Avenues for role expansion in image guided radiation therapy: discussion and recommendations for kilovoltage and megavoltage imaging

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Abstract Recent advances in imaging modalities within radiation therapy departments have the capability to initiate differing roles for radiation therapists. This has the potential to considerably improve the knowledge base and clinical skills of radiation therapists, while also enhancing the relationship between the allied health and medical professions. In addition, the quality of patient care may be improved while reducing the workload of oncologists. This article aims to discuss possible links between role expansion and image guided radiation therapy (IGRT) and avenues where this may be possible in modern radiotherapy departments. The work focuses on kilovoltage (kV) and megavoltage (MV) imaging modalities and their use in IGRT processes – primarily at treatment delivery. A literature review was conducted and knowledge gathered based on clinical experience at a number of departments across New South Wales and Queensland, Australia with the literature discussed framed by the authors’ clinical learning and experiences. It was found that information is available supporting role expansion and IGRT separately; however, there is no direct correlation of information between these two subject areas across the current Australian or international spectra. Role expansion for radiation therapists must be accompanied by a clear definition of redeveloped roles and responsibilities in order to avoid confusion between oncologists and therapists. The authors recommend funding as vital to ensure adequate education and standardised training intra and inter departments. Ultimately, the development of radiation therapists into IGRT specialists may involve exclusively in imaging planning and treatment aspects.

Introduction
Role expansion is currently occurring in the radiation therapy setting across Australia and on an international stage. This is precipitated by advances in technology, particularly medical imaging, and the drive for increased formal recognition of professional responsibility undertaken. There is a need for increasing research and literature to document the evolving nature of the radiation oncology department; specifically the role radiation therapists play in a continuously changing technological environment. This article explores current literature to elucidate the status of role expansion within radiation therapy drawing on examples from similar, or cognate allied health disciplines to identify opportunities for role expansion within IGRT.

Role expansion
One aspect of role expansion allows a specialist from within an area to utilise the skills and areas of practice that were previously performed by another. The specialist role incorporates greater levels of accountability, responsibility and autonomy than the practitioner previously held. In Australia, interest has been expressed in introducing role expansion into radiation therapy departments. This is a result of the effectiveness of role expansion within other allied health disciplines, the development of new technology, desire to gain new skills and to provide a higher level of patient care. Extensive literature has been published on the effectiveness of role expansion within cognate disciplines which also considers the benefits and possible hindrances to the development of an advanced practitioner.

History of role expansion
Role expansion has been implemented within a number of health professions worldwide, particularly nursing and diagnostic radiography. The role of a clinical nurse specialist has been established and implemented internationally, including in the UK and the USA. The emergence of the advanced practitioner was precipitated by staff shortages, skill shortages, a need for cost reduction, government initiatives and health sector programmes. The UK piloted the development of the advanced practitioner in nursing throughout the 1980s. In addition to developing new roles, nurses have also extended their scope of practice performing tasks which were previously performed by a doctor; an example being the prescription of medication.

In the UK, role expansion has been implemented within diagnostic radiography most significantly in the area of image reporting, and also through the development of other specialist roles such as a gastrointestinal radiographer; instigated due to the staff shortages of radiologists. Within Australia, advanced practice for radiography has not been formally established despite many radiographers indicating that they unofficially interpret trauma x-rays for the radiologist.

Radiation therapy advanced practice has not been formally recognised, yet the literature suggests it has been incorporated informally into daily clinical practice. This is evident by the study performed by Smith, et al. who found 40% of radiation therapists surveyed indicated a senior radiation therapist or chief radiation therapist approved a final treatment plan rather than the radiation oncologist. It was further indicated that radiation therapists interpret daily treatment images for verification of treatment field location.

References
2–11,13,14,17,18,22
In a survey of 46 oncology facilities in Australia and New Zealand, Rybovic, et al. showed the roles of image interpretation, and recommendations for subsequent treatment variations, are most commonly shared between professional groups (radiation oncologists, radiation therapists). However, and importantly, for a small number of centres it was seen that these duties have become the sole responsibility of radiation therapists.

This demonstrates that current aspects of modern radiation therapy practice associated with treatment planning, delivery and verification can be utilised as avenues for possible role expansion.

Benefits and hindrances to role expansion

The literature suggests that the development of an advanced practitioner role within the field of nursing has proved beneficial to the profession. The use of an Advanced Nurse Practitioner (ANP) in North American settings can manage 63% of a physician’s workload at 38% of the cost; consequently this results in substantial savings to the health care system. Within a radiation therapy context, the implementation of advanced practice has a potential cost effectiveness as the radiation therapist may perform some of the oncologist’s areas of practice. This may result in a decreased need for hiring oncologists of whom there is a shortage. Areas where radiation therapists may be able to role expand in this context will be discussed shortly.

Eddy advocates that the development of an advanced practitioner role within radiation therapy has the potential to create a higher level of patient care through incorporating additional skills. Role expansion may also be advantageous to the radiation therapy profession through the improvement of professional status and academic. Literature within cognate health disciplines also indicates, however, implications for the radiation therapy profession regarding potential of hindrances for role expansion implementation. Such hindrances include medico-legal aspects, education standards, medical dominance and the available frameworks and policies for progression.

Medico-legal issues are heightened due to the increased level of skills and responsibility associated with advanced practice. This is evident within the field of diagnostic radiography where the professional has skills that extend beyond the normal expectations. Consequently, they are expected to provide a higher level of care and are legally assessed in this manner. Advanced practitioner roles may also introduce greater levels of accountability, responsibility and autonomy for radiation therapists.

Increased responsibility and accountability may introduce the potential for litigation. In a study of radiography professionals, Forsyth and Robertson showed 55% of respondents reported feelings of anxiety related to role extension due to issues of accountability. Forsyth and Robertson identify that mechanisms of accountability, responsibility and clear medico-legal guidelines must be established and documented for the successful expansion of roles within diagnostic radiography. To overcome medico-legal hindrances – perceived and actual – similar mechanisms are required for radiation therapy.

The educational standards and requirements for role expansion are not formally stated in the Australian clinical environments making standardisation between departments difficult. Eddy also highlights potential challenges for traditional education methods which need to be evaluated for effectiveness for successful implementation of advanced practice roles.

In addition to required educational frameworks, the practical implementation of radiation therapy role expansion may be hindered if the time required to gain the necessary knowledge and skills to participate in role expansion tasks is not available. This is highlighted by a study performed by Spalding, who notes that radiation therapists in the UK struggle to complete daily job tasks without the additional pressure of "attending courses, gaining further qualifications and providing documentary evidence of CPD activity".

Medical dominance can provide a significant barrier to role expansion which can upset the traditional balance of power between the allied health professionals and medical professionals. Martino and Olde suggest that the push for professionalism can lead to turf battles and inefficient use of personnel, which may ultimately affect patient outcomes. It is emphasised that a consensus concerning scope of practice boundaries between practitioners is necessary, requiring clearly defined responsibilities of each role. This also prevents any issues pertaining to the medical-legal aspects of accountability, professional responsibility and liability.

Eddy identifies that without a clear framework and policy, which is constant across all centres relating to the achievement of advanced practitioner status, formally recognised role expansion causes complications and confusion. It is difficult to achieve role expansion to its full potential without a foundational basis provided by protocols. Such protocols can provide frameworks in which patients are managed, standardising medical care based upon evidence-based-research and ensuring a minimum of care.

Image guided radiation therapy

Image guided radiation therapy (IGRT) is the process of localisation of the target volume or treatment position by using imaging modalities in direct conjunction with the treatment; usually in the treatment room. The goal of IGRT is to provide a framework to manage both inter- and intra-fraction motion to improve the accuracy of treatment delivery. It involves all steps in the radiotherapy treatment process, from patient immobilisation, CT simulation, treatment planning, planning verification, patient setup verification and correction, delivery, and quality assurance.

IGRT modalities include trans-abdominal ultrasound, implantable markers with MV or kV imaging, optical surface tracking systems, implantable electromagnetic markers, in room CT such as the kVCT on rails system, kilovoltage or megavoltage cone-beam CT (CBCT) and helical megavoltage CT. Due to the variety of methods/techniques used in IGRT, we have limited our discussion to kilovoltage (kV) and megavoltage (MV) imaging modalities and their use in IGRT processes – primarily at treatment delivery. Literature, combined with the authors clinical experience and anecdotal evidence suggests these two new imaging modalities are commonly being introduced or already applied in Australian radiation therapy departments.

Within an oncology department, both kV and MV imaging can be employed for many reasons including at treatment delivery, where an online correction is used to improve setup accuracy, for both kV and MV imaging. Pisani, et al. suggested that MV image based corrections are more effective than MV based corrections; with some site dependence. Pisani, et al. also noted that when using kV imaging, smaller variations in inter-observer alignment variability and intra-observer variability are found when evaluated against MV imaging. Better imaging quality acquired with kV imaging and CBCT provided a highly effective 3D image data set with volume information perhaps explaining these findings.

The ALARA principle (as low as reasonably achievable) which recommends x-ray exposure should only occur when it produces...
a net benefit to the patient and can be clinically justified,27 also indicates kV imaging is justified over MV imaging. The use of kV images in the radiation oncology department has been shown to provide lower exposure doses when compared to portal imaging. For example, Walter, et al.28 found for pelvis that kV imaging reduced patient surface and rectal doses by two orders of magnitude when compared to MV portal imaging techniques.

**Role of the radiation therapist**

The radiation therapist is involved in the design and implementation of radiation treatment and issues of care and wellbeing of people diagnosed with cancer and other conditions undergoing radiation therapy.29 The Australian Institute of Radiography (AIR) defines the scope of practice for an accredited radiation therapist.28

The current scope of practice indicates that a radiation therapist is able to perform the following tasks:28

- Patient assessment including psychosocial issues
- Patient positioning and immobilisation
- Manufacture/Construction of ancillary equipment
- Simulation, including tumour localisation, treatment planning and dosimetry
- Treatment by superficial to megavoltage external beams and verification
- Imaging for planning and treatment verification purposes
- Mentoring, clinical reasoning and research.

The scope of practice includes aspects of modern radiation therapy relating to the use of image guidance for treatment planning and delivery – these include patient positioning, tumour localisation and verification imaging.

It is reasonable to consider modern applications of image guidance through IGRT as an avenue for advanced practice within radiation therapy.

Successful radiation therapy role expansion in IGRT must also be informed by (i) an understanding of the technology and principles underpinning image guidance and (ii) the current role radiation therapists play in radiation oncology. Understanding these two aspects will enable identification of contextually relevant aspects of IGRT where role expansion as potential for success.

It was felt that an exploration of the literature to tie the concepts of role expansion, IGRT and the defined role for radiation therapists was necessary.

**Method**

A literature review was conducted using the internet databases OVID, ScienceDirect, Medline, CINAHL and Scirus from January 1990 to November 2008. Initial broad searches were conducted for abstracts and journal articles written in English using the key words “radiation therapist or radiation therapy and role expansion”; “radiation therapist OR radiation therapy and advanced practice”; “radiation therapist and image guided radiation therapy”; “cone beam computed tomography”; “kV imaging”; “image guided radiation therapy and advanced practice”; and “radiation therapist and advanced practice and protocol development”. Professional organisations were searched via the internet for documents and reports directly relevant to IGRT and role expansion; such bodies included The Royal Australian and New Zealand College of Radiologists, The Australian Institute of Radiography, The Royal College of Radiologists (UK) and The Society of Radiographers (UK). The “view related articles” link and online reference lists were used to find additional relevant articles that were not previously captured through electronic screening. All authors reviewed the resulting abstracts and articles. At the time of composing this article, all authors have undertaken at least 19 weeks of clinical placements, and the knowledge acquired during such placements allowed for a comprehensive analysis of the current status and use of IGRT within Australia. Such knowledge was verified in consultation with article supervisors who have had extensive clinical experience in these settings.

**Results**

The review found a vast amount of information was readily available on the features, description and use of IGRT in a clinical setting. Such information included techniques such as CBCT, kV imaging, electronic portal imaging (EPI), temporal CT image acquisition (4DCT), gating and tomotherapy, and the benefits of implementation of these techniques within a radiotherapy department. Similarly, the incorporation of role expansion in a variety of health sciences disciplines, particularly nursing, appeared to be an eminent theme presented in the majority of literature searches relating to role expansion. The authors found that research relating to role expansion and radiation therapy is minimally available within the international spectrum. However, the literature review resulted in limited specific information on the link between IGRT and role expansion internationally. Most critically, the authors found minimal research relating to the impact of role expansion and IGRT within the Australian environment.

**Discussion**

With new and groundbreaking technology comes the opportunity for radiation therapists to expand their clinical skills and take on more responsibility within the departments operations. In synthesising the literature with our professional experience and opinion we have identified various avenues for role expansion within the radiation oncology profession as a result of the technological advances of IGRT.

Such opportunities include:

- Extension into other working roles and decision making
- Creation of an ‘IGRT Specialist’ role with appropriate education and training
- Significant role in protocol development.

Implications of these expansions will include:

- Increasing the professional profile of radiation therapists
- Increased job satisfaction with an extended knowledge base
- Improved efficiency, and hence quality of care, in radiation oncology practice.

The role expansion opportunities proposed are inter-related by the very nature of practice in radiation therapy departments.

**Extension into other working roles and decision-making**

There is a significant shortage of radiation oncologists in Australia30 and as a result they are subject to an increasing personal workload. It is apparent that there are opportunities for radiation therapists to branch into other roles within the radiation oncology department in order to lessen the workload, particularly for radiation oncologists.

Some examples of the possibilities for extension within the radiation therapists’ clinical skills are found within kV and MV imaging.

Our clinical experience suggests traditional MV portal images or orthogonal kV images are typically acquired and reviewed at the time of treatment by two treating therapists with a joint decision being made for any repositioning that occurs. Any anatomy that lies outside a normal setup tolerance, specific to each
to present their knowledge include seminars, participation in working parties and committees which would allow for sharing of new skills with the department providing benefit to others.

The creation of this role or something comparable will certainly increase the profile of the radiation therapist within the department and demonstrate the capabilities of the profession. This is particularly important to move radiation therapy towards a more defined and fulfilled profession. It is important to note, however, that not all radiation therapists in the department will necessarily make the transition to advanced practice roles, as they will require a significant amount of personal motivation to undertake further study and undertake the increased responsibility.

Other roles which may be inclusive of the IGRT specialist role could include more physics-based or oncology-based studies which can give the specialist a more technical and in-depth understanding of the technologies and machinery and a better knowledge of disease processes. This may also lead into a better technological understanding, as well as improved and expanded capability to define treatment planning volumes and to contour critical structures.

Protocol development
Protocol production and improvement, as part of multidisciplinary oncology teams, is currently within the role of some experienced radiation therapists.

As modern image guidance techniques are being introduced, there is an obvious need for protocols to be developed within the department for simulation, planning and treatment. Examples of this include modifications to existing CT scanning protocols, positioning and mark up of the patient, daily treatment tolerances and verification. An individual with a radiation therapy background in addition to extra IGRT training would be a necessary member on a committee that is deliberating on protocols for this new technology.

Further knowledge allows for a more informed articulation of reasoning with an understanding of both technical and clinical aspects. The scope for radiation therapist participation in protocol and or guideline development should be expanded from not only within the department to state, national and international scale.

As mentioned, the implications of successful expansion into these areas will encourage an increased professional profile, job satisfaction, efficiency and quality of care in radiation oncology practice. The benefits in departmental recruitment and retention experienced by cognate disciplines, such as nursing, are valuable examples for role expansion in radiation therapy.

By increasing responsibility and autonomy within the workplace, IGRT opens the metaphorical door for both clinical and technical extension within the department and such further specialist training would also allow this new and exciting technology to be utilised to its full potential. On a big picture scale, radiation therapists enriching their skills will consequently enhance communication and relationships between the health and medical professions in addition to providing improved patient care.

Conclusion and recommendations
The concept of advanced practice will undoubtedly evolve over time and is something that will inevitably require consistent evaluation and re-evaluation because of the changing nature of technology. Some concepts that feed into advanced practice within radiation therapy include the extension of the current scope of practice, creation of new positions such as an “IGRT specialist”, increasing job satisfaction and enhancing the
professional standing of radiation therapy. In our current clinical environment, there is a need to standardise and co-ordinate role expansion for radiation therapists, as well as providing clear frameworks that define the nature of role expansion. In the future, the role expansion associated with responsibility of MV and kV imaging (especially in CBCT) may become routine practice for radiation therapists if it is encompassed within training and education in addition to the clinical setting environment.

The traditional role of radiation therapists within their respective profession is rapidly changing due to significant technological advancements in image verification. Numerous recommendations can therefore be made in order to take full advantage of the benefits of role expansion within IGRT in an Australian context.

Indeed, specialist roles with regard to advanced practice within IGRT may include the implementation of an IGRT specialist. An IGRT specialist could be a radiation therapist who specialises in IGRT in both planning and treatment aspects, having the responsibility to take online action regarding repositioning, bladder filling and rectal emptying if this is significantly affecting organ motion on treatment. When used effectively, the IGRT Specialist would have the capacity to lessen the radiation oncologist’s workload due to the current shortages present in Australia. The IGRT specialist may be educated in soft tissue imaging as well as being involved in the quality assurance and physical aspects of IGRT in order to provide a comprehensive role speciality.

A clear definition of specialist roles within the department is fundamental for role expansion in CBCT and kV imaging. A potential model for radiation therapists to advance into IGRT specialist roles through training and further education is suggested in the AIR Professional Advancement Working Party Report (PAWP).

Eddy identifies that without policy providing consistent requirements for advanced practice across all departments, attempts at role expansion cause complication and confusion. This idea is supported by Welgemoed who states, “There is a need for a framework within the profession that clearly conveys the progression of the therapy radiographer”.

We believe that a clearly defined professional structure must essentially encompass IGRT training, education and accreditation. In addition, standardised frameworks across departments will enable advanced practice radiation therapists to move between oncology departments with formal recognition of their skills.

Funding must be available for education and training purposes; additional education and training will provide extensive knowledge in areas such as soft tissue delineation and professional development activities. With the relevant appropriate training, it is considered that radiation therapists will be able to make accurate and correct recommendations concerning kV imaging and CBCT.

We recommend designated time periods be set aside in order for the radiation therapists to participate in suitable training to achieve an advanced level of competency. Alternatively, training modules – potentially for all modalities used in image guidance techniques – could be implemented in radiotherapy departments and in the current undergraduate or graduate entry university courses.

Future work may include designing standardised frameworks for training, creating role definitions for the specialist roles described, as well as modelling resources (physical and monetary) required to develop and promote the recommendations highlighted in this work.

Authorship statement
This article has been produced by Robyn Burow, Jill Cavenagh and Christine Simpson in association with Mark West, Kathryn Szymura and Jenny Cox at the Faculty of Health Sciences, University of Sydney, Australia.

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