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Radiation Exposure and Safety Awareness among Resident Doctors in a Tertiary care centre in Karnataka

Research Article

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Abstract

Introduction: There are an estimated 2.3 million healthcare workers who are engaging in radiation related practices. There is a knowledge gap that exists in medical professionals regarding the radiation exposure and their effects. Hence clinicians must have a good understanding of the potential risks and benefits of the medical radiation use and must be able to justify the radiation exposure to a patient in various settings.

Methodology: It is a cross-sectional questionnaire-based study conducted in a tertiary care centre in Karnataka.Convenience based sampling technique was employed to collect data. The study duration was for 3 months (February-April 2024). A sample size of 180 has been determined, with a confidence interval of 95.5% and fixed precision of 5%.

Results: The performance of majority of participants fell in to Average category constituting 65.1% population. The mean scores of 1sts, 2nd, 3rd year post graduates and interns dealing with radiation exposure were 4.92 ± 1.42, 3.12 ± 1.43, 5.14 ± 1.63 and 5.06 ± 1.26 respectively. There was no significant association between the socio-demographic characteristics and the total scores of participants.

Conclusion: The current study demonstrates that there is lack of knowledge about radiation exposure and safety practices among the resident doctors. In order to bridge the gap of knowledge, educative programmes have to be targeted at the Resident doctors, which can ensure mindful use of healthcare resources and can enhance patient safety.

Keywords: Radiation Safety; Radiation Exposure; Medical Professionals; Resident

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Introduction

The inception of radiology can be traced back to the 1895 when Wilhelm Rontgen first discovered X-rays. Throughout the decades, there has been exponential advancement in the field and significant efforts have been made to adapt X-rays and other ionising radiation in health care for both diagnostic and therapeutic purposes.

Today, there is an estimated 2.3 million healthcare workers who are engaging in radiation related practices [1] and medical uses of radiation constitutes more than 99.9% of radiation exposure to the world's population from man-made sources.[2]

It has been proven through research that acute exposure to high doses of ionising radiation can cause damage to healthy tissues, such as skin burns and radiation sickness (deterministic effects) and at low doses it can cause long term health effects such as cardiovascular diseases, increased risk of cancers and genetic damages (stochastic effects).[3]

However, medical radiation exposure is a necessary evil. One may miss the diagnosis because of insufficient workup and one may unnecessarily irradiate the patient if used without discrimination. Hence, it is up to the discretion of the prescribing clinician to assess the appropriateness of the investigation and justify the radiation exposure. Although there is no data available to indicate if there is a threshold below which no harmful effects will occur4clinicians must request for appropriate examinations based on the principle of benefits outweighing the risks.[5]

Multiple studies have shown that regardless of the field of expertise there is a knowledge gap that exists in medical professionals regarding the radiation doses delivered during various radiological procedures and many doctors tend to underestimate the risks of radiation exposure to the patient during a diagnostic procedure. It is also expressed that they lack adequate knowledge and training with respect to radiation protection.[6-10]

As per the recommendations of International Commission on Radiological Protection 2007,[11] clinicians must have a good understanding of the potential risks and benefits of the medical radiation use and must be able to justify the radiation exposure to a patient in various settings.

Aims and Objectives

The aim of this study was to assess the

1) To assess Knowledge about radiation exposure, radiation doses and radiation safety practices among resident doctors (Interns and Junior residents)

2) To assess Awareness, attitude and practices of radiation use in professional life

Methodology

Study design and setting: Cross-sectional questionnaire-based study conducted in a tertiary care centre in Karnataka.Study population consisted of students pursuing internship and post-graduation in various medical specialities. Convenience based sampling technique was employed to collect data. Ethical clearance was taken from the medical institution prior to start of data collection. Informed consent from participants obtained prior to the start of the questionnaire.

Study duration: 3 months (February-April 2024)

Sample Size: A sample size of 180 has been determined considering a positive awareness prevalence of 87% from a previously published study, with a confidence interval of 955 and fixed precision of 5%.[1]

Inclusion and exclusion criteria: Residents pursuing internship or post-graduation in various specialities in the tertiary care centre and who have consented to participate.

A questionnaire was in the digital form (Google forms) and was circulated through messenger services.

The questionnaire consisted a total of 37 multiple choice questions, of which Section A comprised of 4 questions on sociodemographic details. Section B consisted of 10 questions concerning radiation and harmful effects of radiation exposure. Section C consisted of 6 questions on radiation dose. Section D consisted of 8 questions on radiation safety and Section E consisted of 13 subjective questions to assess the practice of radiation use in professional life. A total of 23 questions were objective type with few questions with multiple correct answers. Each right answer was awarded 1 point and total score was calculated for each response, maximum score being 29 and minimum score being 0.

Topography: Data obtained were entered into an MS Excel spreadsheet and subsequently analysed using SPSS version 22. Demographic characteristics such as age and gender were summarized as numbers and percentages. The associations of age, gender, and year of study with participant scores were analysed using the Mann-Whitney U test for age and gender, and the Kruskal-Wallis test for the year of study. A p-value of less than 0.05 was considered statistically significant.

Results

A total of 201 resident doctors participated in the study and filled out the questionnaire. Of which majority of the participants (70.1%) fall within the 26 - 31 years age group, making up over two-thirds of the sample. The gender distribution is almost balanced with near equal distribution of male (49.3%) and female (50.7%) participants. Of the total study population, majority participation is seen with post-graduate resident doctors accounting to about 84.1 % of the population, out of which the 3rd year has the highest representation, comprising nearly half of the sample (46.8%), followed by 1st year post graduates with 20.9% representation and 2nd year postgraduates with 16.4% representation. Intern residents account for 15.9% population. This distribution indicates a diverse range of specializations, with Radiology having the highest representation, comprising 19.9% of the sample followed by General Medicine (14.4%) also accounting for a significant portion.The least represented specialties are Psychiatry (1.5%) and Dermatology (2.0%).

The total score of participants were categorized as low for 0-10,

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Table 1: Demographic distribution of the study population

Variables	Categories	n	%
Age (in years)	20 - 25	51	25.4
	26 - 31	141	70.1
	32 - 37	7	3.5
	Above 37 years	2	1.0
Gender	Male	100	49.8
	Female	101	50.2
Department	Anesthesiology	5	2.5
	Dermatology	4	2.0
	Emergency medicine	8	4.0
	ENT	9	4.5
	General Medicine	29	14.4
	General Surgery	14	7.0
	Not PG	30	15.9
	OBGY	12	6.0
	Ophthalmology	6	3.0
	Orthopaedics	10	5.0
	Other	8	4.0
	Paediatrics	11	5.5
	Pathology	5	2.5
	Psychiatry	3	1.5
	Pulmonary medicine	7	3.5
	Radiology	40	19.9
Year of study	1st year PG	42	20.9
	2nd year PG	33	16.4
	3rd year PG	94	47.3
	Intern	32	15.4

Table 2: Scores of participants

Categories	Number (n)	Percentage (%)
Poor	63	31.3
Average	131	65.1
Good	7	3.4

Score 11 - 20 is considered as average
Score 21- 29 is considered as good

Table 3: Awareness level regarding radiation exposure, radiation dose and radiation safety

Awareness regarding	Radiation exposure	Radiation dose	Radiation safety
Year	Mean ± SD	Mean ± SD	Mean ± SD
1st year	4.92 ± 1.42	2.59 ± 1.19	2.35 ± 1.07
2nd year	4.66 ± 1.96	3.12 ± 1.43	2.3 ± 0.96
3rd year	5.14 ± 1.63	2.90 ± 1.22	2.45 ± 0.87
Intern	5.06 ± 1.26	2.62 ± 1.18	2.59 ± 0.83

average for 11-20 and good for 21-29 score. The performance of majority of participants fell in to Average category constituting 65.1% population. 31.3% participants performed poorly and scored below 10. Only 3.4% population exhibited good performance. Mean score was 13.29 and it belonged to average category.

The mean scores of 1st year postgraduates, 2nd year post graduates, 3rd year post graduates and interns in the section B questions dealing with radiation exposure were 4.92 ± 1.42, 3.12 ± 1.43, 5.14 ± 1.63 and 5.06 ± 1.26 respectively.

The mean scores of 1st year postgraduates, 2nd year post graduates, 3rd year post graduates and interns in the section C questions dealing with radiation dosage were 2.59 ± 1.19, 4.66 ± 1.96, 2.90 ± 1.22and 2.62 ± 1.18respectively

The mean scores of 1st year postgraduates, 2nd year post graduates, 3rd year post graduates and interns in the section D questions dealing with radiation exposure were 2.35 ± 1.07, 2.3 ± 0.96, 2.45 ± 0.87and 2.59 ± 0.83 respectively.

Table 4: Association between respondents'socio-demographic characteristics and their total scores

Variables	Median (IQR)	Mean ± SD	p - value
Age			
20 - 25 years	11 (9 - 13)	10.90 ± 2.60	0.80
Above 26 years	11 (9 - 13)	10.96 ± 2.79	
Gender			
Male	11 (9 - 11)	11.26 ± 2.79	0.06
Female	10 (9 - 12)	10.64 ± 2.66	
Year			
1st year	10 (9- 13)	10.5 ± 2.34	0.46
2nd year	11 (9 -13)	10.84 ± 3.40	
3rd year	11 (10 -13)	11.25 ± 2.86	
Intern	11 (10 – 11.5)	10.75 ± 2	

*Mann whitney U test
#Krushkal wallis test

Awareness Concerning Radiation and Harmful Effects of Radiation Exposure

The questions 5 to 14 in the questionnaire aim at assessing the knowledge of participants on radiation hazards. Majority of participants correctly answered the questions on basic radiation characteristics, however 70% of them grossly underestimated the total ionizing radiation exposure to humans contributed by medical imaging. 64% of the participants did not know that there is no safe dose below which harmful effects due to radiation exposure becomes nil. 37.8% of the population were unaware of the association of age and gender with the susceptibility to risk of cancer because of radiation exposure. Only 18.9% residents were right about infant female having the highest susceptibility to cancer risk due to radiation exposure. 53% of participants overestimated the radio sensitivity of a child compared to an adult.

Awareness Regarding Radiation Dose

Questions 15 to 20 in the questionnaire are related to radiation dose and helps to assess participants' knowledge of the same. Majority of the participants correctly estimated the radiation doses of various imaging studies. However, 22 % of the participants said they had no idea about the radiation dose of one chest radiograph. Only 34% of the participants rightly estimated the radiation dose of NCCT abdomen and pelvis in equivalent chest x-rays. 31% of the participants were not aware that MRI study does not involve radiation exposure. 22% of the population thought that the radiation exposure for different CT imaging involves same radiation dose. 15% of the population underestimated and 51% of the population overestimated the radiation dose of CECT abdomen study.

Awareness Regarding Radiation Safety

In the questionnaire, questions 21 to 28 deal with knowledge of

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radiation safety and radiation safety practices. 74% of the participants knew that it is necessary to advise patients about the risks related to the use of ionizing radiation for medical purposes always. 50% of the participants were not aware that there is no safe limit for the radiation received by a patient, beyond which you will not advise further radiation exposed investigations. 47% of the study population were unaware of ALARA principle. Only 66% of the participants correctly answered the recommended investigation for 29-year-old female with no positive family history with complains of lump in breast. 40% of the participants did not know the safe distance from x-ray equipment. 95% and 79% correctly thought that lead aprons and lead collars are radiation safety devices, however 47% were unaware that dosimeters are not radiation safety devices. 95% of the participants knew about the different ways to reduce radiation exposure.

Radiation Use in Professional Life

Section E of the questionnaire comprising of questions 29 to 37 were subjective type and was aimed at gaining awareness about the use of radiation in everyday clinical practice by the residents. 40% of the population were of the opinion that their knowledge and awareness on radiation safety was insufficient and 35.8% thought that it was just sufficient. 33 % of the participants felt that the information provided on radiation safety in under graduation training to be inadequate and 46% thought that it could be better. 95% felt the need forlearning program on radiation safety awareness. 55% residents felt the most appropriate time for radiation safety awareness program was in internship and 33% in MBBS training. 56% said that they asked for patients' consent before prescribing them investigations involving ionizing radiation. 36% said they rarely discussed the possible risks of ionizing radiation with the patients before prescribing it to them. 68% practiced ruling out pregnancy before subjecting a patient into ionizing radiation. Only 20% said that they always follow or take help of appropriateness criteria/national/international imaging guidelines while requesting imaging study.

The mean scores of subgroups of participants according to age, gender and year of residency was compared. There was no significant association which was found between the socio-demographic characteristics and the total scores of participants.

Discussion

Although it is well established among the scientific community that at high doses radiation exposure can cause cancer, it is now believed that any amount of radiation may pose some risk for causing cancer. The U.S. Nuclear Regulatory Commission (NRC) accepts the LNT hypothesis (Linear no-threshold (LNT) dose-response relationship) for estimating radiation risk which suggests that any increase in dose, no matter how small, results in an incremental increase in risk.[12-15] As per a study conducted by Gonzalez et al in 2004, it was estimated that Japan which had the highest annual frequency of diagnostic x-rays, also had the highest attributable risk of 3.2% of the cumulative risk attributed to diagnostic x-rays, equivalent to 7587 cases of cancer per year.[16-18] It can be confidently assumed that the use of diagnostic x-rays has only gone uphill since then. Furthermore, a 2004 report in BMJ said that up to a third of all requested radiological studies are completely or partially unnecessary.[19-21]

The results of the current study highlight a significant gap in radiation exposure and safety awareness among resident doctors in the tertiary care centre in Karnataka. The results are in consensus with multiple similar studies carried out in various parts of the world.[5,14-16,22]

In our study the participants scored a mean of 13.29 (45.8%) out of a maximum of 29 in the knowledge assessment questionnaire. It is slightly more than the mean score of 6/19 in a similar study conducted by Zhou et al in Australia.[22] In a study conducted among healthcare professionals in a private hospital, it was observed that participants with 1-5 years of experience had greater knowledge about radiation safety compared to those with less than 6 months or more than 5 years of experience.[23] Our study however found that there was no significant difference in knowledge in participants of different years of study. A majority of the participants felt that the information provided on radiation safety in under graduation training to be inadequate. 95% showed interest in a learning program on radiation safety awareness. These statistics and positive attitude points to the role for a dedicated educative program in the form of either seminars, workshops, training programs or lectures in the curriculum to about the appropriateness and risk assessment of various diagnostic imaging techniques

Although 40.3% of the residents felt that their knowledge and awareness on radiation safety was sufficient, about 13% wrongly believed that MRI utilised ionizing radiation, and >80% wrongly estimated the radiation burden by medical imaging and only 13.4% knew all the conditions caused by radiation exposure correctly. Similar results are noted in previous studies, where about 8-28% participants were unaware that MRI does not emit ionizing radiation.[24-26]

Although ALARA is the corner stone principle of radiation safety, 47.3% of the residents had not heard of the concept and were unaware what it stood for. In a past study conducted in 2015 among paediatric residents, only 27% of the participants correctly identified the ALARA principle of radiation protection.[1] Additionally, a study among healthcare personnel in Thailand reported that 85.5% correctly identified the ALARA principle, indicating that awareness levels may vary by region and specific professional training[13]. Majority of the participants admitted that they did not use proper guidelines to check for the appropriateness of the requested imaging study and they did not discuss the risks associated, with the patients before prescribing it. This shows the need for an awareness program communicating the various guidelines, consensus and protocols for radiological imaging.

Recommendations

1. Our study emphasises the need for awareness programmes to bridge the knowledge gap that exists with respect to radiation safety. Regular refresher courses which can help residents stay updated about the fast-growing subject maybe be conducted.

2. The under-graduate training programme in India should incorporate training in radiology more efficiently and extensively in the curriculum by conducting mandatory radiology lectures and rotation in radiology department.

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3. Practicing discussing with patients the risks and benefits of the requesting imaging study, mandating informed consent and educating people about the radiation doses can not only help increase awareness among the patients but also among referring doctors.

It also facilitates more mindful decision making by the referring doctor.

4. Formulating standard protocols and guidelines in accordance with the ALARA principles by the Radiology departments and communicating the same with the referring doctors can help keep radiation exposure of both patient and community in check.

Limitations of the Study

The study population (sample size) was limited to only one tertiary care hospital hence the generalisation of the results is not possible. Equal representation of different departments and different years of experience could not be achieved. Some of the questions in the questionnaire are self-constructed and hence may restrict accurate comparison.

Conclusion

There is no contention about the usefulness of radiation in clinical diagnostics today. However, the current study in consensus with previous similar studies demonstrates that there is lack of knowledge about radiation exposure and safety practices among the resident doctors. Inadequate awareness may result in injudicious use diagnostic radiation, exposing both patients, healthcare workers and community to unnecessary radiation exposure and thereby increasing the burden of radiation induced disease conditions. Bridging the knowledge gap with the help of education programmes is the need of the hour. Resident doctors being the future referring doctors are the vital target demographic for implementing educative programmes, which can ensure mindful use of healthcare resources and can enhance patient and community safety.

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