

Australian radiation therapy: an overview

– Part one

Abstract Introduction: Over the last century radiation therapy has developed and improved in many facets of treatment delivery. Radiation therapy is now recognised as an important treatment modality for malignant disease. Continued research and development has gradually changed the general medical opinion of radiation therapy. It is now recommended that more than 50% of all cancer patients receive radiation therapy. **Background:** The development of radiation therapy personnel in Australia started with doctors' assistants arising from a practical need in the application of treatment. This assistant role gradually extended to a more technical role and saw the birth of the radiation therapist [originally known as radiotherapy technician; therapy radiographer]. The historical progress of this profession in Australia is important to understand for further role development and enhancement of radiation therapists. It is also significant if the profession is to embrace the changes in medical approaches, particularly in oncology, where a bio-psychosocial model of health is rapidly becoming the preferred approach. Part one outlines the history and development of Australian radiation therapy from the discovery of radiation until today. Part two is a subsequent paper providing discussion of Australian radiation therapists' perspectives on the radiation therapy workplace and work-practices from 1960 until today.

Keywords: historical development, radiation therapy, radiation therapists.

Introduction

The announcement of the discovery of x-rays in 1896 and radium in 1898 marked a significant change in approaches to diagnosing sickness and providing treatment.^{1,2,3} It is from these discoveries in combination with better pathology, diagnostic and treatment methods, curative and preventative health care has evolved.

Medical radiations, both diagnostic and therapeutic have become an important part of modern health care.⁴ Over the past 100 years there have been rapid improvements in many areas of radiation treatment delivery made possible by diagnostic procedures continuing to develop and provide better preventative screening measures for human health and well being. As a result earlier disease detection has contributed to increases in the number of radical treatments, advances in treatment delivery and improvements in outcomes.

Radiation therapy is now recognised as an important treatment modality for malignant disease. Early use of radiation therapy was as a last resort for the treatment of many malignancies with surgery the favoured treatment method. It is now recommended that 52.3% of all patients diagnosed with cancer receive radiation therapy at some stage during their disease.⁵

Radiation therapists, until more recent years, were not generally responsible for initiating role advancement or research in radiation therapy with the position of radiation therapists seen largely as technical. In the last two decades radiation therapists have become university graduates bringing different ideas, enthusiasm and approaches to radiation therapy.⁶⁻¹⁰

This paper provides an overview of Australian radiation therapy from outset until present day and an understanding and appreciation of the development of

radiation therapy in Australia. It is designed to assist us in understanding the significance of this journey through time on the culture, decision making and education of radiation therapists.

This paper is structured chronologically to provide the reader with the relevant historical advances and changes that have been instrumental in the development of radiation therapy in Australia. A short history of the beginning of radiation therapy in Australia is followed with a timeline that summarises the main events captured in this paper. The section "Development of a Profession" describes the development of radiation therapy and the role of radiation therapists prior to 1950 and is followed by the section "The Early Years of 1950–1979" which describes when education of radiation therapists became more formalised. The introduction of computers and information technology and their impact is discussed in the section "The Formative years of 1980–2000 and beyond". A short summary states the reasons for the further investigation of radiation therapists' perspectives on radiation therapy workplace and work-practices from 1960 until today discussed in a second paper by the authors.

Historical perspective

Scientific pioneers in their discovery of x-rays and radium instigated much excitement amongst medical practitioners around the globe. The news was also embraced energetically by others with interests in the photographic, electrical and communication trades.¹¹

Early days of radiation therapy internationally started in dermatology. *The Handbook of Cutaneous Therapeutics* published in 1907¹² for the consultation of general practitioners is an example of how important x-rays and

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1895–1898	Discoveries of x-rays and radium
	1st radiotherapy mainly in dermatology
1910	UK practical training
	Coolidge tube /Superficial [prior to WW1]
1920s	Orthovoltage [deep x-ray] introduced
	Formation of radiographer society/Theoretical training UK deep x-ray use NSW 1928 SA 1929
1930s	Roentgen as unit of radiation [1928 Stockholm Int Congress]
	Radiation monitoring [1932]
	Aust Radiography Society as branch of UK society [1932]
	Start of X-ray technician training courses hospital based [Australia]
1940s	First formal RT training introduced [Australia]
1950s	AIR formed [1949] Conjoint Board [1952]
	Ultrasound introduced to international medical world
	First treatment on a linac [Qld 1956]
1960s	Co ⁶⁰ machines & linacs in most states of Australia
	Chemotherapy plays greater role
1970s	Calculators introduced
	CT & MRI invented
	Computer planning developed
1980s	RT Certificate → Diploma [full time study with practical]
	CT & MRI in radiation therapy
	Refining of imaging / planning systems /record & verify
1990s	RT Degree courses
	EPI/MLCs
2000+	Electronic booking systems
	Baume report
	Dynamic wedges
	Electronic treatment sheets
	CPD & research involvement
	Monash Masters course/Advanced Practice courses

— Post WW2 Radio isotopes and radiation knowledge leads to new equipment

— Aust National programs for breast screening Pap smear PSA

Figure 1: A diagrammatic summary of major events in the development of radiotherapy in Australia.

radium were in the treatment of skin conditions at the beginning of the 20th Century. The authors of this book gave detailed descriptions of x-ray equipment and the treatment of many different skin diseases. Descriptions of treatment details included equipment and doses for administering the radiation.¹² Further discussions elaborate on the quality and quantity of radiation dose and the impact of these to the success of the treatment. In the span of hundred years these have been the focus of continued change and improvement.

Despite the vast distance from Europe, Australians were quick to become involved in the medical use of radiation. From as early as 1896 there are records of attempted treatments with a variety of skin diseases treated with considerable success.^{12,13,14}

Similarly in the early 1900s Australian doctors chose to use x-rays and radium to treat a variety of skin problems.^{3,13,14} According to Morgan² “Treatment was given by dermatologists and also by radiologists (called

skiagraphists) although they were largely involved in diagnostic work”.

Some of the first treatments were described in a paper presented by Adrian Johnson at the Fifth Annual Meeting of the Dermatological Association of Australia.¹⁵ Johnson, a dermatologist and radiotherapist (radiation oncologist) who, among his many achievements, founded the Combined Skin Cancer Clinic, Royal Prince Alfred Hospital, discussed that the first mention of radiotherapy appeared in Australian medical literature in the July 1896 issue of the *Australian Medical Gazette*. He also talked about the first recorded treatment of lesions with x-rays, given by Dr Cleaver Woods, later that same year. His discussion included early recorded treatments given for cases of ringworm and rodent ulcer.¹⁵ In the early 1900s Radium was also used for treatment, as plaques or moulds that were placed directly onto the skin lesion.²

The timeline as shown in Figure 1 provides a visual summary of the historical points central to the discussion presented within this paper.

Development of a profession

Treatment initially began with the use of single treatment machines in dermatology clinics within public hospitals.^{3,13,14} The first operators of radiation producing equipment were a mixture of doctors, technicians and nurses who embraced the application of radiation as a serious medical intervention. Superficial x-ray therapy was used and greatly improved with the patenting of the Coolidge tube in 1916.² In the 1920s deep x-ray therapy (orthovoltage) was introduced providing even greater treatment scope with increased penetration.^{2,13} As numbers of patients increased, so too did the need for assistance in the administration of the treatment. The more sophisticated the equipment became, greater became the need for theoretical training.

Training in radiation therapy was initially “on the job” with the first practical radiographer training in the UK said to have been about 1910 with theoretical training started in 1917 and approximately 70 individuals obtaining a hospital certificate by 1922.⁴ Many of the early operators of equipment in Britain were nurses, known as x-ray nurses and x-ray sisters.¹¹ Witz¹¹ in discussing the female domination of the role, makes the point that “Woman had originally accessed radiography work through the occupation of nursing, and had established a presence in hospital radiography work prior to the formalisation of routes of access to radiography.”

The involvement of nurses in radiography was similar in many hospitals in Australia while Australian male radiographers were from a variety of backgrounds, similar to the UK male radiographers, such as physics, electrical engineering and photography.^{13,14,16,17} The complexities of role definition in radiography were just emerging.^{11,18,19}

In Australia, on the job training in diagnostic radiography started in Victoria in the late 1920s with radiation therapy skills also continuing to be learnt within hospital departments.¹³ New South Wales followed suit in 1937 and Queensland in 1939 with the introduction of radiotherapy training for diagnostic radiation technicians.¹⁴ The first academic institution based theory course in radiotherapy, for prospective radiation therapists, was conducted at the Melbourne Technical College in 1947 initiated by Dr Kaye Scott.¹⁷ South Australia followed with a similar academic based radiotherapy course introduced in 1954 consisting of one year of theory and a further one year of practical experience for students already qualified as diagnostic radiographers (Personal communication with J Cottrell, 26 June 2008).²⁰ The future would see a greater division of these areas in medical radiations as Sandeman²¹ stated “radiographers, although originally multi-tasked, became orientated to either diagnostic or therapeutic specialties.”

According to Witz¹¹ The Society of Radiographers was formed in Britain in 1920, originally with a great amount of input from The Institute of Electrical Engineers. In Australia the Society of Radiographers of Australia formed as a branch of the British society in 1932.^{22,23} It was not until the late 1940s that the more formal Australasian Institute of Radiography, now the Australian Institute of Radiography (AIR) was formed.²⁴ These associations have provided structure and guidance to the emerging medical radiation professions with an example of this being The Conjoint Board of the AIR. From its instigation in 1952 until 1986, this board was responsible for recognising and guiding the education requirements for all Australian radiographers and radiation therapists. In 1986 it was replaced by the Professional Accreditation and Education Board (PAEB).²⁴

Radiotherapy owes much to the physicists who worked continuously on improving and refining the equipment in an attempt to provide safer machines and greater understanding of radiation doses. During the 1950s the introduction of new equipment required greater numbers of medical

physicists particularly in hospitals. Unlike their radiography counterparts in the northern hemisphere who were an active part of the British Institute of Radiology, Australian hospitals employed one or two physicists with little association with the medical radiations professionals.²⁵ It was not until 1959 that Australian physicists involved in medical radiations began to actively communicate with each other and in 1960 came together to discuss the formation of an organisation, The Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM).²⁵

Another very important part of medical radiations and consequently important in the development of radiotherapy services and personnel was the process of radiation monitoring for the safety of both patient and professional. According to the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)²⁶ Australian radiation monitoring services began in 1932. This service has grown and in 2010 there are more than 32,000 people monitored at any one time.²⁶

The early years 1950–1979

The introduction, to radiotherapy, of the linear accelerator and the Cobalt⁶⁰ (Co⁶⁰) machine provided a change in the focus of radiation therapists and the profession. The greater energies available provided the opportunity to treat deep seated tumours, not previously possible, thus demanding changes in practices. The late 1950s into the early 1960s saw the installation of linear accelerators along with many Co⁶⁰ machines in most Australian states.^{13,14,16,17,20}

The public perception of cancer at this time was of an incurable disease, despite the advances of radiation therapy in the treatment of cancer. Many doctors would refer to the disease as a tumour or growth rather than use the word cancer and patients did not readily seek information or detail of their disease; instead they relied on the judgement of the medical professionals.²⁷

Planning and treatment adapted and changed as the equipment became more sophisticated and complex. Initially treatments were planned and given as a single or opposed pair with one field given daily.²¹ Doses were initially determined by skin reactions and exposure times but over time a greater awareness and understanding of the radiobiological effects of treatment changed the delivery of the radiation.^{27,28} Fractionation of dose and its importance to radiobiological outcomes brought the quality and quantity of radiation treatment to the attention of the prescribing radiation oncologists.

During this time chemotherapy was also being used, having been developed as a treatment aid in the 1950s.²¹ Chemotherapy was initially provided under the direction of the radiation oncologist, but as the complexities of this area of medicine increased the administration of chemotherapy fell to a new medical specialist, the medical oncologist.² Despite this new specialist role, some radiation oncologists continued to administer chemotherapy. Chemotherapy also had implications for radiotherapy departments because it played a role in changes in disease presentation and created the requirement of education for radiation therapists about the cytotoxic nature of the drugs.

The introduction of calculators in the 1970s was a step towards improving accuracy of treatment calculations with the slide-rule finally put to rest around 1976.²⁷ The use of computers was emerging in the 1970s, but it was not until the latter part of the decade that radiation therapy computers became more user friendly and affordable and computer planning was initiated. The invention of CT and MRI and the introduction into the medical world of CT was also part of the same decade with the first commercial MRI introduced in 1980 but it was not until the late 1980s that these were embraced by radiation

therapy internationally and became more common place in radiation therapy during the 1990s.^{29–34}

The formative years 1980–2000+

CT became an important aspect of radiotherapy planning internationally, allowing greater accuracy in dosimetry and greater accuracy in identification of structures.^{32,34} Schirmer³⁵ confirmed this was also occurring in Australia with reference to this in his Varian Award address in 1997, “By the early 1980s much more sophisticated planning using CT scans and computer planning was commonplace...” he commented.

Changes to approaches in treatment planning and the delivery of the radiation also impacted on the workload, the number of hours machines needed to operate and number of radiation therapists to carry out the treatments.³⁶ This was mirrored by Bourne²⁷ who stated that as the treatment planning and delivery became more complex, the number of patients and the number of fields used to deliver the treatment began to increase at a seemingly faster rate than the growth of the population.

Accompanying these changes were the educational needs of the radiation therapists. Like many other occupations there was a movement toward academic based education and the need for professional training and credentials. The formal certificate training in some states, where students were employed in the radiotherapy department, became an academic institution based associate diploma/diploma at the end of the 1970s and early 1980s (Personal communication with T Doherty, 24th June 2008 and J Cottrell, 26th June 2008). This changed the working arrangements in many departments where students had been utilised and considered as part of the staffing numbers required to run a department. The change in educational requirements meant they were no longer available in a full time capacity.²¹

Equipment and technology were being improved and were advancing rapidly with computerised record and verify systems introduced in the latter half of the decade providing greater safety and accountability in the delivery of accurate radiotherapy treatment.^{37,38}

Immobilisation of the patient, to ensure accurate delivery of treatment, produced another important area of development in radiotherapy.³⁵ A variety of in-house and company made devices to provide immobilisation have emerged over the years.³⁸ There is ongoing debate, discussion and in more recent times, research that continues to lead to modification and improvement of devices for optimal treatment outcomes.

Placing lead (and later cerrobend) blocks in the path of the radiation had been instigated early in the history of megavoltage machines, but non-standard shapes involved inventive ways of implementation. Wedges were used to improve the dosimetry of megavoltage treatment.³⁸ Both shielding and wedges were often physically challenging for the radiation therapists when attempting to place them in the correct position. The introduction of multi leaf collimators (MLCs) and dynamic wedges have been welcomed by radiation therapists as they have contributed to a safer work environment and to less physically demanding work practices.

In 1986 one academic institution offered a bachelor degree in medical radiations with the first cohort of students graduating in 1988 (Personal communication with S Brackenridge, 3rd November 2010). In the following years other academic institutions began to follow suit. With this came an even greater need for a good working relationship between these institutions, hospitals and the AIR (PAEB) to coordinate and address clinical placements and academic needs for the industry.²¹ As a result radiation therapists became better educated individuals and as Bourne²⁷ states “Radiation therapists are thus well qualified to deal with the increasing complexity associated with modern radiation therapy”.

Although breast screening and pap smears had been in use for some time, a national campaign in Australia in the early 1990s contributed to earlier detection of cancer in many more women.³⁹ The Prostate Specific Antigen (PSA) screening, although not supported on the same scale nationally,³⁹ has increased the number of men presenting with early stage prostate cancer.^{40,41} Screening has been one contribution to earlier disease presentation and more radical radiation therapy treatments with improved outcomes and survival rates.^{27,35}

Role expansion and continuing professional development (CPD) have been hot topics for many years. *The Baume report*¹⁰ was undertaken with the intention of providing proposals for improving and strengthening radiotherapy services within Australia. One of the many key recommendations for the radiation therapist workforce, made in the Baume report, to increase the number of radiation therapists in Australia, contributed to the establishment of a graduate entry course at Monash University.^{9,10} In recent years there have been a number of higher degrees obtained by radiation therapists indicating that radiation therapists are beginning to show interest in the importance of research and evidence based practice within the radiation therapy profession.

Summary

Throughout this paper the most notable developments of and influences on radiation therapy have been outlined. However, this history does not provide us with an understanding of radiation therapists’ perspectives of how these developments have impacted on the workplace and work practices of radiation therapists. A subsequent paper will therefore be provided which discusses Australian radiation therapists’ perspectives of radiation therapy from 1960 until today.

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