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Assessment of Knowledge of Doctors Regarding Radiation Doses and Hazards in Common Radiological Examinations

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Abstract

Background: Ionizing radiation is extensively employed in diverse diagnostic procedures, playing a pivotal role in diagnosing various diseases. The escalating use of such investigations underscores the importance of judicious and careful application to mitigate associated risks and hazards. This study aims to assess doctors' knowledge regarding radiation hazards and doses in commonly used diagnostic procedures.

Methods: Between July 1 and July 31, 2019, a questionnaire comprising 20 questions was distributed among doctors across various departments in a tertiary care hospital. The questionnaire, divided into three sections, covered topics such as radiological procedures employing ionizing radiation, equivalent dose units, estimation of radiation doses for common procedures, and awareness of risks linked to radiation exposure.

Results: A total of 200 questionnaires were returned, representing diverse specialties. Responses from radiology (11), surgery (53), orthopedics (2), medicine (84), eye (6), ENT (4), pediatrics (9), and gynecology/obstetrics (31) were included. The assessment of doctors' knowledge in each section revealed suboptimal scores, with average correct responses of 64.1%, 21.8%, and 64.5% for the three sections, respectively. Notably, 21.3% of doctors underestimated doses, and 28% had no idea about estimated doses. Additionally, 49% and 12% of participants incorrectly categorized Magnetic Resonance Imaging (MRI) and ultrasonography as procedures involving ionizing radiation.

Conclusion: This study exposes significant knowledge gaps among doctors regarding radiation doses and hazards. The findings underscore an urgent necessity for implementing institutional educational programs on radiation protection at both undergraduate and postgraduate levels.

Keywords: Ionizing radiation, radiation hazards, Magnetic Resonance Imaging (MRI), Computed Tomography (CT), ultrasonography

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Introduction

Ionizing radiation is known for its harmful effects on the human body (1,2). Many imaging investigations make use of these ionizing radiations including radiography, fluoroscopy, angiography, computed tomography and nuclear medicine examination (3,4). The frequency of imaging examinations using ionizing radiation has been increasing over the years. It is estimated that the public receives an average yearly dose of 2.3 mSv out of which 15% is due to medical imaging investigations (5). Although these medical imaging investigations play a pivotal role in the diagnosis and management of patient's adequate knowledge and awareness regarding the hazards related to ionizing radiation is important (1,6). Doses of these ionizing radiations are dependent upon multiple factors including patient factors (age and body habitus), technical factors (equipment settings, model and examination time) (4).

Adverse health effects that occur soon after the exposure to radiation and having linear relationship with radiation dose are referred as deterministic effects. Deterministic effects include radiation syndrome (nausea), skin rash, cataracts, infertility and failure of bone marrow. Stochastic effects on the other hand are those that manifest at intervals, usually many years of exposure. These are believed to result from damaged cells surviving in a modified form increasing the risk of developing cancer (7-9).

Adequate knowledge and assessment of radiation doses is important for all the physicians to enable them to balance the advantages offered by the investigation and radiation risk involved. ICRP (Internal commission on Radiological Protection) suggested three principles of radiation protection to be observed for all radiological examination: justification, optimization, and dose limit (1,10). Studies have shown alarmingly inadequate knowledge of referring physicians about the hazards of radiations and underestimation of radiation doses of commonly used radiological procedures (11-16). A study showed that even the awareness of

radiologists regarding radiation doses and hazards is inadequate (6).

The aim of the present study is to assess knowledge regarding radiation doses and hazards in common radiological examinations amongst doctors of tertiary care hospital. These parameters have not been previously assessed in our setup. The study will be a useful tool to emphasize the need of structuring an institutional educational program regarding radiation protection at under and postgraduate level.

Methodology

This is a cross sectional survey study using an anonymous questionnaire. After the approval from the institutional review board, questionnaires were distributed and collected among the random sample of two hundred doctors of various departments in a teaching hospital of Pakistan over a span of 4 weeks. Informed written consent was taken from all the participants and the rationale of the study was explained.

In addition to the demographic details, professional level and name of departments of the doctor were recorded. The questionnaire comprised of 20 questions was categorized into three sections. The first section consisted of five questions for assessing general knowledge about the ionizing radiation and inquiry about unit of equivalent dose of radiation. The second section was aimed at assessing the knowledge about the estimated radiation doses of eight common radiological procedures keeping radiation dose of Chest X ray as one. The third section included questions regarding the risks associated with radiation exposure. Correct answers to the questions were derived from information available on the internet and counter checked with the Royal College of Radiologist.

The data was entered in IBM SPSS Statistics for Windows, version 21.0. Armonk, NY. Data was presented as frequency and percentages for categorical data. In order to determine the level of significance, a chi-square test was used to analyze the data. A p value of <0.05 was considered statistically significant.

Results

Out of 200 participants 33% (66) were male and 67% (134) were female. Figure (1) shows the number of doctors from various specialties who participated in the study.

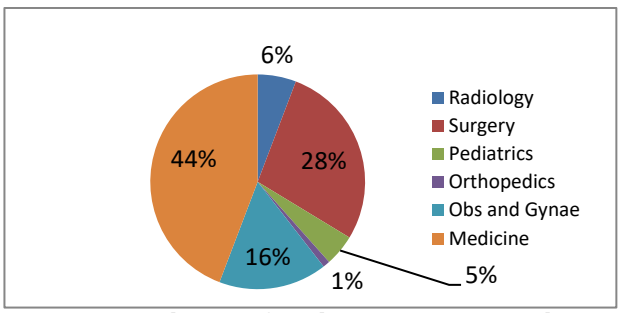

Figure 1: Distribution of study participants according to specialty

Among the participants, 46.5% (93) were house officers, 9% (18) were medical officers, 32% (64) were postgraduate trainees and 12.5 % (25) were consultants.

Regarding general knowledge, questions about ionizing radiation show 64.1 % of average correct responses. However 49% wrongly consider MRI study utilizing ionizing radiation. Only 15.5% correctly knew the measurement unit of equivalent dose of radiation. The percentage of correct responses is shown in figure 2. Overall average correct responses for this section was highest amongst consultants (72.8%) and lowest amongst medical officers (59.5%) with significant P value of <.05 (for question number 5). Table 1 and 2 show correct responses of section 1 amongst physicians of different professional levels and specialties.

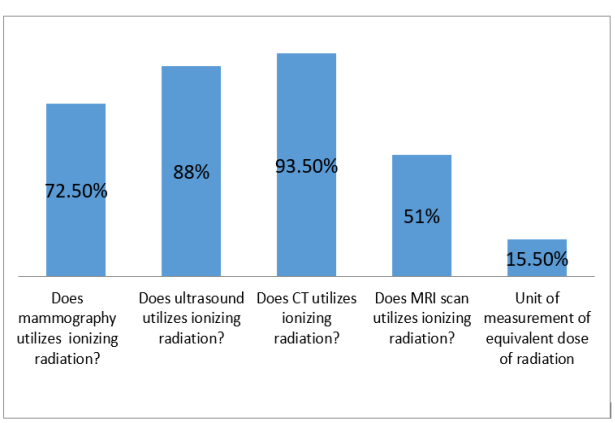

Figure 2: Percentage correct responses to questions in Section I

Table 1: Section I- Percentage correct responses according to professional level

Questions	House Officers	Medical Officers	PG Trainees	Consultants	Chi Square Test		
					Value	df	P-value
Does mammography utilize ionizing radiation?	74	66.7	73.4	68	0.723	3	0.868
Does ultrasound utilize ionizing radiation?	91.4	94.4	79.6	92	6.29	3	0.098
Does CT scan utilize ionizing radiation	89.2	100	95	100	6.103	3	0.107
Does MRI scan utilize ionizing radiation?	51.6	36.7	45.3	72	6.311	3	0.097
What is the unit of measurement of equivalent dose of radiation:	3	0%	6.2	32	38.24	9	0.000
Average Correct Response	61.8	59.5	59.9	72.8			

Table 2: Section I-Percentage correct responses according to specialties

Questions	Radiology	Surgery	Pediatrics	Orthopedics	Orbs n gyn	Medicine	Ophthalmology	ENT	Chi Square Test		
									Value	df	P
Does mammography utilize ionizing radiation?	72.7	71.7	77.8	50	74.2	73.8	75	50	2.30	7	0.94
Does ultrasound utilize ionizing radiation?	100	98.1	88.9	100	87.1	83.3	25	83.3	23.8	7	.001
Does CT scan utilize ionizing radiation	90.9	90.6	88.9	100	93.5	97.6	100	66.7	11.05	7	0.136
Does MRI scan utilize ionizing radiation?	63.6	58.8	55.6	50	35.5	52.4	0	50	9.18	7	0.240
What is the unit of measurement of equivalent dose of radiation:	18.2	37.7	11.1	0	38.7	44	100	0	54.3	21	0.000
Average Correct Response	69.08	71.3	64.4	60	70.2	70.2	60	50			

An overall poor knowledge about the estimated radiation doses of common radiological procedures was observed. An average correct response for this section was only 21.87 % (Table 3). Out of study participants, 41% and 29% wrongly categorized MRI and Ultrasound as ionizing radiations. An average of 28.6 % had no idea about the radiation dose of the mentioned procedures. Overall correct responses of consultants were 26.5% compared to 16.3% and 21.5% for house officers and medical officers (Table 4). Among non-radiology specialties, surgeons had better correct dose estimation than medicine and other specialties as mentioned in the table 5.

Table 3: Section II- Percentage correct responses

Name of investigation	Correct response (%)	Under estimation (%)	Over estimation (%)	No Idea (%)
Abdominal X ray	39.5	1.5	36	23
IVU	14.5	41.5	15.5	28.5
CT Chest	20.5	33.5	22.5	23.5
Bone Scan	7.5	22	36.5	34
MRI Brain	28	0	41	31
CT Head	17	16.5	37.5	29
USG Abdomen	41.5	0	29	29.5
Barium Enema	6.5	56	6	31
Average	21.87	21.3	28	26.1

Table 4: Section II-Percentage correct responses according to professional level

Name of investigation	House Officers	Medical Officers	PG Trainees	Consultants	Chi Square Test		
					Value	df	P value
Abdominal X ray	37.6	55.5	35.9	44	23.3	18	0.179
IVU	5.3	0	26.5	2	52.5	18	0.000
CT Chest	12.9	16.6	29.6	28	44.5	18	0.000
Bone Scan	3.2	0	10.9	20	25.8	18	0.104
MRI Brain	22.5	22.2	29.6	48	32.4	18	0.19
CT Head	13.9	22.2	20.3	16	14.1	18	0.720
USG Abdomen	29	50	46.8	68	35.9	18	0.007
Barium Enema	6.4	5.5	9.3	0	41.6	18	0.001
Average Correct Response	**16.35**	**21.5**	**26.1**	**26.5**			

Table 5: Section II-Percentage correct responses according to specialty

Name of investigation	Radiology	Surgery	Pediatrics	Orthopedics	Obs n gynae	Medicine	Ophthalmology	ENT	Chi Square Test		
									Value	df	P value
Abdominal X ray	27.2	45.2	44.4	50	35.4	40.4	0	33.3	53.4	42	0.11
IVU	0	13.2	11	0	32.2	13	0	0	73.7	42	0.002
CT Chest	36.3	15	22.2	0	25.8	21.4	25	0	45.4	42	0.332
Bone Scan	0	11.3	11.1	0	0	8	25	0	66.8	42	0.009
MRI Brain	45.4	33.9	33.3	0	25.8	22.6	0	50	53.4	42	0.111
CT Head	9	20.7	0	0	9.6	22.6	0	0	53.8	42	0.104
USG Abdomen	63.6	50.9	33.3	50	41.9	34.5	0	50	42.9	42	0.431
Ba Enema	9	5.6	0	50	12.9	4.7	0	0	42.9	42	0.039
Average correct Response	**23.8**	**24.5**	**19.4**	**18.7**	**18.9**	**20.9**	**6.25**	**16.6**			

Regarding risks and hazards of radiation, an average of 64.5% correct responses (Figure 3). Most of the participants agreed that there are tissues in the body that are more sensitive to ionizing radiation than the others. Overall, 88.5% and 76.5% correctly agreed that increasing dose of exposed radiation and a single high dose exposure can cause increased risk of developing cancer. Moreover 89.5% of participants believed that all exposures be made on ALARA principle. Correct responses of section III according to professional level and different specialty are shown in tables 6 and 7.

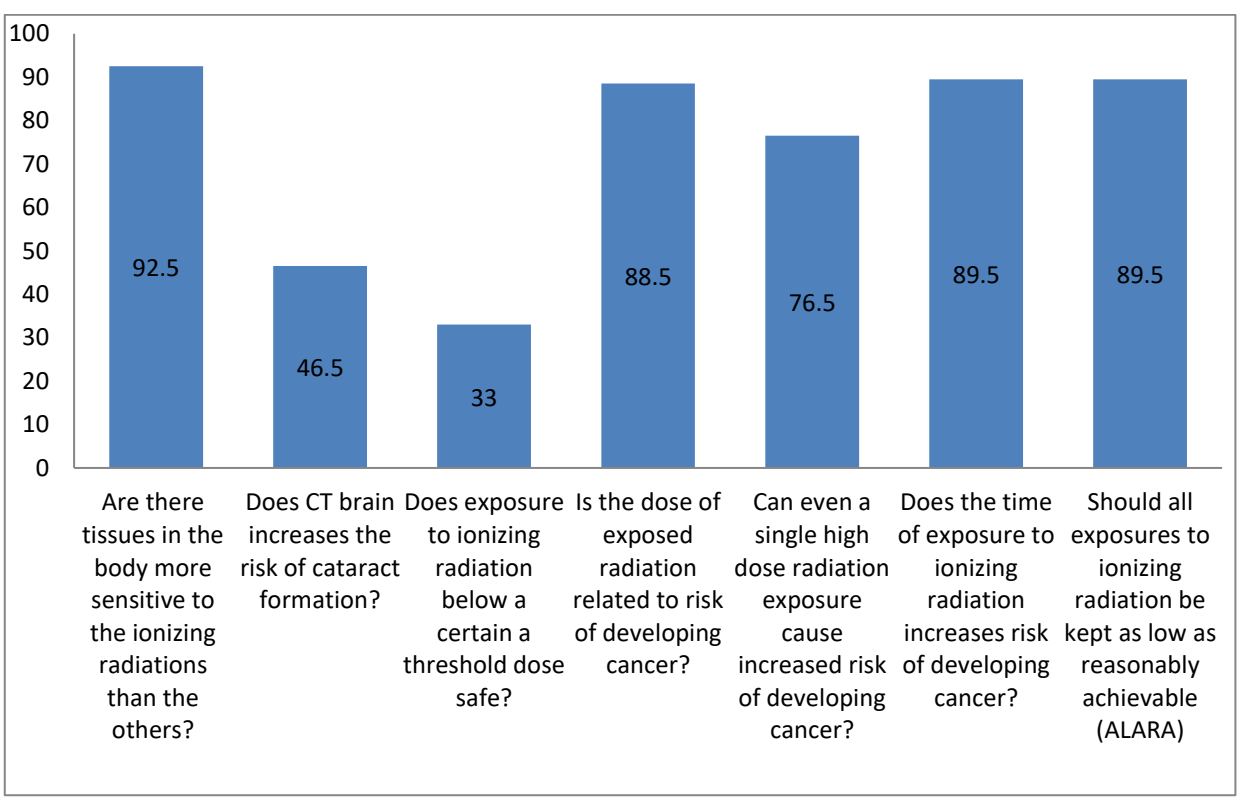

Figure 3: Section III-Percentage correct responses

Table 6: Section III-Percentage correct responses according to professional level

Questions	House Officers	Medical Officers	PG Trainees	Consultants	Chi Square Test		
					Value	df	P value
Are there tissues in the body more sensitive to ionization radiation than the others?	95.6	77.7	89	100	10.11	3	0.018
Does CT brain increase the risk of cataract formation?	46.2	33.3	45.3	60	3.12	3	0.373
Does exposure to ionizing radiation below a certain a threshold dose safe?	33.3	16.6	39	28	3.52	3	0.318
Is the dose of exposed radiation related to risk of developing cancer?	83.8	83.3	95.3	92	5.65	3	0.130
Can even a single high dose radiation exposure cause increased risk of developing cancer?	66.6	100	84.3	76	12.74	3	0.005
Does the time of exposure to ionizing radiation increase the risk of developing cancer?	87	100	90.6	88	4.62	6	0.592
Should all exposures to ionizing radiation be kept as low as reasonably achievable (ALARA)	92.4	88.8	87.5	840	1.95	3	0.581
Average correct responses	72.1	71.3	75.8	75.4			

Table 7: Section III-Percentage correct responses according to specialty

Questions	Radiology	Surgery	Pediatrics	Orthopedics	Obs n gyn	Medicine	Ophthalmology	ENT	Chi Square Test		
									Value	df	P value
Are there tissues in the body more sensitive to ionization radiation than the others?	100	94	88.8	50	64	95	75	100	13.0	7	0.72
Does CT brain increase the risk of cataract formation?	54	39	22	50	61	47	25	50	6.9	7	0.431
Does exposure to ionizing radiation below a certain a threshold dose safe?	36	32	22	50	29	39	0	0	7.45	7	0.383
Is the dose of exposed radiation related to risk of developing cancer?	100	96	77	100	81	89	0	100	39.3	7	0.000
Can even a single high dose radiation exposure cause increased risk of developing cancer?	81	85	88	100	77	68	75	83	7.30	7	0.398
Does the time of exposure to ionizing radiation increase the risk of developing cancer?	90	90	77	100	87	92	50	100	20.4	14	0.118
Should all exposures to ionizing radiation be kept as low as reasonably achievable (ALARA)	100	91	78	100	84	90	75	100	5.63	7	0.583
Average Correct Response	80	75	66	78	69	74	43	76			

Discussion

Use of ionizing radiation is not free of its side effects (7,8,17). Therefore, the prescribing physician must be aware of the estimated doses and hazardous effect of these radiation so as to follow the ALARA (As low as reasonably achievable) principle of radiation protection (1,6). With the easy accessibility and availability of plain radiography, fluoroscopy and computed tomography, careful and appropriate selection of the diagnostic imaging for the patients is the need of the day to stop abusive use of these procedures. This will not only prevent the adverse effects of radiation on the population but also reduce the unnecessary work burden on the radiology departments and will encourage better patient care (17). The study results unveil the wide gaps in the knowledge of the physicians working in the tertiary care hospital about the radiation hazards and estimated doses of the radiological procedures, comparable to the other studies of the west (18-20). Failing to identify ultrasonography and Magnetic Resonance Imaging (MRI) as procedures not using ionizing radiation is alarming.

In our study, over all correct response rates were better for section I and III comprising questions about general knowledge and hazards about radiation comprising of 64.1% and 64.5 % respectively. Surprisingly, however only 15.5 % of the participants correctly identified mSv as unit of equivalent dose. MRI utilizes magnetic field and resonance frequency for acquisition of images and does not use ionizing radiation. Availability of MRI as an imaging tool has an important role in diagnoses especially in domains of musculoskeletal and Central nervous system. Surprisingly 49% of the participants wrongly categorized MRI as technique utilizing ionizing radiations. Similar results were observed by Barnawi RA et al, according to which 67% participants wrongly answered that MRI utilizes ionizing radiation. In their study 55% of participants wrongly categorized ultrasonography as a procedure utilizing

ionizing radiation compared to 12% of participants of our study (11).

Further the results showed discouraging results with less than one fifth of the participants correctly estimated the radiation doses of various radiological procedures. In our study the overall average correct dose estimation of various radiology procedures was 21.87%, whereas 21.3% participants underestimated the doses. Results are comparable to the study by Barnawi RA et al where the average correct dose estimation and underestimation was 20.8% and 28.6% respectively. In their study 40.6% of the participants opted for option "I do not know" for dose estimation whereas in our study, the overall dose-underestimation rate was 28.6% and the dose-overestimation rates was 10%. However, most participants answered "I don't know" (40.6%) (11). In our study however 26.1% participant opted for "No Idea" option. In another study by Lee WJ et al 54.9% of the participating physicians underestimated the doses (13). These results are eye opener and indicate wrong estimation of the doses of common procedure which may lead to over use of these common diagnostic procedures.

Radiological investigations like computed Tomography (CT) plays an irreplaceable role in imaging diagnosis; use higher doses of radiations and in many cases patients may have to undergo repeated CT examinations during the course and follow up of the disease. The risk of cancer associated with radiation exposure is dependent upon the dose and the time of exposure. Pediatric population is more at risk similarly there is variable susceptibility within the human organs and tissues. According to International Commission on radiological protection (ICRP) report; it is of utmost importance that the prescribing doctor is aware of all these side effects and their risks (21).

Conclusion

The results of the study have pointed out a dire need to incorporate radiation awareness and protection in the curriculum of under and post graduate training. In addition periodic short courses or radiation awareness and protection should be introduced and made mandatory for all the physicians' at all professional levels and departments.

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