RADIATION PROTECTION EDUCATION AND TRAINING PROCESS FROM CLASSROOM TO CLINICS

MOHAMED BADAWY
Department of Medical Physics
Austin Health, Heidelberg 3085, Australia

PRADIP DEB
Discipline of Medical Radiations
School of Health and Biomedical Sciences
RMIT University, Bundoora 3083, Australia

ABSTRACT

Ionizing radiation is becoming an increasingly relevant part of modern healthcare, but it is not without its own side effects. Currently more than three billion medical exposures to radiation are conducted per year, which now accounts for a major portion of all background radiation. It is well established that radiation exposure can give rise to both deterministic and stochastic side effects, both of which can be seen in the clinical setting. As such it is important that national and international regulation of radiation exposure exists to ensure the safety of patients and personnel. An important factor in radiation risk management is adequate education and training of radiation staff at both the university and workplace settings. Medical Imaging Radiographers (MI), radiation therapists (RT) and nuclear medicine technologists (NM) receive training at university on managing radiation risk, yet the transition to workplace remains a significant challenge and is subject to site specific practices. The aim of this paper is to present the radiation protection needs and training at both the university and workplace setting, as experienced in a major metropolitan city in Australia. Our three-year undergraduate medical radiations program consists of lectures, tutorials, lab work and 22 weeks of clinical placement during their study. Stream specific radiation safety and protections for working as MI, RT, and NM are taught including radiobiology, radiation regulations, radiation management plan, dose monitoring, and risk communication. In the workplace setting, knowledge retention has been identified as a major issue in the radiation awareness of staff members. Despite regular educational courses provided by the hospital in question, staff knowledge overall remained poor when surveyed. An important finding of the hospital audit showed that staff members who received tailored educational talks rather than the general radiation safety induction consistently scored better in radiation awareness. This knowledge has in turn been used successfully to shape future refresher courses and inductions with the outcome of greater overall knowledge retention in hospital staff. Adequate education and training of staff remains an important factor in managing radiation risk. Such training begins at the university level and is further shaped from workplace practice. The authors suggest that optimal workplace training occurs from personalization to the target audience rather than reliance on traditional, theory based learning methods.

1. Introduction

The use of ionizing radiation in modern healthcare is continuously increasing however, it is not without its own risks. According to reports published by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), more than three billion diagnostic medical radiological examinations are made per year, which accounts for four

million Sieverts (Sv) of annual collective effective dose [1]. Ionizing radiation used in healthcare is responsible for more than half of the total background radiation in the world. It is well established that radiation exposure can give rise to both deterministic and stochastic side effects. Hence safety and protection from radiation is an important task of radiation service providers.

Radiation workers in the healthcare system in Australia consists of physicians, radiographers, radiologists, nuclear medicine technologists, radiotherapists, radiation oncologists, cardiologists, nurses and administrators. At the time of writing more than half of the medical radiation technologists (radiotherapists, nuclear medicine technologists, radiographers) in the Australian state of Victoria are graduates of RMIT university.

The aim of this paper is to cover current radiation practice guidelines in Australia and present the radiation protection needs and training at both the university and workplace setting, as experienced in a major metropolitan city in Australia. A further aim is to explore how best to approach the transition from university to workplace as well as which teaching strategies optimize workplace specific knowledge retention.

2. Methods

Current radiation practice guidelines as distributed by regulatory bodies were examined and correlated to current university teaching curricula. The radiation protection education needs from a lecturing perspective was presented. In the hospital setting radiation protection training at hospitals is a mandatory requirement for all individuals that may potentially be occupationally exposed to ionising radiation. It is also a requirement of the Radiation Management Plan that it addresses training of occupationally exposed staff members. Ongoing workplace education strategies and their effectiveness was examined.

3. Radiation Safety Guidelines

The International Commission on Radiological Protection (ICRP) have made recommendations for education and training for radiation healthcare personnel in many of their publications [2-4]. It is recommended that education should cover the safe management of radiation dose among patients, radiation staff, general public and the environment.

According to ICRP report 113 [2], there are definite scopes of education and training in radiation safety and protection. Knowledge and understanding of radiation hazards, radiation quantities and units, principles of radiation protection, radiation legislation and patient and staff dose factors are considered education. On the other hand, training refers to the individuals' practice relating to the ionizing radiation modalities in medicine.

Radiation protection education and training in Australia are guided and promoted by federal and state government organisations. Adequate education and training of staff remains an important factor in managing radiation risk. Such training begins at the university level and is further shaped from workplace practice.

The Australian Health Practitioner Regulation Agency (APHRA) is the organisation responsible for the implementation of the national regulation and accreditation scheme across Australia. The Medical Radiation Practice Board of Australia (MRPBA) regulates Australia's medical radiation practitioners. The MRPBA sets the professional capabilities for

medical radiation practice identifying the minimum knowledge, skills and professional attributes necessary for safe independent practice in diagnostic radiography, nuclear medicine technology and radiation therapy. One of the main professional capability domains is radiation safety and risk management [6].

The education provider has to demonstrate the medical radiation practice educational program's learning outcomes and assessment ensure each student meets the requirements for the professional capability domain. Medical radiation practitioners' responsibility to protect people and environment from harmful effects of radiation is covered in radiation safety and risk management domain. The task and evidence of capabilities to ensure the high level of radiation protection knowledge and skills are given in table 1 [6].

Capability	Task
1. Implementation of safe radiation practice	a. Understanding of state and federal radiation safety legislation. b. Application of principles of risk management. c. Identification of radiation risks d. Identification and application of safe radiation practice
2. Protection enhancement	a. Identification procedure of patients b. Maintaining of patient/client records c. Identifying and managing patient/client transfer d. Identifying and managing risk of infection
3. Safe and appropriate use of radiation equipment	a. Applying knowledge of equipment to identify if there is any problem with the equipment b. Identifying the problem in equipment and taking action to correct it. c. Reporting non-conformance of equipment
4. Maintaining safety in workplace	a. Demonstrating legal responsibilities for health and safety b. Identification and notification of safety hazards in the workplace c. Identifying and implementing methods of radiation management d. Applying knowledge of biological effects of radiations e. Identification of radiation risks of being close to radioactive source f. Communicating radiation risks and control measures to others in the workplace g. Using appropriate personal protective clothing and equipment
5. Managing radiation and radioactivity in the environment	a. Applying knowledge of environmental risk of radiation and radioactivity b. Identifying safe and legal methods of storage, disposal and handling radioactive materials c. Implementing procedures and protocols of radiation incidents d. Reporting radiation incidents in accordance with protocols, procedures, and legal requirements

Table 1: Capability tasks to ensure the radiation safety education and training

In Australia, no radiation practice is allowed without having appropriate licences. Radiation practice includes the activities of possessing, selling, transporting, repairing, maintaining, controlling, testing, processing, disposing, decommissioning radiation source or radioactive materials. Every Australian state and territory has its own radiation legislation. In Victoria, the Radiation Act 2005 [5] is the state law which governs radiation practice. Radiation facilities must have management licences prior to conducting any radiation practice. For any individual working as a radiation worker must have a radiation use licence. This is obtained by demonstration of adequate education and training in radiation protection. The primary condition to hold the licence is to ensure the safety and protection of people and

environment from the harmful effects of radiation. Adequate education and training in radiation protection is the key factor for obtaining a radiation licence and complying with its conditions.

4. Tertiary Radiation Curricula

University courses in medical radiation must incorporate radiation practice guidelines as well as educate students as to the importance of radiation safety. At RMIT University, students achieve APHRA registration after the completion of a three year BAppSc (Medical Radiations) degree, which allows them to start a career as a medical imaging technologist (MI), nuclear medicine technologist (NM) or radiation therapist (RT).

Students are admitted into one of the three study streams: Medical Imaging, Radiation Therapy, and Nuclear Medicine. This consists of lectures, tutorials, lab works and 22 weeks of clinical placement during their study. Stream specific radiation safety and protections for working as MI, RT, and NM are taught including radiobiology, radiation regulations, radiation management plan, dose monitoring, and risk communication. The list of subjects they complete in three years are given in tables 2-4.

Year/Semester	Course Code (Subject Code)	Course (Subject)	Credit Points
Year 1/ Sem 1	RADI1125	Introduction to Medical Radiations	12
	ONPS2343	Medical Radiations Technology 1	12
	BIOL2280	Human Structure and Function 1	12
	XXXX0000	One Elective	12
Year 1/Sem 2	RADI1184	Introduction to Medical Imaging	12
	RADI1154	Research in Medical Radiations	12
	ONPS2344	Medical Radiations Technology 2	12
	BIOL2281	Human Structure and Function 2	12
	CLINICAL	Clinical Placements 2 Weeks	
Year 2/Sem 1	RADI1130	Medical Imaging Method 1	12
	RADI1132	Medical Imaging Practice 1	12
	ONPS2347	Medical Imaging Technology 1	12
	MED2118	Introduction to Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 2/Sem 2	RADI1131	Medical Imaging Method 2	12
	RADI1133	Medical Imaging Practice 2	12
	ONPS2348	Medical Imaging Technology 2	12
	MED2132	Imaging Anatomy and Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 1	RADI1178	Medical Imaging 3	12
	ONPS2353	Medical Imaging Technology 3	12
	ONPS2437	Computed Tomography	12
	ONPS2438	Sonography	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 2	RADI1177	Medical Imaging 4	12
	RADI1179	Medical Radiations Interdisciplinary Applications	12
	ONPS2436	Magnetic Resonance Imaging	12
	BESC1409	Health Psychology	12
	CLINICAL	Clinical Placements 5 Weeks	

Table 1: Subjects taught in Medical Imaging stream

Year/Semester	Course Code (Subject Code)	Course (Subject)	Credit Points
Year 1/ Sem 1	RADI1125	Introduction to Medical Radiations	12
	ONPS2343	Medical Radiations Technology 1	12
	BIOL2280	Human Structure and Function 1	12
	XXXX0000	One Elective	12
Year 1/Sem 2	RADI1186	Introduction to Radiation Therapy	12
	RADI1154	Research in Medical Radiations	12
	ONPS2344	Medical Radiations Technology 2	12
	BIOL2281	Human Structure and Function 2	12
	CLINICAL	Clinical Placements 2 Weeks	
Year 2/Sem 1	RADI1134	Radiation Therapy Method 1	12
	RADI1136	Radiation Therapy Practice 1	12
	ONPS2349	Radiation Therapy Technology 1	12
	MED2118	Introduction to Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 2/Sem 2	RADI1135	Radiation Therapy Method 2	12
	RADI1137	Radiation Therapy Practice 2	12
	ONPS2350	Radiation Therapy Technology 2	12
	MED2132	Imaging Anatomy and Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 1	RADI1181	Radiation Therapy 3	12
	ONPS2355	Radiation Therapy Technology 3	12
	ONPS2437	Computed Tomography	12
	ONPS2438	Sonography	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 2	RADI1180	Radiation Therapy 4	12
	RADI1179	Medical Radiations Interdisciplinary Applications	12
	ONPS2436	Magnetic Resonance Imaging	12
	BESC1409	Health Psychology	12
	CLINICAL	Clinical Placements 5 Weeks	

Table 2: Subjects taught in Radiation Therapy stream

Year/Semester	Course Code (Subject Code)	Course (Subject)	Credit Points
Year 1/ Sem 1	RADI1125	Introduction to Medical Radiations	12
	ONPS2343	Medical Radiations Technology 1	12
	BIOL2280	Human Structure and Function 1	12
	XXXX0000	One Elective	12
Year 1/Sem 2	RADI1185	Introduction to Nuclear Medicine	12
	RADI1154	Research in Medical Radiations	12
	ONPS2344	Medical Radiations Technology 2	12
	BIOL2281	Human Structure and Function 2	12
	CLINICAL	Clinical Placements 2 Weeks	
Year 2/Sem 1	RADI1126	Nuclear Medicine Method 1	12
	RADI1128	Nuclear Medicine Practice 1	12
	ONPS2345	Nuclear Medicine Technology 1	12
	MED2118	Introduction to Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 2/Sem 2	RADI1127	Nuclear Medicine Method 2	12
	RADI1129	Nuclear Medicine Practice 2	12
	ONPS2346	Nuclear Medicine Technology 2	12
	MED2132	Imaging Anatomy and Pathology	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 1	RADI1183	Nuclear Medicine 3	12
	ONPS2351	Nuclear Medicine Technology 3	12

	ONPS2437	Computed Tomography	12
	ONPS2438	Sonography	12
	CLINICAL	Clinical Placements 5 Weeks	
Year 3/Sem 2	RADI1182	Nuclear Medicine 4	12
	RADI1179	Medical Radiations Interdisciplinary Applications	12
	ONPS2436	Magnetic Resonance Imaging	12
	BESC1409	Health Psychology	12
	CLINICAL	Clinical Placements 5 Weeks	

Table 3: Subjects taught in Nuclear Medicine stream

5. Bridging the transition to workplace

Implementation of radiation practice guidelines in a workplace setting requires constant training and assessment on the radiation providers. In order to maximise knowledge retention, it is best that such training is non-didactic and workplace specific. This can be substantiated from a number of studies that have found radiation knowledge of staff members within the workplace was low, even in departments that received regular training courses or were regularly occupationally exposed [7-9]. One reason for this was because training is usually delivered as a one-off lecture given at the commencement of employment, with further training taking place only by request.

The transition to the workplace involves translating the theory taught in university to practical skills relevant to the task at hand. It is in the authors' experience that methods of delivery must evolve to make the information more relevant, easier to understand and improve knowledge retention. This can be achieved by heavily tailoring the material to address department specific requirements. Typically, the lectures presented follow the same content no matter the audience; beginning with basic principles of ionising radiation and moving towards radiation protection strategies. More engagement has been found if lectures begin by acknowledging the risks, putting it into perspective with other occupations, covering the basic principles then finally advising how to best mitigate the risks.

It is also paramount that radiation courses in the clinical setting are routinely given, not just when requested. This will not only refresh the knowledge of current staff but also capture new staff members that may not have yet undertaken the radiation induction. Surveying the participants or providing simple assessment tasks at the conclusion of the lecture can provide feedback on how well the key information has been retained and if any adjustments need to be made to the lecture material.

6. Conclusions

Adequate education and training of staff remains an important factor in managing radiation risk. Such training begins at the university level and is further shaped during workplace practice. Knowledge and teaching of radiation protection guidelines as administered by regulatory bodies is a fundamental component of both undergraduate curricula and continual regulation of radiation protection education in the workplace. The authors suggest that optimal workplace training occurs from personalization to the target audience rather than reliance on traditional, theory based learning methods.

References

1. UNSCEAR, *Sources and Effects of ionizing Radiation*, in *UNSCEAR 2008*. 2010, United Nations: New York. p. 33-34.
2. ICRP, ICRP Publication 113, in Education and Training in Radiological Protection for Diagnostic and Interventional Procedures. 2009, ICRP.
3. ICRP, The 2007 Recommendations of the International Commission on Radiological Protection, in Annals of the ICRP, J. VALENTIN, Editor. 2007, ICRP.
4. ICRP, Radiological Protection in Medicine, ICRP Publication 105. Annals of the ICRP, 2007. 37(6).
5. Victoria State Government. Radiation Act 2005. 2007 [cited 2017 April 5]; Available from: https://www2.health.vic.gov.au/public-health/radiation/radiation-regulatory framework/radiation-laws/radiation-act-2005.
6. Australia, MRPBA. Professional capabilities for medical radiation practice. 2015 [cited 2017 April 5]; Available from: http://www.medicalradiationpracticeboard.gov.au/Registration/Professional-Capabilities.aspx.
7. Badawy, Mohamed Khaldoun, et al. "An assessment of nursing staffs' knowledge of radiation protection and practice." Journal of Radiological Protection 36.1 (2016): 178.
8. Badawy, Mohamed Khaldoun, Dheeshana Sayakkarage, and Mehmet Ozmen. "Awareness of radiation dose associated with common diagnostic procedures in emergency departments: A pilot study." The Australasian medical journal 8.11 (2015): 338.
9. Günalp, Müge, et al. "Ionising radiation awareness among resident doctors, interns, and radiographers in a university hospital emergency department." La radiologia medica 119.6 (2014): 440-447.