MEDICAL SCIENCE MONITOR

CLINICAL RESEARCH

e-ISSN 1643-3750
© Med Sci Monit, 2019; 25: 6587-6597
DOI: 10.12659/MSM.918381

Received: 2019.06.28
Accepted: 2019.08.09
Published: 2019.09.02

Awareness of Risks Associated with the Use of Plain X-Ray, Computed Tomography, and Magnetic Resonance Imaging Among Emergency Physicians and Comparison with that of Other Physicians: A Survey from Turkey

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ABCDEF 1 Mehmet Cihat Demir
ABCDEF 2 Meltem Akkas

1 Department of Emergency Medicine, Sinop Atatürk State Hospital, Sinop, Turkey
2 Department of Emergency Medicine, Faculty of Medicine, Hacettepe University, Ankara, Turkey

Corresponding Author: Mehmet Cihat Demir, e-mail: mdcihat@gmail.com
Source of support: Departmental sources

Background: Increased use of radiological imaging in all departments of medicine, especially in the Emergency Department, requires that physicians have a high level of knowledge regarding commonly used imaging methods and high awareness of the risks of examinations.

Material/Methods: The physicians were divided into 5 groups according to their specialties as emergency medicine physicians (EMPs), physicians from any specialty of internal sciences, physicians from any specialty of surgical sciences, general practitioners (GPs), and radiologists. A total of 700 physicians answered the questionnaire via email.

Results: 15.7% of EMPs reported that they did not routinely perform any risk assessment before requesting computed tomography (CT); the rate was 17.9% for direct radiography and 29.3% for magnetic resonance imaging (MRI). The proportions of physicians who do not routinely perform risk assessments for direct radiography, CT, and MRI were as follows: 16.4%, 8.6%, and 19.3% in physicians from medical sciences, respectively; 25%, 22.9%, and 35% in physicians from surgical sciences, respectively; 24.3%, 14.3%, and 37.1% in GPs, respectively; and 27.1%, 22.1% and 37.1% in radiologists, respectively. In all radiological examinations, 1.4% of EMPs and ≤1.4% of other physicians routinely explain the risks associated with the imaging method to the patients, and discuss the risks and benefits of the imaging with the patients.

Conclusions: All physicians, including EMPs, need to undergo urgent training to increase their knowledge on risks of imaging methods and discussion of existing risks with patients.

MeSH Keywords: Education, Medical, Continuing • Radiologic Health • Risk Assessment

Full-text PDF: https://www.medscimonit.com/abstract/index/idArt/918381

3619 6 1 46

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Background

Radiological imaging plays an important role in today's medical practice. Developments in medical imaging increase patients' life expectancy and quality of life. Undoubtedly, these developments have significantly assisted physicians in recognizing and treating diseases and injuries and offer millions of people the possibility of treatment with a minimally invasive approach as an alternative to surgery [1].

According to the study published by Papanicolas et al., in high-income countries the average number of magnetic resonance imaging (MRI) and mean computed tomography (CT) scans were 82 and 151 per 1000 persons, respectively. These numbers were 118 and 245 in the United States, respectively, and in terms of the number of radiological imaging, the United States is the second country with the highest rate of MRI and CT technology use, following Japan [2]. Turkey shows similar characteristics to the high-income countries in terms of overuse of radiological imaging methods. According to the Organisation for Economic Co-operation and Development European Union (EU) Health Statistics report, between 2011 and 2014, Turkey ranked first in the number of MRI scans and 8th in the number of CT scans. The EU average increase in the use of CT was 49%, while the increase was 60% in Turkey. The EU average increase in the use of MRI was 38%, while Turkey had a 134% increase [3].

The increase in the number of imaging methods in the Emergency Department (ED) is higher than the total increase in the number of imaging methods in hospital inpatient, outpatient, and private physician office settings [4]. This trend is partly associated with the increase in the number of patients admitted in the ED. However, the use of diagnostic imaging exceeded the number of ED visits [5].

The increasing use of imaging methods has led to discussions regarding excessive and unnecessary use. The discussions are mostly centered on increased healthcare cost, exposure to radiation, reactions to contrast material (allergy, contrast-induced nephropathy, nephrogenic systemic fibrosis), and crowding in hospitals related to tests [6–8].

Since its introduction in the 1970s, CT has seen an explosion in its utilization. The major concern with the widespread use of CT is the increased risk of malignancy associated with ionizing radiation. Some authors declare that the relationship between radiation and cancer is based on data from survivors of atomic bombs explosions in Japan and patients occupationally exposed to radiation within the nuclear industry. They state that with the developing technology, patients are given much lower doses of radiation and the news media exaggerates the subject. In addition, these authors emphasize that the relationship between cancer and radiation dose less than 50 mSv for single procedures and less than 100 mSv for multiple procedures is speculative because the radiation dose given for CT is well below these values [9]. However, many studies in the literature suggest that cumulative radiation exposure due to increased CT use may lead to a significant increase in cancer incidence, especially in pediatric patients, young patients, patients with chronic diseases, and patients with cancer susceptibility [10–13]. While the debate about the increase in malignancy due to CT use continues, physicians should balance the benefits and risks of examinations well.

The studies conducted to date were mostly focused on physicians' knowledge regarding test-related radiation doses [14–16].

The main purpose of this study was to investigate self-assessment of adequacy of knowledge of emergency medicine physicians (EMPs) on commonly used imaging methods in the ED and their attitudes toward questioning the risks of imaging methods and explaining the risks to patients. Moreover, the answers of EMPs were compared with those of physicians from other specialties, radiologists, and general practitioners (GPs).

Material and Methods

The study was conducted between May 15, 2015 and October 30, 2015, after obtaining approval from the Ethics Committee on April 16, 2015, numbered 16969557/565 with registration number GO 15/286 from the Hacettepe University Non-interventional Clinical Research Ethics Board.

The questions which were used in the survey were based on similar studies in the literature and on past experience. The questionnaire was designed to find the answers to the following three questions:

1. Do doctors consider their level of knowledge sufficient on imaging methods?
2. Do doctors evaluate the risks associated with the radiological test, before ordering an imaging method?
3. Do physicians explain the risks associated with the imaging method to the patients, and discuss the risks and benefits of the imaging with the patients?

The questionnaire consists of 5 parts (Table 1). The first part of the survey contained data on the specialties of physicians and the total duration of their work in the relevant specialties.

In the second part of the questionnaire, physicians were asked to evaluate their knowledge about imaging methods as "very little", "little", "moderate", "good" and "very good".

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 1. Survey questions.

Part 1.
1. What is your academic degree? a – General practitioner b – Research assistant c – Specialist doctor 2. Which medical specialty do you work in? (for research assistants or specialists) ..... 3. a – How many years have you been working in your field of specialty, including specialty training? (only for research assistant / specialist) ..... (year) b – How many years do you work as a general practitioner? (for general practitioner) ..... (year)
Part 2.
1. How can you assess your own level of knowledge on imaging methods? a – Very little b – Little c – Moderate d – Good e – Very good
Part 3.
1. What is the source of your information on imaging methods? You can select multiple choices. a – Medicine school training b – Specialty training c – Individual interest- based research d – Radiological courses or seminars e – Other (.....)
Part 4.
1. Do you routinely consider the risks associated with direct radiography for the patient before ordering? a – Yes b – No 2. Do you routinely consider the risks associated with computed tomography for the patient before ordering? a – Yes b – No 3. Do you routinely consider the risks associated with magnetic resonance imaging for the patient before ordering? a – Yes b – No 4. Do you routinely pay attention to radiation exposure before you order a direct radiography? a – Yes b – No 5. Do you routinely pay attention to whether the examination was performed already for the same indication before ordering direct radiography? a – Yes b – No 6. Do you routinely pay attention to radiation exposure, before you order a computed tomography scan? a – Yes b – No 7. Do you routinely pay attention to contrast-induced nephropathy, before you order a computed tomography scan? a – Yes b – No 8. Do you routinely pay attention to contrast agent allergy, before you order a computed tomography scan? a – Yes b – No

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 1 continued. Survey questions.

9. Do you routinely pay attention to whether the examination was performed already for the same indication before ordering computed tomography? a – Yes b – No
10. Do you routinely pay attention to radiation exposure, before you request a magnetic resonance imaging? a – Yes b – No
11. Do you routinely pay attention to contrast-induced nephropathy, before you request a magnetic resonance imaging? a – Yes b – No
12. Do you routinely pay attention to contrast agent allergy, before you request a magnetic resonance imaging? a – Yes b – No
13. Do you routinely pay attention to whether the examination was performed already for the same indication before requesting magnetic resonance imaging? a – Yes b – No
Part 5.
1. Do you routinely inform the patient regarding the risks associated with the imaging method and discuss the risks and necessity with the patient before ordering direct radiography? a – Yes b – No
2. Do you routinely inform the patient regarding the risks associated with the imaging method and discuss the risks and necessity with the patient before ordering computed tomography? a – Yes b – No
3. Do you routinely inform the patient regarding the risks associated with the imaging method and discuss the risks and necessity with the patient before ordering magnetic resonance imaging? a – Yes b – No

In the third part of the survey, the physicians were asked to indicate one or more sources from which they obtained information on imaging methods.

In the fourth part of the survey, the clinicians were asked whether they routinely considered the risks associated with the imaging methods before ordering commonly used imaging methods (direct radiography, CT, MRI) for their patients. Moreover, before requesting imaging methods, clinicians were asked whether the imaging method-related risks such as cancer, nephropathy, and allergies were questioned. The survey questions in Table 1 have been modified for radiologists, and the radiologists were asked whether they routinely re-evaluated risks associated with the imaging methods when clinicians ordered an imaging method.

In the fifth part, physicians were asked whether they routinely explained and discussed the risks and benefits related to the imaging methods with the patient.

The comprehensibility and clarity of the items in the questionnaire were tested by 6 EMPs, 8 physicians from any specialty of internal sciences, 6 physicians from any specialty of surgical sciences, 6 radiologists, and 11 GPs by face-to-face interview. In order not to affect the results, the answers of these physicians were excluded from the study.

The physicians were divided into 5 groups: In addition to EMPs who were specialists or research assistants for at least 3 years, physicians who were specialists or research assistants for at least 3 years from any specialty of internal or surgical sciences, GPs who worked for at least 3 years, and radiologists who were specialists or research assistants for at least 3 years were included in the study. Those who did not complete the questionnaire and did not work as a research assistant, specialist, or GP for at least 3 years to gain sufficient experience were excluded.

In our country, emergency medicine is a new specialty in the medical field. There were only 903 emergency medicine specialists in Turkey in 2014, when this study was started [17]. When we added doctors who had been working as emergency medicine assistants for at least 3 years, the number of emergency medicine doctors was 1150. Email address of 803

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

emergency physicians were obtained. Since only 140 EMPs responded to the questionnaire, when the number of physicians from other specialties who answered the questionnaire reached 140, the survey was completed.

In this study, the internet-based assessment survey was used. Survey data were obtained via electronic data form from an electronic database. Participation of more than once with the same email address was not allowed.

Data were analyzed using IBM SPSS version 22.0. Numerical variables were summarized with mean ± standard deviation or median (min, max). Categorical variables were presented as numbers and percentages. The Kruskal-Wallis test was used to determine whether there were any differences between the departments in terms of working time. The difference was found using the Siegel-Castellan test. The chi-square test was used to determine the difference between the groups. The group that created the difference was found using the Marascuilo test. A *P*-value <0.05 was considered statistically significant.

Results

Of the 803 EMPs whose email addresses were obtained, 140 answered the questionnaire. The response rate of EMPs was 17.4%. The study consisted of answers of 700 physicians, 140 in each group. Distribution of the physicians according to the specialties is presented in Table 2.

Table 3 shows the average work duration of physicians according to their specialties. The total work duration of GPs was found to be significantly less than those of other physicians (*P*<0.001).

Figure 1 shows the distribution of the sources of the physicians' radiological knowledge by specialty. The physicians were able to mark more than one option as an information source. EMPs and radiologists reported a higher rate of specialty training as a source of information on imaging methods than physicians from other specialties (*P*<0.001). The number of physicians with specialty training as a source of information was lowest (58.6%) among those in surgical medical departments and highest (100%) among those in radiology departments. EMPs reported specialty training to be a source of radiological information more often than physicians from internal and surgical medical sciences (*P*<0.001).

The rate of participation in radiology courses or seminars was found to be significantly higher among radiologists, and the rate of research based on personal interest was significantly higher among EMPs and radiologists than among other physicians (*P*<0.001).

Table 2. Distribution of physicians according to their specialties.

Departments	n
Emergency Medicine Physicians	**140**
Internal Medical Sciences	**140**
Internists	65
Family physicians	13
Neurologists	13
Pulmonologists	12
Cardiologists	11
Physical therapy and rehabilitation specialists	8
Psychiatrists	7
Sports medicine specialists	5
Infectious diseases and clinical microbiology physicians	4
Dermatologists	2
Surgical Medical Sciences	**140**
General surgeons	37
Orthopedists	24
Anesthesiologists	16
Ophthalmologists	14
Gynecologists	11
Otolaryngologists	11
Urologists	11
Neurosurgeons	10
Plastic and reconstructive surgeons	3
Cardiac surgeons	2
Thoracic surgeon	1
General Practitioners	**140**
Radiologists	**140**
Total	**700**

Table 4 shows physicians' self-evaluation of their level of knowledge on imaging methods according to specialties. Particularly, 20.7% of radiologists, 46.4% of EMPs, and >50% of physicians from other specialties reported their knowledge to be "very little", "little", and "moderate", respectively. Radiologists and EMPs evaluated their level of knowledge as "good" compared with other physicians from other specialties, and radiologists evaluated their level of knowledge as "very good" compared with physicians from other specialties (*P*<0.001).

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 3. The average work duration of the physicians according to their specialties.

Departments	Total working time of doctors (years)		
	Mean (Minimum–Maximum)	Median	Standard deviation
EMPs	**8.86** (3–28)	7	5.046
Internal Medical Sciences	**9.43** (3–37)	7	7.436
Surgical Medical Sciences	**7.68** (3–44)	5	5.580
GPs	**4.70** (3–30)	3	5.108
Radiologists	**9.21** (3–34)	6	6.905
Total	**7.98** (3–44)	5	6.323

EMPs – emergency medicine physicians; GPs – general practitoners.

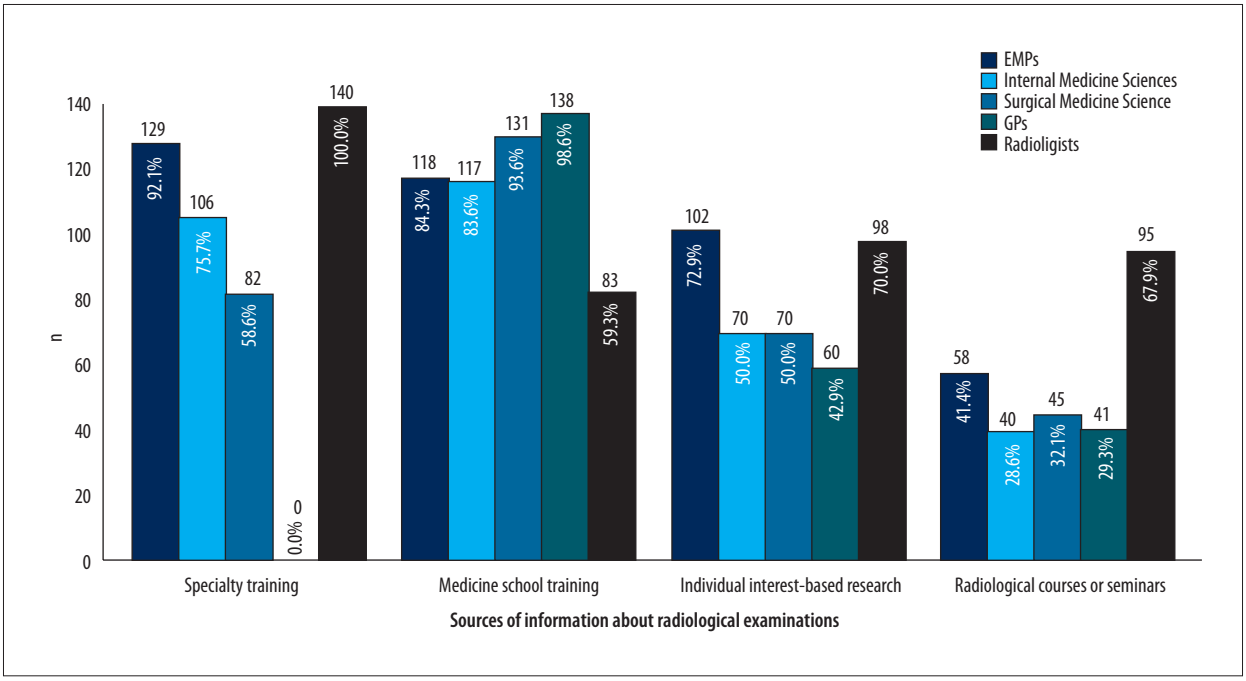

Figure 1. Distribution of the sources of the physicians' radiological knowledge by specialty.

Of the EMPs, 15.7% reported that they did not routinely perform any risk assessment before requesting CT, which is 17.9% for direct radiography and 29.3% for MRI. The proportions of physicians who did not routinely perform any risk assessments for direct radiography, CT, and MRI were as follows: 16.4%, 8.6%, and 19.3% in physicians from medical sciences, respectively; 25%, 22.9%, and 35% in physicians from surgical sciences, respectively; 24.3%, 14.3%, and 37.1% in GPs, respectively; and 27.1%, 22.1%, and 37.1% in radiologists, respectively (Table 5).

In all radiological examinations, 1.4% of EMPs and ≤1.4% of other physicians routinely explain the risks associated with the imaging method to the patients, and discuss the risks and benefits of the imaging with the patients (Table 6).

Discussion

In 2015, according to the data from the National Hospital Ambulatory Medical Care Survey, almost half of all ED visits in the United States resulted in at least one imaging examination, and about 1 in 6 patients were ordered to undergo CT [18]. MRI, which is one of the advanced imaging modalities, has been recently used by the emergency services especially in neuroimaging [19,20]. In the study by Rosenkrantz et al., it was found that the use of CT as an advanced imaging method increased without any significant reduction in ultrasonography and plain radiography in the diagnosis of some diseases such as pneumonia and appendicitis. Furthermore, it was determined that use of diagnostic modalities including multiple imaging methods such as CT and ultrasonography or CT, radiography, and

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 4. Physicians' self-evaluation of the level of knowledge regarding imaging methods.

Departments	Level of Knowledge					Total	
	Very little	Little	Moderate	Good	Very good		
	%	%	%	%	%	n	%
EMPs	0.0	12.1	34.3	52.9	0.7	140	**100**
Internal Medical Sciences	2.9	26.4	52.1	17.9	0.7	140	**100**
Surgical Medical Sciences	3.6	20	54.3	20.0	2.1	140	**100**
GPs	12.9	32.9	47.9	6.4	0.0	140	**100**
Radiologists	0.7	1.4	18.6	50.0	29.3	140	**100**
Total	**4.0**	**18.6**	**41.4**	**29.4**	**6.6**	700	**100**

EMPs – emergency medicine physicians; GPs – general practitoners.

Table 5. Self-assessment by the physicians' attention to the risks of commonly used imaging methods before ordering the imaging tests.

	EMPs		Internal Medical Sciences		Surgical Medical Sciences		GPs		Radiologists		Total	
	n	%	n	%	n	%	n	%	n	%	n	%
Before ordering direct radiography												
I do not routinely question the risks associated with the method	25	**17.9**	23	**16.4**	35	**25**	34	**24.3**	38	**27.1**	155	**22.1**
I routinely pay attention to radiation exposure	44	**31.4**	36	**25.7**	40	**28.6**	41	**29.3**	37	**26.4**	198	**28.3**
I routinely pay attention to recurrent radiological imaging	7	**5**	11	**7.9**	22	**15.7**	3	**2.1**	9	**6.4**	52	**7.4**
Before ordering CT												
I do not routinely question the risks associated with the method	22	**15.7**	12	**8.6**	32	**22.9**	20	**14.3**	31	**22.1**	117	**16.7**
I routinely pay attention to radiation exposure	74	**52.9**	62	**44.3**	59	**42.1**	71	**50.7**	53	**37.9**	319	**45.6**
I routinely pay attention to contrast-induced nephropathy	32	**22.9**	45	**32.1**	25	**17.9**	28	**20**	28	**20**	158	**22.6**
I routinely pay attention to contrast-agent allergy	40	**28.6**	30	**21.4**	27	**19.3**	29	**20.7**	30	**21.4**	156	**22.3**
I routinely pay attention to recurrent radiological imaging	9	**6.4**	19	**13.6**	17	**12.1**	7	**5**	11	**7.9**	63	**9**
Before ordering MRI												
I do not routinely question the risks associated with the method	41	**29.3**	27	**19.3**	49	**35**	52	**37.1**	52	**37.1**	221	**31.6**
I routinely pay attention to contrast-agent allergy	21	**15**	15	**10.7**	19	**13.6**	17	**12.1**	18	**12.9**	90	**12.9**
I routinely pay attention to contrast-induced nephropathy	10	**7.1**	30	**21.4**	12	**8.6**	11	**7.9**	15	**10.7**	78	**11.1**
I routinely pay attention to radiation exposure	0	**0**	0	**0**	1	**0.7**	1	**0.7**	0	**0**	2	**0.3**
I routinely pay attention to recurrent radiological imaging	22	**15.7**	19	**13.6**	11	**7.9**	14	**10**	7	**5**	73	**10.4**

EMPs – emergency medicine physicians; GPs – general practitoners.

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

Table 6. Self-evaluation by the physicians on providing information to patients about the risks of commonly used imaging methods and discussing the risks and benefits with the patients before ordering imaging tests.

Specialties	Imaging methods					
	Direct tadiography		Computed tomography		Magnetic resonance imaging	
	n	%	n	%	n	%
EMPs	2	1.4	2	1.4	0	0.0
Internal Medical Sciences	0	0.0	0	0.0	0	0.0
Surgical Medical Sciences	1	0.7	2	1.4	1	0.7
GPs	0	0.0	2	1.4	1	0.7
Radiologists	0	0.0	0	0.0	0	0.0
Total	**3**	**0.4**	**6**	**0.9**	**2**	**0.3**

EMPs – emergency medicine physicians; GPs – general practitoners.

ultrasonography in the diagnosis of urinary calculi increased at the same visit [21].

EMPs should have a good knowledge of the imaging methods often used. In this study, EMPs evaluated their knowledge on radiological imaging as higher than GPs and other physicians, with the exception of radiologists. Additionally, EMPs reported their specialty training to be a source of information at a higher rate than physicians from internal and surgical medical sciences. We found that EMPs and radiologists obtain information through learning and research based on personal interest more than other physicians. These results indicate that EMPs are aware of the importance of their frequent use of imaging methods and that they are making more efforts than physicians from other specialties to improve themselves. However, almost half of the EMPs evaluated their knowledge on the subject as very little, little, and moderate.

Radiologists may not always be available in all institutions. It may also take hours for radiologists to interpret the relevant examination. In many emergency cases in the ED, the radiological examination may need to be evaluated immediately because time is critical. An EMP must be able to interpret the basic imaging studies and situations that need to be identified urgently in more complex imaging studies.

Radiology education is an important issue in the field of emergency medicine, and emergency medicine residents undergo formal radiology training within their curriculum. However, EMPs may encounter some difficulties in interpreting methods such as chest radiography and head CT [22–25].

Studies in the literature show that physicians have insufficient knowledge on the amount of radiation the patient is exposed to during radiological examinations [14,15,26,27] and there is a lack of awareness at undergraduate and postgraduate level [28,29]. The curriculum of undergraduate and postgraduate education should be revised to include a broader and more effective training on the subject. In 2015, the Emergency Medicine Consensus Conference was held in the United States to optimize the use of diagnostic imaging in emergency medicine [30]. One of the 6 titles of this conference was "Training, Education, and Competency". In this conference, it was stated that simulations could be used to increase the training and education of EMPs. Furthermore, it was emphasized that effective methods should be developed for the dissemination and administration of the clinical decision rules.

Courses and simple efficient training on radiological imaging can help correct the deficiencies in the matter [30–32]. Radiology training must include more than just the information on the use and interpretation of imaging methods. Sequential and appropriate use and the assessment of risks associated with the method are also important components of radiology education. Radiological imaging is like a double-edged blade. Excessive and unnecessary use of imaging methods causes overdiagnosis and increases costs without a significant increase in quality of the results. Other unintended consequences associated with overuse are crowding in the ED, prolonged hospital stay, radiation exposure, and contrast-induced nephropathy and allergic reactions caused by the contrast material [2,4,5,8,10–12,33–35].

In this study, a high percentage of physicians reported that they did not routinely pay attention to the risks associated with radiological examinations. Furthermore, it was determined that the risks such as cancer, contrast allergy, and contrast-induced nephropathy were questioned at a low rate. It was found that physicians leave the assessment of these risks to radiology technicians and nurses. Since we did not expect high-risk assessment to be ignored to this extent, we did not investigate why risks were not examined by physicians in this study. However,

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

we believe that physicians may ignore the risks related to imaging methods because of lack of knowledge. A United States study of health care providers showed that less than 50% of radiologists and only 9% of ED personnel were aware of the potential relationship between CT and malignancy development [36]. An assessment of American pediatric surgeons found that 75% of all respondents underestimated the dose delivered by CT compared with a chest x-ray [37]. In addition to lack of knowledge, factors such as crowding and lack of time may cause non-questioning of the risks associated with imaging methods [14,15,26,38,39].

Unfortunately, these diagnostic tools come at a cost in the form of radiation exposure. There is an increasing concern that, in the future, there may be an increase in malignancy associated with diagnostic imaging. CT is the most discussed diagnostic tool since it uses more radiation compared with radiography. Brenner and Hall estimated that 1.5–2% of all cancers in the United States may be related to radiation exposure due to CT [10]. Especially in pediatric patients with longer life expectancy, the risk of cancer is more likely to increase. Miglioretti et al. estimated that 4 million pediatric CT scans (head, abdomen/pelvis, chest, or spine) performed annually will cause 4870 cancer cases in the future [11]. Sodickson et al. suggested that 0.7% of the expected total basal cancer incidence and 1% of total cancer mortality were associated with CT [12]. Although some authors argue that the CT devices used in the above studies were older and therefore the amount of radiation given to the patient was calculated more and less radiation is now given to the patients by using newer CT devices and radiation protection strategies [9], there is a general acknowledgment by many authors that there is a potential risk of cancer from radiation exposure [10–13]. Physicians should have adequate training and knowledge in order to establish a good balance between the benefits and risks of imaging methods.

One of the important issues that are ignored is the cumulative radiation dose in patients who undergo recurrent radiological examinations. In this study, high rate of physicians reported that they did not pay attention to whether the examination was performed already for the same indication before requesting test. The healthcare system in our country does not allow access to patients' examinations at other hospitals. Therefore, patients are at risk of re-exposure to the same examination at each new hospital. Additionally, in cases that cannot be diagnosed, complaints in more than one system, or patients who are diagnosed but followed, and patients with chronic diseases, the incidence of cancer increases due to the cumulative radiation dose they are exposed to [12,13,26,27,35,38–41]. The development of warning systems where physicians are provided with radiation information due to previous examinations of the patient may reduce the cumulative radiation dose.

In this study, 2 physicians (0.3%) revealed that MRI could lead to radiation exposure despite the fact that, so far, no radiation exposure related to MRI has been determined. The literature shows that a large number of physicians with a wide range of experience and in different branches, such as interns, GPs, pediatric surgeons, radiologists, family physicians, and specialists, did not know whether MRI examinations involved ionizing radiation [26,27]. Since MRI does not use ionizing radiation such as CT and direct radiography and offers increased accessibility and, in some cases, good, or even better, diagnosis as that in CT, MRI is increasingly used in EDs [19,20]. However, MRI is not a completely harmless examination tool. The risk of MRI-incompatible materials and claustrophobia is important for the quality of the examination, patient's safety, and prevention of possible complications. Contrast allergy and contrast-induced nephropathy are relatively rare with iodinated agents used in MRI but should be considered in every patient [42–44].

In this study, it was determined that very few physicians provided information to the patients by discussing the benefits and risks of imaging methods. Other studies in the literature similarly show that only a low percentage of physicians talk to the patient about the risk of cancer due to imaging methods [14,26,30,38,45]. EMPs may order the imaging methods without obtaining patients' consent if the patient is unstable, unconscious, or unresponsive or if the patient's life is in danger. However, for many emergency patients, there are time and opportunities to inform the patient about the risks associated with the examination. Although the risk of medical imaging-induced radiation has become a matter of debate for both public and policymakers, EMPs do not routinely inform patients about these risks. For patient-centered care, it is important for patients and their families to have high-quality communication, and informed consent is a good opportunity for patients to become part of the shared decision-making process. Physicians should discuss with the patient the purposes, benefits, risks, and alternatives of imaging methods and clearly answer the questions of patients. However, the lack of potential methods to involve patients in the imaging decision, worry about whether the risk associated with the imaging methods will be exaggerated and the test will be refused by the patient, and physicians' inadequate knowledge of the imaging methods and their risks may prevent them from discussing the imaging methods with the patient [30]. However, Baumann et al. showed that patients rely on the physician's decision to request CT [46]. It is only possible for physicians to provide accurate information to their patients about the benefits and risks of the imaging methods by increasing their training on the subject.

This study includes data from a particular region. Due to the low number of EMPs, differences between residents and specialists could not be compared. Additionally, it is likely that the

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

results of the study would be different if the EMPs were compared to physicians specializing in one department such as general surgeons only instead of physicians in surgical medical sciences. However, in our opinion, this study is not far from reflecting the situation about this topic in our country.

Conclusions

EMPs reported their knowledge of radiological imaging studies as "good" at a higher rate than GPs and physicians from other specialties, with the exception of radiologists. However, about half of EMPs and more than half of all physicians, with the exception of radiologists, evaluated their knowledge of radiological imaging to be "very little", "little", or "moderate". It was determined that all physicians, including the EMPs, did not pay attention to the risks associated with imaging methods at high rates, and discussing the risks with the patients was at extremely low rates. Improvements are required in the education of physicians about this topic. This and similar studies will increase awareness among physicians who request imaging methods, people preparing medical education curriculum, and trainers. During specialty and medical school education, more information and training should be provided on balancing the risks and benefits of imaging methods and explaining the risks and benefits to the patient. Increasing and disseminating training about indications of imaging methods, sequential use, and risk assessment can reduce excessive use, recurrent radiological tests, health costs, and radiation-related cancer incidence. In addition, informing the patient about the risks and benefits of imaging methods will also contribute to improving patient-centered care.

Conflict of interest

None.

References:

1. Hendee WR, Becker GJ, Borgstede JP et al: Addressing overutilization in medical imaging. Radiology, 2010; 257(1): 240–45
2. Papanicolas I, Woskie LR, Jha AK: Health care spending in the United States and other high-income countries. JAMA, 2018; 319(10): 1024–39
3. OECD, EUHS, and Turkey, 2015. Available from: *https://www.saglikaktuel.com/d/file/35c966a9f1d343909d4d0858bec69333.pdf*
4. Levin DC, Rao VM, Parker L et al: Recent shifts in place of service for noninvasive diagnostic imaging: Have hospitals missed an opportunity? J Am Coll Radiol, 2009; 6(2): 96–99
5. Lee J, Kirschner J, Pawa S et al: Computed tomography use in the adult Emergency Department of an academic urban hospital from 2001 to 2007. Ann Emerg Med, 2010; 56(6): 591–96
6. Medicare Payment Advisory Commission. A Data Book: Healthcare spending and the Medicare program. Washington, DC: MedPAC. 2012. Available from: *http://67.59.137.244/documents/Jun10DataBookEntireReport.pdf*
7. Andreucci M, Faga T, Pisani A et al: Acute kidney injury by radiographic contrast media: pathogenesis and prevention. BioMed Res Int, 2014; 2014: 362725
8. Yoon P, Steiner I, Reinhardt G: Analysis of factors influencing length of stay in the Emergency Department. CJEM, 2003; 5(3): 155–61
9. Power SP, Moloney F, Twomey M et al: Computed tomography and patient risk: Facts, perceptions and uncertainties. World J Radiol, 2016; 28: 8(12): 902–15
10. Brenner DJ, Hall EJ: Computed tomography – an increasing source of radiation exposure. N Engl J Med, 2007; 357(22): 2277–84
11. Miglioretti DL, Johnson E, Williams A et al: The use of computed tomography in pediatrics and the associated radiation exposure and estimated cancer risk. JAMA Pediatr, 2013; 167(8): 700–7
12. Sodickson A, Baeyens PF, Andriole KP et al: Recurrent CT, cumulative radiation exposure, and associated radiation-induced cancer risks from CT of adults. Radiology, 2009; 251(1): 175–84
13. Fabritius G, Brix G, Nekolla E et al: Cumulative radiation exposure from imaging procedures and associated lifetime cancer risk for patients with lymphoma. Sci Rep, 2016; 6: 35181
14. Badawy MK, Sayakkarage D, Ozmen M: Awareness of radiation dose associated with common diagnostic procedures in Emergency Departments: A pilot study. Australas Med J, 2015; 8(11): 338–44
15. Griffey RT, Jeffe DB, Bailey T: Emergency physicians' attitudes and preferences regarding computed tomography, radiation exposure, and imaging decision support. Acad Emerg Med, 2014; 21(7): 768–77
16. Barbic D, Barbic S, Dankoff J: An exploration of Canadian emergency physicians' and residents' knowledge of computed tomography radiation dosing and risk. CJEM, 2015; 17(2): 131–39
17. Yanturali S: Today's academic emergency medicine in Turkey with numbers. Turkiye Klinikleri J Emerg Med-Special Topics, 2016; 2(3): 65–68
18. National Hospital Ambulatory Medical Care Survey: 2015 Emergency Department Summary Tables. Available from: *https://www.cdc.gov/nchs/data/nhamcs/web_tables/2015_ed_web_tables.pdf*
19. Kwong RY, Schussheim AE, Rekhraj S et al: Detecting acute coronary syndrome in the Emergency Department with cardiac magnetic resonance imaging. Circulation, 2003; 107(4): 531–37
20. Quaday KA, Salzman JG, Gordon BD: Magnetic resonance imaging and computed tomography utilization trends in an academic ED. Am J Emerg Med, 2014; 32(6): 524–28
21. Rosenkrantz AB, Hanna TN, Babb JS, Duszak R Jr.: Changes in Emergency Department imaging: Perspectives from national patient surveys over two decades. J Am Coll Radiol, 2017; 14(10): 1282–90
22. Evans LR, Fitzgerald MC, Mitra B, Varma D: Emergency department interpretation of CT of the brain: A systematic review. Postgrad Med J, 2017; 93(1102): 454–59
23. Boyle A, Staniciu D, Lewis S et al: Can middle grade and consultant emergency physicians accurately interpret computed tomography scans performed for head trauma? Cross-sectional study. Emerg Med J, 2009; 26(8): 583–85
24. Dolatabadi AA, Baratloo A, Rouhipour A et al: Interpretation of computed tomography of the head: Emergency physicians versus radiologists. Trauma Mon, 2013; 18(2): 86–89
25. Gatt M, Spectre G, Paltiel O, Hiller N, Stalnikowicz R: Chest radiographs in the Emergency Department: Is the radiologist really necessary? Postgrad Med J, 2003; 79(930): 214–17
26. Wong CS, Huang B, Sin HK et al: A questionnaire study assessing local physicians, radiologists and interns' knowledge and practice pertaining to radiation exposure related to radiological imaging. Eur J Radiol, 2012; 81(3): e264–68
27. Lee RK, Chu WC, Graham CA et al: Knowledge of radiation exposure in common radiological investigations: A comparison between radiologists and non-radiologists. Emerg Med J, 2012; 29(4): 306–8
28. Subramaniam R, Hall T, Chou T et al: Radiology knowledge in new medical graduates in New Zealand. N Z Med J, 2005; 118(1224): U1699
29. O'Sullivan J, O'Connor OJ, O'Regan et al: An assessment of medical students' awareness of radiation exposures associated with diagnostic imaging investigations. Insights Imaging, 2010; 1: 86–92

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]

30. Mills AM, Raja AS, Marin JR: Optimizing diagnostic imaging in the Emergency Department. Acad Emerg Med, 2015; 22(5): 625–31
31. Minkowitz S, Leeman K, Giambrone AE et al: Emergency Radiology "Boot Camp": educating emergency medicine residents using e-learning radiology modules. AEM Educ Train, 2017; 1(1): 43–47
32. Dym RJ, Burns J, Taragin BH: Appropriateness of imaging studies ordered by emergency medicine residents: Results of an online survey. Am J Roentgenol, 2013; 201(4): W619–25
33. Amis ES Jr., Butler PF, Applegate KE et al: American College of Radiology white paper on radiation dose in medicine. J Am Coll Radiol, 2007; 4(5): 272–84
34. Welch HG, Black WC: Overdiagnosis in cancer. J Natl Cancer Inst, 2010; 102(9): 605–13
35. Kocher KE, Meurer WJ, Fazel R et al: National trends in use of computed tomography in the Emergency Department. Ann Emerg Med, 2011; 58(5): 452–62.e3
36. Lee CI, Haims AH, Monico EP et al: Diagnostic CT scans: Assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. Radiology, 2004; 231(2): 393–98
37. Rice HE, Frush DP, Harker MJ et al: Peer assessment of pediatric surgeons for potential risks of radiation exposure from computed tomography scans. J Pediatr Surg, 2007; 42(7): 157–64
38. Lee CI, Haims AH, Monico EP et al: Diagnostic CT scans: Assessment of patient, physician, and radiologist awareness of radiation dose and possible risks. Radiology, 2004; 231(2): 393–98
39. Baloescu C: Diagnostic imaging in emergency medicine: How much is too much? Ann Emerg Med, 2018; 72(6): 637–43
40. Hobbs JB, Goldstein N, Lind KE et al: Physician knowledge of radiation exposure and risk in medical imaging. J Am Coll Radiol, 2018; 15(1 Pt A): 34–43
41. Soye JA, Paterson A: A survey of awareness of radiation dose among health professionals in Northern Ireland. Br J Radiol, 2008; 81(969): 725–29
42. Murphy KJ, Brunberg JA, Cohan RH: Adverse reactions to gadolinium contrast media: A review of 36 cases. Am J Roentgenol, 1996; 167(4): 847–49
43. Napp AE, Enders J, Roehle R et al: Analysis and prediction of claustrophobia during MR imaging with the claustrophobia questionnaire: An observational prospective 18-month single-center study of 6500 patients. Radiology, 2017; 283(1): 148–57
44. Davenport MS: Choosing the safest gadolinium-based contrast medium for MR imaging: Not so simple after all. Radiology, 2018; 286(2): 483–85
45. Zwank MD, Leow M, Anderson CP: Emergency department patient knowledge and physician communication regarding CT scans. Emerg Med J, 2014; 31(10): 824–26
46. Baumann BM, Chen EH, Mills AM et al: Patient perceptions of computed tomographic imaging and their understanding of radiation risk and exposure. Ann Emerg Med, 2011; 58(1): 1–7.e2

Indexed in: [Current Contents/Clinical Medicine] [SCI Expanded] [ISI Alerting System] [ISI Journals Master List] [Index Medicus/MEDLINE] [EMBASE/Excerpta Medica] [Chemical Abstracts/CAS]