

Knowledge and practices of radiation protection among Malaysian radiographers working in nuclear medicine: A preliminary study

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SUMMARY

This study is aimed to determine knowledge and practices on radiation protection among radiographers in nuclear medicine department. A cross-sectional survey was conducted among radiographers in nuclear medicine departments in four health institutions in Malaysia. A set of questionnaires was distributed to 17 respondents using convenience sampling. Approximately more than 75% and 44% - 56% of the radiographers have good knowledge of radiation protection and frequent adherence to radiation protection practices, respectively. Levels of education and length of service were statistically correlated with radiation protection knowledge and practices attributes ($p < 0.05$), respectively. More training is necessary for knowledge and practice improvement.

KEYWORDS:

Knowledge, practice, radiation protection, radiographers, nuclear medicine

INTRODUCTION

Nuclear medicine is a part of radiological imaging studies using a wide range of radiopharmaceuticals for diagnostic and therapeutic purposes. Two common nuclear medicine procedures are Single Photon Emission Computed Tomography (SPECT) using a gamma emitter e.g., technetium -99m and Positron Emission Tomography (PET) using a positron emitter e.g., fluorine-18. The properties of radiopharmaceuticals administered into the body facilitate to indicate the function of tissue and organ. Approximately 37 million nuclear medicine procedures are carried out globally each year.¹ Ionizing radiation exposure could result in cancer, genetically induced mutations, aberrant development, and degenerative disorders.² Thus, it is obligatory to ensure the safe practice of ionizing radiation exposure while minimizing its associated risk.

Radiological staff should possess adequate knowledge and good practice in radiation protection. Continuous training and courses should be provided from time to time for radiological staff to enhance their knowledge and practice on

the safety of ionizing radiation. Several studies on the level of knowledge, awareness and practice in radiation protection and safety among medical personnel in nuclear medicine departments in several countries have been reported.^{3,4} However, there is insufficient evidence of the knowledge and practices in radiation protection among Malaysian radiographers particularly those practicing in nuclear medicine presently. Therefore, this study is aimed to determine the level of knowledge and practices on radiation protection among radiographers in the nuclear medicine department and their correlations with demographic factors.

MATERIALS AND METHODS

Questionnaire Instrument

A cross-sectional survey was conducted among radiographers in the Department of Nuclear Medicine at four health institutions in Malaysia from July until December 2022.

A self-administered questionnaire which was adapted and adopted from previous studies^{3,4} was employed in this study. The questionnaire consisted of three sections: demographic information in section A (four questions), knowledge of radiation protection in section B (eight questions) and practice of personnel in radiation protection in section C (seven questions). With regards to the practice attributes, three questions were addressed on personal protection and patient protection, respectively while one question addressed on protection of the environment.

A pilot study was conducted among ten radiographers to test the reliability of the questionnaire. The results of the pilot study showed acceptable Cronbach's alpha values of 0.828 and 0.928 for the questionnaire of knowledge and practice, respectively.

Sample Collection

The questionnaire was constructed using Google Forms and was distributed through WhatsApp and Telegram apps using convenience sampling method. The consent of the respondents was obtained before answering the questionnaire. A total of 17 samples was estimated following

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sample size calculation with a 95% confidence level using the Raosoft sample size calculator. Trainee radiographers were excluded from the samples.

Statistical Analysis

Descriptive and inferential statistical analyses were performed using Statistical Package for Social Science (SPSS) version 26.0 for Windows (SPSS Inc., USA) with a p-value < 0.05 was considered statistically significant.

Ethics Approval

Ethics approval was granted by the Research Ethics Committee of Faculty Health Sciences, Universiti Teknologi MARA (FERC/FSK/MR/2022/0153).

RESULTS

Demographic Characteristics

A total of 16 out of 17 radiographers responded to the survey (94.1%). The demographic data of the participants showed 62.5% were females and 37.5% were males. Most of the radiographers were aged between 30 – 39 years (62.5%) while 25% were between 20 – 29 years and 12.5% were between 40 – 49 years. Most of the radiographers were diploma holders (93.8%) with 6 - 10 years of service in the nuclear medicine department (50%) while 25% of them with less than 5 years and 11 – 15 years of service, respectively.

Level of Knowledge of Radiation Protection among Radiographers

Table I shows the level of knowledge of radiation protection of the radiographers in nuclear medicine. The results showed most of the radiographers had a good level of knowledge of radiation protection in nuclear medicine. It was found that 100% of the respondents were aware of the basic terms of radiation protection including ALARA, time, distance and shielding and TLD badge as well. It was noticed that 75% of them were familiar with radioactive materials' half-life.

Furthermore, most of the radiographers were aware of radiation risks at the workplace (75%) and radiation protective equipment (81.3%).

Level of Practices of Radiation Protection among Radiographers

From the point of view of radiation protection practices, the results revealed frequent adherence to radiation protection in personal protection (50% – 56.3%), patient protection (43.8% - 87.5%) and protection of the environment (100%) as shown in Table II.

Particularly, only 56.3% of the radiographers frequently wear their dosimeter during working, 50% read thermoluminescent dosimeter badge and 56.3% frequently keep enough distance from the radiation source. Similarly, only 43.8% of the respondents frequently check all information about radiopharmaceuticals before administration to the patients and 56.3% of the respondents frequently use minimal exposure time when handling radiopharmaceutical-injected patients. However, better practice has been observed as 87.5% of the respondents asked about the pregnancy status of female patients. Moreover, all the respondents (100%) frequently have the radiation symbol light working in their practice.

Correlation of Knowledge and Practices with Demographic Factors

Furthermore, Pearson Chi-square correlation analysis showed the level of education was significantly correlated with the knowledge attribute of the annual limit on the effective dose for a radiation worker, $X^2 (1, N=16) = 7.467, p = 0.006$ (Table III). Interestingly, length of service in the nuclear medicine department was significantly correlated with most practice attributes including wearing a personal dosimeter during working, $X^2 (4, N =16) = 9.667, p = 0.046$, reading a TLD dosimeter badge, $X^2 (4, N=16) = 9.714, p = 0.046$ and checking information about radiopharmaceuticals before administration to the patient, $X^2 (2, N=16) = 8.382, p = 0.015$.

Table I: Knowledge attributes of radiation protection

Knowledge attribute	n (%)
The annual limit on the effective dose for a radiation worker set by Act 304 under Basic Safety Radiation Protection 2010 is 2 mSv (K1)	
Yes	2 (12.5%)
No	14 (87.5%)
Do you know what the TLD badge is? (K2)	
Yes	16 (100%)
No	0 (0%)
Are you familiar with radioactive materials' half-life? (K3)	
Yes	4 (25%)
No	12 (75%)
Are you familiar with the term ALARA? (K4)	
Yes	16 (100%)
No	0 (0%)
Are you familiar with the terms; stochastic and deterministic effects? (K5)	
Yes	6 (37.5%)
No	10 (62.5%)
Do you have an idea about the radiation risks you are exposed to at the workplace? (K6)	
Yes	12 (75%)
No	4 (25%)
Are you familiar with the terms; Time, Distance, Shielding? (K7)	
Yes	16 (100%)
No	0 (0%)
Do you have an idea about the various protective equipment? (K8)	
Yes	13 (81.3%)
No	3 (18.8%)

Table II: Practice attributes of radiation protection

Practice attribute	n (%)
Personal protection	
Do you wear the personal dosimeter during work? (P1)	
Rarely	1 (6.3%)
Sometimes	6 (37.5%)
Often	9 (56.3%)
Personal protection	
Do you read your thermoluminescent dosimeter badge? (P2)	
Rarely	1 (6.3%)
Sometimes	7 (43.8%)
Often	8 (50%)
Patient protection	
Do you check all information about radiopharmaceuticals before administration to the patient? (P3)	
Rarely	0 (0%)
Sometimes	9 (56.3%)
Often	7 (43.8%)
Patient protection	
Do you use minimal exposure time when handling radiopharmaceutical-injected patients? (P4)	
Rarely	0 (0%)
Sometimes	7 (43.8%)
Often	9 (56.3%)
Personal protection	
Do you keep enough distance from the radiation source? (P5)	
Rarely	3 (18.8%)
Sometimes	4 (25.0%)
Often	9 (56.3%)
Patient protection	
Do you ask about the pregnancy status of female patients? (P6)	
Rarely	0 (0%)
Sometimes	2 (12.5%)
Often	14 (87.5%)
Protection of the environment	
Do you have the radiation symbol light working? (P7)	
Rarely	0 (0%)
Sometimes	0 (0%)
Often	16 (100%)

Table III: Correlation of knowledge and practice attributes of radiation protection with demographic factors of the radiographers

Attribute	Gender	Age	Level of education	Length of service
K1	0.242	0.504	0.006*	0.565
K2	-	-	-	-
K3	0.551	0.202	0.074	0.264
K4	-	-	-	-
K5	0.182	0.808	0.182	0.202
K6	0.074	0.202	0.551	0.368
K7	-	-	-	-
K8	0.247	0.171	0.620	0.158
P1	0.159	0.255	0.660	0.046*
P2	0.212	0.240	0.587	0.046*
P3	0.091	0.202	0.242	0.015*
P4	0.147	0.202	0.362	0.090
P5	0.837	0.310	0.660	0.070
P6	0.051	0.633	0.696	0.565
P7	-	-	-	-

* p < 0.05

- no statistics are counted because the variables (K2, K4, K7 and P7) are constant.

This study revealed gender and age demonstrated no significant correlation with any attributes of knowledge and practice of the radiographers in nuclear medicine ($p > 0.05$).

DISCUSSION

The results showed that most of the radiographers have a good level of knowledge of radiation protection in nuclear medicine. More than 75% of the respondents had knowledge

of radiation protection in nuclear medicine including the annual dose limit for radiation workers, TLD badge, radiation risk, methods of radiation protection and radiation protection equipment. However, only 25% and 37.5% of them familiar with radioactive materials' half-life and biological effects of radiation, respectively. This finding is in accordance with a previous pilot study on radiation safety awareness among Malaysian nurses in the nuclear medicine department.⁵

On the contrary, only 44% - 56% of the radiographers had practiced frequently most of the attributes of good practice of radiation protection in nuclear medicine including wearing a personal dosimeter during work, reading a TLD dosimeter badge, using minimal exposure time when handling radiopharmaceutical-injected patients and keeping enough distance from the radiation source. Remarkably, 87.5% and 100% of the radiographers had practiced frequently on querying the pregnancy status of female patients and working on radiation symbol light, respectively. The results are in accordance with the previous report on the practice of radiation safety among Egyptian healthcare workers.⁶ As a result of the present findings, strict measures on radiation protection and safety are substantially necessary for the department to ensure that radiographers are complying with the standard safety measures.

On the other hand, this study showed the level of education significantly correlated with the knowledge of the annual dose limit for radiation workers. The result may prove that higher education levels would lead to improved knowledge radiographers which fosters feelings of self-assurance, personal growth, self-realization, and professional achievement. These characteristics would lead to greater professional satisfaction, which is crucial for delivering high-quality medical care.³ Similarly, the length of service of the radiographers significantly correlated with most attributes of radiation protection practice. It means that the level of radiation protection practice is directly proportional to the radiographers' working years of service. An Iranian study on radiation protection knowledge, attitude and practice in interventional radiology reported that the radiation protection practice score was significantly higher among radiological staff with more than 15 years of practice age as compared to those with less than 15 years of practice.⁷ Exposure to radiation protection training and experience-based learning by radiographers could be the potential factors leading to good radiation protection practice. Over time, radiographers are exposed to various situations, equipment, protocols, and procedures, which provide the opportunity for learning and self-improvement. It is also important to note that ongoing education and training in radiation protection and safety is crucial to update knowledge and practice as radiation protection regulations and guidelines are constantly evolving.

There are several guidelines should be adhered by the radiographers and health personnel for radiation protection and safety in radiology and nuclear medicine. These guidelines include Act 304 (Atomic Energy Licensing Act 1984) and Guidance Document for Occupational Radiation Protection, which addressed the protection of health and safety of radiation workers. Furthermore, Ministry of Health Malaysia has published Operational Policy in Nuclear Medicine Services as an important national policy document to provide a general guideline for nuclear medicine personnels for delivering nuclear medicine services in Malaysia.⁸ This document has been developed based on the needs of latest requirements under the Atomic Energy Licensing (Basic Safety Radiation Protection) Regulations 2010. To ensure the current knowledge and skills of the health personnels in nuclear medicine are updated, they should attend continuous medical education (CME) in the

service initiated by the authorized organization such as Ministry of Health Malaysia at least 6 hours per year.⁹ Some of the training modules include Radiation Safety Awareness in Nuclear Medicine, Update in Nuclear Medicine Technology and others. The training is also essential for the renewal of radiation worker status.

The present study is limited by the small sample size of respondents which may lead to average bias.¹⁰ More sample sizes with a greater population of radiographers practicing in the nuclear medicine department in the public, private and teaching hospitals in Malaysia are recommended for future study.

CONCLUSION

The radiographers in the nuclear medicine department generally have good knowledge of radiation protection and moderate adherence to radiation protection practices. Level of education and length of service are the important factors contributing to radiation protection knowledge and practice, respectively. Hence, more knowledge acquisition programs and training are necessary to improve the knowledge and practice of radiation protection among radiographers in nuclear medicine.

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CONFLICT OF INTEREST

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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