MEDICAL PHYSICS TRAINING, EDUCATION AND PROFESSIONAL RECOGNITION IN AUSTRALIA AND NEW ZEALAND

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Abstract— **Over the last fourty years the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) has developed a Training, Education and Assessment Program (TEAP) that provides medical physicists with a pathway to a career in radiation oncology, diagnostic imaging or nuclear medicine. The program is ambitious in its scope and aligned with international guidelines by IOMP and IAEA. More than 400 colleagues have so far been assessed by ACPSEM forming the foundation of better technical and scientific services to patients in Australia and New Zealand.**

Keywords— **Medical Physics, Education, Accreditation and Certification, A.**

I. Introduction: medical physics in australia and new zealan

The history of medical uses of radiation in both countries goes back to 1896.(1) William Hosking, a medical doctor in New Zealand, and in Australia three gentlemen from very different background (Professor Thomas Rankin Lyle at University of Melbourne, Railway engineer Walter Drowley Filmer in Newcastle and Father Joseph Slattery in Bathurst) commenced taking x-ray images. The need for medical physicists however, only became apparent in the 1930 when the first radiotherapy departments opened and the first 'hospital physicists' were employed with physics background being the only requirement. The medical physics community grew and was for many years closely associated with the UK Hospital Physicists Association. In 1977, the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM, http://www.acpsem.org.au/) was founded with Kenneth Clarke as Foundation President.(2)

Since then, the organisation and medical physics has grown considerably and ACPSEM represents now more than 500 medical physicists working in Australia and about 100 in New Zealand. ACPSEM ('the college') has been publishing the scientific journal Physical and Engineering Sciences in Medicine (formerly Australasian Physical and Engineering Sciences in Medicine) for more than 40 years and holds annual scientific conferences (Engineering and Physical Sciences in Medicine, EPSM) which regularly attract 300 or more attendees. ACPSEM has six branches across Australia and New Zealand, which provide opportunities for members to meet and host local educational and professional development events.

Medical physicists in Australia and New Zealand are mostly employed in hospitals and provide a wide range of services to radiation oncology, diagnostic radiology, nuclear medicine and a variety of other areas, including academia. Six universities in Australia and one in New Zealand offer a master's program in medical physics. This is backed by several active research groups throughout the countries resulting in many important contributions to radiation medicine (3, 4) and lively discussions about the future (5).

However, challenges remain with professional recognition. The present paper discusses these challenges and their relation to education, certification and, in the context of New Zealand and Australia, based on a description of academic education and clinical training as it has developed over the last 30 years.

II. Graduate training

There are currently seven universities offering degrees in medical physics across Australia (6) and New Zealand (1). They vary from an undergraduate degree at the University of Wollongong, through MSc by coursework and research to PhD programmes (with a coursework component). The first medical physics MSc degree was offered at the Queensland University of Technology (QUT) in 1977, followed by the Otago University in 1983 (now discontinued) and the University of Adelaide (1992).

Most of the universities offer several degrees (MSc, PhD or even MPhil) to have flexible educational offerings for potential students. All degrees contain coursework accredited by ACPSEM and a research project as per the particular degree requirements. If a PhD graduate from another physics discipline wishes to train in medical physics, they can also undergo the Graduate Diploma pathway, where they only

participate in medical physics coursework but a research project is not required. While ACPSEM prescribes overall knowledge expectations for graduates of these degrees, there is some freedom for the universities to construct the content of courses. In general, the following topics are covered: basic radiation and nuclear physics, radiation therapy physics, dosimetry, imaging and nuclear medicine physics, anatomy and physiology, radiation biology and epidemiology, radiation protection. Practical sessions and research projects are often conducted in collaboration with hospitals and clinical physicists as supervisors. Graduates of these ACPSEM accredited degrees are then eligible to apply for trainee medical physics positions (known as registrar positions) to complete their clinical training.

III. Clinical training

At the core of the pathway to becoming a clinical medical physicist is a structured training program. Similar to many other countries, Australia and New Zealand established examinations and certification (then called accreditation) of individuals before a training program was developed.

In 1985, ACPSEM Council considered the need for formal recognition of members qualified to practice and decided to take steps to introduce an accreditation scheme for individuals (now referred to as 'Certification'). ACPSEM Accreditation was a voluntary system for members who sat a written, practical and oral examination set by their peers. Radiotherapy examination was established in 1987, Radiology by mid 1990s and Nuclear Medicine soon after that. However, it was soon realised that a competency based assessment such as ACPSEM accreditation would also require developing a suitable training program based on a formal syllabus.

Several surveys over the years probed the medical physics workforce(6) and a professional survey sent to all radiotherapy departments in 1998 showed that there were 100 linear accelerators and 97 medical physicists employed in radiotherapy of which only two thirds had achieved five years of experience. The rest were learning on-the-job. Considering this, an important position paper in 2001 defined the requirements for radiation oncology physics in Australia and New Zealand.(7)

After a major Federal Inquiry (the Baume Committee) into Australian radiotherapy services in the early 2000s recommended the establishment of a medical physicist training program, Richard Fox (ACPSEM President), Lyn Oliver (ACPSEM Vice-President and co-ordinator of the ACPSEM submission to the Inquiry), Natalka Suchowerska (Chair of the ACPSEM Education Committee) and John Drew (Chairman of the Radiation Oncology Medical Physics (ROMP) Accreditation Examiners) met and took action in establishing the 'Training, Education and Accreditation Program' (TEAP – is now the acronym for Training, Education and Assessment Program). The program consists of three years clinical training, academic education to a postgraduate level and a combination of written, oral and practical examinations.

The TEAP program for radiation oncology formed the creation of an IAEA training guide (8) when John Drew was appointed to the agency. The syllabus was expanded, improved and adjusted to suit radiation oncology practice for all across the world. Clinical training requirements in Australia and New Zealand are three years as opposed to two in the IAEA document and most AFOMP countries.(9, 10) However, the syllabus is very similar and distinguishes five core modules (Radiation Protection, Dosimetry, External Beam Radiotherapy Equipment, Treatment Planning and Brachytherapy) and accompanied by several other requirements in the areas of professionalism, leadership and imaging. It is expected that candidates achieve level 3 competence in each of the core modules to allow certified physicists to practice safely and independently in their chosen specialty. Competence is also demonstrated in a progressive fashion through work submitted to a webpage and graded by a supervisor.

2013 marked the 10th anniversary of TEAP.(11) In her editorial to Phys. Eng. Sci. Med., Anne Perkins highlights that the program is rather demanding both for registrars and the departments which train them.(11) After many discussions and consideration of the workforce the training program was extended to include diagnostic physics and nuclear medicine. As it is recognised that there is considerable overlap in these disciplines it is now possible to get certified in the second by completing the training requirements for the first followed by an additional year in the other discipline. Also a certification in Radiopharmaceutical Sciences was developed and is now up and running.

After the Baume Inquiry was implemented in 2003, the Australian and New Zealand governments recognised the shortfall of medical physicists and are funding dedicated training positions to meet the increased demand in radiotherapy services and the need for more qualified medical physicists in the diagnostic departments of radiology and nuclear medicine. These positions are hospital based and administered either through health departments or the ACPSEM. Candidates are usually employed for three years as 'registrars', often with the possibility of an extension, for example, to complete the exams. In most departments, registrars are expected to be involved in all clinical activities and often contribute significantly to the workload of the department. However, they should have some protected time and must meet regularly with their clinical supervisor(s). They are also expected to attend training days and other

educational events provided by the college and its regional branches.

Enrolment in the ACPSEM TEAP program requires employment by an accredited department or organisation. The departmental accreditation process considers the number and level of qualified medical physics specialist staffing, equipment within the department and resources available to support training.

Certification is awarded following a written, an oral and a practical examination. To qualify for the written exam, all competencies must have been completed at least to level 2. Typically, candidates sit the practical exam six months later when all competencies have been completed to level 3. In addition to this, the candidate is expected to have published in a scientific journal. A lot of discussion has taken place over the years about the practical exam which involves the candidate performing typical tasks such as calibration of a radiation beam or assessment of shielding of a nuclear medicine facility in front of two examiners. ACPSEM is one of a very few medical physics organisations that provide a practical exam. It is similar to some exams for medical colleges and provides an excellent opportunity for the registrar to demonstrate ability to work in their chosen profession. However, it is costly and difficult to standardise and requires ACPSEM support and training, not only for registrars, but also for examiners.

The number of medical physics registrars enrolled in TEAP, as of May 2020, is summarised in Table 1. Approximately 88% of these registrars are employed within Australian departments, with 12% employed in New Zealand. The proportion of female registrars is growing.

Table 1 Medical physics registrars enrolled in Australia and New Zealand in 2020

Specialty	Registrars	Female	Male
Diagnostic radiology	19	9 (47%)	10 (53%)
Radiation oncology	95	41 (43%)	54 (57%)
Nuclear medicine	15	3 (20%)	12 (80%)
Total	129	53 (41%)	76 (59%)

IV. ONGOING REGISTRATION

The successful completion of the clinical training program enables the graduate to be added to the ACPSEM Register of Qualified Medical Physics Specialists and Radiopharmaceutical Scientists, a recognition of current competency to practice safely and independently in their respective specialty. Admission to the register also requires candidates to abide by a code of ethics. Registration is also open to experienced medical physicists who have not completed ACPSEM TEAP, such as the graduates of recognised international clinical training programs. These experienced applicants are required to provide evidence demonstrating a level of competency at least equivalent to that of TEAP graduates and must complete a "safe to practice" structured interview.

Continuing registration requires the completion of Continuing Professional Development (CPD) activities as part of a program that has been developed in parallel with TEAP.(12, 13) This program is now a web-based system which extends over 3 year registration periods. Participants are awarded points for the completion of professional development activities, including attendance of scientific meetings, contributions to professional bodies, publications, teaching and supervision, and the attendance of training courses. Evidence of completion of these activities is audited by the ACPSEM.

The number of ACPSEM registered physicists working in Australia or New Zealand, as of September 2020, is summarised in Table 2. Approximately 95% of these physicists are employed within Australian departments, with 5% employed within New Zealand departments.

Table 2 ACPSEM Registered medical physics specialists in Australia and New Zealand

Specialty	Qualified Medical Physics Specialists	Female	Male
Diagnostic radiology	41	10 (24%)	31 (76%)
Radiation oncology	357	121 (34%)	236 (66%)
Nuclear medicine	38	8 (21%)	30 (79%)
Total	436	139 (32%)	297 (68%)

The number of medical physics specialists has increased from 335 to 436 since 2015.(14) Much of this increase can be attributed to the training of physicists through the ACPSEM TEAP, with approximately 92% of currently registered physicists certified by the ACPSEM (either through the completion of TEAP or pre-TEAP assessment of skills).

The proportion of female medical physics specialists working in Australia and New Zealand has also increased since 2015, rising from 28% (93) to 32% (139).(14, 15) This trend is expected to continue, supported by the number of women enrolled in TEAP.

V. Future opportunities and challenges

Since their introduction, the clinical training and professional recognition services of the ACPSEM have been continually revised. These revisions have been largely informed in consultation with members and stakeholders, and with reference to educational research and standards. There have also been several formal internal and external reviews such as a review by the Allen Consulting Group to assess TEAP and a government funded project to strengthen the Australian Medical Physics Workforce. Of particular importance was a review in 2013 when Wayne Beckham and Bruce Gerbi spent a week in Australia as representatives of the Commission for Accreditation of Medical Physics Educational Programs (CAMPEP). Based upon this review, the CAMPEP representatives found that the ACPSEM graduate and residency educational programs were comparable in content and expectations to CAMPEP requirements.

More recent projects have included the development of TEAP supervisor educational material and workshops, the introduction of a standardised schedule of periodic progress review meetings between registrars and assessors, the online testing of first-year competencies, and the development of a research support strategy to assist registrars complete the TEAP publication requirement within three years.

As clinical practices change, so must professional standards and training curricula. The ACPSEM radiation oncology medical physics clinical training guide is currently being reviewed. This will likely see the addition of new material to match future trends in radiation oncology in Australia and New Zealand (such as particle therapy and magnetic resonance image guided radiation therapy). When new material is added to the curriculum, other material must be removed. This may be achieved through sub-specialisation or the addition of elective content. For example, in recognition that not all centres could offer high level training in brachytherapy, the ACPSEM made the completion of high level learning outcomes optional in version 3.4 of the Clinical Training Guide.

ACPSEM registration is not currently a formal legal requirement to be employed as a medical physicist in Australia or New Zealand, though it does have an impact on qualifying to be licensed to use radiation sources or apparatus and award wages in some states. Registration and certification are also aspects of the safety code and the associated guidelines by the Australian Radiation Protection and Nuclear Safety Australian Radiotherapy (ARPANSA),(16, 17) the Radiation Oncology Practice Standards,(18) and feature as a common criterion when advertising medical physics positions. The ACPSEM is currently investigating enforceable national registration through regulatory agencies, which would provide a protected title and could impact potential scope of practice and the viability of the ACPSEM which is currently the organisation through which physicists are self-regulated.

Also university education is always under threat. Medical Physics is a small profession and the number of students that can be sustained make medical physics courses not overly attractive to universities. Numbers are supplemented by enrolling overseas students and making the course more flexible to attract nuclear workers and radiation protection specialists. The latter also resonates with ACPSEM which is one of the three professional organisations sponsoring the Australian Radiation Protection Accreditation Board (ARPAB).

The ACPSEM represents members separated by large distances, with the distance between Perth, in Western Australia and Auckland, in New Zealand, exceeding 5,000 km. Some physicists work in small regional hospitals and treatment centres. As such, training, for both registrars and qualified medical physics specialists, is increasingly being delivered online. The outbreak of COVID-19 resulted in practical and oral final exams being conducted remotely. These challenges also represent potential opportunities – specifically the delivery of training outside of Australia and New Zealand.

VI. Conclusions

Training and certification are key activities for professional organisations and ACPSEM in its more than 30 years of history has been actively involved in many aspects of this. Members of the ACPSEM have contributed to the delivery of training internationally, through organisations including the International Atomic Energy Agency and the International Medical Physics Certification Board.(19) The Asia-Pacific Special Interest Group (APSIG) of the ACPSEM has organised training and mentoring volunteer assignments in low-to-middle income countries in the region. Physics works the same all over the world and medical physicists in Australia and New Zealand hope to contribute to making training, education and professional recognition similarly available for everyone aspiring to this exciting career.

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