to clinical medicine. However, it is

10020 **Table 1.3** The career framework for radiographers within the UK.

Career level	Band	Education	Descriptors
Assistant practitioner	4	NVQ level III or equivalent	Specific task related skills supervised by registered practitioners An assistant practitioner performs non-complex, protocol-limited clinical tasks under the direction and supervision of a registered radiographer
Practitioner	5–6	BSc(hons)	A practitioner in radiography autonomously performs a wide-ranging and complex clinical role, is accountable for his or her own actions and for the actions of those they direct They undertake a wide range of both simple and complex imaging examinations or radiotherapy and oncology treatments on the full range of patient types and conditions and in a variety of settings
Advanced practitioner	7	Masters level education	An advanced practitioner, autonomous in clinical practice, defines the scope of practice of others and continuously develops clinical practice within a defined field Advanced practitioners work in a specific area of expert clinical practice and are involved in delivering specialist care to patients. They also contribute to the evidence base and the development of other staff, act as an expert resource for their particular field of practice and demonstrate team leadership
Consultant practitioner	8	Masters and working/ studying at doctorate level	A consultant practitioner provides clinical leadership within a specialism or area of service, bringing strategic direction, innovation and influence through practice, research and education, based on specialized knowledge and skills Such roles will nominally comprise at least 50% clinical work and significant work on research and development, audit, education and training of others, and policy and practice development

From The College of Radiographers, Implementing Radiography Career Progression: Guidance for Managers May 2005.

likely that, similar to the situation within radiography, radiologists will continue to specialize to ensure they can provide the best care for their patients and will need to introduce innovative solutions to respond to changing patterns of care, including a move towards a 24/7 department and increasing opportunities in molecular imaging (Thomas, 2005a).

International perspectives

p0385 Having outlined the historical and current situation in the UK, we will now consider how these compare to shifting professional boundaries within selected other countries, and will attempt to ascertain why any differences exist. Cowling (2008) offered a global overview of the changing roles of radiographers, suggesting that the UK has led the way in widening their scope of practice and are unquestionably the world leaders in advanced practice. She outlines four different levels of role advancement, with the UK and the USA being in the first tier, having implemented an effective system of role advancement. In the second level lie countries such as Australia and New Zealand, Canada, South Africa and Japan, where the driving forces are the same but implementation has not yet happened to any great degree. The third level countries have made moves towards having formal recognition for their profession, with role development being their next step, and the fourth group have yet to achieve formal acceptance of radiography as a distinct profession. The situation in the USA, Australia and New Zealand will now be explored further in terms of gastrointestinal imaging role advancements and will be compared to that of the UK.

The United States of America

p0390 In the USA, the practice of GI radiography varies widely from state to state. In some states, radiographers are able to perform many examinations independently, while in other parts of the country radiographers are limited to more of an assistant's role. There are few national statutes regulating the practice of GI radiography, however, the American Society of Radiologic Technologists (ASRT) has developed practice standards and the American Registry of Radiologic Technologists (ARRT) designed a task inventory that provides general guidance to radiographers in the performance of GI exams (ASRT, 2007a; ARRT, 2004). These principles would be further defined by the individual states, whose law supersedes those of the national Societies.

p0395 According to the practice standards and task inventory mentioned above, radiographers in the USA are able to obtain a patient history, confirm a proper preparation for an exam, take a lead role in radiation safety during the GI exam and set the technical factors on the radiographic and fluoroscopic equipment. In addition, the radiographer may perform particular non-fluoroscopic (over-couch) projections, including individual images of the esophagus and upper GI series and abdominal images as part of a small bowel series and barium enema.

p0400 The radiographer's role in a majority of these studies is to assist the radiologist during the fluoroscopic portion of the exam and perform any additional over-couch follow-on images independently. The most notable exception to

the role of the radiographer compared to the situation in the UK is results reporting. Fluoroscopy can be performed by a radiographer, as long as there is no reporting connected to the procedure (ASRT, 2007a).

p0405 Within the last several years, however, the role of the radiographer in GI imaging has been evolving, in large part due to the developing role of the radiologist assistant (RA). The RA is a relatively new role for radiographers in the USA that can actually trace its development back to the 1970s. The idea of an additional rung on the career ladder for radiographers in the USA has gained a great deal of support recently when, in 2002, the ASRT began to explore an expanded role for radiographers. The RA concept was approved by the American College of Radiology (ACR) in 2003 and the ARRT began offering a certification exam to radiologist assistant graduates in June of 2007.

p0410 The additional role of the RA was developed for several reasons: to provide a career ladder for radiographers; to increase the job satisfaction of radiographers; to reduce radiographer attrition; to address the radiologist shortage; to increase efficiency; and to reduce expenses (Smith and Applegate, 2004; McLeod and Montane, 2006; Carlos and Keast, 2006). These drivers for change are not dissimilar to those culminating in role developments within the UK. The concept of a radiologist assistant was also developed because there was a wide acceptance that properly trained radiographers could perform specific examinations independently. Arguably, the area of imaging identified where RAs could make the greatest impact was in GI imaging. Several studies performed in the USA indicate that properly trained radiographers can perform fluoroscopic GI examinations to a level comparable to radiology residents (Schreiber et al., 1996; Davidson et al., 2000) and, in some cases, even practicing radiologists (Van Valkenburg et al., 2000; Thompson et al., 2006).

p0415 In their new roles, radiologist assistants are able to perform an expanded array of procedures in GI radiology and the ASRT and ARRT have consequently expanded the guidelines for RAs, allowing them to perform many examinations with some degree of independence. According to the ARRT's (2005) Registered Radiologist Role Delineation, RAs may perform the following GI procedures without the physical presence of the radiologist in the room (although they must be immediately available for consultation if necessary):

u0245 Upper GI

u0250 Esophagus

u0255 Small bowel series

u0260 Barium enema

u0265 Nasogastric or oroenteric feeding tube placement.

p0445 Although the exam can be performed by the RA and preliminary findings can be reported to the radiologist, the RA is still prevented from rendering a final diagnostic reading of the images (ASRT, 2007b). Similar to the 'Red Dot' system utilized in other countries, the RA may strictly point out areas of concern for the radiologist but the final report is approved by a board certified radiologist. This limitation imposed upon radiographers is perhaps understandable while these new roles are in their infancy, particularly in the absence of published literature supporting radiographer reporting in the GI field.

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However, one approach strongly advocates that the person undertaking a dynamic, real-time examination is in the best position to write a diagnostic report on the findings, as they have been party to the fluoroscopic findings which may not have all been captured on static images (Halligan et al., 2003). Perhaps the fact that the USA operates a fee per service system (including the report) may influence the professional latitude awarded to the radiographers. Within the UK National Health Service, a fee per service system does not affect the pay and awards of an individual radiologist. However, over time, it may be possible to develop the radiographers' reporting skills to enable them to contribute fully to a double reporting system, where they write the report, which is then verified by the radiologist.

p0450 By November 2007, there were 59 radiologist assistants who had graduated from 10 educational programmes (May et al., 2008). Early evaluations showed that there was the potential to save radiologists an average of 100 minutes per day, with a resultant cost saving, even though RA salaries are some 62% higher than radiographers (Wright et al 2008). Based on evidence such as this, radiologist support for the RA program is growing (May et al., 2008).

p0455 Regardless of the degree of performance in GI radiography, all radiographers in the USA must understand the general principles behind GI radiography, GI anatomy and how the examination is performed. This knowledge is vital whether the radiographer is performing the examination or assisting the radiologist. The ability to anticipate the needs of the radiologist and to act as a second pair of eyes during the GI examination can sometimes make all the difference in providing a quality examination for the patient.

s0065 Australia and New Zealand

p0460 At the time of writing, Australia and New Zealand has no formalized system of either role extension or expansion. In a national system where private healthcare and fee for service is well entrenched and has dominated the greater percentage of not only imaging services, but healthcare provision generally for many years, the incentive for change and the change itself is made considerably more difficult.

p0465 It may be considered that Australia is perhaps somewhere in the order of 20 years behind the UK in the area of radiographer role development. In comparison to the UK, Australia is a very large country with a number of states that act as their own governors, thus regulations vary from state to state. Most imaging services are delivered within private radiology groups, some operating in very remote places. While a limited extension of the scope of practice is occurring in small pockets around Australia (e.g. IV cannulation, contrast injections and Red Dot flagging), it has normally come about through approval at hospital level as a result of local need, rather than as part of a coordinated national approach (Smith et al., 2008). In Australia, there is currently little radiographer involvement in GI procedures beyond acting in an 'assistant to the radiologist' capacity, although in New Zealand, two radiographers are currently performing DCBE examinations.

p0470 The topic of radiographer role development is gathering momentum, however, with a continuing shortfall of radiologist numbers required for timely service delivery, coupled with an increase in the demand for

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imaging services in light of technological evolution and the aging population (Smith and Baird, 2007). Journal and press articles raising awareness and concern are increasing in number, detailing reporting backlogs, unmet service demands and associated risks regarding patient welfare and diagnostic outcomes (Patty, 2007). In New Zealand, a high rate of colorectal cancer, coupled with difficulties in providing a responsive service in some of the more remote areas, would seem to be potential catalysts for future radiographer-led GI services. However, the current fee for service system seems to work against radiologists delegating the examinations and, in particular, the reporting aspects, to radiographers. As has been evident in both the UK and the USA, the radiologists continue to be the gatekeepers to the role development of radiographers.

p0475 The Productivity Commission's Health Workforce Report of 2005 (Productivity Commission, 2005) examined the impact on healthcare services taking into account the supply and demand of trained health practitioners, and the current workforce's ability to meet service demands. As has already been established in other countries, the question of limited task transfer in some professions within Australia, has been identified as holding the key to alleviating some of the current stress (Smith and Baird, 2007). To date, an advanced practice model has been developed and implemented within the Australian Nursing Profession.

p0480 The Australian Institute of Radiography (AIR) is Australia's leading national body representing radiographers, radiation therapists and sonographers. In anticipation of the escalation of this mis-match of supply, demand and increased patient risk, AIR is actively working towards implementation of an advanced practice model to suit the Australian workforce environment. The AIR is simultaneously negotiating with the Australian government and with the Royal Australian and New Zealand College of Radiologists (RANZCR) to propose a new hierarchical structure that includes an advanced practitioner tier. RANZCR's position, in a similar stance to that of the USA professional organizations, is that a radiological report cannot at this time be provided by anyone who is not a trained medical practitioner and who has not subsequently undergone training as an imaging specialist (Kenny and Andrews, 2007).

p0485 In 2005, the AIR, committed to this initiative, commissioned the Professional Advancement Working Party (PAWP). The aim of PAWP was to identify a pathway of role evolution for radiographers and radiation therapists that would ultimately improve the healthcarestatus of the patient, the functioning of the healthcare team and add value to the role of the radiographer (PAWP report 2006). Subsequently, the AIR has commissioned the Advanced Practitioners'Working Group (APWG) which is currently working to further therecommendations of the PAWP report and will be active until April 2009.

p0490 In New Zealand, however, the previously 'ad hoc' role developments have gained national interest, culminating in working groups specifically set up to look at the future skills mix in radiology departments. Reports from both the New Zealand Institute of Medical Radiation Technology (NZIMRT) and the District Health Boards of New Zealand were due to be published in 2008. The NZIMRT has approved a recommendation to introduce a three-tier career framework, including assistant practitioners, practitioners and advanced

practitioners. It is anticipated that the first advanced practice roles will be introduced before the end of 2008 (Smith et al., 2008).

p0495 Change takes time, but it is hoped that, in the future, workforce restructuring in the delivery of Australian and New Zealand medical imaging and radiation therapy services will allow for an improved patient focused care and delivery.

s0070 Summary

p0500 While radiographers in the UK have embraced role developments, particularly within the GI field, the pace of change has been slower in other countries. The USA, in particular, has implemented education and training for the new RA roles on a national scale, albeit limited to performing GI exams and not contributing fully to the report. However, in Australia and New Zealand, also largely dominated by private radiology practice, there has been much resistance to change, even in remote regions where it could inevitably improve the patient experience. Nevertheless, in the light of published evidence of the success of role changes, the weight of public and professional opinion will shift and this may, ultimately, effect change.

p0505 While the scope of practice of the radiographer has gradually expanded, the practice of GI imaging has evolved rapidly at the same time. Conventional radiography and fluoroscopy, once the foundation of GI imaging, are quickly being replaced by other imaging modalities. Computed tomography (CT) imaging of the GI tract and flexible sigmoidoscopy have become commonplace in the USA and the UK. Even magnetic resonance imaging (MRI) is beginning to compete for GI patients (Goldberg and Margulis, 2000; Tait and Allison 2001). Although there will probably always be a need for fluoroscopic imaging where function is a concern, the acquisition of cross-sectional images via CT, MR, ultrasound and hybrid imaging (such as PET-CT) will be likely to reduce the number of conventional fluoroscopic procedures being performed in the future. It is therefore even more critical that radiographers strive to develop and maintain their competence in GI imaging so that when they are involved in GI examinations they are up to the challenge.

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Publication media	Professional journal article	
Abstract	Extract from introduction: A videofluoroscopic swallowing assessment (VFS) is defined by the Royal College of Speech and Language Therapists (RCSLT) as a modification of the standard barium swallow examination used in the assessment and management of oropharyngeal swallowing disorders [1]. Whilst other swallowing investigations are available such as fibreoptic endoscopic evaluation of swallowing (FEES) and manometry, VFS is often described as the "gold standard" for the assessment of dysphagia [2,3,4]. Dysphagia is defined as a disorder of swallowing food from the mouth to the stomach [5]. Swallowing disorders can occur at every age and they have various aetiologies, as seen in Table 1. The effects on the patient of their swallowing dysfunction can range from mild irritation, to psychosocial issues related to discomfort and difficulty eating and drinking, through to life-threatening debilitation with a risk of pneumonia, dehydration, malnutrition and death. VFS can be used for the assessment, treatment and management of swallowing where the suspected condition or disease process impacts upon swallow function [1]. Videofluoroscopy has the additional benefit of providing an objective baseline to which future examinations can be compared as a measure of improvement, thus enabling management strategies to be formulated.	
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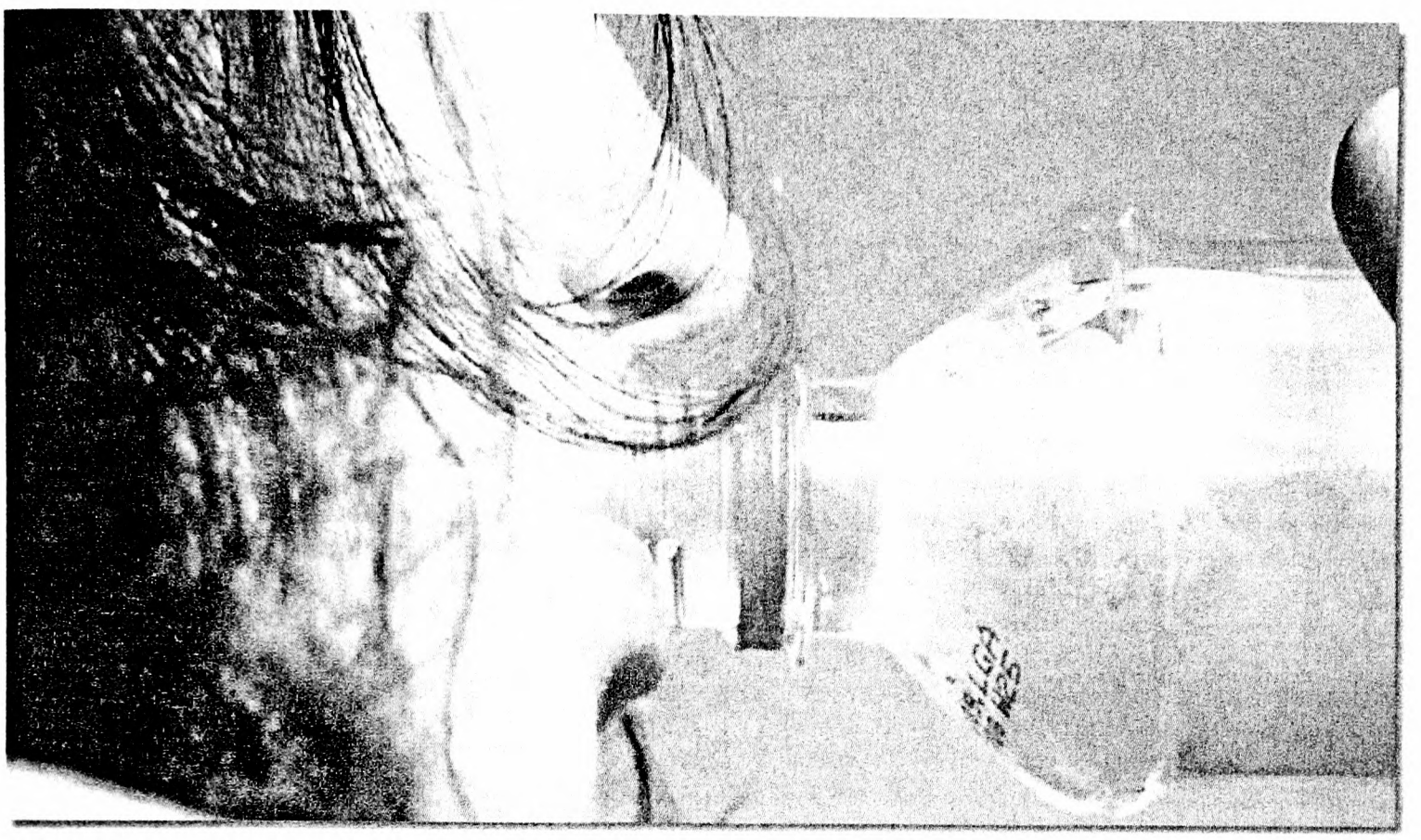


The swallowing function by videofluoroscopy

By Julie Nightingale and Roger D Newman

Introduction

A videofluoroscopic swallowing assessment (VFS) is defined by the Royal College of Speech and Language Therapists (RCSLT) as *a modification of the standard barium swallow examination used in the assessment and management of oropharyngeal swallowing disorders*[1]. Whilst other swallowing investigations are available, such as fibreoptic endoscopic evaluation of swallowing (FEES) and manometry, VFS is often described as the 'gold standard' for the assessment of dysphagia[2,3,4], which is defined as *a disorder of swallowing food from the mouth to the stomach*[5].

Swallowing disorders can occur at every age and have various aetiologies, as seen in Table 1. The effects on the patient in terms of swallowing dysfunction can range from mild irritation to psychosocial issues related to discomfort and difficulty eating and drinking, through to life-threatening debilitation with a risk of pneumonia, dehydration, malnutrition and death.

VFS can be used for the assessment, treatment and management of swallowing where the suspected condition or disease process impacts upon swallow function[1]. It has the additional benefit of providing an objective baseline to which future examinations can be compared as a measure of improvement, thus enabling management strategies to be formulated.

Also known as a modified barium swallow, a VFS is simply an adjustment to the traditional barium swallow. Low density contrast is

Table 1: Classifications of disorders which may affect swallowing function.

Classification	Examples
Head and neck pathologies	Inflammations and tumours of the oral cavity, oropharynx and larynx
Developmental abnormalities	Cleft palate, tracheo-oesophageal fistula
Neurological diseases and injuries	Strokes, multiple sclerosis, motor neurone disease (MND), Parkinson's disease, tumours and head injury
Other illnesses	Psychological/functional, or as a side effect of medication

Table 2: Range of positional modifications and manoeuvres.

Positional modification	Disorder & presentation
Chin tuck: chin is tucked down so the patient is 'looking into their lap'	◆ Reduced base of tongue movement – residue in the valleculae ◆ Delayed pharyngeal trigger – overspill of contrast into the pharynx prior to onset of the swallow ◆ Laryngeal penetration – contrast evident in the laryngeal inlet and/or resting on the vocal cords ◆ Aspiration – residue evident in the airway below the true vocal cords
Chin lift: chin is lifted up so the patient is looking up to a 45° angle	◆ Poor lip seal – anterior spillage of contrast ◆ Reduced oral strength – poor formation and manipulation of the bolus, often resulting in anterior spillage or premature overspill ◆ Nasal regurgitation – contrast noted to enter the naso-pharynx
Head turn: patient turns the head to the affected side if the damage is unilateral (eg, unilateral pharyngeal weakness post-CVA)	◆ Unilateral pharyngeal wall disorder – residue in the affected pyriform fossa ◆ Reduced opening of the cricopharyngeal sphincter – residue in the pyriform fossae (often bilateral)
Lean/head tilt: patient leans, or tilts their head to the stronger side	◆ Oral *and* pharyngeal weakness – residue noted in the mouth and pharynx on the same side
Lie down: patient reclines beyond 45° angle	◆ Reduced laryngeal elevation – residue at the entrance to the larynx ◆ Bilateral pharyngeal weakness – equal amounts of residue evident in bilateral pyriform fossae after swallowing

utilised which highlights flow through the oro-pharynx much better than the high density used in traditional barium swallows and meals (where increased coating of the mucosal wall is desired). Further modifications are associated with the volumes and consistencies of the contrast agents provided, together with the speed at which they are given, thus attempting to replicate the consistencies of everyday food and fluid. Barium sulphate combines effectively with other food products to create this range of consistencies, replicating liquid, syrup, custard and solid (biscuit) foods. A patient who has difficulty with one particular consistency may find that their swallowing function and safety is improved with an alternative consistency.

Trialling various different viscosities of contrast during the procedure not only assesses the patient's ability to manage each of them, but also provides invaluable information as to the most functional way forward for safe oral feeding. Mixing barium with real foods that the patient is familiar with and likes the taste of can prove very beneficial, especially in the case of patients with cognitive disorders and dementia. Several companies now produce their own ready-mixed contrast agents for VFS, increasing standardisation and reducing the time required for the preparation of fluids and foods in advance.

Where swallowing dysfunction is identified, the VFS may be used to trial a range of positional modifications and manoeuvres which may improve swallowing (see Table 2). If successful, these modifications can then be explained to patients and carers so that they can be employed when eating and drinking, thus enabling oral intake to commence safely.

The VFS procedure is therefore a rarity within radiology because it is an examination more of function than of structure, offering radiographers an opportunity to be involved in identifying the most appropriate management for the patient.

Increasingly, the VFS examination is undertaken by a speech and language therapist (SLT) working alongside a radiographer, rather than a radiologist. The SLT will often be working with the patient over a period of time, and will have undertaken an appropriate clinical assessment of swallowing beforehand. The purpose of this evaluation is to establish the aims of VFS if undertaken, assess candidate suitability for the procedure, and offer a full explanation in order to obtain informed consent. It also identifies factors which may contribute to the conduct of the VFS, such as cognition, presence of the carer, feeding arrangements, positioning and anxiety[1]. Patients rarely present with an isolated dysphagia, but often have other associated motor, sensory and emotional/psychological problems. These must all be taken into account when planning and arranging a VFS examination.

Because the SLT has often already built up a relationship with the patient, they will usually direct the examination and take the lead in terms of communication with the patient. The radiographer, on the other hand, is responsible for all aspects of room preparation (including specific VFS seating and handles), imaging quality and safety within the procedure. There is a particular emphasis on radiation protection, because many patients require considerable assistance and may need a carer in the fluoroscopy room (for example, paediatrics and learning disability patients).

Close co-ordination between the SLT and radiographer is required to ensure that the radiographer takes appropriate and timely spot films and real-time video, because the swallowing motion is rapid and often uncoordinated in dysphagia patients. Every stage of the swallowing process must be captured to identify the extent of the patient's problems, whilst keeping dose to a minimum. Post-examination discussion with the patient is vital to enable them (and their carers) to understand the importance of any recommended positional/texture modification. Ideally, the video/DVD recording can be used for visual feedback to demonstrate this more clearly.

Many radiographers have developed their role to become a GI specialist or advanced practitioner, and VFS is an ideal opportunity to cement their role within an interdisciplinary environment. Skills for Health published working competences and core skills to enable professionals involved in VFS to offer the highest quality to patients, by demonstrating what is required of the VFS team[6].

Standardisation of the procedure is important (allowing modifications where necessary), particularly because patients may be examined more than once to check response to treatment following a baseline assessment. Even where the examination is conducted by different staff members, consistency of approach is essential – achieved by working within an agreed evidence-based protocol, a detailed framework within which a patient is managed[7]. Some

radiographers now contribute to the reporting of VFS examinations, often as a joint report with the SLT. In some centres, the SLT comments on the function of the oro-pharyngeal swallow and any modifications trialled and recommended, while the radiographer focuses his/her report on any structural abnormalities seen within the pharynx and oesophagus. Ideally, both reports should be available on the radiology/PACS system, but in some centres the two reports are housed on different networks.

Applied anatomy

Radiographers who work predominantly in fluoroscopy, or who rotate through this modality, will find the VFS procedure more interesting and enjoyable with increasing knowledge of the potential findings and therapeutic outcomes. A pre-requisite of interpreting and reporting VFS is a firm grounding in anatomy and normal swallowing function.

Figure 1[8] demonstrates the anatomy of the pharynx in the median sagittal plane. The pharynx is a complex anatomical structure serving as a gateway to both the digestive and respiratory passageways, coupled with additional functions related to speech, choking, vomiting and yawning[9]. It is a 12.5cm long funnel-shaped tube of skeletal muscle, extending from the base of the skull (C1) to the lower border of the cricoid cartilage (C6), and lies anteriorly to the cervical vertebral bodies and their associated muscles and connective tissues. The buccopharyngeal fascia (surrounding the oral and pharyngeal musculature) is only loosely attached to the prevertebral layer of muscle, forming the retropharyngeal space (a potential route of spread for infection and metastases).

The pharynx lies posteriorly to the nasal cavities, the oral cavity and the larynx. Laterally lie the muscles of the neck, the lateral portions of the hyoid bone and thyroid cartilage, and the carotid sheath[10]. It can be divided into three parts:

◆ **The nasopharynx**, a permanently patent respiratory tract structure lying behind the nasal cavity, which is normally excluded from the digestive tract by the soft palate. During swallowing, the bilateral pharyngo-tympanic (Eustachian) tubes, which connect the middle ears to the nasopharynx, open up to allow equilibrium of air pressures on either side of the tympanic membrane. During respiration, this passageway is closed. Within the posterior walls of the nasopharynx lie the pharyngeal tonsils, or adenoids, which are most prominent during childhood.

◆ **The oropharynx** extends from the soft palate to the level of the hyoid bone, although this is a seemingly arbitrary description because the hyoid bone and soft palate position changes during speech, respiration and swallowing[9]. The oropharynx communicates anteriorly with the oral cavity, with the anterior wall made up of the base of the tongue and the valleculae. The valleculae are paired cup-shaped spaces sitting behind the tongue, separating it from the epiglottis, a leaf-shaped cartilage which is essential in closing off the respiratory passages during swallowing (figure 1). The valleculae are not permanent structures, disappearing on swallowing as the epiglottis inverts. The aryepiglottic folds form the upper lateral margins of the epiglottis. The lateral wall of the oropharynx is made up of the palatine tonsils, tonsillar fossa and fauceal arches.

◆ **The laryngopharynx** opens anteriorly into the triangular entrance of the larynx. It is indented anteriorly by the laryngeal structures, resulting in two grooves running antero-laterally in the laryngopharynx – these are known as the piriform sinuses. The lower end of the laryngopharynx is collapsed in the antero-posterior direction except when a food bolus passes. Radiologically, the laryngopharynx is indented by the cricoid cartilage and the cricopharyngeus muscle. When tonically contracted, this muscle assists in forming the upper oesophageal sphincter.

The shape of the pharynx is determined by the underlying muscles as well as the indentation of cartilages as described above. It is divided into two intrinsic muscle layers: an inner longitudinal layer and an outer circular layer. The outermost layer forms a ring of constricting muscles, which are incomplete anteriorly and which are divided into superior, middle and inferior bands – they serve to push the food bolus sequentially through the pharynx (figure 2). The internal layer of longitudinal muscle is closely associated with major folds of mucosa, resulting in the appearance of longitudinal striations on the lateral and posterior walls on contrast studies. Transverse patterns along the anterior wall result from redundant mucosa overlying the arytenoid and cricoid cartilages[9].

Killian's dehiscence is a triangular area in the wall of the pharynx, lying in the midline between the inferior constrictor muscle and the cricopharyngeus muscle. It is of clinical significance because it represents a potentially weak spot where a pulsion diverticulum (Zenker's diverticulum) is more likely to occur.

Figure 1: Anatomy of the pharynx in the median sagittal plane[8].

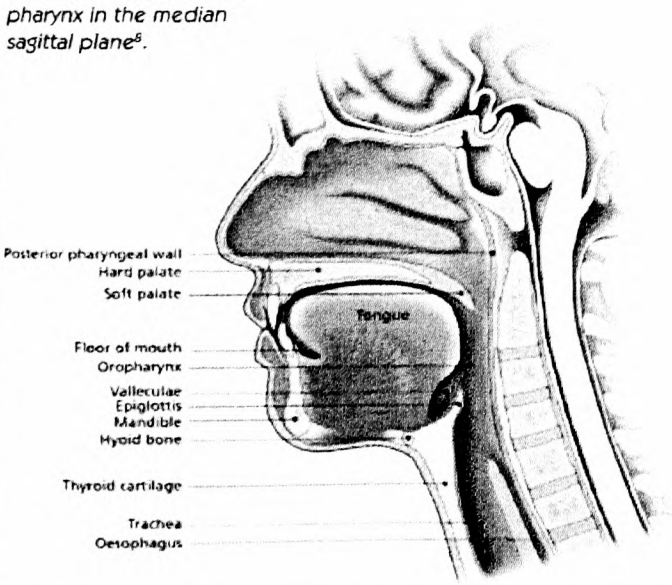
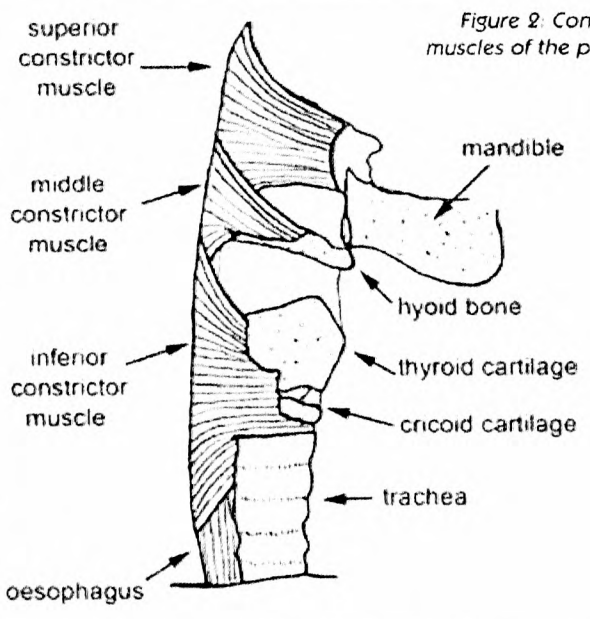


Figure 2: Constrictor muscles of the pharynx.



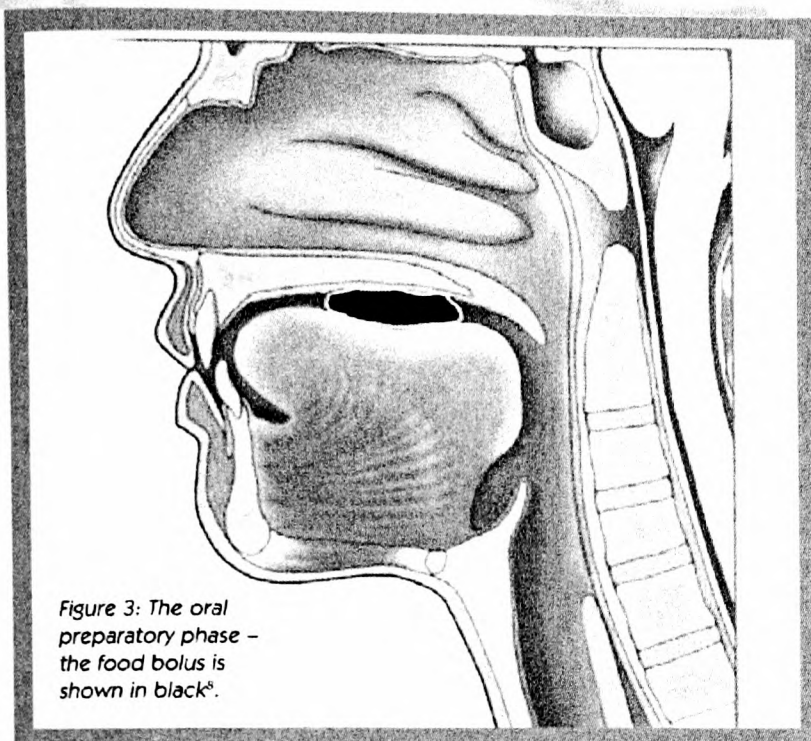


Figure 3: The oral preparatory phase – the food bolus is shown in black[8].

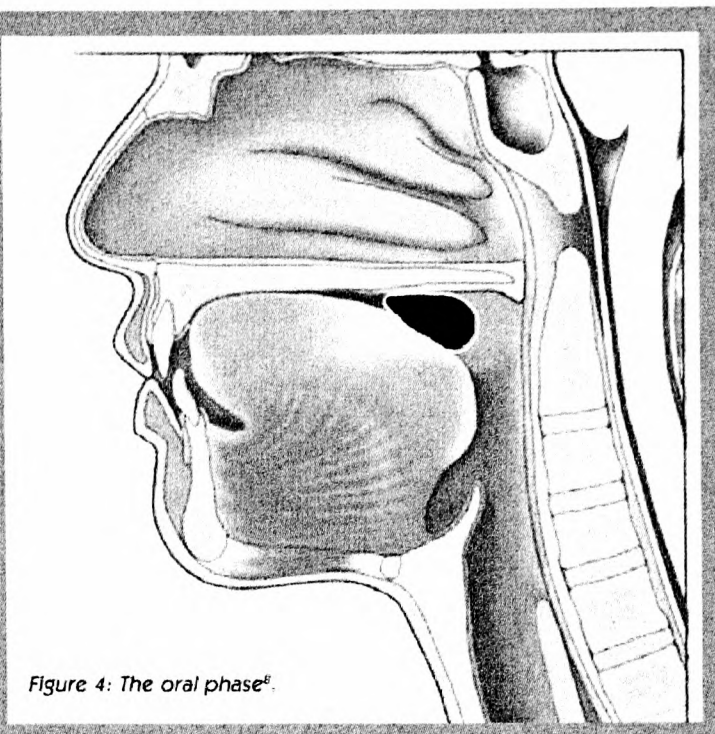


Figure 4: The oral phase[8].

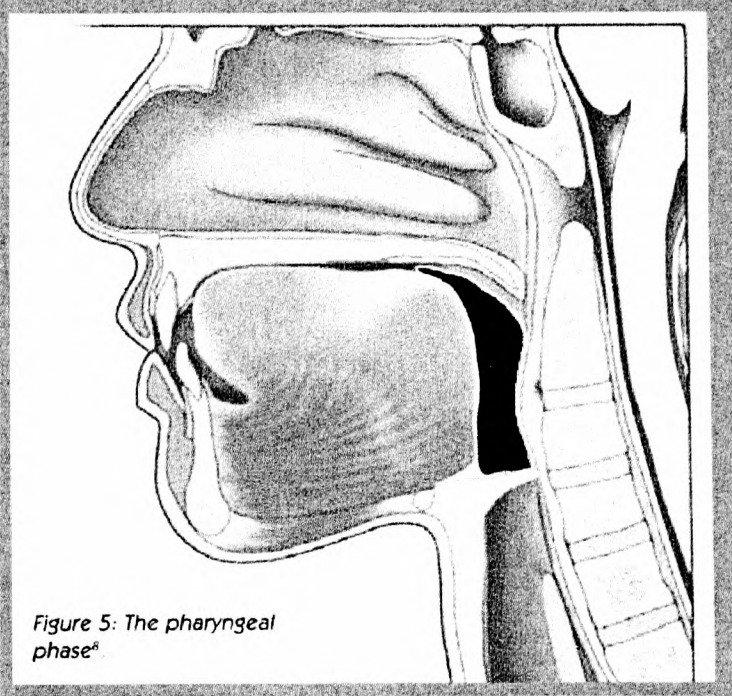


Figure 5: The pharyngeal phase[8].

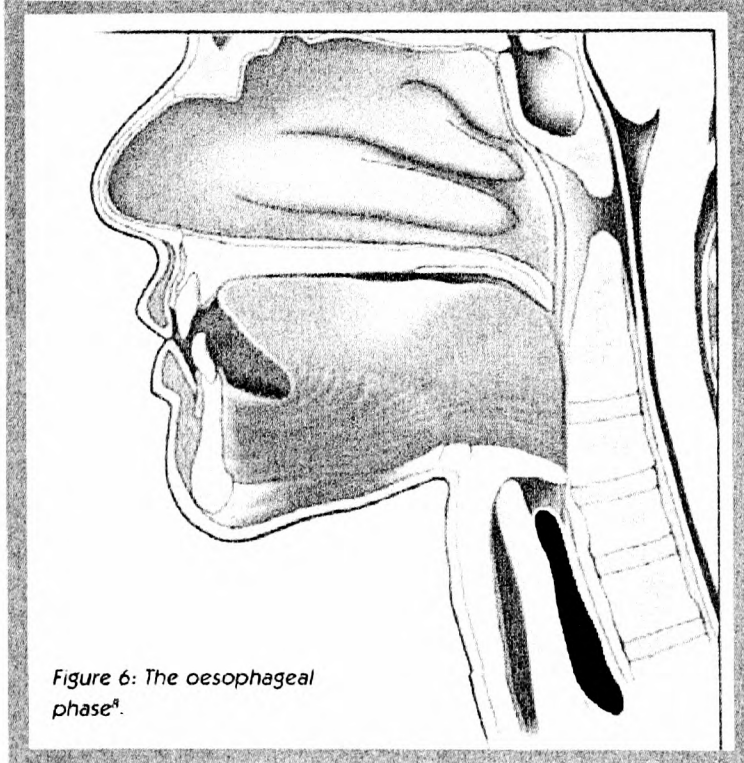


Figure 6: The oesophageal phase[8].

The physiology of swallowing

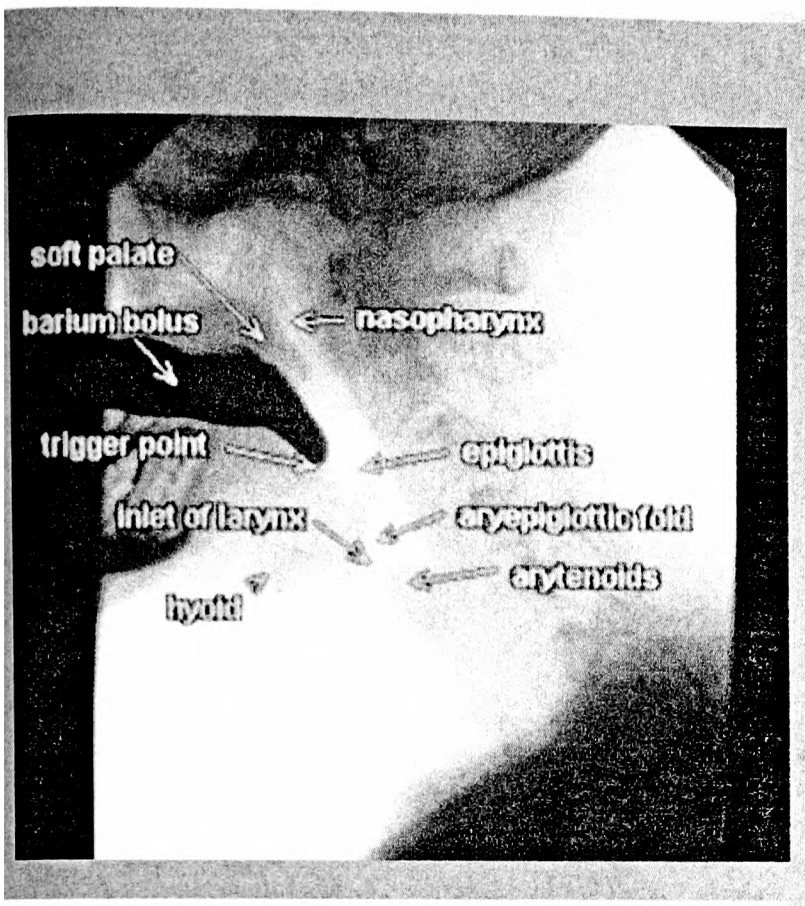
Pharyngeal function depends on the interplay of the intrinsic muscles of the pharynx and larynx, along with the extrinsic muscles of the pharynx, arising from the base of skull, neck, tongue, mandible, and hyoid bone. The mechanism of swallowing, known as deglutition, depends on a complex sequence of muscular contraction co-ordinated by six cranial nerves and three cervical nerves[11], enabling passage of the food bolus into the oesophagus, whilst protecting the airway.

In preparation for swallowing, the pharynx is drawn upwards and sideways, so increasing its transverse diameter. Anterior and superior movement of the tongue and larynx open it antero-posteriorly. When the food bolus is passed into the pharynx, the elevator muscles relax, the pharynx descends, and the constrictor muscles begin to contract sequentially, so conveying the bolus into the oesophagus. The process of deglutition is commonly divided into the oral preparatory stage (figure 3), the oral stage (figure 4), followed by involuntary pharyngeal (figure 5) and oesophageal phases (figure 6).

◆ **The oral preparatory phase** consists of food entering the mouth, masticated if necessary, being mixed with saliva and formed into a bolus. Here, the individual distinguishes the taste, temperature and volume of food. This stage is completely voluntary and movements involved include those of the lips, tongue, mandible and cheeks. The airway remains open and the soft palate is lowered, with the individual able to breathe through the nose (figure 3).

◆ **The oral phase** (also voluntary) consists of lip closure and increased pressure of the buccal musculature (cheeks), plus anterior-posterior 'wave-like' motion of the tongue against the hard palate, forcing the prepared bolus to be propelled to the base of the tongue (figure 4) Nasal breathing remains possible throughout because the soft palate has not yet been raised and the airway is still open.

◆ **The pharyngeal phase** is the first stage of the 'voluntary to involuntary' swallowing mechanism (figure 5). The soft palate is raised and articulates with the posterior pharyngeal wall to ensure none of the bolus enters the naso-pharynx. The base of the tongue raises and forms a seal with the posterior pharyngeal wall, while the pharyngeal constrictor muscles contract at the same time to meet the base of the tongue. This propels the bolus through positive pressure inferiorly as the swallow is triggered. As an involuntary reflexive response, the hyoid bone is drawn in a superior-anterior triangular motion which in turn elevates the larynx to form a seal with the lowered epiglottis. The vocal cords adduct to form an additional airway seal to protect from food



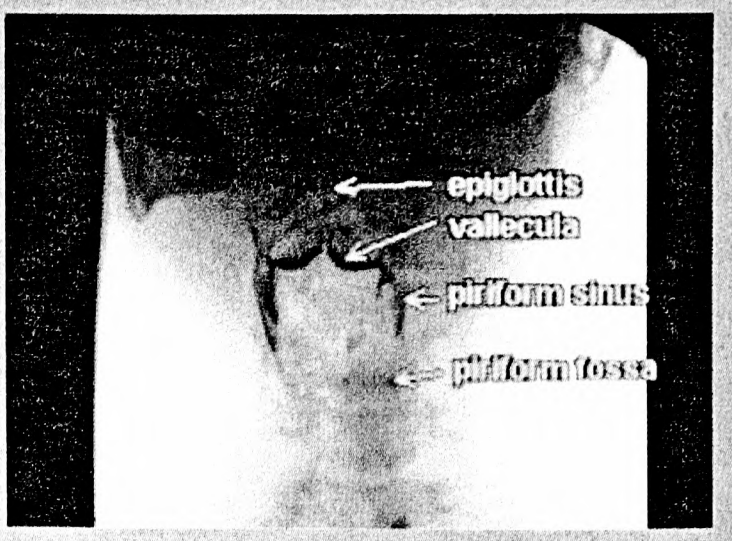


Figure 5 (above): Lateral VFS with anatomical structures.
Figure 6 (below): APVFS with anatomical structures.

Figure 7 (below): Aspiration – lateral view of the head and neck showing penetration of contrast into the laryngeal inlet and tracheo-oesophageal aspiration onto the anterior tracheal wall.

entering beyond. The cricopharyngeus muscle within the pharynx also relaxes, facilitating bolus entry into the oesophagus. It is during this stage that many disorders are commonly observed.

◆ **The oesophageal phase** of the swallow is completely involuntary (figure 6). Once the cricopharyngeus has constricted behind the bolus, the oesophageal peristaltic wave commences which transports the bolus to the lower oesophageal sphincter into the stomach. The oesophageal phase of swallowing can give rise to many disorders, but those presenting most like a true 'aspiration-based' disorder may arise from a tracheo-oesophageal fistula, where fluids and foodstuffs (and during videofluoroscopy, an x-ray contrast) enter the airway through a small 'puncture' between the oesophageal and tracheal walls. In childhood, they may be caused by congenital abnormality, but in adulthood they are usually as a result of radiation burns, spread of tumour, or the sequela of surgical procedures, eg, laryngectomy.

Identification of structures on spot films

The ideal initial position for VFS is a lateral view, which enables early warning of laryngeal penetration and aspiration – the anatomical structures can be seen in figure 7. For a patient who is only able to manage supine or semi-supine positioning, anterior-posterior (AP) viewing may be required in the absence of a fluoroscopy c-arm (see figure 8). The AP view has benefits for assessment of laterality of deficit, but full assessment of laryngeal penetration and aspiration is not as clear as in the lateral position.

Review of pathology and dysfunction seen on VFS

Many abnormalities are observed within the pharyngeal phase of swallowing. These may be due to neurological dysfunction (motor and/or sensory), causing barium pooling or residue with subsequent overspill into the laryngeal inlet with secondary aspiration (see figure 9). Aspiration is defined by Logemann as food or fluids (or in this case x-ray contrast) penetrating the laryngeal inlet and entering the airway beyond the vocal cords[5]. This differs from penetration, whereby fluids, etc, may enter the laryngeal inlet, but not go beyond the vocal cords. Aspiration occurring over a period of time is generally seen to be as a result of some form of neurological, respiratory or structural deficit, and results in a lower respiratory tract infection or aspiration pneumonia. This is a potentially life-threatening disorder, making fast diagnosis and management essential.

Barium aspirated into the lungs is usually harmless and can be expectorated either spontaneously or aided by a physiotherapist. In cases where aspiration is suspected and the reason for it is the primary purpose of the investigation, administering small volumes initially would therefore be reasonable in order to limit the amount of contrast entering the airway. Gastromiro® is a water soluble

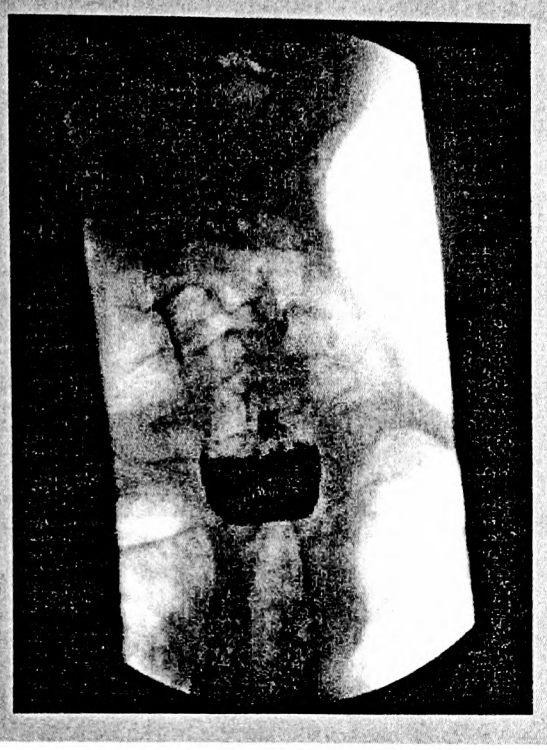


Figure 10 (far left): Slight coating of contrast in the bilateral valleculae and a small amount of residue in the right pyriform fossae, with a large pharyngo-oesophageal pouch at the level of C7-T1.

Figure 11 (left): Zenker's diverticulum.

Figure 12 (below): Incomplete pharyngeal clearance, with slight residue in the pyriform fossae, overspill of contrast along the anterior wall of the laryngeal vestibule, plus aspiration with contrast clearly visible sitting on the anterior surface of the tracheostomy tube.

iodine based contrast agent designed specifically for GI use, and is recommended where there is suspected leakage into the lungs, pleural cavity or peritoneal cavity, due to the fact that re-absorption is rapid and generally innocuous. Patients who have undergone specialist surgery, eg, laryngectomy and have a tracheo-oesophageal speaking valve, would also benefit from Gastromiro® because fistula formation is prevalent and aspiration could result. Due to the fact that barium also contains particles dissolved in water, these may block such a valve, making it ineffective.

A patient who demonstrates immediate aspiration with water-consistency barium can be assessed with a chin tuck position which may help. If this is ineffective, the barium can be made slightly thicker (eg, with yoghurt/custard) to reduce the speed of bolus transition both within the mouth and the pharynx, providing the patient with increased control in order to trigger a swallow at an appropriate time, thus reducing the potential for aspiration.

Structural abnormality can also be detected during VFS, eg, pharyngeal pouch (see figure 10) and Zenker's diverticulum (see figure 11): both are easily visualised by x-ray examination. Contrast enters the 'outpouching' of the pharyngeal wall, and transit will be poor from then on, usually resulting in contrast remaining in the pouch until it is regurgitated back into the pharynx, possibly resulting in aspiration, or subsequently swallowed successfully. Endoscopy may be difficult because the patient cannot easily swallow the endoscope, and Zenker's diverticulum is one of the reasons for the very rare complications during endoscopy: perforation. A pharyngeal pouch or Zenker's diverticulum is usually treated surgically by stapling the pharyngeal mucosa at the opening to seal the inlet. Healing is rapid and prognosis is good.

Similarly, the presence of a foreign body such as a tracheostomy tube which can 'anchor' the larynx in place and reduce elevation necessary to create complete airway protection can also cause swallowing problems (see figure 12).

The VFS can also be used to examine the structure of the oro-pharynx in conjunction with the functional aspect of swallowing. Patients with a known diagnosis of some form of cancer of the head and neck will often require a VFS to examine the extent of the dysphagia resulting from the tumour, plus possible ways to continue with oral intake, whether in a modified position or with a modified consistency (or both). Figure 13 (overleaf) shows a soft tissue mass on the posterior pharyngeal wall extending from C3 to C5, impacting on the success of flow of contrast, resulting in aspiration.

In addition to this, the examination can highlight completely unexpected results and, as previously mentioned, the radiographer may be the professional involved in the VFS who identifies these. Figure 14 (overleaf) highlights a patient with generally weak swallowing strength resulting in residue in the valleculae and pyriform fossae. However, closer inspection shows some degree of 'collapse' of C5, prompting the necessity for further investigation to ascertain the exact nature and potential cause(s), possibly by magnetic resonance imaging.

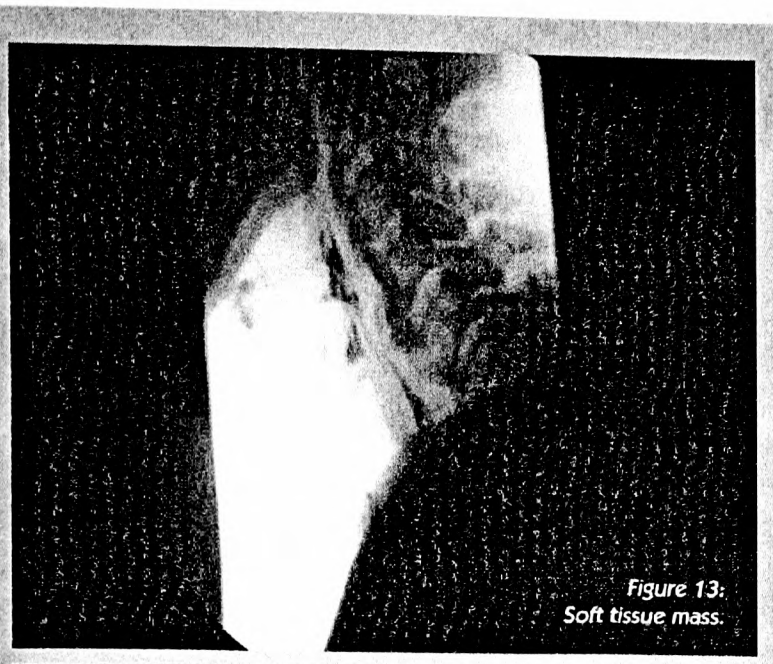


Figure 13: Soft tissue mass.

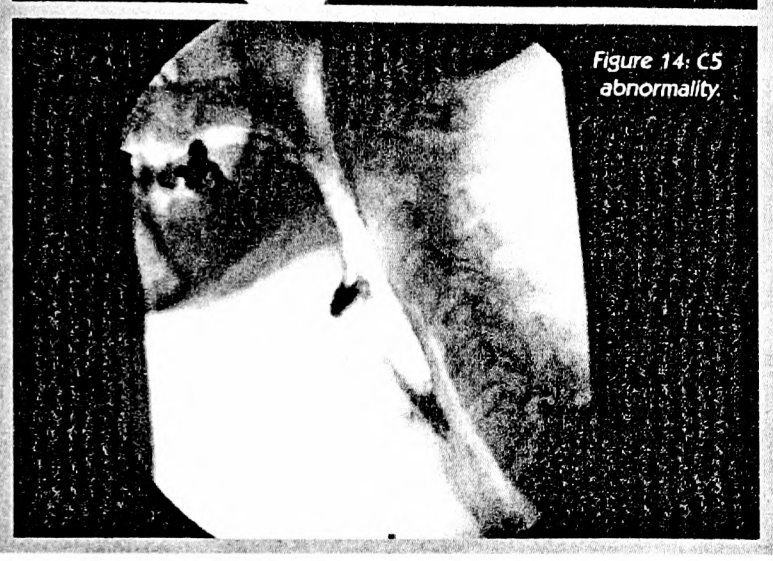


Figure 14: C5 abnormality.

Conclusions

Familiarising yourself with the normal anatomical features and common anatomical variants of the structures involved in swallowing, plus other structures of the head and neck as shown in figure 1 will undoubtedly help to increase awareness of the interpretation of images obtained during a videofluoroscopy. Observation and understanding of a normal oro-pharyngeal swallow during videofluoroscopy/barium swallow will be invaluable in identification of a compromised swallowing pattern. Identification of the timing, strength and location of trigger of a normal swallow, bolus management at each of the stages listed, and anatomical shift during swallowing will help to appreciate and evaluate the images obtained when difficulties with the swallow arise. Accurate interpretation is essential by the team to allow the SLT, medical team and inevitably the patient to manage the dysphagia in a safe and productive manner.

About the Authors

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References for this article can be found under 'Synergy resources' at http://www.sor.org/members/pubarchive/synergy.htm

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The answers will be available online from January 5 under 'Synergy resources' at: *http://www.sor.org/members/pubarchive/synergy.htm*

1. VFS is said to be the gold standard for dysphagia assessment. Name two alternative instrumental assessments of swallowing.
2. Why is it essential that the VFS protocol is standardised within a department?
3. VFS procedures utilise:
   a. high density barium preparations
   b. low density barium preparations
4. Name the four different viscosities (consistencies) of barium that are frequently used.
5. Name the three main parts of the pharynx.
6. What is the name of the paired cup-shaped spaces sitting behind the tongue?
7. Which muscle, when contracted, assists in forming the upper oesophageal sphincter?
8. What is the name of the potential weak spot where pulsion diverticula are likely to form?
9. Name the four phases of normal swallowing. Which phases are involuntary?
10. Which structure is responsible for sealing off the nasal passages during swallowing?
11. Define the difference between penetration and aspiration.
12. Name three positional modifications that could be used to improve the safety of the swallow.

Further Reading

- Evaluation and Treatment of Swallowing Disorders (2nd Edition), JA Logemann, 1998, Austin-Texas: PRO-ED.
- Manual for the Videofluorographic Study of Swallowing (2nd edition), JA Logemann, 1993, Austin: PRO-ED.

These texts, written by one of the world's leading figures in dysphagia research, will provide an invaluable understanding of the normal and abnormal features of swallowing disorders giving rise to dysphagia with specific symptoms, evaluation techniques of swallowing disorders, and the resulting images during videofluoroscopy.

For information on the latest research in the area of dysphagia, please see the dysphagia special issue of *Physical Medicine and Rehabilitation Clinics of North America*, Volume 19, Issue 4, November 2008.

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