9

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A Questionnaire Survey on Radiation Protection among Medical Staff Working in Cardiac Catheterization Laboratory

Hala T. Salem

Health Radiation Research Department, National Center for Radiation Research and Technology (NCRRT), Egyptian Atomic Energy Authority, Cairo, Egypt.

IT IS ESSENTIAL for cardiologists, technologists, and nurses working in the cardiac catheterization laboratory to understand radiation protection. However, protective equipment usage is still low, wearing dosimeters is also low, and thier needs to be more aware of radiation protection in practice. This study aims at assessing the awareness and knowledge of medical staff (cardiologists, nurses, and technicians) working in the cardiac catheterization laboratory of occupational radiation protection tools and detecting areas of defects in their knowledge. Therefore a validated questionnaire to 180 medical staff working in a cardiac catheterization laboratory was conducted.

A total of 180 subjects from different institutions were surveyed. There were 103 (57.2%) cardiologists, 53 (29.4%) nurses, and 24 (13.3%) technologists. Although almost all staff members 176 (97.8%) always wear a lead apron, only 43 (23.9%) wear a thyroid collar and lead glasses 17(9.4%). The rate of wearing a radiation dosimeter was insufficient at 85 (47.2%). A few subjects know the radiation exposure dose of the procedure 33 (18.3%), and slightly about 46 (25.6%) had attended lectures on radiation protection. Cardiologists who were aware of the radiation exposure dose of each procedure were significantly more likely to wear dosimeters than those who were not ($P<0.005$). Experienced cardiac catheterization staff wear dosimeters more than the staff with fewer years of experience ($P<0.011$).In conclusion, it could be noticed that medical staff in cardiac catheterization laboratories need more radiation protection knowledge and education.

Keywords: Radiation protection, Cardiac Catheterization Laboratory, Questionnaire survey.

Introduction

Cardiovascular catheterization laboratory uses fluoroscopic guidance. Fluoroscopy increases exposure to ionizing radiation in both patients and the laboratory staff and it is associated with various harmful effects (Heidbuchel et al., 2014)

Ionizing radiation resuting from medical applications represents the majority of radiation doses from artificial sources to which the public is exposed. This results from a steadily increasing demand for radiological examinations (Hricak et al., 2011). Though this has been paralleled by a dramatic evolution of imaging technology over the last decade, it is often worsened by a need for more appropriateness and optimization criteria by referring physicians and radiological staff (Lauer, 2009).

Recently, efforts by both vendors and societies were carried out to reduce radiation doses and sensitize users and patients to the issues of radiological protection (Costello et al., 2013). As shown by several authors, this increasing use of medical radiation can be partly explained by the inaccurate and often inadequate knowledge among professionals about radiation protection issues and radiation doses of commonly performed imaging procedures (Yurt et al., 2014).

The risks of excessive radiation can be divided into two general categories: deterministic effects and stochastic effects. Deterministic effects are

#Corresponding author e-mail: dr.halaasalem148@gmail.com

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due to radiation-induced cell death and occur after a relatively large radiation dose. These effects include cataracts and skin injury. Stochastic effects occur by chance without threshold levels. The probability of an effect is associated with the dose, but the severity is independent of the dose. The main stochastic risk of the increased radiation exposure is the development of haematologic or solid malignancy (Noureldin & Andonian, 2019).

Such lack of awareness about radiation risk can be hazardous in case of high-dose examinations conducted without optimization, resulting in a potentially significant biological lifetime risk for both patients and medical staff (Nosek et al., 2013).

Radiation protection is the basis for the safety of both patients and medical staff due to its adverse effects represented by carcinogenicity and skin disorder (Miglioretti et al., 2013). The International Commission on Radiological Protection (ICRP) stated that an understanding and awareness of radiation hazards among medical staff could prevent unnecessary risks for the population (Mathews et al., 2013).

The new Council Directive 2013/59/Euratom of the 5th December 2013, concerned with “laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation’, is poised to strengthen this need for change, imposing on all professionals an ever-greater duty of care to adequately justify and optimize each radiological procedure (ICRP, 2009).

Furthermore, the “Guidelines on radiation protection education and training of medical professionals in the European Union no. 175 (2014)” has set the minimum knowledge expected of each practitioner involved in radiation protection (European Council Directive, 2013).

These guidelines clearly state the core learning outcomes in radiation protection for radiographers, i.e. to use the appropriate medical devices in an effective, safe, and efficient manner; to use effective, safe, and efficient radiation protection methods concerning staff, patients, and the public applying current safety standards, legislation, guidelines, and regulations; to apply the concepts and tools for radiation protection optimization (European Commission, 2014).

Materials and Method

A questionnaire survey was conducted on radiation exposure protection among workers in the cardiac catheterization laboratory and collected responses from September 2021 to December 2021.

The questionnaire was used to perform a prospective observational study, consisting of 10 questions in a multiple-choice format, and was divided into three parts: background, equipment, and knowledge. The details of the questionnaire are shown in Table 1.

TABLE 1. Questionnaire questions and answers (participants’ responses were anonymous)

Question	Answer
1. What is your gender?	a) Female. b) Male.
2. How old are you?	………….years.
3. What is your job title?	a) Cardiologist. b) Nurse. c) Technologist
4. How many years of career experience do you have?	a) 1–5. b) 6–10. c) 11–15. d) 16–20. e) Over 21 years
5. Do you always wear a lead apron?	a) Yes. b) No
6. Do you always wear a thyroid collar?	a) Yes. b) No.
7. Do you always wear lead glasses?	a) Yes. b) No
8. Do you always wear a radiation dosimeter?	a) Yes. b) No.
9. Do you know how much radiation dose you are exposed to in each procedure under fluoroscopy?	a) Yes. b) No
10. Have you ever attended a basic lecture on radiation exposure?	a) Yes. b) No

Briefly, questions 1–4 regard the background of each person, age, gender, job title, and years of experience. The author studied the job title to detect a possible link between the types of jobs of medical staff and wearing radiation protective equipment, and also studied the years of experience to detect if a long period of experience affects the behavior of the medical staff working in cardiac catheterization laboratories as regard wearing radiation protective equipment.

Questions 5–8 asked about the proper equipment for radiation protection lead apron, thyroid shield, lead glasses, and dosimeters. The lead apron protects the trunk; An apron should be long enough to cover the long bones (femur) and extend to the knee or just below the knee because proper fit is essential. Because the thyroid gland is susceptible to ionizing radiation, a lead thyroid shield should be worn in the presence of ionizing radiation (Kern, 2011). Operators wear leaded glasses to minimize exposure to the eyes (Poole & Larson, 2017).

Dosimeters enable staff to adapt their behavior to minimize unnecessary radiation. The authour investigated whether adding this technique to medical staff's daily practice would reduce radiation exposure (Murat et al., 2021).

Questions 9 and 10 focused on knowledge of radiation exposure, protection, and education. The ICRP has stated the importance of radiation protection knowledge and education (ICRP, 2009). However, many reports still show doctors' low awareness of radiation protection (Thomas et al., 2006).

Results

Responses to the questionnaire

The questionnaire was administered over 4 months to 234 participants equally distributed across different cardiac catheterization laboratory workers in different institutions, only 180 responses were received, and the study sample Mean age ±SD was 40.11 ±9.74.

Regarding the part of the questionnaire about each person's background, there were 137 (76.1%) males. Cardiologists were the most common occupation 103 (57.2%), nurses 53 (29.4%), and technicians 24 (13.3%). Regarding years of experience, 23 (12.8%) had 1–5 years, 37 (20.6%) had 6-10 years, 40 (22.2%) had 11-15 years, 29 (16.1%) had 16 –20 years and 51 (28.3%) over 20 years of experience, respectively. Table 2 shows the results of proper equipment used for radiation protection.

TABLE 2. Study group characteristic regarding usage of radiation protection equipment.

		No.= 180
Lead apron	Yes	176 (97.8%)
	No	4 (2.2%)
Thyroid collar	Yes	43 (23.9%)
	No	137 (76.1%)
Lead glasses	Yes	17 (9.4%)
	No	163 (90.6%)
Dosimeter	Yes	85 (47.2%)
	No	95 (52.8%)

As regards the knowledge of radiation exposure and protection, thirty-three subjects (18.3%) were aware of the radiation dose of each procedure, and 46 subjects (25.6%) had attended courses on radiation protection.

Differences according to job title

The rates of wearing a lead apron, thyroid collar, lead glasses, and dosimeter among cardiologists, nurses, and technologists, are all presented in Figs. 1-4.

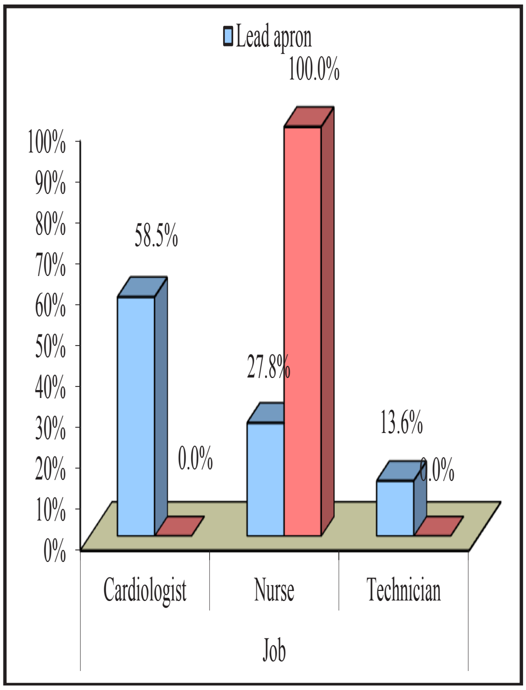

Fig. 1. Relationship between job title and wearing lead apron

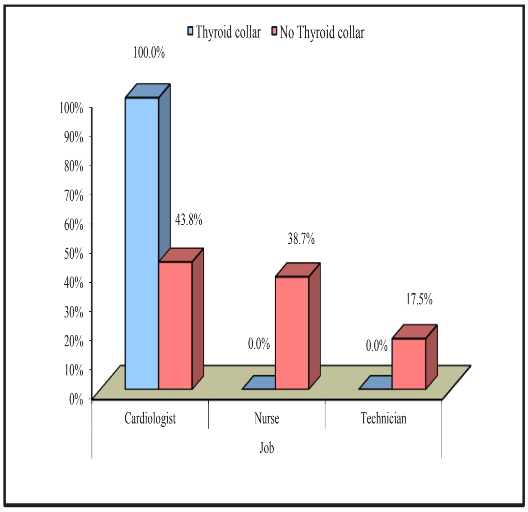

Fig. 2. Relationship between job title and wearing thyroid collar

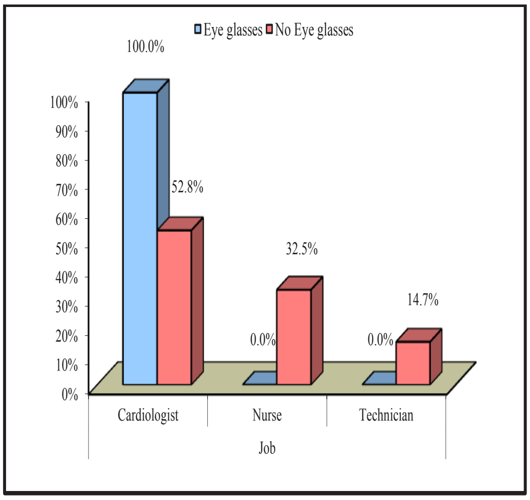

Fig. 3. Relationship between job title and wearing lead glasses

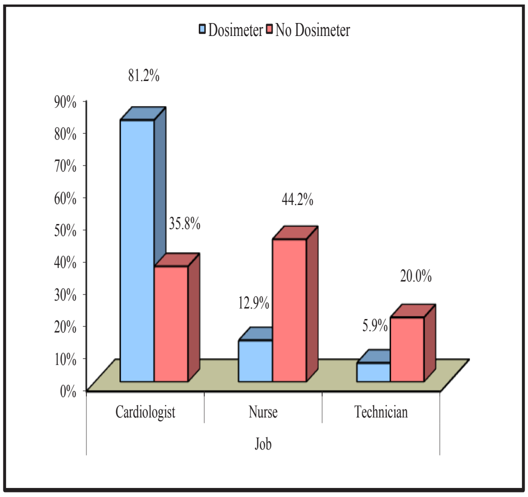

Fig. 4. Relationship between job title and wearing dosimeter

Discussion

This survey questionnaire revealed that most of the medical staff in cardiac catheterization labs usually wear lead aprons (176 about 97.8%), but only 43 (23.9%) wear thyroid collars, 17 (9.4%) wear lead glasses and 85 (47.2%)use dosimeters.

The primary radiation protection tool for cardiac catheterization laboratory workers is the lead apron. It is vital in protecting the bone marrow and reproductive organs. A full-body apron, however, weighs around 7 kg and can cause back problems (Smilowitz et al., 2013). As regards wearing a lead apron, it was found that cardiologists and highly experienced staff are significantly related to wearing a lead apron, while knowing procedure radiation dose or attending radiation protection courses do not relate significantly to wearing a lead apron.

Dauda et al. reported that 80% of doctors had yet to attend introductory lectures about radiation protection (Dauda et al., 2019). Similarly, it is problematic that only about 25.6% of the cardiac catheterization lab staff who operated fluoroscopy equipment in the present survey took introductory radiation protection courses. In cardiovascular medicine, Georges et al. (2009) demonstrated that training in radiation protection for interventional cardiologists was associated with a 50% reduction in radiation exposure (George et al., 2009).

Education can improve radiation safety practices, as the finding in the present survey suggests that radiation safety training is infrequently performed as about 134 (74.4%) of the participants who have never had radiation safety training. The obtained results are similar to those of Menon et al., whose survey suggests that more than half of the participants have never had radiation safety training (Menon et al., 2018).

Of the 17 cardiac catheterization staff who wear lead glasses, we found a highly significant relationship between this behavior and attending a radiation protection course and knowing the radiation dose of the procedure ($P<0.000$) for both.

Despite the recommendation of the international bodies to use two dosimeters

(Cousins et al., 2013), only 85 (47.2%) of respondents wore only one dosimeter. The current results are similar to Menon et al. as only 48.2% of respondents used only one dosimeter.

Considering the 43 medical staff who wear thyroid collars, it was found that also cardiologists were significantly high (P<0.000); otherwise, awareness of radiation exposure doses, years of experience, knowledge of ionizing radiation, or attendance at introductory lectures on radiation protection all that did not affect wearing thyroid collar among the staff.

A previous Korean questionnaire survey conducted in 2011 showed similar adherence rates of endoscopists at endoscopy-fluoroscopy departments (aprons: 100%, thyroid collars: 52%, lead grasses: 14%, dosimeters 10%) (Son et al., 2011). Other sizeable Japanese questionnaire survey revealed that most of the medical staff in endoscopy departments usually wear lead aprons (almost 100%), but that they do not always wear thyroid collars (27%), lead glasses (21%), or dosimeters (52%) (Hayashi et al., 2021). The present research study had lower rates of wearing dosimeters.

The experience did not affect the use of radiation protection, indicating that even experienced staff needed to receive more education.

Our recent study revealed that awareness and education might reduce radiation exposure. The solution is to create an environment where education is widely available to both experienced and novice medical staff in cardiac catheterization laboratory units; for example, mandatory educational lectures at conferences, such as those of radiological societies, may be considered.

Similar to the present study, Omar et al. (2021) conducted a survey to assess the awareness, training, and implementation of ionizing radiation safety measures among Egyptian trainees and urologists and evaluate the safety measures taken during diagnosis and treatment in urology practice in Egypt. In this study, a considerable number of responses from residents, specialists, consultants, and professors were received. Regarding wearing a protective lead apron during C-arm exposure, 23% reported that they always wear it, 38% sometimes wear it, and 13% rarely wear it. In terms of the thyroid shield and X-ray protective gloves and eye goggles, 70% and 89% and 89% reported that they never wear them, respectively. Compared with participants who did not receive a radiation safety course, participants who received a radiation safety course had significantly shorter fluoroscopy time during Ureteroscopy (31±17 vs. 131±181), Percutaneous nephrolithotomy (137±84 vs. 413±556).

Omar et al. (2021) concluded that more radiation safety awareness among Egyptian urology trainees and urologists is required. Respondents who received a radiation safety course showed significantly shorter fluoroscopy time during end-urologic procedures. The previous radiation safety course was the only predictor of better compliance with radiation safety measures.

Conclusion

This questionnaire survey of 180 medical staff showed the current status of protective equipment usage, awareness, and education in cardiac catheterization laboratory departments. The low dosimeter-wearing rate among cardiologists and other medical staff working at cardiac catheterization labs is a significant problem, and there may be a need for more education in the cardiology field. Continuing education can solve these problems, and cardiologists should know the importance of radiation protection to protect patients and staff.

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