



Evaluation of Knowledge of Patients Undergoing CT Examination Regarding Radiation Risks and their Involvement in Decision Making

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Abstract

Background: The objective of the present study is to assess knowledge of patients undergoing CT examination regarding radiation risks associated with it and to evaluate the relationships between patient's knowledge of these concepts and their sociodemographic characteristics. Moreover, this study also evaluates patients' perspectives and their involvement in the medical decision-making process regarding obtaining a CT examination.

Methods: This is a cross sectional study that was conducted in department of Radiology of a tertiary health care hospital. A sample of 500 patients presenting to Radiology department for CT examination was taken. A closed ended questionnaire was distributed to the study participants comprising of knowledge questions and physician's role in knowledge dissemination of radiation risks and patient's involvement in decision making. Statistical analysis was performed by using IBM SPSS software version 23. Chi square and fisher exact test were applied to find the correlation between the radiation awareness scores and patient's gender, age, educational level and monthly income and p values were calculated.

Results: The mean age of the study participants was 41.35 years with 59.7% male and 50.3% female. The knowledge scores were high in males, patients <25 years of age, those with post graduate qualification and high monthly income with p values of <0.0001. 64% study participants were never told about the ionizing radiations. Only 45% participants said that they were involved in decision making of undergoing a CT examination. 91% study participants said that the doctor should be more concerned about diagnosing the medical problem rather than worrying about radiation risks while 98% participants believed that if the doctor advises CT examination, then it outweighs its radiation risks.

Conclusion: It is concluded that patients have poor knowledge of radiation risks involved in CT examination with less involvement in decision making, relying only on their referring physicians.

Keywords: Computed tomography, radiation dose, awareness, radiation risks, ionizing radiation

Introduction

Ionizing radiations are well known for their hazardous effects on the human body. Many imaging investigations make use of these ionizing radiations including computed tomography (CT).

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There is a dramatic increase in the use of computed tomography (CT) in recent years.(1,2,3) It is estimated the number of CT examinations per annum has increased from approximately 2 million in 1980 to about 72 million in 2017.(4) This increase in number of CT examinations is attributed to the fact that CT has many advantages over other imaging modalities. Unlike MRI, it is less time consuming, provides greater anatomical detail than ultrasound and radiographs and helps physicians in reaching a definite diagnosis.(5) It is estimated that apart from the natural background radiation, medical imaging examinations are now the greatest source of radiation exposure, CT being the largest contributor.⁵ This overwhelmingly increase use of CT examinations has raised concerns regarding its radiation risks and their long term effects including the risk of cancer.(6,7) Although CT plays a pivotal role in the diagnosis and management of patients, adequate knowledge and awareness regarding the hazards related to ionizing radiation is important.(8,9)

Adverse health effects occurring soon after the exposure to radiation are referred as deterministic effects. *Deterministic effects* are dose dependent and include radiation syndrome (nausea), skin rash, cataracts, infertility and failure of bone marrow. *Stochastic effects* on the other hand are those that manifest at interval usually many years after exposure. These effects result from damaged cells surviving in a modified form, increasing the risk of developing cancer. ICRP (Internal commission on Radiological Protection) suggested three principles of radiation protection to be observed for all radiological examination; justification, optimization and dose limit. (10) Thus it is the responsibility of health care providers to keep radiation doses of all radiological examinations "as low as reasonably achievable". Every CT examinations should be justified, optimized with lowest radiation dose possible administered.

Adequate knowledge of radiation risks is important for all the patients undergoing CT examination. Moreover their involvement in decision making of CT examination is also vital so as to enable them to balance the advantages offered by the investigation and radiation risk involved. Many studies have evaluated the knowledge of doctors, radiographers, radiologists and patient's regarding radiation doses of common radiological procedure and risks associated with them. These studies have shown that the radiation doses and risks of these radiological procedures are significantly underestimated by patients.(11-17) Recent studies have

also shown that patients expectations are high regarding CT examinations and they feel more confident when it is a part of their medical examination but on the other hand they have a very poor understanding of radiation risks and hazards.(4) Thus if the patients have poor understanding of radiation risks and high level of expectations from CT study then this will pose a big challenge for doctors and health care providers to reduce the number of unnecessary CT examinations and the radiation exposure resulting from them.(18).

The objective of the present study is to assess knowledge of patients undergoing CT examination regarding radiation risks associated with it and to evaluate the relationships between patient's knowledge of these concepts and their sociodemographic characteristics. Moreover, this study also evaluates patients' perspectives and their involvement in the medical decision-making process regarding obtaining a CT examination.

Methodology

This is a cross-sectional study that was conducted in department of Radiology of a tertiary health care hospital after approval by the institutional review board. Using non-probability convenient sampling a sample of 500 patients presenting to Radiology department for CT examination was taken. A sample size of 498 was calculated with expected rate of more than 70% (70% of participants underestimated the radiation dose of CT relative to chest radiography, and cancer risk) with 5% level of significance and 5% margin of error.⁴ However a large sample of 500 was used. Patients more than 18 years of age presenting to Radiology department for CT examination were included in the study. Patients were excluded if they were less than 18 years of age, pregnant (as ionizing radiations are hazardous for the growing fetus) , were too ill to participate and could not comprehend the questionnaire due to language problems.

A total of 500 patients underwent CT examination during the study period out of which 54 patients did not meet the inclusion criteria and 16 patients declined participation leaving a total of 430 eligible patients. Among the 430 eligible patients, 26 patients did not complete the questionnaire leaving a total of 404 patients who completed the study.

An informed written consent was obtained from all study participants after explaining the aims and objective of the study. A questionnaire comprising of

closed ended questions was developed and distributed to the study participants by a qualified radiographer having more than 2 years of experience. The questionnaire was available both in English and Urdu languages. The questionnaire comprised of three sections. First section consisted of questions regarding demographic characteristics including age, gender, monthly income and educational level. The second section comprised of knowledge questions regarding ionizing radiations and associated risks (Table 1). The answers of this section for each participant were scored out of 4. Each correct response was given a score of 1 and incorrect 0. The average of the score was taken. Correlation between the radiation awareness scores and patients demographic characteristics was calculated. Third section comprised of questions about the decision to obtain a CT examination (Table 2). In particular, patients were asked about their physician’s role regarding knowledge dissemination of radiation risks and whether the patient had indulged in any discussion concerning the benefits or risks of radiation associated with CT imaging.

Statistical analysis was performed by using IBM SPSS software version 23. Data were presented as frequency and percentages for categorical data. Correlation between the radiation awareness scores and patient’s gender, age, educational level and monthly income were calculated. Chi square and fisher exact test were applied to find the association between various categorical factors and p values were calculated.

Table 1. Knowledge questions regarding ionizing radiations and associated risks

1. Are u aware of ionizing radiation?	a. Yes	b. No
2. Does CT imaging utilizes ionizing radiation?	a. Yes	b. No
3. Can ionizing radiation be hazardous?	a. Yes	b. No
4. Is there a risk of developing cancer from CT imaging?	a. Yes	b. No

Table 2. Questions regarding physician’s role in knowledge dissemination of radiation risks and patients involvement in decision making to obtain a CT examination.

1. Were u told about the radiation risks of CT imaging?	a. Yes	b. No
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2. If yes, who told u the risks and benefits of CT imaging?	a. Referring physician	c.
	CT technician	
	b. Radiology doctor	d. others
3. Were the risks and benefits of CT imaging sufficiently explained to you?	a. Yes	b. No
4. Is it important that your doctor explains the risks and benefits of CT scan to you before ordering a CT examination?	a. Yes	b. No
5. Were you involved in decision making of undergoing a CT examination?	a. Yes	b. No
6. Should your doctor be more concerned about diagnosing your medical problem rather than worrying about radiation risks?	a. Yes	b. No
7. If your doctor advices CT examination; then it outweighs its radiation risks?	a. Yes	b. No

Results

Participants Demographics:

The mean age of the study participants was 41.35 years out of which 59.7% were male and 50.3% were female. Out of the 404 study participants, 245(60.6%) patients had no formal education, 109(26.9%) patients were undergraduate, 34(8.4%) patients were graduate and 16(3.9%) patients had postgraduate qualification. Among the study participants, 317(78.4%) patients had less than 25000PKR monthly income, 85(21%) patients had 25000-50000PKR monthly income and only 2(0.5%) patients had more than 50,000PKR monthly income.

Knowledge questions:

Overall, out of 404 study participants, only 204 participants (50.4%) said that they know about ionizing radiations while 200 participants (49.6%) had not heard of ionizing radiations earlier. Only 41.5% study participants were aware that computed tomography (CT) utilizes ionizing radiations. About 51.9% study participants said that ionizing radiations can be hazardous. Only 46.5% of the study participants thought that there is a risk of developing cancer after exposure to ionizing radiations. (Figure 1)

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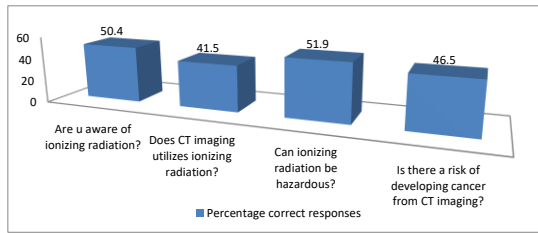


Figure 1. Percentage correct response to knowledge questions

The answers of this section for each participant were scored out of 4. Each correct response was given a score of 1 and incorrect 0. The average of the score was taken. Correlation between the radiation awareness scores and patient's gender, age, educational level and monthly income were calculated. Chi square and fisher exact test were applied to find the association between various categorical factors and p values were calculated. It was found that males had higher knowledge score than females with p value of <0.0001. (Table 3) When knowledge score was stratified for age, patients <25 years of age had the highest score. (Table 4)

Table 3. Scoring of knowledge questions in section II according to gender.

Knowledge regarding ionizing radiations and associated risks	Gender						P-Value
	male		female		Total		
	n	%	n	%	n	%	
Score 1	51	25.6%	104	50.7%	155	38.4%	<0.0001
Score 2	29	14.6%	2	1.0%	31	7.7%	
Score 3	8	4.0%	34	16.6%	42	10.4%	
Score 4	111	55.8%	65	31.7%	176	43.6%	

Table 4. Scoring of knowledge questions in section II according to age.

Knowledge regarding ionizing radiations and associated risks	Age						P-Value
	Less than 25		25-50 Years		More than 50		
	n	%	n	%	n	%	
Score 1	3	7.0%	141	52.4%	11	12.0%	<0.0001
Score 2	9	20.9%	9	3.3%	13	14.1%	
Score 3	0	0.0%	15	5.6%	27	29.3%	
Score 4	31	72.1%	104	38.7%	41	44.6%	

The data was stratified for level of education into four groups, those with no formal education, undergraduates, graduates, and postgraduates. It was

found that knowledge scores were highest (100%) for patients with postgraduate qualification. (Table 5)

Table 5. Scoring of knowledge questions in section II according to level of education.

Educational level	Score 0	Score 1	Score 2	Score 3	Score 4	P-Value
No formal education	47.3%	5.7%	9.3%	10.6%	26.9%	<0.0001
Undergraduates	23.8%	12.8%	17.4%	2.7%	43.1%	
Graduates	47%	5.8%	0%	0%	47%	
Post graduates	0%	0%	0%	0%	100%	

The data was stratified for monthly income into three groups, group I having a monthly income of <25000PKR, group II having monthly income of 25000-50000PKR and group III with monthly income of >50000PKR. Correlation between the radiation awareness scores and patients monthly income was calculated. It was found that in group III all the participants (100%) attained a maximum score of 4. (Table 6)

Table 6. Scoring of knowledge questions in section II according to monthly income.

Monthly Income	Score 0	Score 1	Score 2	Score 3	Score 4	P-Value
Group I	33.1%	7.6%	10.7%	10.1%	36.2%	<0.0001
Group II	57.6%	1.2%	9.4%	18.8%	12.9%	
Group III	0%	0%	0%	0%	100%	

Questions regarding physician's role in knowledge dissemination of radiation risks and patients involvement in decision making:

Out of the 404 study participants, 146(36%) participants said that they were told about the ionizing radiations prior to CT examination while remaining 258(64%) participants said that they were never told about the ionizing radiations. Out of the 146 participants, 27(19%) participants said that the information was provided by the referring physician, 28(19%) said that the radiology doctor provided the information, 56(38%) participants were told by the CT technician while other sources

provided the information to 35(24%) participants.(Figure 2)

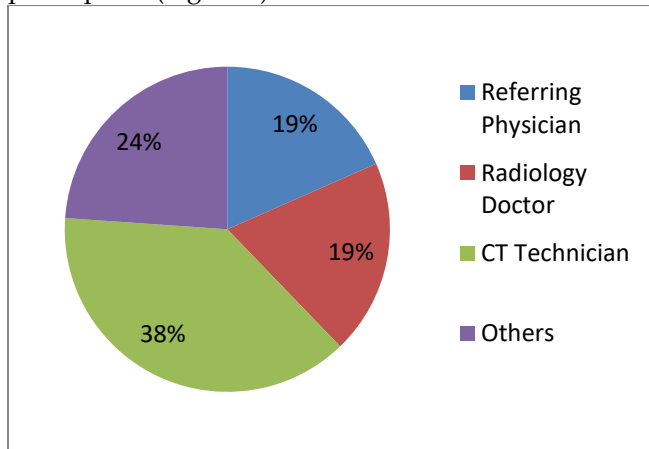


Figure 2. Source of Knowledge Provision

Only 92(23%) study participants said that the risks and benefits of CT examination were sufficiently explained to them. Out of the 404 study participants, 340(84%) said that it is important that the doctor should explain the risks and benefits of CT examination before advising while 64(16%) said that it was not important. 184(45%) participants said that they were involved in decision making of undergoing a CT examination, while 220(54%) participants were not involved in the decision making process. 369(91%) study participants said that the doctor should be more concerned about diagnosing the medical problem rather than worrying about radiation risks while only 35(9%) said that the doctor should be concerned more about the radiation hazards. 396(98%) study participants said that if the doctor advises CT examination then it outweighs its radiation risks.

Discussion

The study aimed to assess knowledge of patients undergoing CT examination regarding radiation risks and to evaluate the relationships between patient's knowledge of these concepts and their sociodemographic characteristics. Second, this study also aimed to evaluate patients' perspectives and their involvement in the medical decision making process regarding obtaining a CT examination. The questionnaire designed was simple, basic and easy to comprehend.

Results of the study showed a low level of radiation awareness in patients presenting to public sector hospitals. These results showed that 49.6% had not

heard of ionizing radiations earlier. Only 41.5% study patients were aware that computed tomography (CT) utilizes ionizing radiations. Only 46.5% of the study participants knew that there is a risk of developing cancer after exposure to ionizing radiations. This indicates that most of the patients were unaware of the fact that CT utilizes ionizing radiations and exposure to ionizing radiations can be hazardous. Knowledge scores were good for patients with postgraduate qualification and above and those with monthly incomes of more than 50,000PKR and were lowest in patients with no formal education and with monthly income between 25,000-50,000PKR. Similar results are found in previous studies showing that patients with higher education have better understanding and knowledge of radiation risks as compared to patients with a low level of education.(19,20,21) Another study to evaluate the knowledge of radiation risks of patients older than 18 years who presented to emergency department for CT examination showed that patients had little knowledge of hazards of ionizing radiations; however they felt more confident of CT as an imaging investigation.(4)

In recent years there is an increase in expectations that patients should be in charge of their health encouraging patient participation in medical decision making process. Patients have different preferences regarding their involvement in medical decision making process. Some patients leave their decision entirely to the treating physician while others want to share the decision with their physician. It is important that the benefits and risks of the examination should be sufficiently explained to the patient prior to investigation and it should be a mutual decision of the doctor and patient. The results of the present study showed that 64% of study participants were never told about the ionizing radiations. Interestingly, in our study it was found that the main source of information was mainly provided by CT technician (38%) rather than referring physician or radiology doctor. This is contrary to results of study by Caoili EM et al where the major source of information was referring physician.(23) Only 45% participants said that they were involved in decision making of undergoing a CT examination. In a study by Caoili EM et al, 47% of the study patients said that the decision of having a CT examination was made entirely by the referring physician. (23) Majority (91%) study participants believed that the doctor should be more concerned about diagnosing the medical problem rather than

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worrying about radiation risks reflecting their lack of concern for radiation risks. In our study 98% study participants said that if the doctor advises CT examination then it outweighs its radiation risks. This highlights the highly effective role of referring physician regarding patient care. Unfortunately, many studies have reflected upon poor knowledge of referring physicians regarding radiation hazards. A study by Lee et al found that only 47% of radiologists and 9% of doctors working in emergency were aware of the fact that CT examination increases the risk of cancer. (24)

Conclusion

There is a continuously increasing trend of obtaining a CT examination in recent years. However; according to our study, patients have poor knowledge of radiation risks with less involvement in decision making, relying solely on their referring physicians. It is the need of the hour that doctors should educate their patients regarding ionizing radiation risks.

References

1. Repplinger MD, Li AJ, Svenson JE, Ehlebach WJ, Westergaard RP, Reeder SB, Jacobs EA. Emergency Department Patients' Perceptions of Radiation from Medical Imaging. *WMJ*. 2016 February ; 115(1): 22-28.
2. Bellolio et al. Access to primary care and computed tomography use in the emergency department. *BMC Health Services Research* (2018) 18:15.
3. Karim MKA, Hashim S, Sabarudin A, Bradley DA, Bahruddin NA. Evaluating Organ Dose and Radiation Risk of Routine CT Examinations in Johor, Malaysia. *Sains Malaysiana* 45(4)(2016): 567-573.
4. Baumann BM, Chen EH, Mills AM, Glaspey L, Thompson NM, Jones MK, Farner MC. Patient perceptions of computed tomographic imaging and their understanding of radiation risk and exposure. *Ann Emerg Med*. 2011 Jul;58(1):1-7.e2.
5. Power SP, Moloney F, Twomey M, James K, J O'Connor O, Maher MM. Computed tomography and patient risk: Facts, perceptions and uncertainties. *World J Radiol*. 2016 December 28; 8(12): 902-915.
6. Kamiya, K.; Ozasa, K.; Akiba, S.; Niwa, O.; Kodama, K.; Takamura, N.; Zaharieva, E.K.; Kimura, Y.; Wakeford, R. Long-term effects of radiation exposure on health. *Lancet* 2015, 386, 469-478. [Google Scholar] [CrossRef]
7. Kutanzi, K.R.; Lumen, A.; Koturbash, I.; Miousse, I.R. Pediatric Exposures to Ionizing Radiation: Carcinogenic Considerations. *Int. J. Environ. Res. Public Health* 2016, 13, 1057.
8. Khan MO, Khan MS, Janjua O, Ali A, Hussain S. Knowledge of radiation legislation and radiation exposure in common radiological investigations among final year medical students, foundation doctors, specialist radiology registrars and radiographers at a UK university teaching hospital. *BJR | Open* 2019 1:1.
9. Fortin, E.M., Fisher, J., Qiu, S. et al. Privately insured medical patients are more likely to have a head CT. *Emerg Radiol* 23, 597-601 (2016). <https://doi.org/10.1007/s10140-016-1424-z>
10. Do KH. General Principles of Radiation Protection in Fields of Diagnostic Medical Exposure. *J Korean Med Sci*. 2016 Feb; 31(Suppl 1): S6-S9.
11. Ria F et al. Awareness of medical radiation exposure among patients: A patient survey as a first step for effective communication of ionizing radiation risks. *Physica Medica*. Volume 43, November 2017, Pages 57-62.
12. Bohl DD et al. Patient knowledge regarding radiation exposure from spinal imaging. *The Spine Journal*. Volume 17, Issue 3, March 2017, Pages 305-312.
13. Singha N, Mohacsya A, Connell DA, Schneider ME. A snapshot of patients' awareness of radiation dose and risks associated with medical imaging examinations at an Australian radiology clinic. *Radiography*. Volume 23, Issue 2, May 2017, Pages 94-102
14. Banerjee I, McNulty JP, Catania D, Maccagni D, Masterson L, Portelli JL, Rainford L. An Investigation of Procedural Radiation Dose Level Awareness and Personal Training Experience in Communicating Ionizing Radiation Examinations Benefits and Risks to Patients in Two European Cardiac Centers. *Health Physics: July 2019 - Volume 117 - Issue 1 - p 76-83*.
15. Ribeiro A et al. Ionising radiation exposure from medical imaging - A review of Patient's (un)awareness, *Radiography*. <https://doi.org/10.1016/j.radi.2019.10.002>
16. Hamad Mohammed AlDossari et al. Assessing the Level of Knowledge About Radiation Dose in Common Radiological Examinations Among Physicians in Riyadh. *Int. J. Pharm. Res. Allied Sci.*, 2018, 8(1):114-118
17. Irving B, Leswick DA, Fladeland D, Hyun JaLim, Bryce R. Knowing the Enemy: Health Care Provider Knowledge of Computed Tomography Radiation Dose and Associated Risks. *Journal of Medical Imaging and Radiation Sciences*. Volume 47, Issue 3, September 2016, Pages 243-250.
18. Webster, John N, Moore, Nathan, Stewart, Felicia. Reducing Unnecessary Head Computed Tomography in Mild Traumatic Brain Injury. *Advanced Emergency Nursing Journal*, Volume 39, Number 4, October/December 2017, pp. 300-308(9).
19. Repplinger, MD, Li, AJ, Svenson, JE, Ehlenbach, WJ, Westergaard, RP, Reeder, SB: Emergency department patients' perceptions of radiation from medical imaging. *WMJ* 2016;115(1):22-28.

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20. Dasan, TA, Koratagere, RS, Rangaswamy, NB: Interns, postgraduate residents and non radiologist doctors awareness about ionizing radiation in diagnostic imaging investigations in a tertiary hospital, Bengaluru. *Int J Anat Radiol Surg*. 2017;6(1):RO19-RO24.
21. Ewaidat HA et al. Knowledge and Awareness of CT Radiation Dose and Risk Among Patients. *Journal of Diagnostic Medical Sonography* 2018, Vol. 34(5) 347-355.
22. Anne E. M. Brabers, Jany J. D. J. M. Rademakers, Peter P. Groenewegen, Liset van Dijk, Judith D. de Jong. What role does health literacy play in patients' involvement in medical decision-making. *PLoS One*. 2017; 12(3): e0173316.
23. Caoili EM, Cohan RH, Ellis JH, Dillman J, Schipper MJ, Francis IR. Medical Decision Making Regarding Computed Tomographic Radiation Dose and Associated Risk: The Patient's Perspective. *Arch Intern Med*. 2009;169(11):1069-1081. doi:10.1001/archinternmed.2009.139
24. Lee CI, Haims AH, Monico EP, Brink JA, Forman HP. Diagnostic CT scans: assessment of patient, physician, and radiologist awareness of radiation dose and possible risk. *Radiology*. 2004;231(2):393-398.