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Knowledge level of the community and healtcare workers about radiological examinations and harmful effects of radiation: a review

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ABSTRACT

Patients, doctors, and radiology professionals are exposed to ionizing radiation in the diagnostic and therapeutic applications of radiology. Despite the proven harmful effects of medical radiological methods used for diagnosis and treatment, it is not possible to completely abandon these procedures.There is a lack of knowledge in the community about radiological examinations, the effects of radiation, and radiation protection. To increase awareness about radiation, it is essential to educate patients, enhance the education of healthcare students, and provide in-service training for all hospital staff. This way, knowledge levels can be improved, and the harmful effects of radiation can be minimized.

Keywords: Radiation, harmful effects of radiation, patient safety, knowledge level

INTRODUCTION

Patients, doctors, and radiology professionals are particularly exposed to ionizing radiation types such as gamma and X-rays in the applications of radiology for diagnosis and treatment.[1] In recent years, the increase in the number of hospital visits is attributed to easier access to healthcare facilities, the rise of chronic diseases due to aging, and an increase in the demand for medical treatment by patients. Consequently, there is an increase in radiological procedures for diagnosis and treatment. Although the harmful effects of medical radiological methods used for diagnosis and treatment have been proven, it is not possible to completely abandon these methods.[2]

Radiation and its Effects

Radiation has two types of adverse biological effects on living organisms, namely stochastic and deterministic.[3] Stochastic effects, although extremely rare, can manifest as a low risk of cancer even at low doses. However, the threshold dose for causing cancer in humans is unknown.[4-6] Stochastic effects occur with prolonged exposure to low doses of radiation. There is no threshold dose value, but the biological effect increases with the dose, while the effect intensity is independent of the dose. This can lead to the formation of leukemia, lung, gastrointestinal system, and thyroid cancers. Deterministic effects have a threshold dose value, and the effect increases proportionally with the dose. For certain dose levels in humans, effects ranging from blood and chromosome damage to sudden death can be clearly identified.[5-6] As a result of deterministic effects, delayed outcomes such as acute radiation syndrome, radiation burns, fibrosis, necrosis, and sclerosis may occur. These side effects vary depending on the dose and duration of exposure to radiation.

Devices Used in Radiology

There is a wide variety of devices used in radiology, operating on different mechanisms. Direct radiography, angiography, fluoroscopy, and computed tomography (CT) examinations are performed with ionizing radiation. Ultrasonography (USG) uses sound waves, and magnetic resonance imaging (MRI) is a non-ionizing radiation imaging method.[7]

Radiation Protection Methods

Radiation is commonly used in diagnostic and therapeutic procedures today. Controlled use of radiation is crucial for radiation safety during radiological examinations.

To protect healthcare personnel from ionizing radiation in examinations using ionizing radiation, exposure to radiation should be limited by minimizing time, maximizing distance, and using proper shielding.[8] Since the radiation dose decreases inversely with the square of the distance, it is essential to stay as far away as possible from radioactive sources. Additionally, the walls surrounding these environments should have sufficient concrete thickness and lead insulation. The use of lead aprons, lead gloves, lead injectors, lead glass, and shields should be ensured. Procedures should be avoided in unnecessary situations. Despite these precautions, raising awareness among healthcare workers and patients about examinations is crucial to minimize the harm from exposure to radiation.[9]

COMMUNITY KNOWLEDGE LEVEL

With advancements in healthcare technology, the use of ionizing radiation has increased in various diagnostic and treatment methods.[10] However, there is evidence indicating a low level of knowledge about these devices in the community.[11] Many studies on the subject have been conducted in our country. Most studies do not include all segments of society. While some studies included only healthcare professionals or subgroups, some studies included only the patient group. In our study, we evaluated the results of studies conducted with various groups in our country.

Device Information

In a study conducted with 949 patients by Ceylan et al.[12], it was found that 48.4% and 50.3% of patients were unaware of the presence of radiation in non-ionizing USG and MRI examinations, respectively. Moreover, a considerable portion of the group had no knowledge on the subject.

In a study by Yucel et al.[13], 20.5% of patients indicated that CT contains more X-rays than radiography, while 73.2% had no idea about the topic.

Koçyiğit et al.[3] found that about 20% of hospital staff had incorrect knowledge about examinations containing radiation. In the same study, assistant doctors stated that there is no radiation in USG and MRI methods at rates of 0% and 4.3%, respectively.[3]

According to Shiralkar et al.[6], 5% of doctors mentioned the presence of radiation in USG, and 8% in MRI.

Arslanoğlu et al.[14] found that 4% and 27.4% of participants in their study, including doctors with less than 10 years of experience, doctors with more than 10 years of experience, and 6th-year medical students, indicated the presence of radiation in USG and MRI, respectively. In the same study, 93% of doctors and intern doctors believed that the ionizing radiation dose patients are exposed to during radiological examinations is less than the actual dose.[14]

Cankorkmaz et al.[15], in their study with 4th-year medical students, found that 3.5% and 15.9% of participants mentioned the presence of radiation in US and MRI examinations, respectively, which they considered surprisingly low.

All studies indicate that the knowledge levels regarding USG and MRI, which do not involve ionizing radiation, are quite low among patients, students, non-medical healthcare professionals, and even doctors. When looking at knowledge levels, it is noteworthy that patients have the lowest knowledge level, followed by non-medical healthcare personnel, medical faculty students, and doctors.

Some doctors and interns believing that there is radiation in US and MRG can lead to misdirection during the request for tests. This can result in delays in the patient receiving a diagnosis and treatment. On the other hand, another group believes that the ionizing radiation dose in radiological examinations is less than the actual dose. In the study of Arslanoğlu et al.[14], doctors were asked to answer the ionizing radiation dose in radiological imaging methods in millisieverts (mSv) compared to chest radiography. In Koçyiğit et al.'s[3] study, it was asked how many chest radiographs corresponded to the ionizing radiation doses to which patients were exposed in radiological imaging methods. 64.9% of the assistant doctors stated that the abdominal CT, 79.4% in the barium stomach X-ray, and 58.8% in the abdominal X-ray contained less radiation. These rates are lower than in Arslanoğlu's[14] study. However, the fact that more than half of the assistant doctors think that the tests are at a lower dose than normal may lead to unnecessary and excessive requests for tests involving radiation.

Education Level

The higher knowledge level regarding radiation in physicians and assistants suggests that as the duration and intensity of education increase, the knowledge level also increases. Yücel et al.[13] and Sin et al.16 emphasized in their studies, conducted in 224 patients, that as the education level (primary school, secondary school, high school, and university) increases, the knowledge level about the harmful effects of radiation also increases.

Asefa et al.[17] conducted a study in southwest Ethiopia in 2016, indicating that in low-income and low-education countries, patients have insufficient knowledge about radiation and its effects. In studies conducted in Iraq, Nigeria and Uganda, the level of knowledge was even lower than this study.[18-20]

Information the Patients

The importance of informing becomes even more pronounced in situations where patients' knowledge levels are inadequate. In a study by Güdük et al.[11], 37% of patients expressed insufficient knowledge, indicating inadequate patient information. Koçyiğit et al.[3], in their study involving 250 participants, including resident physicians, medical school students, nurses, and administrative staff, found that 53% of participants stated that patients were not informed before medical imaging, and 13% had no idea whether patients were informed or not.

Larson et al.[21] investigated how the opinions of families about performing CT examinations for their children changed after receiving information about the risks of radiation. After a brief information session, it was observed that families rejected the recommended examination in the face of the increased likelihood of cancer risk. When asked if frequent radiological examinations are harmful, 80.4% of participants (n:763) answered 'yes.' However, when asked how often the examinations were repeated, 45.8% of those who had X-ray examinations and 80.1% of those who had CT examinations (n:137) had the same examinations less than a year ago. Despite awareness of the harmful effects of radiation, the repetition rates are high. Reasons for this include inadequate questioning, patient request for re-examination, performance, incomplete examination records, and inappropriate shooting conditions.[12]

Busey et al.[9] concluded in their 2012 study that awareness of radiation dose increased when patients were informed. Baerlocher et al.[22] published a study involving patients applying to the interventional radiology unit, recommending mutual discussion and the use of visual and written methods. Al-Mallah et al.[23] conducted a study with 486 patients, emphasizing the need to inform patients before and during the imaging process using written, visual, or auditory instructions provided by technicians or other auxiliary healthcare workers.

The number of radiological examinations has increased by 50% from 2007 to 2017.24 This increase is attributed not only to technological advancements but also, as identified in the studies of Arslanoğlu et al.[14] and Cankorkmaz et al.[15], to the fact that doctors requesting the examinations perceive the radiation dose to which the patient is exposed as lower than it actually is. Not showing the necessary selectivity in the use of these devices leads to the emergence of new health risks.

Arslanoğlu et al.[14] suggested that if doctors requesting radiological examinations see the amount of radiation dose the patient will receive and its equivalence in terms of the number of chest X-rays in the request screen, they may change the prioritization and preferences of the examinations. This is an important suggestion, as the requesting doctor may abandon an examination that they do not believe is necessary for the diagnosis or prioritize a radiation-free examination that provides the same level of information.

Radiation Protection Methods

In radiological studies, the ALARA (As Low As Reasonably Achievable) principle dictates that the patient and radiology worker should receive the minimum dose.[25-27] This can be achieved by the doctor not requesting the examination unless necessary and the radiology worker protecting themselves and the patient using correct methods.[10] Protection from radiation is based on the three fundamental principles known as time, distance, and shielding. Shielding (lead block, lead apron, concrete block, etc.) is the most practical protection method used compulsorily in radiology clinics and hospitals. Distance is inversely proportional to the radiation dose. The farther away from the source, the lower the dose. Shortening the time spent in the device or environment where radiation is used also plays a significant role in radiation protection.[28]

Yıldırım et al.[10] reported that the knowledge level of radiology students about radiation protection principles was well below expectations. Slechta et al.[29] found an average knowledge score of 82.2 in their study with radiology technicians. Zhau et al.[30], in their study on medical students, found that students' average radiation knowledge was very low, with 6 out of 17 questions correct. Shabani et al.[31] found a knowledge score of 46 in their study on interventional radiology workers. Balsak, in a study with diagnostic radiology workers in 2014, obtained similar results, showing that radiation protection measures and the allowable annual dose specified by laws were generally unknown.[2] University students had a higher knowledge level about radiation and protection compared to high school students.[10] Yenal and Ergör's research on "occupational risk factors" targeted secondary school and university students. It was observed in this study that as the education level of students increased, their knowledge levels also increased.[32] The level of knowledge about radiation protection methods also increases with the level of education.

The most basic ways to protect against radiation in radiology units are wearing lead aprons and protective eyewear. In our study, it was found that particularly 32.1% of the students did not use lead aprons during fluoroscopy/portable radiography, and 93.8% did not wear protective eyewear. When questioned about the reasons for not wearing lead aprons during these procedures, responses included "I don't see the need," "it is not available in my department," "it is too heavy," "I believe distance provides sufficient protection," and "I don't use it because colleagues don't use it."[10]

Similar results were found in Balsak's study, where the prevalence of lead apron usage in the entire radiology unit was 51%, and protective eyewear usage was 14%.2 Slechta et al.[29] reported that only 31% of radiology technicians consistently wore protective aprons. In a study by Güden et al.[33], it was observed that 22.5% of radiology technicians wore lead aprons. Shabani et al.[31] found in their study on interventional radiology professionals that their attitude scores regarding radiation protection (use of lead aprons, protective eyewear, etc.) were 65 out of 100. Awosan et al.[34] (2016) reported a prevalence of 4.5% for the use of protective eyewear in their study with radiology professionals.

In a study by Helvacı[35], no difference was observed in the knowledge and attitudes of radiology professionals based on their school levels at graduation. Regarding attitudes, Holmström and Ahonen's[36] literature review on radiology student education revealed that students behaved like the professionals they worked with in practice, modeling themselves after radiology professionals who protected and supported them from unsafe practices. Despite the higher knowledge levels of vocational school students, they exhibited the same attitude as secondary education radiology students about radiation protection, supporting the view in Tilson's[37] study that personal safety practices do not differentiate with professional education.

Unnecessary radiological examinations increase radiation exposure for both patients and healthcare workers. Therefore, increasing radiation safety and education for medical faculties and healthcare workers will contribute significantly to reducing radiation exposure.14,[38] In a study by Çakmak et al.[28], 84.3% of medical students expressed the desire for lessons on ionizing radiation and its hazards. Moreover, the majority of recommendations made on the Data Collection Form regarding this issue emphasized the need to increase radiation safety and education.[25]

Schuster et al.[39] reported in their studies that in recent years, patient's knowledge levels about radiation have increased. The reason for this increase was attributed to numerous studies on radiation safety and the provision of education to healthcare workers about ionizing radiation and its risks.

CONCLUSION

There is a lack of knowledge in society regarding radiological examinations, the effects of radiation, and radiation protection. As a result of this deficiency, both patients and healthcare workers are exposed to excessive radiation doses, unnecessary tests are conducted, and this process becomes a societal health issue.

To enhance the public's knowledge about radiation, it is essential to provide informative sessions for patients before and after diagnostic procedures. Additionally, increasing the number of courses on radiation and protection methods for radiology students at high school and university levels, as well as for medical students and residents, is crucial. Continuous and high-quality in-service training programs for all hospital staff are necessary. By implementing these measures, we can elevate knowledge levels and minimize the harmful effects of radiation.

ETHICAL DECLARATIONS

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions

All of the authors declare that they have all participated in the design, execution, and analysis of the paper, and that they have approved the final version.

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