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ORIGINAL ARTICLE

Awareness of Radiation Dose and Incurred Risk Among Clinicians at a Tertiary Care Hospital in Bahrain

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Abstract

Background & Objectives: Literature has raised concern about the inadequate knowledge of radiation dose and risk among referring clinicians for radiological procedures. Therefore, we surveyed to assess the knowledge of radiation protection and dose assessment among clinicians.

Methods: A cross-sectional web-based survey where the link was circulated to 87 clinicians who requested diagnostic radiological imaging. A validated questionnaire consisted of 20 multiple-choice questions divided into three sections, viz, demography, awareness of radiation risk, and knowledge of radiation dose, were asked to reply.

Results: A total of 87 physicians from 15 different medical specialties were included in the analysis. Interns had the highest knowledge score in radiation protection (59.5%, P=0.198), while the dose assessment score was highest among radiologists (50.8%, P=0.013). The average knowledge of radiation protection was 43% ± 17%, and awareness of radiation dose was 30% ± 18%. Clinicians having experience >20 years were found with the least score (33.3%) of radiation protection knowledge, while those with <3 years of experience showed a better score (48%, P=0.064). Clinicians who claimed to be attending radiation protection courses regularly were found with better scores of knowledge (47.6%, P=0.340) and dose assessment (37%, P=0.161), although the difference was nonsignificant.

Conclusion: The clinician's knowledge of radiation protection and dose assessment is inadequate which could infer a propensity of the inappropriate use of radiation imaging. There is a substantial need for training/refresher courses to improve the knowledge of radiation dose and consequent risk in order to assure patient safety during radiological examinations.

Keywords: Ionizing radiation, Radiation dose, Risk awareness, Radiological examination, Diagnostic imaging

Introduction

The use of Ionising radiation in medical imaging examinations to diagnose diseases is increasing in modern medicine. Medical applications such as X-rays, computed tomography (CT scans), and mammography represents the most radiation doses from man-made sources to which the referred patients get exposed. Although the radiation dose is low in diagnostic applications, attention is given to avoid unnecessary exposure for patients and occupational workers during X-rays exposure. Evidence shows that medical uses of radiation have harmful effects. X-ray radiation has dose-dependent adverse effects that increase the risk of developing genetic mutations and causing cancer.[1]

The epidemiological evidence-based data reported that the lowest radiation dose for causing cancer is around 10–50 mSv for acute exposure and around 50–100 mSv for prolonged exposure. This is a clear warning that the risk of developing cancer after radiation exposure is increasing, depending on the dose and duration of the exposure.[2] Therefore, the referring clinician should be responsible for judging whether it is suitable for the patient to undergo radiation examinations, considering the expected risk involved.[3] This judgment requires clinicians to have a knowledge and awareness of radiation doses and associated risks due to specific imaging procedures.[4]

Interventional radiological procedures, if accurately used, provide life-saving treatment in various clinical settings. However, inappropriate use of them can lead to unnecessary exposure to radiation, which remains associated with long-term risk for many ailments. The international commission on radiological protection (ICRP) has given recommendations for the system of radiological protection, stating: No practice involving radiation exposure should be adopted unless it produces a sufficient benefit to the exposed individual or society and concerning any particular source within a practice, the magnitude of individual doses, the number of people exposed and the likelihood of incurring exposures where these are not certain to be received should be kept as low as reasonably achievable (ALARA).[3] Previously published reports demonstrate that the knowledge of referring doctors about radiation doses and risks incurred during diagnostic radiological procedures is deficient.[3,5-9] It is also reported that medical students have insufficient knowledge of radiation dose and its associated risks.[1, 8, 10-12]

Although the literature raised the concern about radiation and potential risk during medical imaging are one of the leading concerns for clinicians who refer for diagnostic imaging, we found a lack of literature conducting studies to evaluate the knowledge of ionizing radiation protection and assessment of dose among clinicians at Bahrain Defence Force-Royal Medical Services (BDF-RMS) Hospital. While doing a literature search, we came across a single study conducted in Bahrain concerning awareness and knowledge of ionizing radiation risks among patients but not among clinicians. Therefore, this study aimed to evaluate the knowledge of radiation protection and dose assessment among clinicians who refer for imaging procedures regularly at BDF-RMS Hospital.

Methods

Ethical Consideration

The study protocol was reviewed and approved by the research & research ethics committee of Bahrain Defence Force-Royal Medical Services (BDF-RMS) Hospital (Registration No. 2019-511). BDF-RMS is a tertiary care, 481-bedded hospital with 19 different specialized units in the Kingdom of Bahrain.

Inclusion and exclusion criteria

The clinicians who regularly refer patients for radiological imaging, irrespective of their year of work experience and irrespective of their specialties and subspecialties, were included in this study. While other clinicians, for example, dermatology, microbiology, pathology, etc., who do not refer patients for radiological imaging were excluded from this study.

Sample size calculation

Sampling Method: In this study, non-probability sampling (voluntary sampling) methods were used to collect data. A web-based link for the questionnaire

was distributed to 131 clinicians who were eligible for the inclusion and exclusion criteria. Of 87 (66%), clinicians completed the questionnaire.

Participants

A prospective cross-sectional study was conducted at BDF-RMS Hospital from August to September 2021. Participants were from different specialty units such as; emergency medicine, internal medicine, radiation, anesthesia, family medicine, interns, orthopedic surgery, general surgery, neurosurgery, obstetrics & gynecology, critical care, ENT, vascular surgery, urology, plastic surgery, and ophthalmology. The survey was voluntary, and all responses were confidential and anonymous.

Instruments and Variables

This study used a validated questionnaire with permission from the authors.[8] It consisted of 20 questions in a multiple-choice format and was divided into three sections.

Section 1 was about the participants' demographic features (i.e., sex, age, knowledge of radiation risk, and ever-attended radiation protection training).

Section 2 was about radiation protection knowledge consisting of seven questions assessing: (1) radiation standards, (2) susceptibility to radiation damage, (3) regulations, (4) knowledge about professionals with a higher exposure risk, (5) tissues more susceptible to injury from ionizing radiation, (6) diseases caused by radiation damage, and (7) knowledge about dose optimization.

Section 3 was about knowledge of radiation dose consisting of nine questions assessing: (1) the average dose of a posteroanterior chest X-ray (considered as a standard reference unit to compare radiation exposure from different radiological examinations); (2) background radiation dose absorbed by the general population;(3) lumbar spine X-ray dose; (4) mammography dose (bilateral, two projections per side); (5) chest CT dose; (6) pelvic magnetic resonance imaging (MRI) dose; (7) Whole body PET-CT scan dose; (8) abdominal ultrasound (US) dose; (9) myocardial scintigraphy dose (2-day protocol with99mTC-sestamibi).[8]

Statistical Analysis

Scores for "radiation protection knowledge" and "radiation dose assessment" were calculated based on the percentage of correctly answered questions from section 2 and section 3. The association between Section 1 and the scores was investigated using Kruskal Wallis. A P-value less than 0.05 was considered statistically significant. All analyses were performed using SPSS Statistics for Windows, version 25.0 (IBM Corp., Armonk, NY).

Results

Knowledge of radiation protection and assessment of dose

A total of 87 participants were included in the analysis who responded to the questionnaire. The distribution of the knowledge scores is illustrated in Figures 1A and B. Knowledge score stratified by personal details is shown in table 1. The average knowledge of radiation protection was 43% ± 17%, and the average awareness of radiation dose was 30% ± 18%. None of the respondents gave correct answers to all the questions asked, either from knowledge or dose-related questionnaires. Only 2 participants correctly answered 6 out of 7 questions (85.7%) of knowledge-related questions, while just 1 participant correctly answered 7 out of 9 questions (77.7%) of dose-related questions. Above 50% of correct answers were given by 19 participants on knowledge-based questions and 5 on dose-based questions (Figures 1 and 2).

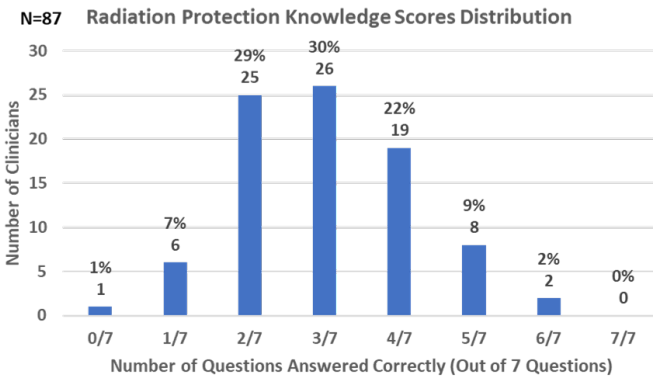

Figure 1: Assessment of radiation protection knowledge among clinicians

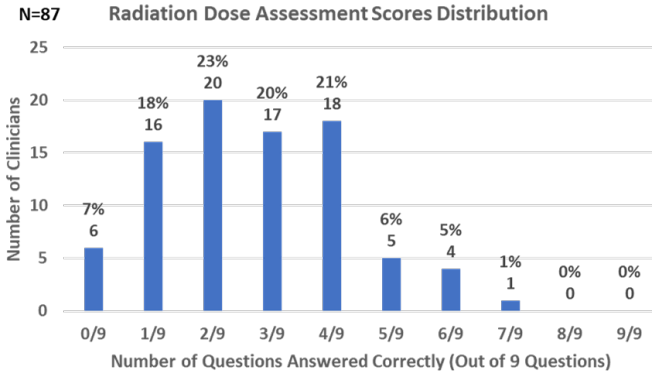

Figure 2: Assessment of knowledge about radiation dose among clinicians

Respondent's replies to radiation protection knowledge and radiation dose assessment.

Further to give more clarity about the respondent's replies for each question related to radiation protection knowledge and radiation dose assessment, the list of all the questions, long with the percentage of correct versus incorrect answers, is given in Figure 3 and Figure 4. Out of 7 questions related to radiation protection knowledge, >50% of correct answers were received for only two questions (questions 1 and 3, Figure 3), and 86.2% of participants failed to correctly reply to the question, the most sensitive organ for IR. While, out of 9 questions related to radiation dose assessment, >50% of correct answers were received only for question 6 (Figure 4), and 96.6% of participants failed to correctly answer the question related to the natural background radiation (question 2, Figure 4). Overall, the knowledge level of participants was inferior in the assessment of radiation dose over the knowledge of radiation protection.

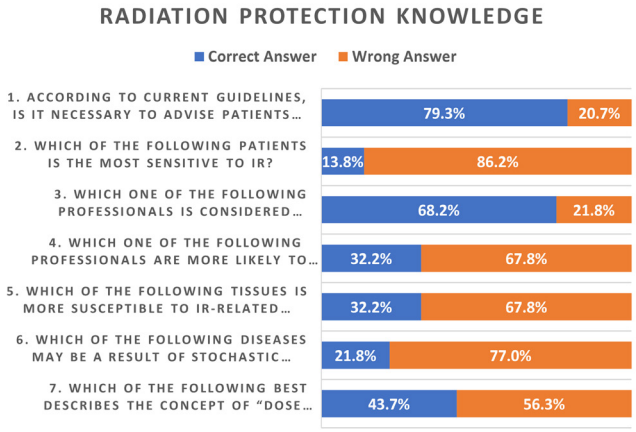

Figure 3: Demonstrates the percentage of participants' replies to each of the seven questions related to radiation protection knowledge.

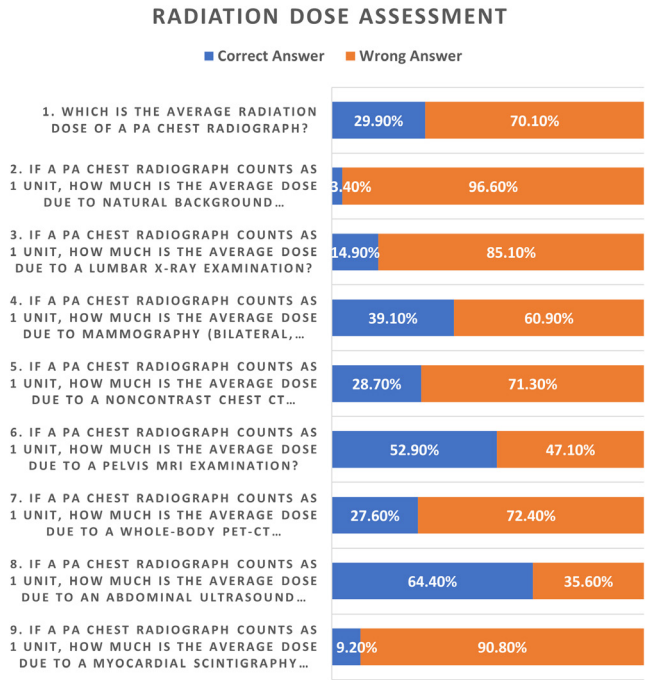

Figure 4 Demonstrates the percentage of participants' replies to each of the nine questions related to radiation dose assessment.

Different specialties and radiation knowledge and dose assessment

The participants were from more than 15 different specialties. The most frequent specialties were emergency medicine, internal medicine, and radiology. Some were with low frequencies, merged, and considered as others for analysis (Table 1). The highest score was achieved by interns (59.5%), followed by radiologists (51%) by answering correctly to the questions on radiation prevention knowledge (P=0.198). In contrast, radiologists achieved the highest score by answering 50.8% correctly of the questions on dose assessment. Anesthetists received the second-highest score in this group by answering 37.0% correctly (P=0.013) (Table 1).

Comparison between the age groups

We categorized the participants into four age groups. Around half of the participants were aged 25-35 (47%). It was observed that, in the 25-35 age group, correct answers were given were 46.3%, while in the age group of 56-65, only 31.0%, which was insignificant (P=0.065, Table 1). However, concerning dose assessment, the 56-65 age group participants gave correct answers were 31.5%, while the 25-35 age group was 30.6% (P=0.941, Table 1).

Table 1: Participants' personal details and their association with knowledge of radiation protection and radiation dose

Variable	N (%)	Radiation Protection (Average percentage of correct answers)	*P†*	Radiation Dose (Average percentage of correct answers)	*P†*
Specialty			0.198		0.013*
Emergency Medicine	23 (27)	38.5 %		31.9 %	
Internal Medicine	11 (13)	41.6 %		23.2 %	
Radiology	7 (8)	51.0 %		50.8 %	
Anaesthesia	6 (7)	50.0 %		37.0 %	
Family Medicine	6 (7)	45.2 %		22.2 %	
Interns	6 (7)	59.5 %		18.5 %	
Others	27 (31)	39.7 %		28.4 %	
Age			0.065		0.941
25-35	41 (47)	46.3 %		30.6 %	
36-45	20 (23)	45.7 %		30.0 %	
46-55	20 (23)	37.1 %		17.6 %	
56-65	6 (7)	31.0 %		31.5 %	
Level of Experience			0.064		0.295
< 3	28 (32)	48.0 %		33.7 %	
4-10	19 (22)	43.6 %		28.7 %	
11-20	24 (28)	42.9 %		25.0 %	
> 20	16 (18)	33.9 %		32.6 %	
What is your knowledge level about ionizing radiation (IR)-related risks?			0.837		0.158
Insufficient	32 (37)	41.5 %		27.4 %	
Sufficient	32 (37)	43.8 %		35.1 %	
Good	17 (19)	43.7 %		24.8 %	
Excellent	6 (7)	45.2 %		31.5 %	
Have you ever attended training events and/or refresher courses on radiation protection?			0.340		0.161
No, never	66 (76)	44.0 %		28.1 %	
Yes, seldom	15 (17)	37.1 %		35.6 %	
Yes, always	6 (7)	47.6 %		37.0 %	

† Using Kruskal Wallis Test

Levels of work experience and radiation knowledge of dose exposure

About half of the participants were with less than ten years of experience. When we evaluated the level of work experience, the participants who had <3 years of experience were found with 48% of correct answers, whereas 4-10 years of experience correctly answered for 43.6%. Participants with>20 years of experience presented poor performance; the correct answers were only 33.9% (Table 1). In response to the questions related to dose assessment, participants with <3 years of experience correctly answered 33.7%, while >20 years correctly answered 32.6% (p=0.295).

Influence of training in radiation on knowledge and dose exposure

Of 87 participants, only 7.0% attended radiation protection training/refresher courses regularly, while 37.1% and 44.0% seldom attended or never attended such courses, respectively. The participants who attended radiation protection training/refresher courses received the highest scores in correctly answered radiation protection (47.6%) as well as dose assessment (37%) questionnaires, as compared to those who rarely or never attended knowledge-enhancing courses (P=0.340). Similar annotations we noted in the case of dose assessment replies; those who regularly attend training courses replied with 37.0 % of correct answers. In contrast, only 28.1% of correct answers were received from those who never attended training courses (P=0.161) (Table 1).

Only about 45.2% and 43.8% of the participants claimed to have excellent and sufficient knowledge of radiation protection issues (P=0.837) and 31.5% and 35.1% of dose assessment-related issues (P=0.158), respectively (Table 1).

We noted the highest deficiencies in radiation protection knowledge were in the questions related to radiation sensitivity, and radiation as a cause of diseases. The highest deficiencies in radiation dose assessment were in the questions related to the natural background radiation, average dose due to myocardial scintigraphy, and average dose due to a lumbar x-ray examination.

Discussion

Our observational study indicates that clinicians and interns' knowledge and practice pertaining to radiation exposure in a radiological examination is poor as the average knowledge of radiation protection observed was 43% ± 17%, and the average awareness of radiation dose was 30% ± 18%. Although radiologists are expected to be experts in the medical imaging specialty, their knowledge score was below the range of our expectations. However, they still scored the best regarding radiation dose assessment among their other colleagues in medical specialties. The results of our study are not different from other previously published reports. They have also raised concerns about the lack of awareness of radiological issues among medical students, interns, and physicians of radiological and non-radiological specialties.[5, 14-16] No research has been performed on radiologists, except one of the Italian groups assessing the knowledge about radiation protection and radiological examination among radiographers.[8] Although radiographers are directly involved in the imaging procedure, the authors identified an urgent need for radiographers to improve their awareness of radiation protection issues.[8] Some of the studies have included radiologists as one among the multiple specialists.[5, 9, 14, 17] While, in one of the studies, the authors compared the knowledge of radiation dose assessment between radiologists and non-radiologists.[14]

With the fast expansion of imaging technology, diagnostic imaging techniques, and interventional radiological procedures are ever more used to enhance the diagnostic accuracy of a wide range of diseases and injuries[-2] Accepting this fact, we consider that the referring clinicians' knowledge about radiation doses and associated risks sustained during radiological procedures must be adequate.[2, 5, 18] Practically, it is not possible vetting of every form by radiologists. Therefore, it is the referring clinician's responsibility to govern the patient's suitability to undergo radiation exposure, considering the expected risk involved. This judgment requires medical knowledge and an understanding the risk/benefit ratio incurred with the specific dose given for specific imaging examinations.[19] In the

present study, we included medical doctors from 15 different specialists since they are the ones who refer for radiological imaging commonly. If they have adequate knowledge about radiation-associated hazards and specified doses for a specific type of ailment, they can refer appropriately for diagnostic imaging. Insufficient knowledge may develop a propensity among clinicians of misusing radiation examination. This may expose patients to increasing imaging investigations that force them to bare the high cost as well as exposure to radiation hazards that increase the risk of causing diseases like cancer in a long term.

Knowing that awareness of radiation-related issues is poor in the medical fraternity, the more difficult question is how knowledge can be improved among them in the future. The previous report demonstrated that health professionals with formal training about ionizing radiation showed a greater awareness of the risks involved than those without training.[5] Our results showed that the clinicians who claimed to be attending training/refresher courses regularly performed better in answering correctly compared to those rarely attending or not at all attending. Generally, adequate training is given to radiologists and radiographers in their formal training; however, advances take place in technology over a period, and they need to attend advanced courses. While non-radiologists are required to attend radiation protection courses on a priority basis.[5] In this study, we noticed that interns received a better score than radiologists by correctly answering questions related to radiation exposure knowledge. This could be because interns are freshers, so they can memorize while replying to questionnaires. The study findings indicate that radiologists must attend refreshing courses to improve their knowledge. This could also apply to clinicians with a high age group and longer work experience since their knowledge and assessment about radiation issues was poor compared to their colleagues who were relatively younger and had less work experience. Previous surveyed studies also expressed concern that radiation safety and awareness training is required for on-job physicians, radiologists, interns,[2] non-radiologists, [20] junior doctors, and medical students.[9, 11, 21, 22]

We found better knowledge about the assessment of radiation doses among radiologists than among their clinical colleagues from other specialties. Of course, we were expecting this simply because the radiologists have ready access to the appropriate information and the training that they have received about dose assessment, which might help them in answering the questions correctly. These results go along with the data presented previously [5] however, it differs from other data available in the literature.[15, 23] Taken together, these findings underscore the importance of understanding instructions on radiation protection and their implementation, to ensure the patients' safety.

As our data show deficient knowledge among clinicians, we recommend conducting appropriate training courses for all clinicians including seniors and auditing their practice on regular basis by certified professionals. The training should be focused on the selection of appropriate imaging techniques considering the illness, optimization of radiation dose suitable for the anatomical region, educating about the risk associated with radiation exposure, updating of the new research studies in the relevant field, and verification of daily performance among the team members. Implications of all these measures will improve clinicians' knowledge and will help them to restrict the overuse of radiation imaging, ensuring the patients' safety.

The questionnaires were sent and returned by email within the requested period of one month. This timeframe gave all responders the opportunity to refer to textbooks or the internet in order to obtain correct answers if they would have wished. However, their performance did not represent that they took the help of other sources suggesting that their reply was based on their inherent knowledge.

Limitations

Limitations of this study include the small sample size, single-centre study, and radio technologists who involved in imaging procedures directly are not being partaken. We believe that this study is important in order to improve upon some of the deficiencies identified. In this direction, we are planning to initiate some training/refresher courses

to improve clinicians' knowledge and, thereby, patient care at our hospital.

Conclusion

The results of this survey show a deficient knowledge of radiation protection and radiological dose assessment among all clinicians including radiologists. Inappropriate knowledge may develop clinicians' propensity to overuse radiation imaging and press patients at risk for causing severe diseases like cancer. Considering this fact, there is a substantial need to plan different training activities to upgrade the knowledge and awareness in the radiation examination of all clinicians for patients' safety.

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Conflict of interests

The authors have no conflicts of interest to declare.

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