Radiation awareness among nurses in nuclear medicine departments

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KEY WORDS

nurses, awareness, radiation, nuclear medicine, Kuwait

ABSTRACT

Objective
The aim of this study is to explore the awareness level of radiation risks among nurses working in nuclear medicine departments (NMDs).

Design
A cross-sectional survey was used. Data were collected between February and March 2011.The data were collected using a self-administered, structured questionnaires. One open-ended question was added at the end of the questionnaire.

Setting
The study was conducted in NMDs representing five Kuwaiti governmental general and specialised hospitals and centres.

Subjects
This study comprised twenty one non-Kuwaiti female nurses who worked in NMDs.

Results
Nearly all of the nurses did not attend any radiation protection courses, they were not aware of the ALARA principle and they were not familiar with Geiger-Mueller counter. Most of these nurses were not able to read the dosimetry reports and they were not familiar with the terms RSO, RSC, and the 10 day rule concept.

Conclusion
Nearly all nurses working in NMDs in Kuwait are not aware of radiation protection and risks. This lack of awareness has serious implications on both patients and nurses. Courses on radiation risks and protection should be provided to nurses during and after their formal nursing education.

INTRODUCTION

The use of ionizing radiation in medicine has led to major improvements in the diagnosis and treatment of human diseases. More than 3,600 million X-ray examinations are performed, 37 million nuclear medicine procedures are carried out, and 7.5 million radiotherapy treatments are given every year worldwide (World Health Organization 2008). As the benefits for patients gain recognition, the exposure to ionizing radiation increases causing potential health hazards for patients and staff (Pearce et al 2012; Huda 2010). Exposure to ionizing radiation can result in cancer, genetically determined ill health, developmental abnormalities, and degenerative diseases (Carlton and Adler 2012; Brent 2009).

In Nuclear Medicine Departments (NMDs), nurses care for patients undergoing diagnostic or therapeutic treatments. This involves patient preparation, administering radioactive and non-radioactive medications, explaining the procedure, comforting and ensuring patient safety (Brown, 2012; Goodhart and Page 2007; Vijayakumar et al 2007). These nurses are vulnerable to the damaging effects of ionizing radiation (Bento et al 2012). However, they can reduce the risks of radiation by using different principles of radiation protection such as ALARA and the 10-day-rule. In addition, they may use the principles of time, distance, and shielding as well as various monitoring devices such as Geiger Muller (GM) counter and Thermoluminescent Dosimeters (TLDs). ALARA refers to As Low As Reasonably Achievable, in other words, to receive the maximum benefits by using the minimum of radiation dose to avoid its risks. The 10-day-rule on the other hand recommends that in women of child bearing age, non-urgent examinations that involve pelvic radiation should be limited to the first 10 days of the menstrual cycle. Time refers to the length of exposure to radiation, in that short exposures will produce less radiation dose. Distance refers to the distance between an individual and the radiation source. Increase in distance can result in dose reduction. Shielding refers to both fixed protective barriers and personal protective equipment such as lead aprons (Bushong 2012; Saia 2012; Sherer et al 2010; ICRP 2007).

Kuwaitis represent only 7% of the total nursing profession with the majority being Asian, the largest group are from India (Department of Nursing services 2012). There are seven NMDs in the Ministry of Health and the total number of nurses working in these departments is 26 (Department of Nursing Services 2010).

Through reading national and international publications, the researchers found one old reference regarding annual radiation doses received by radiologists, radiology nurses, medical radiographers, and industrial radiographers in Kuwait (Mustafa et al 1985). In addition, only one reference regarding awareness of radiology nurses on radiation risks in Kuwait hospitals (Alotaibi and Saeed 2006) was found. The purpose of this study is to explore the awareness level of radiation risks among nurses working in NMDs in Kuwait.

METHOD

A cross-sectional survey was used. Data were collected between February and March 2011using a self-administered, structured questionnaire comprising of two sections, A and B developed by the researchers. Section A comprised of questions regarding demographic data and section B comprised of 15 questions about radiation awareness. One open-ended question was added at the end of the questionnaire. Before the research began, the necessary written permission was obtained from Ministry of Health to conduct the research in the five hospitals and centres. The questionnaire was distributed to the 26 non Kuwaiti female nurses working in NMDs representing five Kuwaiti governmental general and specialised hospitals and centres, namely Mubarak Hospital, Al-Amiri Hospital, Chest Hospital, Organ Transplant Centre (OTC) and Kuwait Cancer Control Centre (KCCC). Nurses who were available, in the various locations at the time of the study and who were willing to participate completed the questionnaire. The aim of the study was explained,

participation was voluntary, that confidentiality would be maintained, and the information given would be used for research purposes only. In addition, no pressure was applied to any nurse to participate and they were offered a chance to ask questions. At the end of data collection period, a total of 21 completed, self-administered questionnaires were returned, yielding a response rate of 80.7%.

Content validity was assessed by a doctorally prepared radiologic technologist and a radiologic technologist who were experts in radiologic sciences as well as a doctorally prepared nurse and a registered nurse who were experts in radiology nursing. To ensure the reliability of the selected list of questions the original version of the questionnaire was analysed by SPSS version 19 for Windows (SPSS Inc 2010). To maximise the Cronbach's alpha (α) estimates the complete list of 15 questions were analysed and all split-half estimates were calculated from the same sample. All 15 questions selected according to (α) were tabulated in sequence and weighted by demographic data as shown in table 2. A p-value of <0.05 was considered as a cut off point for significance.

RESULTS

Table 1 shows a summary of demographic data of nurses. Over one third, nine (43%) were aged between 30 and 39 years. Eight (38%), were 40 years and above. The balance, four (19%), was made up of nurses who were between 26 and 29 years. More than half of the sample, 15 (71.4%), hold a diploma in nursing while the remaining six (33.3%) hold a bachelor's degree. Regarding their experience in nursing, one third, seven (33.3%) had more than 20 years of experience. Less than one third, six (28.6%) had between 11 to 20 years' experience. A further five (23.8%) had only five years or less. The remaining two (9.5%) had 6 to 10 years experience. One person did not respond to this question. Regarding their experience in NMD, more than half of the sample 14 (66.7%) had only five years or less. Four (19%) had 6 to 11years of experience. A further two (9.5%) had more than 16 years of experience. The remaining one (4.8%) had 12 to 16 years of experience.

Table1: Summary of demographic data of nurses

Characteristics		N	%	Mean
Age				2.19
	≤ 25	0	0	
	26-29	4	19.0	
	30-39	9	42.9	
	40 and > 40	8	38.1	
	Total	21	100.0	
Education				1.29
	Certificate	0	0	
	Diploma	15	71.4	
	Bachelor's	6	28.6	
	Other	0	0	
	Total	21	100.0	
Experience in nursing				1.86
	≤ 7. 5	5	23.8	
	6-10	2	9.5	
	11-20	6	28.6	
	> 20	7	33.3	
	Missing	1	4.8	
	Total	21	100.0	
Experience in NMD				0.57
	≤ 5	14	66.7	
	6-11	4	19.0	
	12-16	1	4.8	
	> 16	2	9.5	
	Total	21	100.0	

In table 2 this study found statistically significant differences in nurses' responses for all questions except for Questions 1, 8, and 10. In response to Q2, nearly all of the nurses did not attend any radiation protection courses during work (mean=0.95, p=0.00). In response to Q3, the vast majority of the nurses were not aware of the ALARA principle (mean = 0.90, p=0.00). However, nearly all of the nurses were able to identify the TLD badge as a measure of occupational and patient doses (mean = 0.05, p=0.00). Most of the nurses were not able to read the dosimetry report (mean=0.76, p=0.02). Nearly all of the nurses were not familiar with Geiger-Mueller (GM) counter (mean=0.95, p=0.00).

Regarding decontamination of radioactive spills, the vast majority of nurses knew how to decontaminate themselves (mean=0.14, p=0.001). In response to Q 8 most of the nurses were not familiar with the terms Radiation Safety Officers (RSO) and Radiation Safety Committee (RSC) (mean=0.67, p=0.13 and). In response to Q 9 most of the nurses were not familiar with the term 10 day rule (mean=0.86, p=0.001). In response to Q11 most of the nurses said the Department always make sure nurses wear the TLD badges (mean=0.48, p=0.001).

Regarding the transfer of pregnant nurses to another department as shown in Q12, most nurses said they were transferred in the 1st trimester (mean=0.62, p=0.00) and do not return to NMD before delivery as shown in Q 13 (mean=2.48, p=0.00). In response to Q14 nearly all of the nurses said they always wear the TLD badges (mean=0.24). In response to Q15 nearly all of the nurses were unable to classify doses whether it is high or low for scans of the lung, heart, and bone (mean from 0.1 to 0.14).

Table 2: Reliability and Chi-square overall questionnaire data

List of questions	N	Mean	P-value	(α)
Q1. Are you familiar with radioactive materials half-life (T1/2)?				
Yes (0)	10			
No (1)	11			
(Means range from 0 to 1)		0.52	0.83 NS	0.65
Q2. Have you attended any radiation protection courses?				
Yes (0)	1			
No (1)	20			
(Means range from 0 to 1)		0.95	0*** VHS	0.65
Q3. Do you know the term ALARA?				
Yes (0)	2			
No (1)	19			
(Means range from 0 to 1)		0.90	0*** VHS	0.65
Q4. Do you know what TLD badge is?				
Yes (0)	20			
No (1)	1			
(Means range from 0 to 1)		0.05	0*** VHS	0.65
Q5. Do you know how to read dosimetry reports?				
Yes (0)	5			
No (1)	16			
(Means range from 0 to 1)		0.76	0.02* S	0.65

Q6. Are you familiar with Geiger-Muller counter?				
Yes (0)	1			
No (1)	20			
(Means range from 0 to 1)		0.95	0*** VHS	0.65
Q7. Do you know how to decontaminate radioactive spills?				
Yes (0)	18			
No (1)	3			
(Means range from 0 to 1)		0.14	0.001** HS	0.65
Q8. Are you familiar with the terms Radiation Safety Office (RSO) and Radiation Safety Committee (RSC)?				
Yes (0)	7			
No (1)	14			
(Means range from 0 to 1)		0.67	0.13 NS	0.65
Q9. Are you familiar with the 10 day rule concept?				
Yes (0)	3			
No (1)	18			
(Means range from 0 to 1)		0.86	0.001** HS	0.65
Q10. Are you familiar with the following terms?				
Time	3			
Very familiar (0) Familiar (1) Unfamiliar (2)		1.19	0.1 NS	0.69
Distance	11			
Very familiar (0) Familiar (1) Unfamiliar (2)		1.14	0.28 NS	0.69
Shielding	7			
(Means range from 0 to 2)		0.86	0.28 NS	0.69
Q11. Does the NMD make sure that all nurses wear TLD?				
Always (0)	15			
Sometimes (1)	2			
Never (2)	4			
(Means range from 0 to 2)		0.48	0.001** HS	0.69
Q12. If a nurse gets pregnant will she be transferred to another department? Yes, on:				
1st trimester (0)	16			
2nd trimester (1)	1			
3rd trimester (2)	1			
No. Never transferred (3)	3			
(Means range from 0 to 3)		0.62	0*** VHS	0.69

Q13. If a pregnant nurse is transferred will she be returned to NMD during pregnancy? Yes, after:					
1st trimester	(0)	1			
2nd trimester	(1)	4			
3rd trimester	(2)	1			
No. Never transferred	(3)	15			
			2.48	0*** VHS	0.69
(Means range from 0 to 3)					
Q14. How often do you wear TLD badge?					
Always	(0)	18			
Sometimes	(1)	1			
Never	(2)	2			
(Means range from 0 to 2)			0.24	0*** VHS	0.69
Q15. Which of these nuclear medicine examinations would give the highest dose to a person close to patient?					
Lung dose					
Yes (0)		3			
No (1)		18			
(Means range from 0 to 1)			0.14	0.001** HS	0.69
Heart dose					
Yes (0)		3			
No (1)		18	0.14	0.001** HS	0.69
(Means range from 0 to 1)					
Bone dose					
Yes (0)		2			
No (1)		19			
(Means range from 0 to 1)			0.10	0*** VHS	0.69

NS (Not Significant "P-value > 0.05"); *S (Significant "P-value ≤ 0.05"); **HS (Highly Significant "P-value ≤ 0.005"); ***VHS (Very Highly Significant "P-value ≤ 0.0005")

Finally, nurses were asked to answer one open-ended question: what suggestions do you have to improve the awareness level of radiation risks among nurses working in nuclear medicine departments? Of the 21 nurses, the vast majority, 18 (86%) suggested at least a course on radiation protection as well as a NM procedures course before joining the NMD. The remaining, three (14%) suggested provision of frequent classes and seminars in radiation protection.

DISCUSSION

To the best of the researchers knowledge, this study is the first to explore the awareness level of radiation risks among nurses working in NMDs in Kuwait. It showed nearly all of the nurses did not attend any radiation protection courses. This explains why nearly all of the nurses were not familiar with the ALARA principle and the GM counter. It shows that most of these nurses were not able to read a dosimetry report and they were not familiar with the terms RSO, RSC, and 10 day-rule. In addition, nearly all of the nurses were unable to classify whether doses are high or low for scans of the lung, heart, and bone. It can be assumed that the information provided to these nurses about the effects of radiation and the protective measures needed were

inadequate. These knowledge deficits are supported by previous studies (Morishima et al 2012; Ohno and Kaori 2011; Melaih 2008; Alotaibi and Saeed, 2006). Several studies showed similar findings among medical students, junior and referring physicians (Salih et al 2014; Yurt et al 2014; Ricketts et al 2013; Sarah et al 2011; Heyer et al 2010; Zhou et al 2010).

These knowledge deficits can be explained by the fact that in Kuwait nurses working in NMDs were deployed at the radiology departments without any formal training in radiology nursing. This agrees with similar findings of recent studies conducted in South Africa, Turkey and Malaysia (Makanjee et al 2014; Yunus et al 2014; Yurt et al 2014). However, in some countries, for example, Sweden and Poland, there is a formal Bachelor of Science Degree in diagnostic radiology for nurses (Teresińska et al 2014; Lunden et al 2012). Interestingly, in other countries like Saudi Arabia and Guatemala, formal radiography education and training used to be offered to nurses as a supplement with the absence of professional radiographers. However, after the need for qualified graduate radiographers had been identified, academic radiography education and training were introduced (Alaamer 2012; Cowling 2008).

Nearly all of the nurses knew what a TLD badge was and the vast majority knew how to decontaminate themselves from radioactive spills. This knowledge may be acquired from their working experience in NMDs and that the TLD is placed in front of their pocket and analysed once every month (Leide-Svegborn 2010). Most of these nurses said NMDs always make sure nurses wear TLD badges. This explains why nearly all nurses answered they always wear their TLD badge. All the nurses showed their interest in learning about radiation protection. This is consistent with results of other studies (Morishima et al 2012; Kunugita 2008; Melaih 2008).

Nurse performance is fundamental to improve patient safety in the health care system (Kohlbrenner et al 2011). Patient safety is widely believed to be protecting the patient from injury (WHO 2010). Any threat to patient safety may result in negative outcomes such as long lengths of hospital stay, high rates of infection, injury and death (Shaffer and Tuttas 2009; Gregory et al 2007). According to the International Council of Nurses (ICN) code of ethics, patient safety is a fundamental responsibility of nurses (ICN code ethics for nurses, 2012). Unfortunately, the results of this study showed a lack of awareness level of radiation risks among nurses working NMDs in Kuwait. This means these nurses are unable to effectively protect themselves or their patients from ionizing radiation (Yurt et al 2014). Ultimately, this lack of knowledge compromises the quality of nursing services (Urushizaka et al 2013). Therefore, it is essential that nurses working in NMDs should have some basic knowledge of radiation, radioactive materials and the different effects of radiation. This is supported by previous studies that suggested implementing courses in radiation protection in basic nursing education and frequent classes, seminars and training programs for those who work in radiology departments (Yunus et al 2014; Yurt et al 2014; Ohno and Kaori 2011; Alotaibi and Saeed 2006).

LIMITATIONS OF THE STUDY

The results of this study are limited to NMDs representing five governmental general and specialised hospitals and centres. It is also limited to the time period in which the study was conducted. The study is also confined to a small sample of non-Kuwaiti female nurses. Therefore, generalisability of the results is always a question. Despite the small sample used, the study yielded important evidence on radiation awareness among nurses in NMDs in Kuwait. Future studies in different cultures and contexts should be conducted to help us recognise various aspects of radiation awareness among nurses working in NMDs. It could also analyse the awareness level of radiation risks among nurses working in NMDs, on the basis of those variables examined in the current study, which have not found to be statistically significant and to validate significant relationship found in this study.

CONCLUSION

Nearly all nurses working in NMDs in Kuwait are not aware of the radiation protection and risks. This lack of awareness has serious implications on both patients and nurses. The researchers believe that nurses should be provided with courses on radiation protection and risks during and after their formal nursing education.

REFERENCES

Alaamer, A.S. 2012. Radiography education and training in Saudi Arabia. *Open Journal of Radiology,* 2(4):134-140.

Alotaibi, M. and Saeed, R. 2006. Radiology nurses awareness of radiation. *Journal of Radiology Nursing,* 24(1):7-12.

Bento, J., Teles, P., Neves, M., Santos, A.I., Cardoso, G., Barreto, A., Alves, F., Guerreiro, C., Rodrigues, A., Santos, J.A.M., Capelo, C., Parafita, R. and Martins, B. 2012. Study of nuclear medicine practices in Portugal from an internal dosimetry perspective. *Radiation Protection Dosimetry,* 149(4):438-443.

Brent, R.L. 2009. Saving lives and changing family histories: appropriate counselling of pregnant women and men and women of reproductive age, concerning the risk of diagnostic radiation exposures during and before pregnancy. *American Journal of Obstetrics and Gynaecology,* 200(1):4-24.

Brown, C.D. 2012. Improving patient care in the diagnostic imaging department: The role of the nurse navigator. *Journal of Radiology Nursing,* 31(3):97-100.

Bushong, S.C. 2012. Radiologic science for technologists: Physics, Biology, and Protection (10th edn). Mosby: St. Louis.

Carlton, R.R. and Adler, A.M. 2012. Principles of radiographic imaging: An Art and a Science (5th edn). Delmar: New York.

Cowling, C. 2008. A global overview of the changing roles of radiographers. *Radiography,* 14(1):28-32.

Department of Nursing Services. 2012. *Nursing Staff Statistics.* Ministry of Health, Kuwait.

Department of Nursing Services. 2010. *Nursing Staff Statistics*. Ministry of Health, Kuwait.

Goodhart, J. and Page, J. 2007. Radiology nursing. *Orthopaedic Nursing,* 26(1):36-39.

Gregory, D.M., Guse, L.W., Dick, D.D. and Russell, C.K. 2007. Patient safety: where is nursing education? *Journal of Nursing Education,* 46(2):79-82.

Heyer, C.M., Hansmann, J., Peters, S.A. and Lemburg, S.P. 2010. Paediatrician awareness of radiation dose and inherent risks in chest imaging studies - A questionnaire study. *European Journal of Radiology,* 76(2):288-293.

Huda, W. 2010. Review of Radiologic Physics (3rd edn). Lippincott Williams & Wilkins: Philadelphia.

International Commission on Radiological Protection. 2007. ICRP Publication 103. Ann. ICRP 37(2-4).

International Council of Nurses (ICN). 2012. The ICN Code of Ethics for Nurses. http://www.icn.ch/images/stories/documents/about/icncode_english.pdf (accessed 23.12.14)

Kohlbrenner, J., Whitelaw, G. and Cannaday, D. 2011. Nurses critical to quality, safety, and now financial performance. *Journal of Nursing Administration,* 41(3):122-128.

Kunugita, N. 2008. Investigation of the relationship between knowledge concerning radiation and the level of anxiety toward radiation in student nurses. *Journal of University of Occupational & Environmental Health*, 30(4):421-429.

Leide-Svegborn, S. 2010. Radiation exposure of patients and personnel from a PET/CT procedure with 18 F-FDG. *Radiation Protection Dosimetry,* 139(1):208-213.

Lunden, M., Lundgren, S.M. and Lepp, M. 2012. The nurse radiographer's experience of meeting with patients during interventional radiology. *Journal of Radiology Nursing,* 31(2):53-61.

Melaih, A. 2008. Awareness of radiation safety and protection among nurses at KAUH. http://www.kau.edu.sa/Files/0012718/Files/59009_project%20abstract.pdf. (accessed 20.12.12).

Morishima, Y., Chida, K., Shigeizumi, K., Katahira, Y., Seto, H. and Chiba, H. 2012. Importance of radiation education for nurses. *Japanese Journal of Radiological Technology*, 68(10):1373-1378.

Makanjee, C.R., Bergh, A. and Hoffmann, W.A. 2014. "So you are running between"- A qualitative study of nurses' involvement with diagnostic imaging in South Africa. *Journal of Radiology Nursing,* 33(3):105-115.

Mustafa, A.A., Sabol, J. and Janeczek, J. 1985. Doses from occupational exposure: a study of radiation doses to workers in Kuwait over a four-year period. *Health Physics,* 49(6):1197-1204.

Ohno, K. and Kaori, T. 2011. Effective education in radiation safety for nurses. *Radiation Protection Dosimetry*, 147(1-2):343-345.

Pearce, M.S., Salotti, J.A., Little, M. P., McHugh, K., Lee, C., Pyo Kim, K., Howe, N., Ronckers, C., Rajaraman, P., Craft, A., Parker, L., Gonzalez, A.. 2012. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. *Lancet,* 380:499-505.

Rickets, M.L., Baerlocher, M.O., Asch, M.R. and Myers, A. 2013. Perception of radiation exposure and risk among patients, medical

students, and referring physicians at a tertiary care community hospital, *Canadian Association of Radiologists Journal,* 64(3):208-212.

Sarah, K., Hagi, S.K. and Khafaji, M.A. 2011. Medical student's knowledge of ionizing radiation and radiation protection. *Saudi Medical Journal,* 32(5):520-4.

Saia, D.A. 2012. Lange Q & A for the radiography examination (9th edn). McGraw-Hill: Columbus, OHIO.

Salih, S., Abu Zaidan, Z., Alzalabani, A., Albadani, M.S. and Yousef, M. 2014. Awareness and knowledge towards Ionizing Radiation Hazard among Medical Students, Interns and Residents in Al-Madinah Al-Munawerah, KSA. *Life Science Journal* 11(3):6-10.

Shaffer, F.A. and Tuttas, C.A. 2009. Nursing leaderships' responsibility for patient quality, safety, and satisfaction: current review and analysis. *Nurse Leader*, 7(3):34-38, 43.

Sherer, M.A.S., Visconti, P.J. and Ritenour, E.R. 2010. *Radiation protection in medical radiography* (6th edn) Mosby: St. Louis.

Teresińska, A., Birkenfeld, B., Królicki, L. and Dziuk, M. 2014. Nuclear medicine training and practice in Poland. *European Journal of Nuclear Medicine and Molecular Imaging,* 41(10):1995–1999.

Urushizaka, M., Noto, Y., Ogura, N. Kitajima, M., Nishizawa, Y., Ichinohe, T. and Yamabe, H. 2013. Changes in Nurses' impression of radiation after attending educational seminars on radiation. *Radiation Emergency Medicine,* 2(2):35-42.

Vijayakumar, V., Briscoe, E. G. and Vijayakumar, S. 2007.Role of Nurses in Daily Nuclear Medicine. *The Internet Journal of Nuclear Medicine,* 3(2) http://www.ispub.com/journal/...internet_journal_of_nuclear_medicine/.../volume_3_number_2_35.html (accessed 20.07.10).

World Health Organization (WHO). 2008. WHO global initiative on radiation safety in healthcare settings. http://www.who.int/ionizing_radiation/about/med_exposure/en/index.html (accessed 04.11.12).

World Health Organization (WHO). 2010. A brief synopsis of patient safety. http://www.euro.who.int/_data/assets/pdf_file/0015/111507/E93833.pdf (accessed 10.03.13).

Yunus, N.A., Abdullah, M.H., Said, M.A. and Ch'ng, P.E. 2014. Assessment of radiation safety awareness among nuclear medicines nurses: a pilot study. *Journal of Physics*: Conference series 546 (2014) 012015 doi: 10.1088/1742-6596/546/11012015.

Yurt, A., Çavuşoğlu, B. and Günay, T. 2014. Evaluation of awareness on radiation protection and knowledge about radiological examinations in healthcare professionals who use ionized radiation at work. *Molecular Imaging and Radionuclide Therapy,* 23(2):48-53.

Zou, G.Z., Wong, D.D, Nguyen, L.K., and Mendelson, R.M. 2010. Student and intern awareness of ionizing radiation exposure from common diagnostic imaging procedures. *Journal of Medical Imaging and Radiation Oncology,* 54(1):17-23.