Knowledge, Perception and Practice of Radiation Protection in Paediatric Imaging Amongst IIUM Medical Imaging Students

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Abstract:

Background: The effects of ionizing radiation are more prevalent in children than in adults because the cells in children are still growing and they have a longer life span compared to adults. As such, safety measures must be undertaken to minimize the medical radiation effects. This study aimed to determine the knowledge, perceptions and practices of IIUM Medical Imaging students on paediatric radiation protection and its' importance in paediatric imaging.

Materials and Methods: This cross-sectional study was carried out on 63 randomly selected second to fourth year undergraduate Medical Imaging students at the International Islamic University Malaysia (IIUM), Kuantan from Jun 2019 to July 2020. Data was collected using a self-developed questionnaire. The relationship between knowledge and perceptions as well as perceptions with practices on paediatric radiation protection and its' importance in imaging were obtained using Spearman rho correlation test.

Result: Most respondents have high level of knowledge, perceptions and practices on paediatric radiation protection and its' importance in paediatric imaging. However, no significant relationships were found between knowledge of paediatric radiation protection and perceptions on the importance of paediatric radiation protection as well as the perceptions on the importance of paediatric radiation protection and practices of radiation protection.

Conclusion: The practice of radiation protection in paediatric imaging is not only influenced by knowledge, perceptions and practices but also other contributing factors such as personal value and experiences.

Keywords: Paediatric imaging, radiation protection, knowledge, perceptions

Introduction:

Paediatric imaging is very challenging, especially on radiation dose and radiation protection issues (Thukral, 2015). This is because paediatric patients are prone to get radiation-induced cancer since their cells are vulnerable to damage even at a low level of ionizing radiation (Krille et al., 2010). Possible types of damage to the DNA molecules are diverse and approximately 90% of the cell damage is repairable. However, subsequent or multiple damages to the same cell are more likely to leave permanent damage (Han & Yu, 2009). As the tissues in paediatrics are more sensitive to radiation compared to adults, it has been reported that for a one-year-old infant the risk of developing cancer is approximately 15 times more compared to an adult for the same radiation dose (Mazrani et al., 2007). In addition, the biological consequences of radiation exposure on paediatric patients are twice more likely to lead to leukemia than adults. The possibility of getting thyroid cancer and breast cancer can be increased by three and four folds respectively on paediatric patients (Yahaya & Hassim, 2015).

Radiation protection is utilized to minimize radiation dose during an x-ray procedure in paediatric imaging (Kasim et al. 2018). The radiographer's ability to manipulate the exposure parameters will aid in producing images of acceptable quality with minimal exposure as endorsed by the International Commission for Radiological Protection (ICRP). Radiographers must be competent to utilize optimum exposure parameters to avoid unnecessary radiation doses (Donya et.al, 2014). Furthermore, positioning and immobilization aids can be used to achieve proper positioning that can aid in producing radiographs of diagnostic quality without having to repeat the radiographic procedure.

However, some radiographers are unbothered on the radiation dose dispensed and this is particularly frustrating (Salerno et al., 2015). Insufficient knowledge and poor perception among radiographers on radiation dose and radiation protection in paediatric patients have been reported as attributing factors (Andreassi et.al, 2015) for the increased paediatric cancer cases. The low radiation protection knowledge can consequently lead to low awareness and competency issues on radiation protection. Health care personnel including Medical Imaging (MI) students might not necessarily possess the required knowledge and awareness to competently carry out radiation protection initiatives. Therefore, the objective of this study is to determine the level of knowledge, perceptions, and practices of radiation protection for paediatric patients among the International Islamic University Malaysia (IIUM) undergraduate MI students.

Materials and Methods:

Study design and population

This cross-sectional study was conducted at the Department of Diagnostic Imaging and Radiotherapy, IIUM, Kuantan Campus from June 2019 until July 2020. Using a simple random sampling method, a total of 63 students were selected from the target population that comprised of second, third and fourth-year undergraduate MI students. The sample size was obtained using Slovin's formulae at a 5% margin of error and at a 95% confident interval. Random sampling was obtained by putting all eligible MI students' names into a box and the participants' names were randomly picked from the box. The inclusion criterion for this study was second to the fourth year undergraduate MI students studying in IIUM Kuantan as they would have at least some clinical exposures in the health care area.

Ethical consideration

Ethical approval was obtained from the Kulliyyah Postgraduate and Research Committee (KPGRC) of KAHS, IIUM Kuantan (KAHS 136/2020) and IIUM Research Ethics Committee (IREC 2020- KAHS DDIR) prior to the study.

Questionnaire development

A set of questions in English consisting of four sections were developed. This questionnaire was first assessed for content validity by a panel of three health professionals. Feedback by the members of the panel led to the revised questionnaire consisting of 18 questions.

The first section of the questionnaire is on the demographic characteristics of the respondents whilst the second section of the questionnaire, the respondents' level of knowledge on the effects of ionizing radiation and radiation protection in paediatric imaging. Each correct answer was given a score of one while no score was given for incorrect answer or unanswered questions. The level of knowledge was categorized as "low" for a score in the range 0-50%, "moderate" for a score in the range of 51-69% and "high" for a score in the range of 70-100% (Khan et al., 2014).

The third section is to determine respondents' perception on the importance of radiation protection for paediatric patients. A 5-point Likert scale was used in this section with responses ranging from "strongly disagree" to "strongly agree". The level of respondents' practice on radiation protection in paediatric imaging was determined in section four by using a 3-point Likert scale. Scores of 3, 2 and 1 respectively were awarded to usually, rarely and never. The scores for these two sections were scored using the cumulative percentage and then categorized into three levels: high (≥80%), moderate (61%-79%) and low (≤ 60%) (Al Rubaish, 2010).

Pilot study

A pilot study was conducted using Google Form on ten IIUM undergraduate MI students as a sample of 10 to 30 respondents has been recommended to be used in the pilot study (Hertzog, 2008; Connelly, 2008). This pilot study was conducted on a group of respondents who met the same criteria mentioned in the study. The internal consistency of the questionnaire was tested by performing the Cronbach's Alpha test of reliability. Cronbach's α value obtained for knowledge, perception and practice were 0.796, 0.777 and 0.789, respectively. The value obtained suggested that the items have a relatively high internal consistency (McCrae et al., 2011).

Actual study

When conducting the pilot study using Google Form, the researcher encountered difficulties in getting the responses from the respondents. Hence, the researcher decided to personally hand out the printed questionnaires to the respondents. The purpose of the study was briefly explained to the randomly selected respondents before the questionnaire was given to them. The respondents' willingness to participate in the study was deemed as granting of consent. The questionnaire was answered anonymously by the respondents and returned to the researcher on the same day.

Statistical analysis

All questions were coded and imported into the IBM Statistical Package for Social Sciences (SPSS) version 23 for analysis. Normality tests for knowledge, attitude and practice were conducted using the Kolmogorov-Smirnov test (Ghasemi & Zahediasi, 2012). The demographic characteristics of the respondents were summarized using descriptive data while the relationship between knowledge and perceptions as well as perceptions with practices on paediatric radiation protection was analysed using Spearman rho statistical test.

Result:

Section A: Demographic data

The demographic data is as in Table 1. There were 12 (18.8%) male respondents and 51 (81.0%) female respondents. Eighteen (28.1%) of them were from the second year, 23 (35.9%) from the third year and the remaining 22 (34.9%) respondents were from the fourth year of study. All respondents have attended the radiation protection course.

Table 1: Demographic data of the respondents (n=63)

	Characteristics	Frequency	Percentage
Gender	Male	12	18.8
	Female	51	81.0
Year	Year 2	18	28.1
	Year 3	23	35.9
	Year 4	22	34.9
Frequency of clinical practice	Once	18	28.1
	Two times	23	35.9
	Four times	22	34.9
Have attended radiation protection course	Yes	63	100.0
	No	-	-

Section B: Respondents knowledge on radiation protection in paediatric imaging

This section consists of eight items, assessed using single response and dichotomous questions. The results obtained are summarized in Table 2.

Most of the respondents (95.2%) knew that MRI uses non-ionizing radiation unlike the general X-ray, computerized tomography (CT scan), orthopantomography (OPG) and fluoroscopy. Additionally, 96.9% of the respondents also answered correctly regarding the cardinal principle of shielding, time and distance. However, 22 respondents (34.9%) did not understand the concept of dose optimization in paediatric imaging. In addition, 41.3% of the respondents reflected poor knowledge on the use of high kVp. Figure 1 shows the level of knowledge amongst the respondents. Most of the respondents attained high scores for all the items in this section. As such, the results indicated most respondents possess positive perceptions of the importance of radiation protection in paediatric imaging. However, some respondents (12.7%) showed low perceptions such as disagreeing that children are at a higher risk of getting cancer due to ionizing radiation.

Table 2: Respondents' knowledge on radiation protection in paediatric imaging

Questions	Correct frequency (Score %)	Incorrect frequency (Score %)
1. MRI is an example of non-ionizing radiation-based modality.	60 (95.2)	3 (4.8)
2. Dose optimization refers to medical exposure must provide the best image quality for the diagnosis irrespective of radiation dose received by the paediatric patient?	41 (65.1)	22 (34.9)
3. Kidney is not a radiosensitive organ	54 (85.7)	9 (14.3)
4. Cardinal principle of radiation protection time, shielding and distance.	61 (96.8)	2 (3.2)
5. Radiation dose received by paediatrics can be reduced by using high kVp	37 (58.7)	26 (41.3)
6. Radiation dose received by paediatrics can be reduced by using low mAs	56 (88.9)	7 (11.1)
7. Radiation dose received by paediatrics can be reduced by avoiding repeat examination	57 (90.5)	6 (9.5)
8. Radiation dose received by paediatrics can be reduced by using AP projection for babies and young children for thoracic examination	41 (65.1)	22 (34.9)

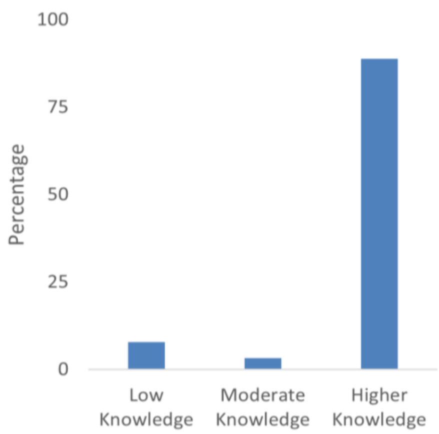

Figure 1: Level of knowledge amongst respondents

Section C: Respondents perception on the importance of radiation protection in paediatric imaging

This section consists of six items with five possible responses using a 5-point Likert scale. The results are tabulated in Table 3.

Most of the respondents attained high scores for all the items in this section. As such, the results indicated most respondents possess positive perceptions of the importance of radiation protection in paediatric imaging. However, some respondents (12.7%) showed low perceptions such as disagreeing that children are at a higher risk of getting cancer due to ionizing radiation.

In addition, 9.5% of the respondents disagree that justification utilizing the principle of "benefit versus risk" is very important in paediatric imaging. Another significant finding is that most of the respondents have the correct perception of the concept on Inverse Square Law that the exposure dose will be one-fourth of the original quantity if the distance from the radiation source is doubled.

Scores for the perception section were categorized into high (positive perceptions), moderate (good perceptions) and low (negative perceptions) as shown in Figure 2.

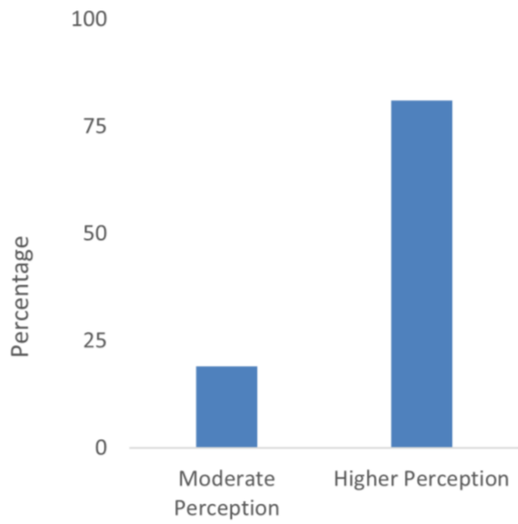

Figure 2: Level of perception amongst respondents

Scores for the perception section were categorized into high (positive perceptions), moderate (good perceptions) and low (negative perceptions) as shown in Figure 2.

Table 3: Respondents perceptions on the importance of paediatric radiation protection

Item	No. of respondents (%)				
	1	2	3	4	5
1. Children are at a higher risk of getting cancer due to ionizing radiation.	5 (7.9)	3 (4.8)	9 (14.3)	**26 (41.3)**	20 (31.7)
2. Proper justification utilizing the principle of "benefit" as opposed risk" is very important in paediatric imaging.	4 (6.3)	2 (3.2)	5 (7.9)	11 (17.5)	**41 (65.1)**
3.Protective shielding should be utilized wisely to reduce unnecessary radiation exposure to other body parts especially the radiosensitive organs during a radiological procedure.	0 (0.0)	2 (3.2)	0 (0.0)	5 (7.9)	**56 (88.9)**
4.The longer the exposure time, the greater the radiation dose received by the paediatric patient.	0 (0.0)	3 (4.8)	1 (1.6)	14 (22.2)	**45 (71.4)**
5. According to the Inverse Square Law, if the distance from the radiation source is doubled, the exposure dose will be one-fourth of the original quantity.	0 (0.0)	1 (1.6)	5 (7.9)	18 (28.6)	**39 (61.9)**
6. Repeat examination may contribute to significant increase in unnecessary patient exposure to radiation.	0 (0.0)	0 (0.0)	0 (0.0)	10 (15.9)	**53 (84.1)**

(5= strongly agree, 4= agree, 3= unsure, 2= disagree, 1= strongly disagree)

Table 4: Respondents practice of paediatric radiation protection

	*No. of respondents (%)		
	1	2	3
1. During clinical practice, I will limit the exposure (s) given to the paediatric patient to what is necessary for the diagnosis.	0 (0.0)	2 (3.2)	61 (96.8)
2. I will use gonadal shielding whenever possible without obscuring the region of interest.	1 (1.6)	7 (11.1)	55 (87.3)
3.I will use a shorter exposure time to avoid motion blurring in the image produced.	5 (7.9)	16 (25.4)	43 (66.7)
4. I will ensure proper positioning to avoid repeat examination.	2 (3.2)	3 (4.8)	59 (92.1)

*(3= usually, 2= rarely, 1= never)

Section D: Respondents practice of radiation protection in paediatric imaging

This section consists of only four items and were assessed using a 3-point Likert scale. The results are summarized in Table 4.

During the clinical practice, 96.8% of the respondents alleged limiting the exposure to paediatric patients while the remaining 3.2% indicated rarely practicing it. Also, most of the respondents (87.3%) usually use gonadal shielding whenever possible. In addition, 7.9% of the respondents claimed they do not use short exposure time whilst another 3.2% of respondents claimed that they never bother to position paediatric patients properly during the imaging examination. The respondents' practice on paediatric radiation protection is further categorized into high (good practice), moderate (moderate practice) and low (poor practice) as in Figure 3.

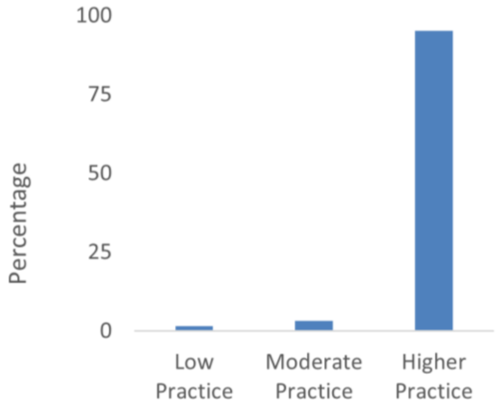

Figure 3: Level of radiation protection practices amongst respondents.

Relationship between knowledge of radiation protection and perception of paediatric radiation protection (K-P) and perception of radiation protection and radiation protection practice for paediatric patients (P-P)

The test of normality was carried out using Kolmogorov-Smirnov test. A p-value of <0.05 indicated the data was not normally distributed as shown in Table 5. Hence, the non-parametric test using Spearman rho coefficient test was utilized to ascertain the fore-mentioned relationships. Table 6 shows the correlation between knowledge on radiation protection and perceptions on the importance of paediatric radiation protection and perceptions on the importance of radiation protection and the practice of paediatric radiation protection.

Table 5: Results of the normality test

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Knowledge	.521	63	.001	.364	63	.001
Perception	.494	63	.001	.479	63	.001
Practice	.535	63	.001	.216	63	.001

Table 6: Correlation between knowledge and perceptions

Variable	rho	*p*-value
Knowledge, Perceptions	0.080	0.536
Perceptions, Practices	0.078	0.542

(Statistically significant at $p < 0.05$)

There is a very weak insignificant correlation between the knowledge of paediatric radiation protection and perceptions on the importance of paediatric radiation protection (r=0.080, p>0.05). Additionally, no significant correlation is indicated between perceptions on the importance of paediatric radiation protection and the practice of paediatric radiation protection amongst the respondents (r=0.078, p>0.05).

Discussion:

The findings of this study indicated that IIUM undergraduate MI students are highly knowledgeable about ionizing radiation and radiation protection in paediatric imaging. This can be expected because they have been exposed to a holistic radiation protection course that includes both theoretical and practical training. In theoretical education, basic principles of radiation protection were thought along with radiobiological risk factors and dose reduction strategies (Ploussi & Efstathopoulos, 2016). This study revealed that the year of study also affects the level of knowledge of respondents on paediatric radiation protection. This is probably due to the higher duration of attachment in the clinical area for the fourth-year respondents compared to the other respondents.

Moreover, this study indicated that the respondents have high positive perceptions of the importance of radiation protection in paediatric imaging. Findings from a literature indicated a strong association between knowledge and dispositional perception (Goodin et al., 2013). If the association is positive, it gets stronger with an increase in knowledge (Kleiner et al., 2013). This positive perception is very important in paediatric imaging because it determines an individual's commitment to implement safe methods and proper techniques to prevent excessive radiation exposure to pediatric patients (Ploussi & Efstathopoulos, 2016).

In addition, the relationship between the knowledge of radiation protection and the perceptions on the importance of paediatric radiation protection was found to be insignificant. This is because basic knowledge alone is insufficient to develop a positive perception (Sarman & Hassan, 2016). Personal values, on the other hand, have a major influence on one's perception as it denotes one's understanding regarding the importance of a particular action. Positive personal values such as integrity and accountability will likely result in positive perceptions (Klinger & Mallon, 2015). As such, a positive perception of the utilization of radiation protection in paediatric imaging is not only dependent on the knowledge of the radiographer but also the values that the radiographer holds.

The practice of radiation protection during clinical practice amongst IIUM MI students is good as the respondents reflected positive perceptions on the importance of radiation protection in paediatric imaging. Added to their high level of knowledge, it helps to shape their way of thinking in making correct decisions and relevant actions (Sindi et al., 2017). Adopting good radiation protection practices during the radiological examination such as using optimum exposure and avoiding retakes of examination (Saia, 2011) is vital to ensure the safety while minimizing the biological effects to the paediatric patients.

The respondents of this study indicated that they would practice radiation protection on patients irrespective of their perceptions. This indicated other factors can influence the practice of radiation protection in the health institutions such as years of service of radiographers which determines their experience. Experiences of the radiographers are required to tailor the needs of paediatric patients such as to avoid repeated examinations, which then reduces the radiation dose received by the patients (Alzen & Benz-Bohm, 2011). Experienced radiographers are believed to have critical mindedness in observing such situations, which results in appropriate actions to optimize the use of radiation protection without compromising the quality of the images produced (Ploussi & Efstathopoulos, 2016).

Conclusion:

It is important that healthcare learners involved with radiation are aware of the importance of paediatric radiation protection. This is important so that they will practice radiation protection measures in ensuring the radiation dose dispensed adheres to the dose limits specified by ICRP (WHO, 2014). In conclusion, this study reflected three elements; knowledge, perceptions and practices amongst future radiographers on paediatric radiation protection are still insufficient for the execution of effective radiation protection initiatives if the fore-mentioned contributing factors are not included.

Limitations:

There were some limitations in this study that should be considered. Firstly, the responses obtained from the respondents might not reflect their level of knowledge, perception and practice if respondents do not provide truthful answers. Secondly, as this is a quantitative study, perceptions and feelings cannot be elicited in-depth from this study. Lastly, the findings of the study can only be generalized to the MI students of IIUM Kuantan.

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