



Original Research

# Radiation Safety Awareness Amongst First-Year Medical and Dental Students

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## Abstract

**Objectives:** To assess awareness of radiation safety amongst medical and dental students and determine how their knowledge could be improved.

**Methods:** An anonymous electronic survey of first-year medical and dental students at McGill University was conducted between February and April 2016. It was made up of 15 close-ended questions assessing knowledge and practice of radiation safety measures. Participants were also questioned about their willingness to learn more about radiation safety measures and the type of educational intervention.

**Results:** Out of 212 questionnaires sent, there were 87 responses (response rate of 41.5%), of which 39.1% were males and 60.9% were female. As expected, most (75.5%) students had never participated in prescribing imaging studies that use radiation. While most students (81.7%) claimed to have an idea about radiation safety measures, only 9.5% (n=8) knew the annual permissible occupational radiation dose limit of 50mSv. Seventy-seven percent of students wanted to learn more about radiation safety in the form of workshops, seminars, and online modules. Most students (76.9%) did not track their annual occupational radiation exposures.

**Conclusions:** Radiation safety awareness among first-year medical and dental students needs to be improved. Students are willing to learn and improve their knowledge about radiation safety awareness, especially during undergraduate and clinical training, in the form of workshops, online courses, and seminars. Since medical and dental students are introduced into clinical practice from 1st year in the New Curriculum, it is recommended that the radiation safety course be given during 1st year rather than 2nd year. In addition, students' competencies in radiation safety needs to be assessed after the course.

**Tags:** Ionizing Radiation, Awareness, Medical Students

## Introduction

Ionizing radiation results from electrons leaving atomic particles of electromagnetic waves and forming ions, a phenomenon that occurs in our natural environment in the form of cosmic rays. German physicist Wilhelm Röntgen discovered the utility of X-rays in 1885, when he saw an X-ray image of his wife's hand on a screen (1). Imaging studies using radiation are important during medical practice and they come in the form of chest X-rays, barium edemas, mammograms, and computerized tomography (CT) scans, among others. An imaging study using ionizing radiation is an extremely useful tool in diagnosis and therapy, however, it is important to understand that exposure to radiation also carries a risk to patients, as well as technicians and physicians who work with ionizing radiation (2,3). In 2008, the World Health Organisation launched the Global Initiative on Radiation Safety in Health Care Settings with the aim of imparting safe use of radiation in medical practice. This was meant to complement the International Action Plan for the Radiological Protection of Patients which was established by the International Atomic Energy Agency in 2002 (4,5). In the United States, medical imaging involving ionizing radiation accounts for about 50% of radiation exposure to the general population (6).

Recent literature has examined medical students' awareness of ionizing radiation (7-10), and these studies have demonstrated that there is limited knowledge of radiation safety among medical students. Faggioni et al. evaluated the awareness of radiation protection among medical students as well as radiology residents (7). They found out that students had limited awareness about radiation protection and that there was a gap in knowledge regarding radiation doses of routine radiological studies (7). Scali et

al. found that many students underestimated the relative doses and risks of common imaging studies (8). Similarly, McCusker et al found that medical students' knowledge of basic radiological procedures and patient doses was extremely limited (9). Another study by Jończyk-Potoczna et al. confirmed the unsatisfactory level of radiation protection awareness of medical students (10). However, there is paucity of literature discussing the most effective methods for educating medical and dental students, and when should radiation safety education take place. The objective of this study was to assess awareness of radiation safety among first-year medical and dental students in a Canadian medical and dental school setting and determine methods that could be used to improve their knowledge.

## Methods

An internet-based questionnaire was sent electronically via SurveyMonkey to first-year medical and dental students at McGill University in Montreal, Canada (Appendix 1). The questionnaire was anonymous and was made available for three months, from February to April 2016. The questionnaire was broadly designed and made up of 15 close-ended questions. This is because students starting medical or dental school come from different backgrounds, some with undergraduate or graduate studies that expose them to radiation in the laboratory or in clinical work. Questions included: age, sex, program of academic study, current knowledge of radiation safety measures, and whether or not they have undergone a radiation safety course. Students were also asked about their willingness to improve their knowledge about radiation safety and the type of learning module they believe would be most appropriate (Appendix 1). Data collected was analysed using Statistical Package of Social Sciences for Windows (SPSS, Chicago, IBM) version 20.

## Results

There were 212 questionnaires distributed to first-year medical (n=192) and dental students (n=20). There were 87 respondents (response rate of 41.5%), of which 39.1% (n=34) were males and 60.9% (n=53) were female (Table 1). When asked about radiation use in clinical practice, 83% (n=39) of students indicated that they did not use it at all and 17% (n=8) used it less than half the time (Table 2). As expected, most students (75.5%) had never participated in prescribing imaging studies that use radiation, 6.7% prescribed imaging studies in 50% of their clinical practice, and 17.8% prescribed less than half the time (Table 3). It is important to note that medical and dental students' prescriptions had to be countersigned by attending physicians and dentists, respectively, since students are not allowed to prescribe imaging studies. Only 23.2% of students had a good idea about what is involved with radiation safety, 58.5% of the students had an idea, 9.8% had almost no idea, and 6.1% had no idea (Table 4). Half of the students (45.4%) reported never using radiation safety measures (Table 5).

**Table 1: Baseline characteristics of participants**

Gender	Number	%
Female	53	60.9%
Male	34	39.1%
<b>Age</b>		
< 20 years	11	12.6%
21-30 years	65	74.7%

31-40 years	11	12.6%
>40 years	0	0%
<b>Total</b>	87	100%

**Table 2: Radiation use by students**

Frequency of radiation use	Number	%
0 (none)	39	83%
1 (less than half the time)	8	17%
2 (half the time)	0	0%
3 (more than half the time)	0	0%
4 (often)	0	0%
5 (all the time)	0	0%
<b>Total</b>	47	100%

**Table 3: Prescribing imaging studies that use radiation**

Frequency of prescribing imaging studies that use radiation	Number	%
0 (none)	34	75.5%
1 (less than half the time)	8	17.8%
2 (half the time)	3	6.7%
3 (more than half the time)	0	0%
4 (often)	0	0%
5 (all the time)	0	0%
<b>Total</b>	45	100%

Note: Prescriptions were signed by an attending staff physician or dentist

**Table 4: Grading knowledge of radiation safety**

Self-assessed knowledge of radiation safety	Number	%
0 (no idea)	5	6.1%
1 (almost no idea)	8	9.8%
2 (have idea but not very well)	48	58.5%
3 (good idea)	19	23.2%
4 (almost expert)	2	2.4%
5 (expert)	0	0%
<b>Total</b>	82	100%

**Table 5: Practice of radiation safety measures**

How often radiation safety measures are practice?	Number	%
1 (never)	25	45.4%
2 (less than half the time)	1	1.8%
3 (half the time)	4	7.3%
4 (more than half the time)	5	9.1%
5 (often)	11	29%
5 (all the time)	9	16.4%

<b>Total</b>	72	100%
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Most students (75%) had never received education training on radiation safety. Of the 25% who had received training, 50% completed a lecture-based course, 25% had completed an online course, and 25% had completed a seminar or workshop. Only 9.5% of students knew the annual permissible occupational radiation dose limit of 50mSv, while 52.4% did not know, and 38.1% were not exactly sure. Finally, only 5.1% of students reported monitoring their annual radiation dose.

The majority of students (77.1%) indicated that they would benefit from improved radiation safety training measures, while 16.9% were neutral, and 6.0% were not interested in receiving additional radiation safety training measures. The preferred methods of delivering radiation safety education were workshops (34.7%), online courses (23.6%), tutorials (18.1%), and seminars (13.9%) (Table 6). When asked when any additional training should be delivered, students were divided such that 48.8% wanted training during residency training and 47.6% wanted training during their undergraduate degree (1st to 4th year medical or dental studies). Only 3.6% of students indicated they would like to undergo additional radiation safety training during clinical practice (Table 7).

**Table 6: Type of learning modules preferred**

Preferred learning modules by students	Number	%
Seminar	10	13.9%
Workshops	25	34.7%
Tutorials	13	18.1%
Courses	5	6.9%
Online courses	17	23.6%
Other	2	2.8%
<b>Total</b>	72	100%

**Table 7: Most appropriate time to have radiation safety lectures**

Preference of students for timing of radiation safety lectures	Number	%
College/Undergraduate (Medicine, Radiology Technology)	40	47.6%
Clinical Training (Clinical rotations, Residency, Fellowship)	41	48.8%
Clinical Practice (Attending Physician/Dentist, Radiology Technologist)	3	3.6%
<b>Total</b>	84	100%

## Discussion

Currently, medical imaging plays an important role in diagnosis and treatment. Therefore, it is vital that future physicians understand and exercise safe radiation practices. Although previous studies have examined medical students' knowledge of radiation safety, the present study is the first to examine first-year medical and dental students' willingness to learn about this topic.

There was a higher number of responses from females (60.9%) compared to males (39.1%), reflecting the class distribution which had a higher percentage of female than male students. While most students (81.7%) claimed to have an idea about radiation

safety measures, only 9.5% (n=8) knew the annual permissible occupational radiation dose limit of 50mSv. Therefore, in the present study, we have confirmed that first-year medical and dental students have limited knowledge of radiation safety. This is perhaps due to the fact that most students (75%) had never received training on radiation safety. In addition, all participating students were in their first year of medical and dental studies. Therefore, their knowledge regarding radiation safety may improve after finishing clinical rotations during 4th year of medical and dental school.

The lack of medical students' knowledge regarding radiation safety has been previously reported (8-10). Scali et al. investigated senior medical students' awareness of radiation risks from common diagnostic imaging studies at the University of British Columbia and found that 54% of senior medical students felt their knowledge of radiation safety was worse than their knowledge in other subjects (8). Similarly, McCusker et al. from Ireland found that only 7% of the medical students had formal or informal radiation protection education (9). However, medical students' knowledge regarding radiation protection significantly increased from pre-clinical to the clinical years ( $p < 0.001$ ). Therefore, it is possible that our first-year medical and dental students' knowledge regarding radiation safety measures may increase at the end of the 4th year. Although McCusker et al. did not inquire if the students were willing to improve their knowledge about radiation, they recommended that undergraduate teaching should be expanded to improve core understanding and facilitate safe practice in radiation (9). Another study from Poland found that when 207 medical students took radiation safety assessment questionnaire, the median score was only 4 out of 13 (31%) (10).

In the present study, a majority of students (77.1%) indicated that they would benefit from radiation safety training. Students were divided as to when radiation safety education was appropriate: 47.6% preferred having radiation safety lectures during undergraduate medical/dental degree and 48.8% preferred having radiation safety lectures during residency training. Only 3.6% thought it would be best taught during clinical practice. With more students preferring radiation safety lectures before clinical practice, it can be inferred that awareness instigated at earlier stages during undergraduate medical/dental degree will have a positive impact on clinical practice when medical and dental students graduate. This is similar to what Hagi et al. found where additional lectures corrected students' misunderstandings and significantly improved their knowledge about ionizing radiation (11). They found that amongst 253 students who attended a three-hour lecture on radiation safety, the average student score improved from 47% on pre-lecture test to 78% post-lecture test ( $p = 0.01$ ) (11). This means that a three-hour lecture was sufficient to significantly improve medical students' knowledge of radiation awareness.

When the curriculum is taken into consideration, McGill University seems to offer more teaching related to Radiology and radiation safety, which is taught longitudinally throughout the 4 years of undergraduate medical studies with emphasis placed in Transition to Clinical Practice in the 2nd year (12). In Transition to Clinical Practice the students have a week exclusively on Radiology including a lecture on radiation safety. They spend time in the radiology departments of teaching hospitals where they are introduced to common and important conditions requiring imaging. Prior to graduation, a student gets a minimum of 50 hours of radiology. This is more than other Canadian medical schools. For example, at the University of British Columbia, which houses the largest medical school in Canada, students receive about 40 hours of radiology teaching throughout their 4 years of medical school (8). In the present study, because first-year medical and dental students were surveyed, most students had not yet

received the lecture on radiation safety. Since medical and dental students are introduced to patients from 1st year, it is recommended that Radiation Safety course be given during the 1st year rather than the 2nd year. In addition, competency of medical and dental students in radiation safety should be assessed after the course to ensure its effectiveness.

Several national and international associations advocate for radiation safety education to medical and dental students. Euroatom 97 advocates for medical schools to implement radiation protection lectures in the undergraduate medical curriculum (13,14). In addition, the Canadian Association of Medical Radiation Technologists stresses the importance of Canada Safe Imaging developing awareness and adopting current and emerging radiation protection strategies (15). Finally, the Canadian Association of Radiologists acknowledges the fact that medical schools throughout the world teach very little about radiological studies and their potential harm. As such, they have created a guideline called the Medical Imaging Primer that is aimed at providing a concentrated and focused information package about diagnostic radiation usage and safety to medical students across Canada (15). This online resource could be used by medical and dental schools to help increase students' knowledge regarding radiation safety.

This study is not without its limitations. Despite having a good response rate of 41.5%, there was a small sample size of 87 respondents in the present survey. Another limitation of the study is that the survey was conducted before the students had taken a radiation safety course. It was not possible to assess improvements in radiation safety awareness after taking the course during the 2nd year. Nevertheless, this survey demonstrated the knowledge gap of first-year medical and dental students regarding radiation safety. In addition, it showed that the majority (77%) of students wanted to learn about radiation safety.

## Conclusion

This study confirmed that first-year medical and dental students' knowledge about ionizing radiation and radiation safety awareness is limited and needs to be improved. Medical students are willing to improve their knowledge about ionizing radiation in the form of workshops, online courses, and seminars. Most of the students agreed to have lectures on radiation safety before starting their clinical rotations. A radiation safety course is usually given in the 2nd year. Since medical and dental students are introduced into clinical practice from 1st year in the New Curriculum, it is recommended that the radiation safety course be given during 1st year rather than 2nd year. In addition, students' competencies in radiation safety needs to be assessed after the course.

## References

1. Glasser O. W.C. Röntgen and the discovery of the Röntgen rays. *AJR Am J Roentgenol* 1995;165:1033-40.
2. Agarwal A. Radiation risk in orthopedic surgery: ways to protect yourself and the patient. *Oper Techn Sports Med*. 2011; 19:220-223. doi: 10.1053/j.otsm.2011.10.002.
3. ICRP, 1991. 1990 Recommendations of the International Commission on Radiological Protection. ICRP Publication 60. Ann. ICRP 21 (1-3). Available from: <http://www.icrp.org/publication.asp?id=icrp%20publication%2060> [Accessed April 2, 2017].

4. International Atomic Energy Agency. International Action Plan for the Radiological Protection of Patients GOV/2002/36-GC(46)/12. Available at: <https://www-ns.iaea.org/downloads/rw/radiation-safety/PatientProtActionPlangov2002-36gc46-12.pdf> [Accessed April 2, 2017].
5. WHO, 2008. WHO Global Initiative on Radiation Safety in Health Care Settings. World Health Organization, Geneva. Available at: [http://www.who.int/ionizing\\_radiation/about/GI\\_TM\\_Report\\_2008\\_Dec.pdf?ua=1](http://www.who.int/ionizing_radiation/about/GI_TM_Report_2008_Dec.pdf?ua=1) [Accessed April 28, 2016].
6. Vetter RJ, Stoeva MS. Radiation Protection in Medical Imaging and Radiation Oncology. Dec. 2015 by CRC Press. ISBN 9781482245370
7. Faggioni L, Paolicchi F, Bastiani L, et al. Awareness of radiation protection and dose levels of imaging procedures among medical students, radiography students, and radiology residents at an academic hospital: Results of a comprehensive survey. *Eur J Radiol.* 2017;86:135-142.
8. Scali E, Mayo J, Nicolaou S, et al. Senior medical students' awareness of radiation risks. *CMEJ* 2017, 8(4):e31-e41
9. McCusker MW, de Blacam C, Keogan M, et al. Survey of medical students and junior house doctors on the effects of medical radiation: Is medical education deficient? *Ir J Med Sci.* 2009; 178:479-83.
10. Jończyk-Potoczna K, Strzelczuk-Judka L, Szlyk E, et al. Medical students' awareness of radiation exposure related to radiological imaging procedures. *Journal of Medical Science* 2014; 83 (3):244-249.
11. Hagi SK, Mawya A. Khafaji. Medical students' knowledge of ionizing radiation and radiation protection. *Saudi Med J* 2011; 32(5):520-4.
12. Undergraduate Medical Education. Curriculum Components. McGill University. Available from <https://www.mcgill.ca/ugme/mdcm-curriculum-joint-programs/curriculum-structure/curriculum-components>. [Accessed October 20, 2019]
13. O'Sullivan J, O'Connor OJ, O'Regan K, et al. An assessment of medical students' awareness of radiation exposures associated with diagnostic imaging investigations. *Insights Imaging* 2010;1(2):86-92.
14. Euroatm. Council Directive 97/43/Euratom, June 1997 on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure and repealing Directive 84/466/ Euratom. *Official Journal of the European Communities.* July 1997; L180: 0022-0027 [Accessed April 2, 2017].
15. Canadian Association of Medical Radiation Technologists. Canadian Association of Medical Radiation Technologists Available from <http://www.camrt.ca/about-camrt/advocacy/radiation-safety/>. [Accessed April 2, 2017]



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