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IONIZING RADIATION KNOWLEDGE AMONGST MEDICAL SUPPORT STAFF: A PRELIMINARY STUDY

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ABSTRACT

Radiation exposure is one of the critical issues in the medical field. Medical support staff especially those working in nuclear department should possess good knowledge associated with radiation ionization and radiation safety due to a very high chance of being exposed to radiation during radiological procedures. Proper training is of utmost importance in reducing the risk associated with radiation exposure. However, there has been no research conducted as yet to assess the ionizing radiation knowledge amongst Malaysian medical support staff. Often, the impact of job training on increasing radiation safety knowledge is unknown. This study is designed to identify the level of general radiation knowledge and radiation safety knowledge possessed by a group of Malaysian medical support staff; to measure the strength and the direction of the relationship between these two variables; and to assess whether training program can result in a measureable change in the knowledge of medical support staff. A standardized pre-test and post-test questionnaire was administered to each of a group of 27 medical support staff during a training program on radiation safety. The data obtained were analyzed using a descriptive statistics, t-test, and correlation analysis. Based on the findings, it can be observed that the total post-test scores were better than pre-test scores. The findings also revealed that the mean score for radiation safety knowledge was slightly better than the mean score for the general radiation knowledge. There is no significant relationship between the general radiation knowledge and radiation safety knowledge measures. The results of the study indicated that the current knowledge of ionizing radiation among the medical support staff is at moderate level only. It is recommended that a national study be conducted to determine the level of knowledge about

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radiation among all the medical staff in all Malaysian hospitals. Besides that, future strategies to improve medical support staff's radiation knowledge also need to be investigated, developed, implemented and evaluated.

Keywords: General Radiation Knowledge; Radiation Safety Knowledge; Questionnaire Survey; Medical Support Staff.

1. INTRODUCTION

Nowadays, with the advancement of technology, radiation is extensively used by medical imaging tool to screen for, diagnose and treat numerous medical problems. Some of the popular diagnostic tests that use radiation are radiography (X-rays), fluoroscopy, nuclear medicine, positron emission tomography (PET), computed tomography (CT), intraoperative imaging and mammography. Exposure to radiation can give rise to serious biologic effects on medical support staff. It is crucial to be considered and therefore there is a requirement for medical support staff to follow the prescribed procedures for designing, running and decommissioning practices involving ionizing radiation according to the standards, as established in The International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) (IAEA, 1996). This paper intends to bring this issue to the attention of the medical support staff who are involved in radiology to avoid over exposure to radiation and any associated risks in order to protect patients and the medical support staff themselves from the potential risks. All medical support staff especially those who work in nuclear department should possess a good knowledge related to ionizing radiation and have a high level of radiation safety knowledge. In addition, proper training is of critical importance to refresh and increase the medical support staff's knowledge.

In recent years, there has been a notable concern on assessing the radiation related knowledge and protection awareness among the medical doctors, paediatricians, medical students, cardiology fellows (Wong et al., 2012; Bosanquet et al., 2011; Heyer et al., 2010; O'Sullivan et al., 2010; Kim et al., 2010). For example, Dauer et al. (2006) conducted a research on the effectiveness of radiation safety training intervention for oncology nurses. All of the studies were conducted in other countries. Unfortunately, there is no research assessing the ionizing radiation knowledge amongst Malaysian medical support staff. In addition, the impact of job training on expanding radiation safety knowledge among local medical support staff is also unknown.

This study is designed to identify the level of basic ionizing radiation knowledge and radiation safety knowledge held by the medical support staff working in one of the hospitals in Malaysia; to measure the strength and the direction of the relationship between these two variables; and to assess whether training program can result in a measureable change in the knowledge of medical support staff.

1.1 Objectives of the study

The objectives of the research are as follows:

1. To evaluate the medical support staff's general radiation knowledge and radiation safety knowledge levels.

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2. To evaluate the effectiveness of a radiation safety training in increasing the medical support staff's radiation knowledge.

3. To identify whether there is a positive and significant relationship between medical support staff's general knowledge on radiation and radiation safety knowledge.

1.2 Research questions

The three research questions addressed in the study are as follows:

RQ1. What are the medical support staff's general radiation knowledge and radiation safety knowledge levels?

RQ2. Is the radiation safety training effective in increasing the medical support staff's radiation knowledge?

RQ3. Is there a significant relationship between medical support staff's general knowledge on radiation and radiation safety knowledge?

2. MATERIALS AND METHOD

The study was conducted in a well-known hospital in Putrajaya, Malaysia. A self-administered questionnaire was used in this study. The questionnaire was adapted from the questionnaires used in the previous studies (Ekşioğlu & Uner, 2012; Quinn et al., 1997). The questionnaire consisted of 16 questions in multiple-choice format. It was divided into two main sections, i.e., general radiation knowledge (8 items) and radiation safety knowledge (8 items). Following the design of this questionnaire, the content was validated by the medical physicists of Nuclear Medicine Department (NMD). The questionnaire, together with the correct answers, is presentedin Appendix 1. The questionnaire was distributed to the medical staff of NMD during a one-day radiation safety training program organized by the hospital in November, 2013. The same set of questionnaire was administered twice, i.e. before and after the training program

The completed questionnaires were assessed by one assigned researcher and the scores from general radiation knowledge section and radiation safety knowledge section were calculated. The correct answer for each item was awarded one mark, whereas the incorrect answer or omission received a mark of 0. The total aggregate score was presented in the unit of percentage. The data from the pre-test and post-test were collected before and after the training and then were analyzed using Statistical Package for Social Science (SPSS), version 21.0. Two levels of data analysis were performed on the aggregate scores of the pre-test and post-test. The first used descriptive statistics and the second employed hypothesis evaluation statistics. The significant alpha level chosen for all statistical tests was 0.05.

3. RESULT AND DISCUSSION

3.1 Demographic profile of respondents

A total of 27 medical support staff comprising Trained Nurses and Community Nurses who attended a radiation safety training program had participated in this study. The findings

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showed that the distribution of gender was higher for females with a total of 26 respondents (96%). On the other hand, there was only 1 male respondent or 4% out of the total respondents. As for age, the results showed that 26 respondents (or 96%) fell in the age range of 20 – 29 years old while 1 respondent was in the range of 30 – 39 years old. In terms of academic qualifications, 15% of the respondents' education is of certificate level whereas 85% of them are diploma holders. The respondents of this study were identified to have very limited working experience with radiation (0 – 2 years).

3.2 Overall test scores

Descriptive statistics including the total score, maximum score, minimum score, mean, standard deviation, and skewness were calculated for both the pre-test and post-test overall scores (Table 1). The overall test scores showed that the ranges of the total aggregate of the pre-test and post test scores obtained by the medical support staff were 37.50 – 87.50% (mean score = 69.91, standard deviation = 12.01) and 81.25 – 100% (mean score = 92.82, standard deviation = 5.67), respectively. For both pre-test and post-test, the skewness statistics were found approaching zero value, indicating a normal distribution. The distribution of pre-test and post-test total scores is shown in Table 2. For pre-test, 3.7% of the respondents failed this test (total score is less than 50%), while only 25.9% of the respondents scored higher than 80%. As for post-test, although it was observed that all of the respondents scored greater than 80%, only a limited number of the respondents (25.9%) answered all the questions correctly. The results of the item analysis for this study are reported in Yunus et al. (2014).

Based on the paired samples t-test statistics between pre-test and post-test scores (Table 3), it was found that there was a significant increase in terms of total scores of the respondents ($p<0.001$).

TABLE 1: The descriptive statistics of pre-test and post-test total score

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
Total pre-test score	27	37.50	87.50	69.9074	12.01424	-.670	.448
Total post-test score	27	81.25	100.00	92.8241	5.67121	-356	.448
Valid N (listwise)	27						

TABLE 2: The distribution of pre-test and post-test total scores

Number of correct responses	Score (in %)	Total pre-test score			Total post-test score		
		Frequency	Percent	Cumulative Percent	Frequency	Percent	Cumulative Percent
6	37.50	1	3.7	3.7			
8	50.00	1	3.7	7.4			
9	56.25	3	11.1	18.5			
10	62.50	3	11.1	29.6			
11	68.75	7	25.9	55.6			
12	75.00	5	18.5	74.1			
13	81.25	4	14.8	88.9	2	7.4	7.4
14	87.50	3	11.1	100.0	7	25.9	33.3
15	93.75				11	40.7	74.1
16	100.00				7	25.9	100.0
	Total	27	100.0		27	100.0	

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TABLE 3: Paired-samples t-test

		Paired Differences					T	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Total pre-test score - Total post-test score	-22.91667	13.97542	2.68957	-28.44516	-17.38817	-8.521	26	.000

3.3 General radiation knowledge

As for general radiation knowledge, the scores of this are presented in Table 4. The results showed that the ranges of the total aggregate of the pre-test and post test scores obtained by the medical support staff were 37.50 – 100.00% (mean score = 71.76, standard deviation = 16.84) and 75.00 – 100% (mean score = 94.91, standard deviation = 7.15), respectively. For general radiation knowledge section, the distribution of pre-test and post-test total scores is shown in Table 5. For pre-test, 7.4% of the respondents failed this test (total score is less than 50%), while only 37% of the respondents scored higher than 80%. As for post-test, it was observed that 96.3% of the respondents scored higher than 80%, and only 63% of the respondents could answer all of the 8 questions in this section correctly.

TABLE 4: The descriptive statistics of pre-test and post-test scores on general radiation knowledge

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
General radiation knowledge pre-test score	27	37.50	100.00	71.7593	16.83938	-.507	.448
General radiation knowledge pre-test score	27	75.00	100.00	94.9074	7.15493	-1.055	.448
Valid N (listwise)	27						

TABLE 5: The distribution of pre-test and post-test on general radiation knowledge

Number of correct responses	Score (in %)	General radiation knowledge					
		Pre-test score			Post-test score		
		Frequency	Percent	Cumulative Percent	Frequency	Percent	Cumulative Percent
3	37.50	2	7.4	7.4			
4	50.00	3	11.1	18.5			
5	62.50	6	22.2	40.7			
6	75.00	6	22.2	63.0	1	3.7	3.7
7	87.50	9	33.3	96.3	9	33.3	37.0
8	100.00	1	3.7	100.0	17	63.0	100.0
	Total	27	100.0		27	100.0	

3.4 Radiation safety knowledge

For radiation safety knowledge, this section's scores are presented in Table 6. The results showed that the ranges of the total aggregate of the pre-test and post test scores obtained by the medical support staff were 37.50 – 100.00% (mean score = 68.06, standard deviation = 16.01) and 75.00 – 100% (mean score = 90.74, standard deviation = 8.2), respectively. For radiation safety knowledge section, the distribution of pre-test and post-test total scores is

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shown in Table 7. For pre-test, 3.7% of the respondents failed this test (total score is less than 50%), while only 22.2% of the respondents scored higher than 80%. For post-test, it was observed that 88.9% of the respondents scored higher than 80%, and only 37% could answer all of the 8 questions in this section correctly.

TABLE 6: The descriptive statistics of pre-test and post-test scores on radiation safety knowledge

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error
Radiation safety knowledge pre-test score	27	37.50	100.00	68.0556	16.01282	.370	.448
Radiation safety knowledge post-test score	27	75.00	100.00	90.7407	8.19870	-.319	.448
Valid N (listwise)	27						

TABLE 7: The distribution of pre-test and post-test on radiation safety knowledge

Number of correct responses	Score (in %)	Radiation safety knowledge					
		Pre-test score			Post-test score		
		Frequency	Percent	Cumulative Percent	Frequency	Percent	Cumulative Percent
3	37.50	1	3.7	3.7			
4	50.00	5	18.5	22.2			
5	62.50	10	37.0	59.3			
6	75.00	5	18.5	77.8	3	11.1	11.1
7	87.50	4	14.8	92.6	14	51.9	63.0
8	100.00	2	7.4	100.0	10	37.0	100.0
	Total	27	100.0		27	100.0	

Based on the analysis of the sections' scores, it was found that the respondents in general performed slightly better on general radiation knowledge as compared to radiation safety knowledge. As shown in Table 8, there was a significant increase in terms of participants' scores for both sections after the training ($p<0.001$). With this, the researchers have enough evidence to conclude that the radiation safety training program was effective in increasing both general radiation knowledge and radiation safety knowledge of the respondents.

TABLE 8: Paired-samples t-test for sections' scores

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	General radiation knowledge pre-test score - General radiation knowledge pre-test score	-23.14815	18.24766	3.51176	-30.36668	-15.92961	-6.592	26	.000
Pair 2	Radiation safety knowledge pre-test score - Radiation safety knowledge post-test score	-22.68519	16.27477	3.13208	-29.12327	-16.24710	-7.243	26	.000

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3.5 The relationship between general radiation knowledge and radiation safety knowledge

The Pearson product moment correlation coefficient was used to check whether there is a relationship between medical support staff's general knowledge on radiation and radiation safety knowledge. The significance level used is 0.05. The relationships were investigated between the sections' scores, for pre-test (Table 9) and post-test (Table 10). Since both of the correlation coefficient values of the tests are $r \approx 0$ ($r = 0.069$ and $r = 0.087$, respectively), therefore, it was found that there was no significant relationship between general radiation knowledge and radiation safety knowledge for both pre-test and post-test scores.

TABLE 9: Relationship between general radiation knowledge and radiation safety knowledge using pre-test scores

		General radiation knowledge (pre-test)	Radiation safety knowledge (pre-test)
General radiation knowledge (pre-test)	Pearson Correlation	1	.069
	Sig. (2-tailed)		.731
	N	27	27
Radiation safety knowledge (pre-test)	Pearson Correlation	.069	1
	Sig. (2-tailed)	.731	
	N	27	27

TABLE 10: Relationship between general radiation knowledge and radiation safety knowledge using post-test scores

		General radiation knowledge (post-test)	Radiation safety knowledge (post-test)
General radiation knowledge (post-test)	Pearson Correlation	1	.087
	Sig. (2-tailed)		.665
	N	27	27
Radiation safety knowledge (post-test)	Pearson Correlation	.087	1
	Sig. (2-tailed)	.665	
	N	27	27

4. CONCLUSION

Based on the results of this study, the training program provided by the hospital for the medical support staff in the nuclear medicine department was effective in increasing the overall post test scores of the respondents. This finding has supported the results obtained by Dauer et al (2006). However, their achievement in radiation knowledge and radiation safety knowledge is found to be at moderate level. There is a need for in-service training to educate the medical support staff about ionizing radiation knowledge and radiation safety knowledge. It is further recommended that a national study be conducted to determine the level of knowledge about radiation among all the medical support staff in all Malaysian hospitals. There are many factors that can influence the success of effective in-service training. One of the interesting findings of this study was there was no significant relationship between the respondents' general radiation knowledge and radiation safety knowledge. Although the training intervention was found to be effective for increasing cognitive

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knowledge about radiation, it is still unknown whether it implies the same in their practical skills. Further research is recommended to investigate this matter. Future strategies to improve medical support staff's knowledge also need to be investigated, developed, implemented and evaluated.

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APPENDIX.

QUESTIONNAIRE

Section 1 : General Radiation Knowledge

1. Radiation refers to ……

   ☑ Ionizing radiation ☐ Non-ionizing radiation

2. Which of the following radiations will be completely stopped by a piece of paper?

   ☑ Alpha particle ☐ Gamma radiation ☐ X-ray

3. What is the unit of contamination?

   ☑ Bq/cm^2 ☐ Sv ☐ mR/hr

4. What is the annual whole body dose limit for radiation worker?

   ☐ 25 mSv ☑ 20 mSv ☐ 30 mSv

5. What is the annual whole body dose limit for a patient?

   ☐ 150 mSv ☐ 50 mSv ☐ 5 mSv ☑ No limit

   ☐ 100 mSv ☐ 20 mSv ☐ 0.5 mSv ☐ Don't know

6. Which of the following explains the ALARA principle?

   ☐ Assurance Limit Applied to Radiation ☐ Allowable Administered Radiation

   ☑ As Low as Reasonable Achievable ☐ Don't Know

7. Which of the following is more sensitive to radiation?

   ☑ Unborn Child ☐ Child ☐ Adolescent ☐ Adult

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8. A radiation dosimeter provides protection from radiation exposure?

   ☐ True ☑ False

Section 2 : Radiation Safety Knowledge

1. Which of the following is the basic principles of radiation safety :

   ☐ Dosimeter and survey meter ☐ Shielding, dose and time

   ☑ Shielding, time and distance

2. Medical practitioner should …….. the amount of the time in the room with radiation therapy patient in order to decrease radiation exposure

   ☐ Increase ☑ Decrease

3. As the distance between medical staff and radiation source increases, the radiation exposure……

   ☐ Increase ☑ Decrease

4. A shield between a gamma-emitting radiation source and medical staff causes the radiation exposure to ……

   ☐ Increase ☑ Decrease

5. The radiation dose may be reduced by ……

   ☐ Wearing dosimeter ☐ Wearing alarm dosimeter ☑ Moving further

6. What is the annual whole body dose limit for public?

   ☑ 1 mSv ☐ 20 mSv ☐ No limit

7. Radiation Safety Office at respective department will be notified immediately if there is a radiation incident.

   ☑ True ☐ False

8. Which one of the following items is most important from the point of view of radiation safety:

   ☐ Emergency tongs ☑ Survey meter

   ☐ Radiation warning signs ☐ Safety manual

Note: ☑ indicates the correct answer.

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