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The knowledge range and availability of radiation protection tools in Benghazi hospitals

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Abstract:
Background: *All imaging techniques utilizing ionizing radiation, such as X-ray modalities used for diagnosis and therapy, require high awareness of all radiation protection principles. High-level knowledge of ionizing radiation exposure risks among medical staff is essential for planning diagnostic and therapeutic procedures.*
Materials and Methods: *This study consisted of a questionnaire survey. The study included a total of 90 individuals from professional groups: Radiologists and technologists. The study was carried out in the following hospitals: Al-jalla, Al-hawarie, Benghazi medical centre (BMC), Ibn Sina, and Dar Al-Shifa. Data were collected in the period between December 2020 to February 2021.*
Results: *The results indicate that most medical staff, especially radio-technologists, are not adequately aware of the risks involved with the ionizing radiations they work with it. While protective tools in most hospitals are available, there are underlying beliefs among most medical staff regarding the use of these protective tools. Our conclusion is to present lectures and periodic training that deals with these serious risks, with a view to educate all medical staff about early ionizing radiation and late biological effects in all radiological departments of private and public Benghazi hospitals.*
Conclusions: *The conclusion from the conducted survey is that increased attention to the issue at hand is required and systematic education is needed for all healthcare professionals with regard to radiological protection.*
Key words: *Radiation protection, Occupational exposure Image-guided interventional methods, protective implements, protective clothes Monitoring.*

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I. Introduction

The medical use of X-rays in diagnostic and interventional radiology and radiotherapy remains a rapidly changing field. It involves a wide range of applications, procedures and techniques undertaken by the largest single group of workers who are occupationally exposed to artificial sources of radiation, including physicians, medical physicists, technicians, and nurses. Similarly, public members are also required to be protected against radiation while in a radiological facility [1]. The use of radiation in medical applications continues to rise globally. The latest UNSCEAR estimates suggest that there are about 4 billion X-ray examinations per year worldwide. All these procedures need to be performed by medical personnel, and these procedures have the potential for occupational radiation exposure [2]. Therefore, it is pertinent to ask, does the increasing demand for X-ray imaging have implications for the radiation protection of medical staff? An increased usage could be viewed as simply a workload issue with no novel challenges. However, there has also been a change in the types of X-ray imaging procedures being performed, along with changes in who conducts them, wherein personnel are required to be close to the patient. These procedures present a challenge to ensuring the most appropriate radiation protection for medical staff. The term X-ray imaging is used in this paper to cover both diagnostic radiology and image-guided interventional procedures. Occupational radiation protection is achieved via the application of the three ICRP principles of justification, optimization, and dose limitation. In practice, to afford radiation protection for medical staff in X-ray imaging, it is the application of optimization and dose limitation that are arguably the most important factors. However, it should be recognized that a lack of rigorous application of the justification principle has resulted in a significant number of unnecessary X-ray imaging examinations, which add to occupational exposure [3].

This study aims to evaluate the current level of understanding of radiation protection among medical staff in the radiology departments of Benghazi hospitals and to indicate gaps in current approaches to radiation protection in medicine. This paper could not cover all the aspects of radiation protection of medical staff but instead focuses more on the most salient challenges in the ongoing issue of occupational radiation protection. The paper includes a brief discussion of factors that determine the level of occupational exposure in X-ray imaging, a discussion on the implications of recent trends in X-ray imaging for occupational radiation protection and deals with the basis for ensuring effective radiation protection of medical staff in the light of these new developments. In addition, the paper seeks to identify tools for improving radiation protection in Benghazi hospitals.

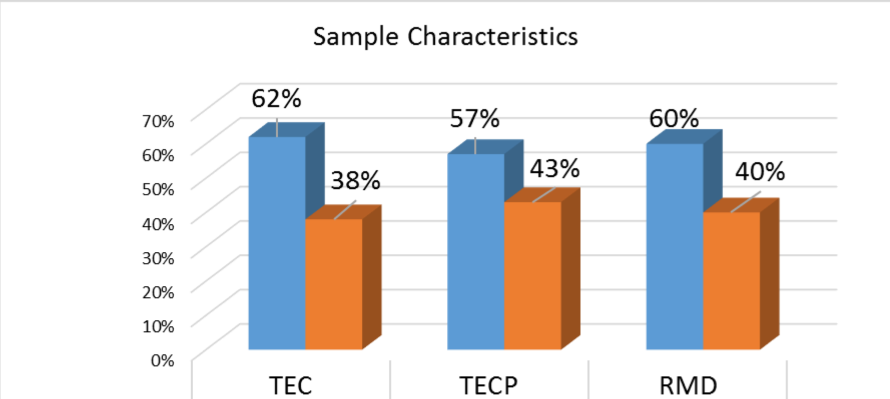
II. Material And Methods

A questionnaire was distributed among the medical staff working in the field of radiology inside Benghazi hospitals. The selection was randomly from governmental and private hospitals. This study was conducted to assess the degree of knowledge of medical staff working at radiology departments in Benghazi city. In addition, tools and methods of radiation protection and their availability. The study was conducted with 90 questionnaires were distributed to the following hospitals: Al-jalla hospital, Alhawarie hospital (including: National centre of tumors, National Cardiac centre), Benghazi Medical Centre (BMC), Ibn Sina, Dar Al-Shifa, Period of collecting data was from December 2020 to February 2021. Data were summarized, divided into groups and analyzed using SPSS.

Our data were collected from 90 employees of radiology departments of different medical facilities in Benghazi city privet and public including: Al-jalla hospital (public), Alhawarie hospital (public) (including: National centre of tumors, national cardiac centre), Benghazi Medical Centre (BMC) (public), Ibn Sina (privet), Dar Al-Shifa (Privet), A questionnaire was distributed to medical staff inside Benghazi hospitals to know the knowledge level of radiation protection principles and the availability of radiation protection tools.

III. Result

Figure (1) indicates the male/female ratio of technologists of public facilities (62% male and 38% female), the male/female ratio of medical doctors (MDs) in both public and private facilities (50% male and 50% female) and the ratio of male/female technologists in private facilities (TECP), which was approximately (57% male and 43% female).



	TEC	TECP	RMD
Male	62%	57%	60%
Female	38%	43%	40%

Figure 1: The study population, including male and female technologists of public hospitals (TEC), private technologists (TECP) and radiologists (RMD), who are all employees in the radiology departments in the medical facilities that have been mentioned in the previous section. The percentages of male and female employees are shown in the figure.

The availability of radiation protection tools and the awareness of the radio technologists

Personal protective devices include aprons, thyroid shields, eyewear, and gloves. Protective aprons with thyroid shields are the primary radiation protection tool for interventional workers and should be employed at all times. operators prefer the vest/skirt configuration prefer the vest/skirt configuration prefer the vest/skirt configuration in order to reduce the risk of musculoskeletal/back injury. Aprons should be inspected fluoroscopically on an annual basis to detect deterioration and defects in the protective material. Figure (2) indicates the availability of radiation protection tools, which should be used daily and routinely by employees in the radiology departments of the mentioned facilities. During our data collection, we noted that these tools are impractical, thus, we looked at the employees' awareness inside each radiology department, as shown in figure (3). The ratio of technologists (TEC) in the public facilities unaware of radiation protection tools was 61% unaware TEC to 39% aware TEC. The ratio of radiologists and medical doctors (RMDs) in both public and private facilities was 63% unaware to 37% aware, and the ratio of unaware to aware technologists in the private facilities (TECP) was about 64% unaware to 36% aware.

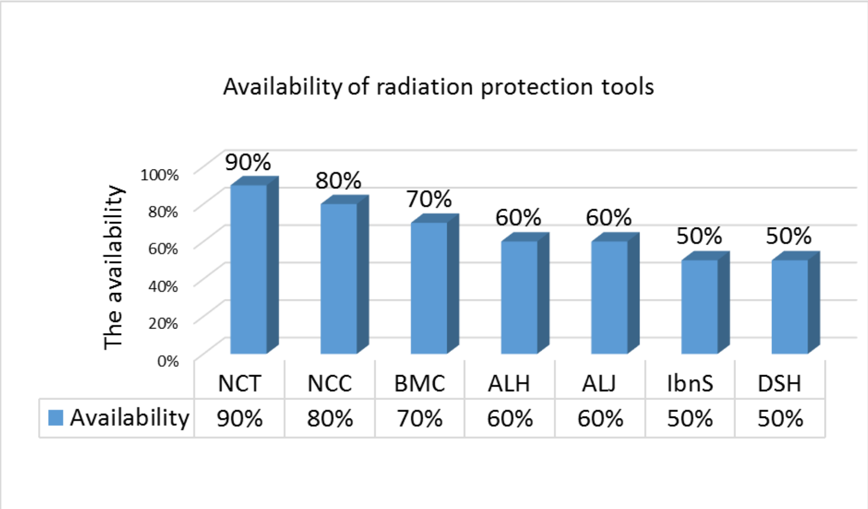


Figure 2: an illustration of the availability of radiation protection tools in the different radiology departments of randomly chosen public and private hospitals in Benghazi (NCT: National Tumor Center, public), (NCC: National Cardiac Center, public), (BMC: Benghazi Medical Center, public), ALH: Alhwarie hospital, public), (ALJ: Al-jalla hospital, public),(IbnS: Ibin Sina hospital, private), and (DSH: Dar Al-Shifa hospital, private).

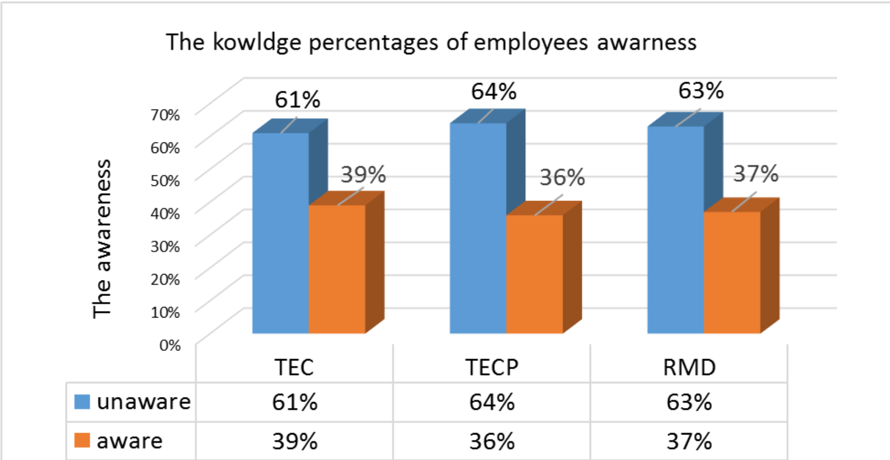


Figure 3: indicates the awareness of radiology department employees for the facilities mentioned in the previous section. TEC: public technologists, TECP: private technologists, and RMD: radiology medical doctors. As shown, the percentages of unawareness are higher than that of awareness, which means that, most employees need to be more alert to radiation risks and need to use the available radiation protection tools.

Knowledge of medical staff regarding occupational dose limit

Occupational exposure is subject to dose limits established to ensure that the risks arising from occupational exposure are not unacceptable. The dose limit (an effective dose) addresses cancers and hereditary effects, while other dose limits (in terms of equivalent dose) prevent radiation effects, particularly for tissues or other areas of the body. In addition, the application of the principle of optimization of protection should ensure that occupational doses to medical staff in X-ray imaging are as low as reasonably possible (ALARA principle), and typically well below the established dose limits [4-9]. Figure (4) indicates the availability and the awareness of radiation protection tools among the radiology department employees in the mentioned facilities. The awareness ratio of radiation protection tools among technologists in public facilities was 61% aware to 39% unaware. The ratio of radiology medical doctors (RMDs) in both public and private facilities was 63% aware to

37% unaware, while the ratio of aware to unaware technologists in private facilities (TECP) was about 64% aware to 36% unaware.

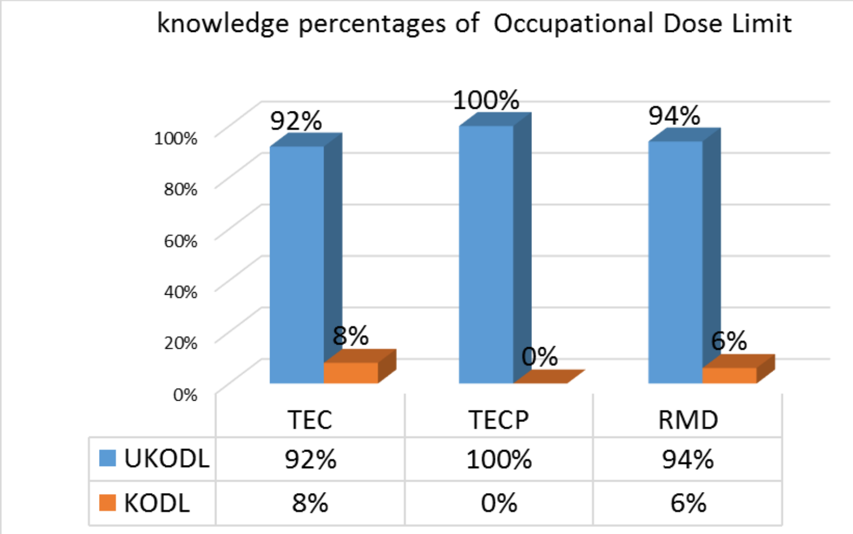


Figure 4: an illustration of the knowledge percentages of technologists working in public hospitals (TEC), technologists working at private hospitals (PTEC), and radiologist medical doctors (RMD) working in both public and private hospitals. The knowledge percentage of Occupational Dose Limit (ODL) for employees who do not know the precise limit (UKODL) is higher than that of the knowledge percentages of employees who do know the precise limit (KODL).

The knowledge percentages of radiation protection training:

Regarding X-ray imaging, personnel need training in occupational radiation protection and patient radiation protection, as the later can influence occupational exposure. Most countries have regulatory requirements for training relating to protection in practice. Guidance has been published on what the training for medical staff should cover, i.e., by the European Commission [10].

Several resources for training are freely available, including IAEA material for diagnostic and interventional radiology and cardiology and the MARTIR project (multimedia tool for training in interventional radiology), which is particularly useful for distance learning purposes [11-16].

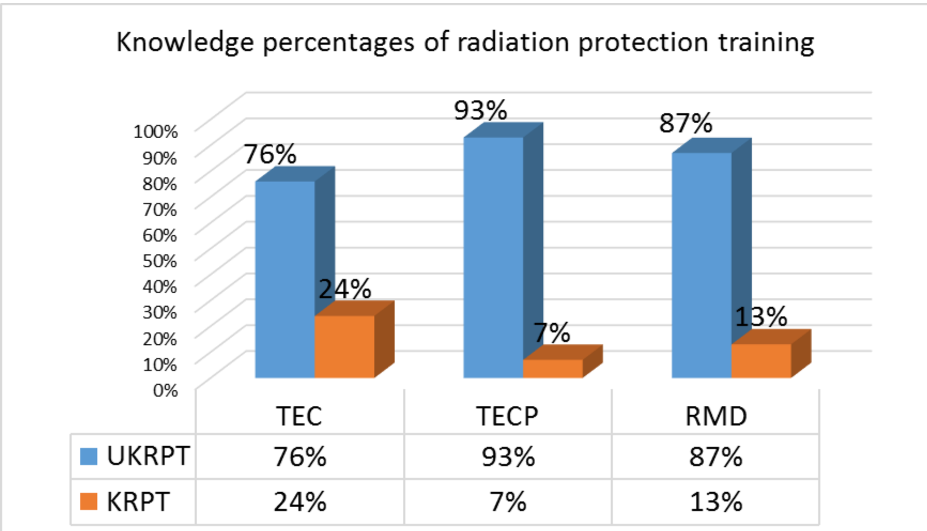
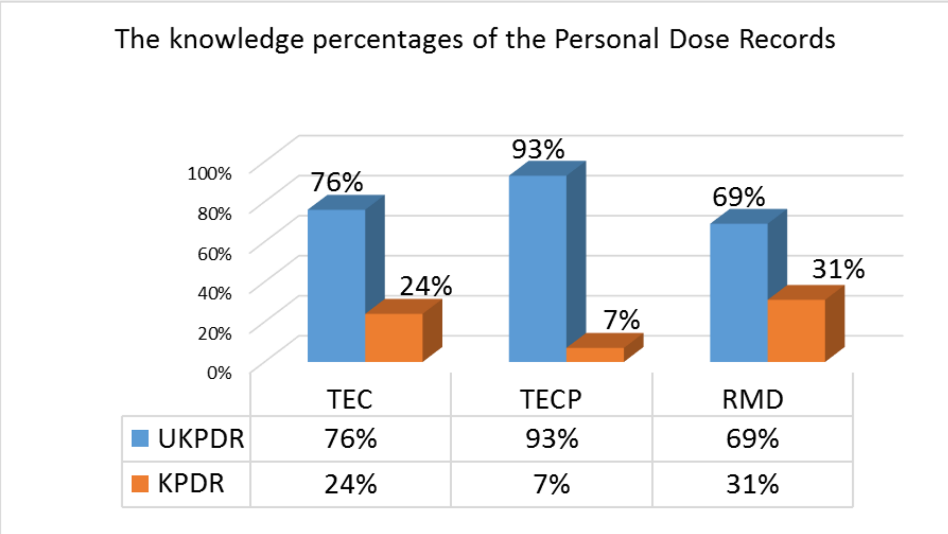


Figure 5: Knowledge percentages of radiation protection training. Employees who do not know about radiation protection training (UKRPT) are greater in number than those who know about the radiation protection training (KRPT) (TECP private technologists, RMD radiology medical doctors).

Knowledge percentages of Personal Dose Records

X-ray imaging may sometimes involve monitoring the fingers and hands. Such procedures require special dosimeters, such as ring or bracelet dosimeters. It is essential to position the dosimeter in the position most likely to receive the highest exposure. This may not always be the dominant hand. In all cases of individual monitoring, specific advice from a medical physicist or RPE should be obtained [17].

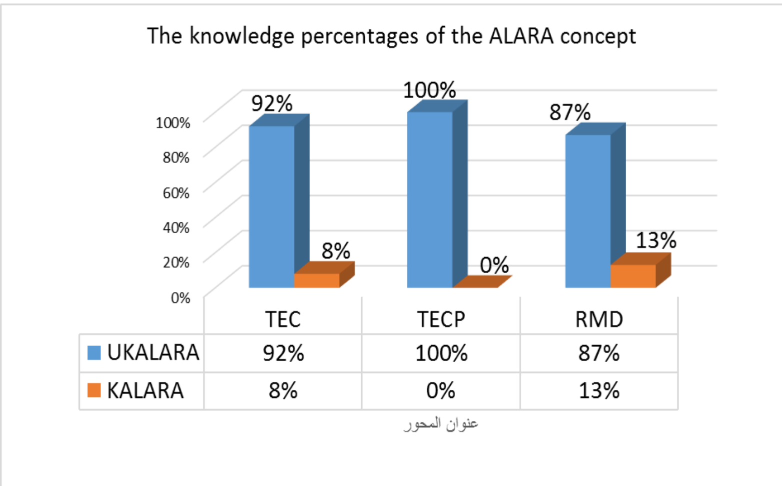


	TEC	TECP	RMD
UKPDR	76%	93%	69%
KPDR	24%	7%	31%

Figure 6: The knowledge percentages of the Personal Dose Records (PDR). The knowledge percentages of employees who do not know about personal dose recorders (UKPDR) are higher than those who know about personal dose recorders (KPDR) (TEC public technologists, TECP private technologists, RMD radiology medical doctors).

The percentage knowledge of the ALARA concept

In the context of the radiation protection system, optimization signifies keeping doses "as low as reasonably achievable" (ALARA). In particular, for medical imaging, ALARA means delivering the lowest possible dose necessary to acquire adequate diagnostic data images, best described as "managing the radiation dose to be commensurate with the medical purpose" (ICRP, 2007a & 2007b). The International Commission of Radiation Protection (ICRP) has suggested three keywords as general principles of radiation protection: justification, optimization and dose limit. [7]. As indicated in figure 7, knowledge among radiology employees of the ALARA concept in the hospitals in this study was almost non-existent. Private technologists (TEC) show 8% knowledge, private technologists (TECP) show 0% and radiologists (RMD) show 13%.



	TEC	TECP	RMD
UKALARA	92%	100%	87%
KALARA	8%	0%	13%

Figure 7: Knowledge percentages of employees who know about the ALARA concept (KALARA) and employees who do not know about the ALARA concept (UKALARA). The UKALARA is therefore higher than KALARA (TEC public technologists, TECP private technologists, RMD radiology medical doctors).

The Knowledge percentages of periodic examination

A Radiation Protection Program (RPP) is one means of implementing occupational radiation protection via the adoption of appropriate management structures, policies, procedures and organizational arrangements. For medical staff in X-ray imaging, topics would include the need for local rules, procedures for personnel to follow, arrangements for the provision of personal protective equipment, a programmer for education and training in radiation protection, arrangements for individual monitoring, and methods for periodically reviewing and auditing the performance of the Radiation Protection Program (RPP) [18]. Figure 8 illustrates the knowledge of radiological employees regarding periodic examinations, including blood samples tests to assess the radiation effects on their blood samples (especially the normal number of all blood cells and its normal appearance), in addition to an assessment of the early and late effects of radiation. The figure shows a low percentage of knowledge, indicating that the radiological employees included in this study must become more aware of the periodic examinations required to monitor their physical health.

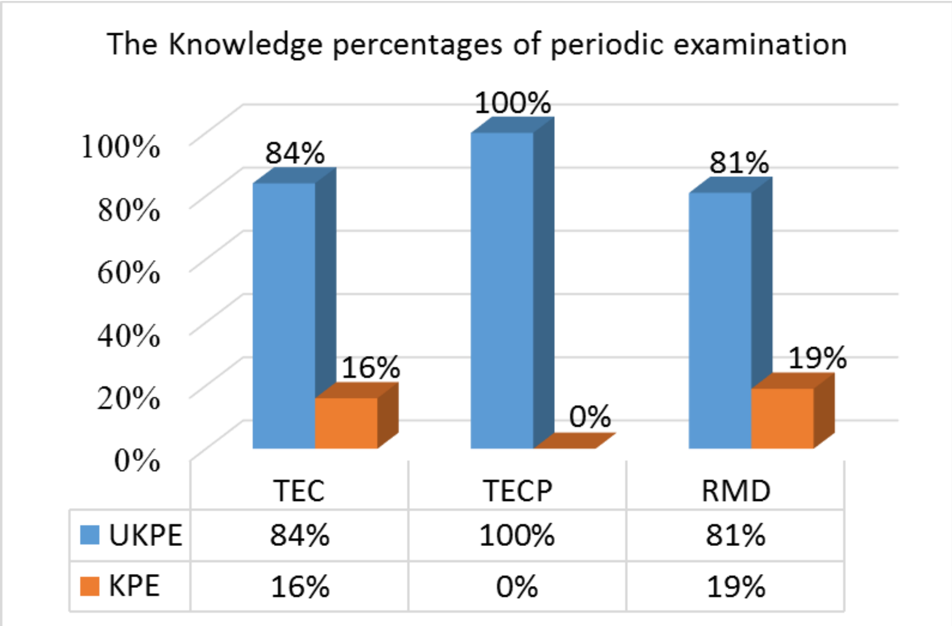


Figure 8: The knowledge percentages of periodic examination (PE). UKPE (Unknown Periodic Examination) for employees who do not know about the periodic examinations required for radiological employees, KPE (Known Periodic Examination) for those who know about the periodic examinations. UKPE is thus higher than that of KPE (TEC public technologists, TECP private technologists, RMD radiology medical doctors).

IV. Discussion

The safety of patients and staff is the priority of every diagnostic or therapeutic procedure involving ionizing radiation. Medical staff in contact with ionizing radiation must proceed in accordance with the As Low As Reasonably Achievable (ALARA) principles. This includes performing scans with the lowest possible doses of ionizing radiation allowed in order to obtain the desired diagnostic effect [17].

The number of published studies regarding the awareness of radiological protection issues in medical staff regardless of position is low [18-23]. The everyday clinical practice and incorrect (and sometimes contradictory) information provided by medical staff have instigated us to attempt to determine the level of radiation protection awareness among medical staff in selected hospitals in Benghazi. The study group purposefully included physicians and medical technicians. This was due to the frequent contact that these medical professionals have with patients, both before and during procedures that involve ionizing radiation. The obtained results provided useful information on the knowledge, expertise and convictions of medical professionals with regards to radiation protection [24-27].

The ICRP's recommendations offer principles of protection that are fundamental for protection systems and have presently formulated a single set of principles used to plan emergency and existing exposure situations. Those recommendations clarify how the fundamental principles are used to radiation sources and to the individual and how the source-related principles apply to all controllable situations [28].

There is an apparent lack of good knowledge among medical staff in Benghazi hospitals regarding the full spectrum of ionizing radiation effects among the employees of radiology departments. The relatively poor awareness of radiological protection within radiology departments is noted, resulting in a poor understanding of radiological procedures. It would appear that this might be due to the poor availability of radiological protection training among workers. There is no existing training on radiation protection for medical staff. The analysis also revealed a relatively low level of knowledge about ionizing radiation among the study population.

The greatest source of radiation exposure to both operators and staff is scattered from the patient. Generally, controlling patient dose also decreases scatter and limits operator dose. However, chronic radiation exposure in the workplace mandates the usage of protecting tools in order to reduce occupational radiation dose to an acceptable level. The goal of radiation protection tools is to develop operator and staff safety without impeding the procedure or jeopardizing the patient's safety. The ICRP publications introduced forth recommendations on occupational dose limits, which are trusted by most countries. These limits are shown as effective doses for the whole body and equivalent doses for specific tissues or regions of the professional's body. The limit for the effective dose is 20 mSv per year (an annual average over five years) and must not exceed 50 mSv in a single year for the eye lens. In contrast, the limit for extremities and the skin is 500 mSv per year. Nevertheless, occupational doses should be "as low as reasonably achievable", which is known as the ALARA principle of radiation protection [29-31].

Dose-limiting is a clearly defined practice in radiation protection for occupationally exposed individuals (OEIs). Each OEI should be monitored monthly to ensure the doses received are not over the limits established. Frequent dose monitoring can inform practices involving high exposures and thus determine the need for more objective and efficient radiological protection strategies. To increase accuracy in dosimetry, the International Commission on Radiological Protection (ICRP) suggests the use of two dosimeters, one inside personal protection items and one on the outer layer. This gives a more reliable estimate of the doses received by professionals. Extra dosimeters can be applied to measure doses in eye lenses and the upper extremities [32].

Management should provide appropriate resources, such as staff, facilities, and equipment, to ensure that radiation doses are adequately controlled. Facilities and equipment involve but are not limited to shielding, radiation monitoring instruments, and protective clothing. Quality assurance is a vital component of any monitoring program [33]. Each department should analyze occupational doses; high doses and outliers should be investigated, and adequate and related training programs should be presented for all levels of staff within the organization, including management, to improve a commitment to radiological protection and so that all concerned can contribute to the reduction and control of exposures [34- 38].

V. Conclusion

Despite more than 120 years passing since Roentgen's breakthrough discovery, protection against ionizing radiation is a fundamental problem in the everyday practice of all medical professionals. Although radiation diagnostics are an essential and broadly used part of the therapeutic process, protection-related issues are usually addressed in a rather offhand manner.

In an era of increasing pro-health awareness within society, as well as increasingly common claims filed against medical personnel, improved knowledge of radiation protection issues has become an essential element of professional expertise, not only for radiologists and radiation therapists but also for other specialists, along with medium-level or auxiliary staff.

The survey concludes that increased attention must be paid to the issue at hand via thorough and systematic education of all healthcare professionals about radiological protection.

VI. RECOMMENDATION

• Use protective shielding.
• Use appropriate imaging equipment.
• Obtain appropriate training.
• Wear the dosimeters and know the exposed dose limit.

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