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Knowledge and attitude of radiation safety and the use of protective measures among healthcare workers in a tertiary center

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Abstract. – OBJECTIVE: World Health Organization (WHO) reports that medical applications used in different fields account for the majority of the artificial source of radiation. Due to the high exposure to ionizing radiation, healthcare workers (HCWs) and patients are considered at high risk of suffering its harmful effects.

SUBJECTS AND METHODS: A questionnaire survey was used to conduct a cross-sectional study that aimed to estimate the radiation safety, knowledge, attitude and the use of protective measures among HCWs in a tertiary hospital.

RESULTS: A total of 174 participants were included in our study, the majority of them were physicians (100, 57.1%), nurses staff were 67 (38.3%), and the technicians were 8 (4.6%). Across the entire spectrum, the low level of attitude toward radiation safety was 96 (54.8%), majority of them were physicians 69 (71.9%). On the other hand, the high level of attitude toward radiation safety was 79 (45.2%), majority were nurses staff 42 (53.2%). Regarding the knowledge of radiation safety, out of all low-level attitudes, 53 (55.2%) had knowledge about the optimal thickness of the lead shield, 80 (83.3%) had knowledge about leukemia and lymphoma, 56 (58.3%) had knowledge regarding cataract, and 70 (72.9%) had knowledge regarding birth defect.

CONCLUSIONS: Our study found that the majority of our physicians had a low attitude regarding radiation safety, although the majority of them were found to have knowledge about it. A recommendation for solid curricular application of radiation safety should be implemented in medical schools, postgraduate with continuous training, and practical courses which may help to improve the level of attitude and knowledge among HCWs regarding radiation safety.

Key Words:
Fluroscopy, Protection, Healthcare workers.

Introduction

Radiation technologies are evolving and are being used substantially in different fields. World Health Organization (WHO) reports[1] that medical applications account for the majority of the artificial source of radiation. Currently, fluoroscopic imaging is commonly used in a variety of procedures on a daily basis in different departments in the hospital.

Healthcare workers (HCWs) and patients are exposed to ionizing radiation. Therefore, they are at risk of developing well-established links to mutations and carcinogens that may lead to short-term effects (deterministic effects) and long-term effects (stochastic effects) such as malignancies. The damage is proportionally dose and duration-dependent. Therefore, guidelines were implemented, and strong recommendations were stated by the International Commission on Radiological Protection[2] (ICRP) for dose limitation of ionizing radiation as known as "As Low As Reasonably Achievable (ALARA)". The ALARA principle emphasizes decreasing the exposure time, using protective measures, and increasing the distance from the radiation source.

Despite the guidelines and recommendations by the ICPR[3], physicians who are routinely exposed to fluoroscopy are not adequately trained in radiation safety, and the majority have received informal education, as reported from a study[4] in USA. Locally, only 20% of physicians have received formal education in radiation safety in a multi-center study[5].

In this study, we assessed the radiation safety knowledge, attitude, and the use of protective

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measures among HCWs in a tertiary hospital in Riyadh, Saudi Arabia, in King Abdulaziz Medical City (KAMC). We hypothesize that the level of formal education in radiation safety is lacking, and a solid curricular application of radiation safety should be implemented in medical school, postgraduate, and a higher level of training.

Subjects and Methods

This is a cross-sectional study that aims to estimate the knowledge and attitude of radiation safety and evaluate the association between radiation safety knowledge and the use of protective measures at a single point in time among KAMC's HCWs.

A questionnaire was created, which consists of three parts. The first part included some baseline characteristics such as age, gender, specialty, level of training, and the frequency of radiation exposure. The second part included the use of protective measures such as the lead apron, leaded gloves, etc. The last part assessed the knowledge about diagnostic imaging. The first and second parts assessed the baseline demographics and frequencies using a Likert scale of frequencies and no need for validation, in the last part the knowledge was assessed by questions that have been widely used by a previous published studies questionnaire[4]. Unfortunately, no validated questionnaire is available in the literature for the knowledge of diagnostic imaging. The questionnaire was sent using SurveyMonkey. All e-mails were collected from the departments, and a reminder was sent after two weeks. After 2 weeks, a self-administered questionnaire was distributed to those who did not fill the questionnaire.

Statistical Analysis

All categorical variables were presented as numbers and percentages. Continuous variables were presented as mean ± standard deviation (SD). A level of attitude score was calculated by taking the average of the responses to the 12 items of protective measures. Scores were rounded to the nearest whole integer. A score of 3 and above indicated a high-level attitude towards safety measures, whereas a score lower than 3 indicated a low-level attitude.

Pearson's Chi-square or Fisher's exact test was used to determine significant relationships between categorical variables. A two-tailed *p*-value lower than 0.05 was considered significant for all comparisons. Data were entered and analyzed using SPSS Version 25.0 for Windows (IBM Corp., Armonk, NY, USA).

Results

We identified 174 participants who met the criteria of the study. Of the total population of the study, 109 (62.3%) were male, and 66 (37.7%) were female. The response rate after the self-administered questionnaire was 72%. The mean age of the study population was 36.25 ± 8.95 years old. Of the total population, physicians were 100 (57.1%), nurses staff were 67 (38.3%), and technicians were 8 (4.6%). We found out that 41 (23.4%) of the participants received formal education about radiation safety. The majority of physicians' specialties were Orthopedic 33 (33%), Urology and Plastic surgery were 14 (14%) each, Neurosurgery was 13 (13%), Vascular surgery was 7 (7%), Gastroenterology was 6 (6%) Interventional Radiology and Cardiology were 5 (5%) each, and Electrophysiology were 3 (3%) (Table I).

We have found that across the entire spectrum, the low-level attitude toward radiation safety was 96 (54.8%), while the high-level attitude was 79 (45.2%). The majority low-level attitude was among males, 69 (71%), with a significant (*p*-value=0.004). The majority of the low-level attitude toward radiation was detected in physicians, which was 69 (71.9%), while nurse staff was 25 (26%) and in technicians 2 (2.1%). On the other hand, the majority of the high-level attitude toward radiation safety was among nurses staff 42 (53.2%) and was statistically significant (*p*-value = 0.001). There is a significant association between orthopedic surgeons and a low-level attitude toward radiation safety. The majority of low-level attitude was among Orthopedics 28 (40.6%), Plastic Surgery (17.4%), Urology 10 (14.5%), Neurosurgery 9 (13%), Vascular Surgery 5 (7.2%), Interventional Cardiology and Gastroenterology 2 (2.9%) (Table II).

Out of all participants, we have found that the level of attitude regarding lead apron was high in 159 (91.4%) and thyroid shield were 88 (50.6%), and eyeglasses were 21 (12.0%) (Table III).

Regarding radiation safety knowledge, out of all low-level attitudes, 53 (55.2%) were found to have knowledge about the optimal thickness of the lead shield, 80 (83.3%) had knowledge about the fact that leukemia and lymphoma are believed

Table I. Demographic characteristics of participant regarding radiation safety knowledge and attitude.

Variables	Description	N (n%)
Gender	Male	109 (62.3%)
	Female	66 (37.7%)
Age (years)	Mean ± SD	36.25 ± 8.95
Occupationa	Physician	100 (57.1%)
	Nurse	67 (38.3%)
	Technician	8 (4.6%)
Physicians	Orthopedics	33 (33.0%)
	Urology	14 (14.0%)
	Plastic Surgery	14 (14.0%)
	Neurosurgery	13 (13.0%)
	Vascular Surgery	7 (7.0%)
	Interventional Cardiology (IC)	5 (5.0%)
	Electrophysiology (EP)	3 (3.0%)
	Interventional Radiology (IR)	5 (5.0%)
	Gastroenterology	6 (6.0%)

Table II. Association between demographic characteristics of participants and attitude level of radiation safety.

Characteristics	Descriptions	Low level of attitude of radiation safety protective measures (n = 96)	High level of attitude of radiation safety protective measures (n = 79)	*p*-value
Gender	Male	69 (71.9%)	40 (50.6%)	0.004
	Female	27 (28.1%)	39 (49.4%)	
Occupation	Physician	69 (71.9%)	31 (39.2%)	< 0.001
	Nurse	25 (26.0%)	42 (53.2%)	
	Technician	2 (2.1%)	6 (7.6%)	
Speciality	Orthopedics	28 (40.6%)	5 (16.1%)	0.002
	Urology	10 (14.5%)	4 (12.9%)	
	Plastic Surgery	12 (17.4%)	2 (6.5%)	
	Neurosurgery	9 (13.0%)	4 (12.9%)	
	Vascular Surgery	5 (7.2%)	2 (6.5%)	
	Interventional Cardiology (IC)	2 (2.9%)	3 (9.7%)	
	Electrophysiology (EP)	1 (1.4%)	2 (6.5%)	
	Interventional Radiology (IR)	0 (0.0%)	5 (16.1%)	
	Gastroenterology	2 (2.9%)	4 (12.9%)	

to be related to radiation exposure, 56 (58.3%) had knowledge regarding cataract related to radiation exposure, 70 (72.9%) had knowledge regarding a birth defect in children and its related to radiation exposure. On the other hand, out of all high-level attitudes, 55 (69.6%) were found to have knowledge about the optimal thickness of the lead shield, and 59 (74.7%) had knowledge that leukemia and lymphoma are believed to be related to radiation exposure, 53 (67.1%) had knowledge regarding cataract related to radiation exposure, 65 (82.3%) had knowledge regarding a birth defect in children which is related to radiation exposure (Table IV).

Table III. Level of attitude regarding protective measures.

Attitude of radiation safety measures	Descriptions	N (n%)
Level of attitude of lead apron	Low level attitude	15 (8.6%)
	High level attitude	159 (91.4%)
Level of attitude of thyroid shields	Low level attitude	86 (49.4%)
	High level attitude	88 (50.6%)
Level of attitude of eye glasses	Low level attitude	154 (88.0%)
	High level attitude	21 (12.0%)

Table IV. Association between knowledge of radiation safety and level of attitude.

Characteristics	Descriptions	Low level of attitude toward radiation safety protective measures (n = 96)	High level of attitude toward radiation safety protective measures (n = 79)	*p*-value
The optimal thickness of the lead shield used for rotection against radiation is 0.5 mm.	True False	53 (55.2%) 43 (44.8%)	55 (69.6%) 24 (30.4%)	0.051
Leukemia and lymphoma are believed to be potentially related to radiation exposure.	True False	80 (83.3%) 16 (16.7%)	59 (74.7%) 20 (25.3%)	0.159
Cataracts are believed to be potentially related to radiation exposure.	True False	56 (58.3%) 40 (41.7%)	53 (67.1%) 26 (32.9%)	0.234
Birth defects in children conceived after fluoroscopic exposure are believed to be potentially related to radiation exposure.	True False	70 (72.9%) 26 (27.1%)	65 (82.3%) 14 (17.7%)	0.142

Discussion

Radiation safety is a concern for patients and HCWs in many departments, including Orthopedic, Urology, Interventional Radiology, and many others. Having a high level of knowledge and attitude about radiation can reduce the harmful effects of radiation. Furthermore, some studies[6] suggest that the potential risk for patients and health staff were alike. Our study found the majority of low attitudes regarding radiation safety were among males, while other studies conducted by Khamtuikrua and Suksompong[7], and Karami et al[8], found that men had high standards regarding radiation safety. The level of attitude regarding radiation safety among physicians, nurses, staff, and technicians could be an initial step to reduce its harmful side effects. Therefore, our study found that the majority of low-level attitude was among physicians, and the majority high-level attitude was among nurses and staff, while a study conducted by Jones et al[9] found that physicians had the highest score regarding the attitude toward radiation safety, and physician's assistant (nurses staff) were the lowest. In addition, Llurda-Almuzara et al[10] found that nurses have poor knowledge of radiation safety. Another study[11] conducted in Turkey found that physicians had higher knowledge regarding radiation safety and were statistically significant.

Due to increased exposure, many specialties are considered at high risk, including Orthopedic surgery, Urology, Plastic Surgery, Neurosurgery, Interventional Radiology, and Interventional Cardiology. In our study, the majority of orthopedic, plastic surgeons, and urologists were found to have a low-level attitude and were statistically significant, although some studies[4,12] found that orthopedics, neurosurgeons, and urologists had a good attitude regarding wearing protective radiation materials.

Numerous studies in literature have investigated the frequency of using protective measures among HCWs. In our study, 91% of participants had a good attitude about wearing a lead apron, around half of the participants had a low attitude about wearing a thyroid shield, and only 12% had a high attitude about lead goggles. A study conducted by Khamtuikrua and Suksompong[7] found that 78.5% of the participants wore a thyroid shield, but only 31.3% of them wore lead goggles. In controversy, a study[13] found that electrophysiologists use eye lead glasses in 40% of the cases. In regard to the use of dosimeters, our study showed that around 67% have never used dosimeters. While another study[14] showed that 38% of physicians have used dosimeters.

Regarding the knowledge of radiation safety, surprisingly, the majority of participants who had a low level of attitude regarding radiation safety were found to have knowledge about the optimal thickness of lead apron and possible harmful effects of radiation, including leukemia, lymphoma, cataract, and a birth defect that could happen after radiation exposure.

Limitations

There are several limitations to our study. First, its cross-sectional design and the self-administered questionnaire might lead to a recall bias. Second, the limited number of staff in some specialties, such as electrophysiologists, might not represent the specialty. Finally, the study was carried out in a single center, and the results might not be generalized. Future studies in a multi-center with prospective nature are encouraged to estimate the exact relevance of radiation safety of protective measure used.

Conclusions

This study documents a low level of attitude and low formal education in radiation safety among HCWs using radiation. A recommendation for solid curricular application of radiation safety should be implemented in the medical school, postgraduate, and a higher level of training to ensure radiation safety.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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The study was not funded.

Ethics Approval

The study was approved by King Abdullah International Medical Research center (KAIMRC).

Authors' Contribution

Dr. Alkhayal and Dr. Alathel conceived and designed the study, conducted research, provided research materials, and collected and organized data. Dr. AlMaslamani, Dr. Alfehaid and Dr. Alhassan analyzed and interpreted data and provided logistics. Dr. Alothman wrote the initial and final draft of the article, and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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