75219_Auto_Edited.docx

WORD COUNT	3564	TIME SUBMITTED	04-MAY-2022 02:18PM
		PAPER ID	85531002

Name of Journal: *World Journal of Methodology*
Manuscript NO: 75219
Manuscript Type: ORIGINAL ARTICLE

Prospective Study

Are We Aware Of Radiation: A Study About The Necessity Of Diagnostic X-Ray Exposure

Erdal Karavas, Bunyamin Ece, Sonay Aydın, Mehmet Kocak, Zeliha Cosgun, Isil Esen Bostanci, Mecit Kantarci

Abstract

BACKGROUND

Total exposure to ionizing radiation has nearly doubled in the last two decades. This increase is primarily due to increased computed tomography (CT) exposure. Concerns have been raised about the risks associated with medical imaging patients' exposure to radiation, which can increase a person's lifetime risk of developing cancer. Preventing unnecessary examinations becomes critical at this point. To avoid unnecessary examinations, it is necessary to understand the demanding process.

AIM

Through a questionnaire, we hope to ascertain clinicians' awareness of and reasons for requesting a CT examination.

METHODS

We developed an online questionnaire that included twenty questions about clinicians' awareness of radiation safety and their reasons for requesting a CT examination, as well as demographic information such as age, gender, and year of medical practice experience. Additionally, we asked participants the number of CTs requested in a month, the patients' questions and approaches about the imaging method, and the effect of the patient's previous imaging history on the current imaging request, whether believed they had sufficient information about radiation doses and whether they requested CT without an indication. We administered the questionnaire to clinicians from a variety of different professions in four different cities.

RESULTS

195 clinicians participated. Internal medicine specialists were the most crowded group (38/195, 19.5%). Mean age of the population was 33.66±5.92 years. Mean year of experience was 9.01±5.96. Mean number of requested CT scans in a month was 36.88±5.86. 45 (23.1%) participants stated that they requested CT scans without clinical

indication. The most common reasons for CT scan requests were work load, fear of malpractice, and patient demand/insist.

CONCLUSION

CT scan requests are influenced by a variety of factors, both internal and external to the doctors and patients. Raising awareness of radiation safety and reducing fear of malpractice by limiting the number of patients per physician may result in a reduction in unnecessary CT examinations and ionizing radiation exposure.

Key Words: Ionizing radiation; Exposure; Tomography; Physicians; Knowledge; Awareness

Karavas E, Ece B, Aydın S, Kocak M, Cosgun Z, Bostanci IE, Kantarci M. Are We Aware Of Radiation: A Study About The Necessity Of Diagnostic X-Ray Exposure. *World J Methodol* 2022; In press

Core Tip: Total exposure to ionizing radiation has nearly doubled in the last two decades. This increase is primarily due to increased computed tomography (CT) exposure. Preventing unnecessary examinations becomes critical. We developed an online questionnaire about clinicians' awareness of radiation and their reasons for requesting a CT. The most common reasons for CT scan requests were work load, fear of malpractice, and patient demand/insist. CT scan requests are influenced by a variety of factors. Raising awareness of radiation and reducing fear of malpractice by limiting number of patients per physician may result in a reduction in unnecessary CT and radiation exposure.

INTRODUCTION

Normally natural exposure to small doses of radiation is inherent in life. The average exposure is approximately 3 mSv/year. On average 2.4 mSv of the annual dose is due to

radon and naturally-occurring radiation sources (natural background radiation) and 0.6 mSv is due to the man made medical imaging and treatment methods[1].

Today, due to development of technology and clinicians' easy access to medical imaging, ionizing radiation is one of the most used methods in diagnosis and treatment of diseases in daily practice[2–4].

Radiation is a potential carcinogen affecting lots of patients undergoing medical imaging worldwide. Total exposure to ionizing radiation has nearly doubled in the last decades. This increase is primarily the result of increased exposure from computed tomography (CT), nuclear medicine, and interventional fluoroscopy [5,6]. Concerns have been expressed about the risks associated with medical imaging patients' exposure to radiation[7,8]. Ionizing radiation exposure can damage DNA, increasing an individual's lifetime risk of developing cancer. The radiation doses associated with routine CT examinations are comparable to those received by individuals with a documented increased risk of cancer. For example, an increased risk of cancer has been identified in long-term survivors of the Hiroshima and Nagasaki atomic bombings who were exposed to 10 to 100 millisieverts of radiation[9,10]. A single CT scan can expose patients to an equivalent amount of radiation, and patients may undergo multiple CT scans over time[11,12]. While a single medical imaging exam with radiation does not pose a significant risk to an individual, the annual exposure to radiation from millions of imagings with radiation is a significant public health problem. Additionally accidental exposure to high doses of ionizing radiation can also result in short-term injuries, including burns and hair loss. Exposure to such doses directly in the eyes can increase the risk of developing cataracts[13,14].

In these days, the incidence of radiation exposure from medical imaging will continue to rise exponentially for several reasons. Firstly, medical imaging technology has allowed physicians to evaluate easily and quickly both anatomy and function. Thereby, medical imaging provides benefits such as increased confidence of clinicians' decision, patient management and protection from malpractice. In addition, patients are demanding more tests to ensure correct diagnosis and treatment[5].

Preventing unnecessary medical imaging examinations is an option to reduce total exposure to radiation. To avoid unnecessary examinations, it is necessary to understand the demanding process. At this point, concerns have also been raised that clinicians may lack important information in ordering medical imaging exams that use radiation. Clinicians may not have access to patients' medical imaging history or radiation dose history. Due to insufficient information, clinicians may unnecessarily order imaging procedures that have already been conducted. Additionally If clinicians see a record of the total radiation dose to patients' previous medical history, such information might influence clinicians' decision to order a medical imaging test with radiation. Sometimes clinicians may be unaware or have insufficient knowledge of recommended criteria about whether medical imaging testing will be effective in their medical decision. As a result, clinicians may request unindicated medical imaging tests and unnecessarily expose patients to radiation[14,15].

In this study, we aim to learn about the radiation awareness of clinicians and their reasons for requesting medical imaging tests with radiation through a questionnaire.

MATERIALS AND METHODS

We developed a 20-question questionnaire for clinicians to evaluate radiation awareness and the reasons for requesting radiation-containing tests. The content of the questionnaire is shown in appendix 1.

We sent the online invitation to participate in the questionnaire to 500 clinicians from various specialties in four different cities. Of those who were invited, 195 clinicians participated in the questionnaire.

The study was designed as a descriptive cross-sectional study and local ethics committee approval was obtained for this study.

Questionnaire Content: The first four questions of the twenty-question survey inquired about the clinician's specializations, age, experience in medical practice, and professional title. In Question 5, we inquired as to whether participants believed they

had sufficient information about radiation doses. Questions 6-8 were designed to ascertain participants' level of knowledge about radiation dose. In question 9, the number of CTs requested by clinicians in a month was asked. Questions 10–12 were designed to evaluate the patient's questions and approaches about the imaging method. Questions 13–16 were designed to investigate the effect of the patient's previous imaging history on the current imaging request. The 17th question inquired about the factors that can affect clinicians' CT request. The 18–20th questions were prepared for the purpose of analysis regarding the CT request that was made without indication (Appendix 1).

Statistical analysis: Data were analyzed using the Statistical Package for Social Sciences (SPSS) for Windows 20 software (IBM SPSS Inc., Chicago, IL, USA). Conformity of the data to normal distribution was assessed with the Kolmogorov-Smirnov test. Numerical variables with normal distribution were shown as mean± standard deviation (SD) values, variables without normal distribution as median (minimum-maximum) values, and categorical variables as number (n) and percentage (%). Chi-square test was used to analyze the difference of the answers according to gender, title, profession and year of experience of the participants.

A value of $p < 0.05$ was accepted as statistically significant.

RESULTS

195 clinicians participated in the questionnaire from four different cities. The participants' mean age was 33.6±5.9 (24-56) years. Their mean years of medical practice was 9.0±6.0 (1-28) years. %64.1 of the participants were specialists, %26.2 were research assistants, and %9.7 were general practitioners. The participants were from various specialties, with internal medicine doctors accounting for the highest percentage at %19.5. Descriptive data is shown in table 1.

159 (81.5%) of the participants stated that they did not feel sufficient about radiation knowledge.

The answers to the questions asked to ascertain participants' level of knowledge about radiation dose are given in Table 2. According to these results, in the 6th-7th-8th questions, respectively 60.2%, 60% and 79.5% of participants underestimated and respectively 12.8%, 22.6% and 0% of participants overestimated the radiation dose rates of the examinations.

Mean number of requested CT scans in a month was 36.88±5.86(1-300). Among the participants, the specialties with the most CT requests per month were emergency medicine (mean 82), general surgery (mean 76) and neurosurgery (mean 57).

There was no statistically significant difference between duration of medical practice experience and monthly CT requests ($P = 0.385$).

The proportions of the answers given to the 10–12th questions evaluating the patient's questions and approaches about the imaging method, as well as to the 13-16th questions investigating the effect of the patient's previous imaging history on the current imaging request are shown in Table 3. The most commonly mentioned causes were found to be indication, concern about failure to diagnose, and fear of malpractice (Table 4).

24.6% of the participants stated that they requested CT even though there was no clinical indication. The reasons for requesting CT even though there is no clinical indication are shown in Table 5. The most common reasons were the desire to complete the diagnosis quickly, the patient's demand, and fear of malpractice.

The answers given to the question of what should be done to prevent CTs' without indication are shown in table 6. The most frequently stated response of the participants (67.2%) was "reducing the patient density and allocating sufficient time for doctors to examine patients".

DISCUSSION

Estimating the dose rates of examinations is a frequently used technique in questionnaire studies to assess participants' knowledge and awareness of ionizing radiation. For this purpose, posteroanterior (PA) chest radiography which is frequently

used in clinical practice and a daily radiation dose encountered in nature can be taken as a basis[16]. In this way, the opinions of the participants about the radiation doses of the examinations used in clinical practice can be reached. The majority of participants in our study underestimated the dose rates of examinations. In the literature, in a survey study conducted with research assistants, Koçyiğit *et al* [17] found that 64.9% of participants underestimated the radiation dose associated with abdominal CT examinations and 58.8% underestimated the radiation dose associated with abdominal radiography. Ataç *et al* [18] in their questionnaire study with radiology workers, found that majority of participants underestimated the dose value and dose rate questions. Lee *et al* in their questionnaire study among non-radiologists, found that 77% of participants underestimated the radiation dose for a chest X-ray[19]. The findings of our study and similar findings in the literature led us to believe that participants' underestimation of the dose contents may be a factor in facilitating the request for medical imaging examinations with ionizing radiation.

In our study, we found that 48.2% of patients were informed about radiation prior to requesting an examination containing ionizing radiation. There are also studies in the literature demonstrating that the sharing of radiation risk information between clinicians and patients is rare[20–22]. One possible explanation for this low rate may be the high patient density which results in insufficient time to give detailed information to the patient. Additionally, there are studies in the literature showing that clinicians are uncomfortable sharing radiation risk information with patients[23]. In our study, the rate of asking questions by patients about radiation dose or potential harm in examination containing ionizing radiation was found to be as low as 40 percent. This result could be interpreted as the patient's low awareness of radiation exposure. Informing patients about the potential risks of radiation is left to the radiology units in many hospitals. However, after the imaging examination is requested by the clinician, the patient comes to the radiology unit to perform the desired examination, so it is not possible for the patient to think about the subject again. It is also emphasized in the FDA White Paper that informed clinical decision making together with the clinician doctor during the

clinical examination will be more effective[14]. By informing patients about radiation exposure associated with imaging methods and increasing their awareness, it may be possible to reduce unindicated and unnecessary CT scans[24,25]. In the literature, it has been stated that awareness of radiation exposure has increased with the participation of patients and doctors in courses on radiation[26–28]. In addition, Sullivan *et al* demonstrated that short-term and repetitive refresher training had a positive effect on raising awareness of radiation[29].

In our study, while the mean number of requested CT scans in a month was 36.9±5.86, 81.5% of the participants stated that they did not feel sufficient about radiation knowledge. These findings are significant because they demonstrate a lack of competence about radiation information despite the frequency of CT demand as an imaging method in daily practice. In the literature, it is seen that while participants express growing concern about the risk of cancer caused by ionizing radiation, they have insufficient information about how much radiation the patient is exposed to[30,31].

In our study, it is important that a very large part of the participants (91.8%) review the previous examinations before requesting a radiation-containing examination and that a significant portion (66.7%) will be affected by the high dose warning in the hospital system record. These results can be accepted as an indicator that physicians' attention can be increased with the help of assistive methods integrated into the hospital system, regarding the request for examinations containing radiation. Again, based on these results, doctors' inability to access medical imaging containing radiation performed in different health centers may be a factor in the procedure's unnecessary repetition.

The factors affecting participants' decisions to request a CT were examined in our study. A great majority of the participants stated the option of indication as the main factor and primary reason for requesting CT. It has been understood that options such as the concern about not being able to diagnose, the worry about doing malpractice, the high patient density and patient's insist or request are significantly effective in requesting CT. Due to these various factors, it is inevitable that there will be an increase

in CT requests, unnecessary/unindicated CT scans and ionizing radiation exposure. It is important that the desire to make a diagnosis quickly and the concern for malpractice are frequently seen among the reasons for requesting CT even though there is no clinical indication. Additionally, it is important that the majority of the participants believe that patient density should be reduced and examination times should be extended in order to prevent non-indication CT scans. Yıldız *et al*[32] reported in their study in the emergency department that CT was frequently used in childhood head traumas, but normal imaging results were obtained in 98.5%. Additionally, they emphasized the need to prioritize clinical decision-making rules and patient follow-up for CT request. Dağlar *et al*[33] evaluated 51.2% of CT examinations performed for spine and pelvis evaluation as normal CT in their study. They emphasized that due to this high rate, precautions should be taken for unnecessary CT use. Karavas *et al*[34] stated that due to unnecessary CT requests may result in an increase in workload and patient density in radiology units, and related problems in reporting and an increase in diagnostic errors. We think that providing the opportunity to spend more time on clinical examination by limiting the number of patients per physician will help reduce fear of malpractice, avoid unnecessary CT examinations and reduce ionizing radiation exposure.

According to the findings of our study, some solutions can be offered to prevent unnecessary radiation exposure. The first and most critical of these is to raise patients' and clinicians' radiation awareness and consciousness, and to schedule regular radiation training sessions. If the patient's previous radiation exposure and total dose of exposure are displayed as warnings in the patient information system in the hospital prior to clinicians make a request a medical exam that includes radiation, this can help reduce unnecessary request and exam repetition. By reducing patient density, doctors can spend more time with the patient rather than rushing to a CT diagnosis, and radiation exposure can be reduced. Additionally, with detailed informed consent to the patients about the potential risks of radiation, the patient's insistence on examination with radiation is reduced, and unnecessary radiation exposure can be prevented.

Our study has some limitations, such as the low number of participants and the fact that the participating clinicians are from different specialties. However, a heterogeneous sample with diversity was created by providing participants from various cities and hospitals. There may be variations in practice based on the participants' specializations and whether they provide emergency or outpatient care. However, the study's primary objective is not to analyze these differences, but to provide an overview of ionizing radiation awareness. Additionally, the questionnaire is a test method and contains closed-ended questions are limitations of the study.

CONCLUSION

As a result of our study's findings, both patients and physicians have a low level of knowledge and awareness about ionizing radiation. While the primary consideration when requesting a radiation-containing imaging method is the indication, other considerations such as concern about not being able to diagnose, worry about doing malpractice, high patient density, and the patient's insistence also factor in. Desire to complete diagnosis quickly and fear of malpractice may be the reasons for unindicated CT demand and increase exposure to ionizing radiation. Unnecessary and unindicated ionizing radiation exposure can be reduced by reducing patient density in daily practice, extending examination times, and improving hospital systems in a way that allows for detailed documentation of the patient's previous radiation doses. Thus, potential risks to the patient associated with radiological imaging and ionizing radiation exposure can be minimized.

ARTICLE HIGHLIGHTS

Research background

Radiation-containing imaging and treatment techniques are frequently used in daily clinical practice. The advancement of technology and clinicians' increased access to radiation-containing examinations also expands the applications of radiation-containing examinations. Recently, the use of radiation-based medical exams has increased

exponentially. The dangers of radiation should be highlighted, and awareness of radiation should be increased.

Research motivation

Radiation is a potential carcinogen. Ionizing radiation exposure can damage DNA, increasing an individual's lifetime risk of developing cancer. Medical exams containing radiation can sometimes unnecessary and overused. Preventing unnecessary medical imaging examinations is an option to reduce total exposure to radiation. To avoid unnecessary examinations, it is necessary to understand the demanding process.

Research objectives

It is aimed to increase radiation awareness and thus reduce unnecessary radiation exposure.

Research methods

We developed a 20-question questionnaire for clinicians to evaluate radiation awareness and the reasons for requesting radiation-containing tests.

Research results

Most of the participants stated that they did not feel sufficient about radiation knowledge and majority of participants underestimated examination dose rates. Both patients and physicians have a low level of knowledge and awareness about ionizing radiation. In our study, we found that 48.2% of patients were informed about radiation prior to requesting an examination containing ionizing radiation. Large part of the participants (91.8%) review the previous examinations before requesting a radiation-containing examination and that a significant portion (66.7%) will be affected by the high dose warning in the hospital system record. Indication, concern about not being able to diagnose, worry about doing malpractice, high patient density, and the patient's insistence are various factor in requesting a radiation-containing imaging method.

Desire to complete diagnosis quickly and fear of malpractice may be the reasons for unindicated CT demand.

Research conclusions

According to the findings of our study, some solutions can be offered to prevent unnecessary radiation exposure. The first and most critical of these is to raise patients' and clinicians' radiation awareness and consciousness, and to schedule regular radiation training sessions. If the patient's previous radiation exposure and total dose of exposure are displayed as warnings in the patient information system in the hospital prior to clinicians make a request a medical exam that includes radiation, this can help reduce unnecessary request and exam repetition. By reducing patient density, doctors can spend more time with the patient rather than rushing to a CT diagnosis, and radiation exposure can be reduced. Additionally, with detailed informed consent to the patients about the potential risks of radiation, the patient's insistence on examination with radiation is reduced, and unnecessary radiation exposure can be prevented.

Research perspectives

Following radiation awareness training for patients and clinicians and the addition of a total radiation dose warning to the hospital's patient information system, prospective studies can be conducted to determine whether the number of requests for radiation-containing examinations has decreased in certain centers.

75219_Auto_Edited.docx

ORIGINALITY REPORT

5%
SIMILARITY INDEX

PRIMARY SOURCES

1	www.fda.gov Internet	96 words — 3%
2	jamanetwork.com Internet	43 words — 1%
3	Patricia K Nguyen, Joseph C Wu. "Radiation exposure from imaging tests: is there an increased cancer risk?", Expert Review of Cardiovascular Therapy, 2014 Crossref	23 words — 1%
4	hdl.handle.net Internet	15 words — < 1%

EXCLUDE QUOTES	ON	EXCLUDE SOURCES	< 12 WORDS
EXCLUDE BIBLIOGRAPHY	OFF	EXCLUDE MATCHES	< 12 WORDS