International Journal of Research in Medical Sciences
Gour S et al. Int J Res Med Sci. 2018 Jan;6(1):99-105
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20175502

Original Research Article

Evaluation of physicians and junior residents' knowledge and awareness of radiation dose and its risks: a cross-sectional survey in tertiary health centre of central India

Sushil Gour[1], Rajesh Kumar Maurya[1]*, Punya Pratap Singh[2], Himanshu Sharma[3], Prashant Maravi[1]

[1]Department of Radiotherapy, [2]Department of Radiodiagnosis, [3]Department of Pharmacology, Bundelkhand Medical College Sagar, Madhya Pradesh, India

Received: 18 November 2017
Accepted: 24 November 2017

***Correspondence:**
Dr. Rajesh Kumar Maurya,
E-mail: mauryaas80@yahoo.com

Copyright: © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

ABSTRACT

Background: The frequency of radiological investigations increases to many fold now-a-days, so it is necessary to know the knowledge of all physicians about radiation dose, safety measures and regulations which governs the use and practice of radiation examination and their therapeutic use. The objectives comprise to investigate amongst all Physicians: (1) level of knowledge and awareness of radiation dose of radiological investigations and radiobiology of radiation exposure, and (2) to assess physicians' knowledge about the risks associated with the use of radiological examinations and their safety measures.
Methods: A questionnaire targeting about knowledge, safety measures, and radiation biology about some commonly performed radiological procedures was addressed: (1) Relative radiation doses, (2) Associated risks of radiation exposure, (3) What safety measures should be considered before examination. (4) What risk and hazards all physicians considered when requesting radiological examinations.
Results: A questionnaire answered by physicians demonstrates loops in knowledge. In all, 15% (14/92) incorrectly believed that magnetic resonance imaging involved radiation exposure and 3% (3/92) incorrectly believed that ultrasound involved radiation exposure; 38% (35/92) stated that they always explain the benefits and risk of radiation to their patients when obtaining informed consent for examinations involving radiation.
Conclusions: This study concluded a deficit of knowledge about radiation dose exposure, and hazards among Physicians, which may cause them to request more radiological investigations than appropriate and high-dose investigations instead of lower dose alternatives. Providing better radiation protection training may help improve their basic knowledge on the subject and reduce unnecessary patient exposure to radiation.

Keywords: Ionizing radiation, Medical education, Radiation dose, Radiological examinations, Radiation injuries, Radiation safety

INTRODUCTION

Radiology comprises various imaging modalities such as X-ray, CT-scan Ultrasonography, MRI and Nuclear Medicine for the diagnosis and treatment of disease. The most energetic form and of major public health significance is ionizing radiation. Use of ionizing radiation in medical field has been dramatically increased

along with radiation hazards in patients and health workers. Medical and dental X-rays now constitute the major man-made sources of radiation exposure.[1-3] During the examination the radiation hazards depends upon the amount of radiation dose imparted on the patients. The aim of this study was to assess the knowledge and awareness of physicians regarding the hazards of utilizing radiological examinations with patients in their clinical practice aimed to investigate the knowledge, awareness of risks, and usual practice of physicians, with regard to:

- Radiation dose of routinely performed radiological investigations and the associated risks of radiation exposure,
- What to consider when requesting radiological examinations, and
- How they obtained informed consent for examinations involving high-dose radiation.

Nowadays, Radiation has been widely used in the diagnosis and treatment of many diseases. Radiological investigation test involving the use of radiation, are used routinely in health care centre for more accurate diagnosis of disease. Different imaging modalities involve radiation, and in particular, high-radiation- dose investigations such as computed tomography (CT) are increasingly used to diagnose the disease. However, the use of ionizing radiation such as X-rays, computed tomography (CT) is also associated with potentially harmful biological effects. The effect of radiation on cells is depends on their dose like high dose radiation kill it while low dose of it only damage or alter the DNA of cells. Different imaging modalities involve radiation, and in particular, high-radiation- dose investigations such as computed tomography (CT) are increasingly used as a routine investigation. In due course of the times various studies have documented hazardous effects of radiological examination. The physician and junior residents have poor awareness and knowledge about the risk to the patient health and do not discuss possible risks of radiological investigations with their patients. Actually, physicians tend to under estimate the actual dose of ionization radiation involved in various radiological examinations.

Since, radiation has documented harmful biological effects that vary with the dose and duration of exposure, the knowledge of physicians awareness of such matters including associated risks is important.[4,5] Since, physicians refer patients for such investigations, they obviously bear some responsibility under the Ionizing Radiation (Medical Exposure) regulations.[6,7] Internationally, the issue concerning that the knowledge of referring physicians about radiation doses of routine radiological investigations and their awareness of associated risks of radiation exposure are insufficient.[8,9] Assessing areas of such knowledge deficiency among Physicians could help raise their knowledge and improve training about radiation protection and safety methods.

METHODS

A cross-sectional study was conducted in a tertiary health care centre (Bundelkhand Medical College, Sagar Madhya Pradesh) of Central India. A questionnaire was designed and distributed to Physicians and junior residents under different specialties (Appendix 1).

Target population

Cross-sectional study design was utilized. The participants of the study were physicians and junior residents, who were recruited from tertiary health care centre in central India: Bundelkhand medical college hospital (750 beds), located in Sagar division of Madhya Pradesh and offering both IPD and OPD facilities in most medical specialties, including internal medicine, surgery, pediatrics, gynaecology, and orthopedics, affiliated by medical council of India (MCI). Annually this hospital treats more than 1,50,000 (one lakh fifty thousand) people. There were 130 physicians working in Bundelkhand medical college hospital. A cross-sectional study was conducted in a tertiary hospital. A questionnaire was designed and distributed to 110 physicians and junior residents.

Table 1: Demographic distributions of target population.

Item	No of participant	%
Health care centre		
Bundelkhand medical college Sagar MP (Tertiary level health centre)	74	80.4
District Hospital Sagar (secondary health care centre)	18	19.6
Sex		
Male	67	72.8
Female	25	27.2
Category		
Physicians	58	63.0
Junior Resident	34	37.0
Years of clinical experience		
Less than 2 years	52	56.5
From 2 to 4 years	26	28.2
More than 4 years	14	15.3
Specialty		
Medicine	14	15.2
Emergency	10	10.9
Radio-diagnosis	04	4.3
Radio-therapy	02	2.1
Paediatrics	09	9.8
Anaesthesia	07	7.6
Orthopaedics	14	15.2
Gynaecology	12	13.0
Surgery	10	10.9
Pulmonary medicine	02	2.1
Psychiatrics	04	4.3
ENT	04	4.3

Physicians were asked to estimate the radiation dose and associated risk of radiation exposure for various commonly performed procedures including abdominal ultrasonography (USG), barium enema, intravenous pyelography (IVP), bone scintigraphy (Tc-99m), CT scan of the abdomen pelvis, abdominal magnetic resonance imaging (MRI), and. Since the participants may not have been familiar with units of radiation doses, they were only asked to estimate the relative dose associated with each of these procedures in comparison to one chest radiograph.

Physicians were also asked to priorities factors they would consider when requesting radiological examinations. These factors included diagnostic accuracy of the examination, radiation dose and associated radiation risks, for the various radiological examinations. Physicians were asked whether they considered the risks and benefits of radiation exposure to patients, whenever they obtained informed consent for examinations involving radiation.

Participants were divided into three groups as per their years of practice: less than two years; two to four years and more than four years of work experience. These cutoffs were used as they reciprocate approximately as per the basic, intermediate, and higher stages of specialty training. Written informed consent was obtained from the Physicians.

RESULTS

A total of 110 questionnaires were distributed to all the participants under specialist training, of which 92 filled it completely and returned while 18 did not responded accordingly. Of which 52, 26, and 14 questionnaires were distributed to those who had less than 2 years of working experience, 2 to 4 years and more than 4 years of working experience, respectively. A total of 92 questionnaires were completed (response rate, 83%), the numbers (and response rates) in the three respective groups being 52 (56%), 26 (28%), and 14 (16%). The male participants were 67 (73%) in number and female were 25 (27%).

The numbers of physicians in total participants were 58(63%) and junior resident were 34 (37%).Most of physicians belongs to medicine (15%), orthopedics (15%) and gynecology (13%). The participants had a mean of four years and three months of working experience after graduation from medical college, and a median of seven years of working experience.

Knowledge about basic radiation

The questions ranging from number 1 to 7 in the questionnaire are related to basic radiation dose and knowledge. The responses given by participants were divided into main two groups and each group is subdivided into three categories according to their years of experiences. i.e. first is less than two years of experience, second is two to four years of experience and third is more than four years of experience. The first group has physicians and the second have junior residents. The percentage of correct answers among physicians were 55%, 62% and 68% in first, second and third category respectively. The results of the same among junior residents were 39% and 53% in first and second category. These figures indicate that physician have better knowledge of basic radiation dose as compared to junior residents, and its percentage increases with their years of experience (practice).

Knowledge about radiation protection and safety

Question no 8 to 13 in the questionnaire were put to know the knowledge of participants about radiation protection and safety measures.

The physician's group well answer the questions comprises the knowledge about protection and safety, the third category (>4 years' experience) physicians were given correct answer for most of the questions. The percentage of correct answer were 51%, 57% and 61% in first, second and third category respectively. In second group (junior residents), only less than half of the junior residents were given right answers with a correct answers percentage of 33% and 41% in first and second category.

Table 2: The average correct answers percentage among the participants.

Questions	Participant	<2 years experience	=2 to 4 years ex	>4 years
Knowledge about basic radiation (Question no 1-7)	Physician	55 (15/28)	62 (10/16)	68 (10/14)
	Junior Resident	39 (9/24)	53 (5/10)	NA
Knowledge about radiation protection and safety (Question no 8-13)	Physician	51 (14/28)	57 (9/16)	61 (8/14)
	Junior Resident	33 (8/24)	41 (4/10)	NA
Knowledge about radiation biology and its effect (Question no 14-17)	Physician	57 (16/28)	49 (8/16)	52 (7/14)
	Junior Resident	69 (17/24)	67 (7/10)	NA
Awareness of radiation protection rules and regulations (Question no 18-20)	Physician	32 (9/28)	26 (4/16)	23 (3/14)
	Junior Resident	23 (6/24)	15 (2/10)	NA

Knowledge about radiation biology (Radiobiology)

Radiobiology is basically deals with effect of radiation on cells of body. Radiobiology is basic science learnt in MBBS courses and in some postgraduate courses that's why junior resident knows it well as compared to senior physicians. In this study the scenario is the same as we expect it, the correct answers percentage among junior residents were 69% and 67% in their two categories. The physician group were little lower side, but they were also responded well with a 57%, 49% and 52% for respective their three categories as mentioned above

Awareness for rules and regulations

The main regulatory body for radiation use and protection is "Atomic energy regulatory board". It governs the various rules and regulation for the safe use of radiation for diagnostic and therapeutic purpose. Unfortunately, most of participants were not able to give correct answers for questions related to it. Only 32% of physicians having less than two years of practice tick a correct answer and figures even came down to 26% and 23% for the rest two subcategory of physicians. This indicates poor knowledge about rules and regulation for radiation protection. The junior residents group was also not up to mark and responded poorly. The percentage for their two subcategories was 23% and 15% respectively. The result shows gap in knowledge in physician group and junior residents. The factor which was come into light after this study is age of participants and their years of experience.

One of the most important question come in mind nowadays is how often physician ask for any radiological examination like X rays, CT etc and did he weight the parameter supporting its use and its adverse effect. We asked for the frequency of requesting such examination by our participants and got the following figures depicted in table 3. In this study the frequency of examination is divided into three types like very often (>80% times), sometimes (30-80% times) and rarely (<30% times). The frequency of requesting X rays and CT scan were asked by the participants and the result indicates that most of the participants (68%) were very often requested X ray examination while 26% and 4% of participants were requesting it sometimes and rarely respectively. The frequency for asking for CT scan by the participants was 41%, 47% and 12% for frequency types very often, sometimes and rarely respectively.

Table 3: Frequency of radiological examinations requested by participants.

Physician reported frequency of requests for examinations				
Frequency of requests	**Routine X-ray**		**CT Scan**	
	Number	**Percentage**	**Number**	**Percentage**
Very often (more than 80%)	63	68	37	41
Sometimes (30-80% of the time)	24	26	44	47
Rarely (<30 % of the time)	04	4	11	12
Never	01	2	00	00

Table 4: Distribution of answers to questions about relative radiation dose of commonly performed radiological examinations compared to one chest X ray.

Imaging Modality	Total percent of different participants answer			
	Does not involve dose	**Less than actual dose**	**Equal to actual dose**	**More than actual dose**
USG Abdomen or pelvis	89	NA	NA	03
Intravenous Pyelography	08	67	13	04
Barium enema	03	79	09	01
Bone scintigraphy Tc-99m	09	73	10	00
Abdominal CT	02	57	30	03
Abdominal MRI	78	NA	NA	14

Abbreviations: CT = computed tomography; MRI = magnetic resonance imaging; US = ultrasonography; N/A = not applicable.

The participants were asked for relative dose of various performed radiological examinations to know the basic radiological dose knowledge. Regarding knowledge of radiation doses, 62% (57/92) to 86% (79/92) of the participants underestimated the relative radiation dose of commonly performed radiological investigations (such as CT, barium enema and IVU; Table 4). In all, 3% (3/92) and 9% (8/92) incorrectly believed that barium enema and IVU do not involve exposure to radiation

respectively; 10% (9/92) wrongly believed that bone scan does not involve radiation exposure; 15% (14/92) incorrectly believed that MRI involved radiation exposure, and 3% (3/92) incorrectly believed that ultrasound did so too.

DISCUSSION

Radiation has an important role in the diagnosis and therapeutics in modern medicine with proven adverse biological effects. The results of the current study in Sagar, Madhya Pradesh are similar to the results of previous studies in the literature and indicate a lack of knowledge among physicians and junior residents regarding the basic radiation dose and possible risks of radiological examinations.[10-12]

This lack of knowledge of radiological facts was certainly evident, with only 27% of our physicians able to identify the ALARA principle, even though this principle comprises the core of radiation protection philosophy. The 'ALARA concept' entails that radiation exposure be reduced to' As Low As Reasonably Achievable (ALARA)'but not exceeding the limit on effective dose recommended by the International Commission on Radiological Protection (ICRP).[13-15]

This is of mainly concern especially for high radiation doses are used as a screening tool or repeatedly to monitor disease progression.[16]

Like the studies conducted by Lee et al, Jacob et al, and Arslanoğlu et al, our study also demonstrated that most physicians were unable to provide an accurate estimate of the relative radiation dose of commonly performed radiological investigations.[17] Thus, it appears that knowledge regarding radiation dose and associated hazards have not been well known to physician and junior residents. If referring physician have adequate knowledge of radiation dose, unnecessary examinations may be avoided, and high-dose radiation examinations might give way to lower risk alternatives.[18] Moreover, knowledge of radiation dose and associated hazards for non-radiologist is important due to their pivotal clinical role in providing most accurate information about risks to patients.

A proportion of participants in this study answered that MRI and USG involved radiation, which was similar to findings in some international studies. Such basic knowledge deserves more emphasis during MBBS course and training. Our study showed that only a small proportion of participants considered radiation risk as a high priority when requesting radiological examinations, which is a drawback that needs also reemphasis during medical education and training.

Information on radiation dose and the associated hazards from exposure should be made more widely available to medical students and junior residents. Referring physician should be educated on the basic aspects of radiation doses, radiation protection, and their effects.

The information on radiation doses and associated hazards of exposure could also be provided to junior residents via the radiological examination electronic requesting system.

With reference to the study conducted by Lee et al, we also demonstrated that physicians do not always delineate the risks and benefits of radiation exposure to patients when obtaining informed consent for investigation involving radiation such as CT of the abdomen. Patients undergoing such investigation are often poorly informed about possible associated hazards.[19] This probably related to the poor physicians' knowledge of radiation doses, and associated harmful effects. The Radiologists/Radiological Safety Officer could help educate junior residents about the basics of radiation doses and the associated risks following different procedures. Only such information is made available to patients can they themselves weigh the risks and benefits from their own perspective. The possible methods might include providing accurate information on radiation doses and reference ranges in radiology department, as well as patient information pamphlets in outpatient facilities and inpatients rooms.

The limitations of the study include, small sample size, the use of a self-reported questionnaire, making it difficult to validate the accuracy of the findings. Also, this study involved only the two referral hospitals in Sagar, thus the generalization of the findings to other health settings may be limited. Further research is required to assess the level of radiological knowledge among medical students in their final year of medical studies and among other health professionals, such as radiological technicians. Further studies with a larger sample, further research into the effectiveness of radiation safety courses, and the extent and causes of unnecessary radiological examinations requested by junior residents may help reduce patient exposure to unnecessary radiation. This situation suggests the need to design and conduct such courses or training workshops, both within the medical colleges and in district hospital workplaces, taking into consideration the frequent changes in the available biological and physical information and radiation safety standards.

CONCLUSION

This study demonstrated that most physicians and junior residents underestimated the radiation dose of commonly performed radiological procedures. This deficit may lead them to request more and / or use unnecessarily high - dose examinations, despite the availability of lower-risk alternatives. In general, the results of the current study in tertiary health centre Sagar, Central India are similar to the findings of previous studies in the literature and indicate a similar lack of knowledge among physicians regarding the possible risks of radiological examinations.

Providing radiation protection training to medical students and junior residents in the basic curriculum of medical college course, and information radiation doses / risks via online resources or electronic request systems for radiological examinations may be beneficial for physicians and patients. Enactment of radiation safety courses in health education programmed could be an effective method to reduce the patient's dose and its hazards in radiation exposures. Also, the importance of informing patients about these matters needs to be emphasized, so that they can properly weigh up the risks and benefits of radiological examinations from their own perspective.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Park K. Park's textbook of preventive and social medicine. 20th ed. Jabalpur, India: M/s Barnasidas Bhanot; 2009.
2. Charles M. Sources and effects of ionizing radiation. J Radiol Prot. 2001;21:83-5.
3. Adetokunbo OL, Herbert MG. Short textbook of public health medicine in the tropics. 4th ed. London: Arnold; 2003.
4. Brenner D, Elliston C, Hall E, Berdon W. Estimated risks of radiation-induced fatal cancer from pediatric CT. AJR Am J Roentgenol. 2001;176:289-96.
5. Brenner DJ, Doll R, Goodhead DT. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. Proc Natl Acad Sci USA. 2003;100:13761-6.
6. Jacob K, Vivian G, Steel JR. X-ray dose training: are we exposed to enough? Clin Radiol. 2004;59;928-34.
7. Integrated Environment Management Inc (IEM). The ALARA concept. Available at: http://www.iem-inc.com/information/radioactivity-basics/radiation-risks/the-alara-concept.
8. Arslanoğlu A, Bilgin S, Kubal Z, Ceyhan MN, Ilhan MN, Maral I. Doctors' and intern doctors' knowledge about patients' ionizing radiation exposure doses during common radiological examinations. Diagn Interv Radiol. 2007;13:53-5.
9. Soye JA, Paterson A. A survey of awareness of radiation dose among health professionals in Northern Ireland. Br J Radiol. 2008;81:725-9.
10. Arslanoğlu A. Doctors' and intern doctors' knowledge about patients' ionizing radiation exposure doses during com-mon radiological examinations. Diagnost Intervent Radiol. 2007;13:53-5.
11. SEER Cancer Statistics Review 1975-2007 (NCI 2010). Cancer Facts and Figures 2010. American Cancer Society; 2010.
12. Soye JA, Paterson A. A survey of awareness of radiation dose among health professionals in Northern Ireland. Brit J Radiol. 2008;81:725-9.
13. Jacob K, Vivian G, Steel JR. X-ray dose training: are we exposed to enough? Clinic Radiol. 2004;59:928-34.
14. International Commission on Radiological Protection (ICRP). Recommendations of the ICRP: ICRP Publication 103. Annals of the ICRP. 2007; 37.
15. International Commission on Radiological Protection, 2007. Recommendations of the ICRP, Publication 103, Pergamon Press, Oxford; 2007.
16. Earnest F, Swensen SJ, Zink FE. Respecting patient autonomy: screening at CT and informed consent. Radiol. 2003;226:633-4.
17. 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 risks. Radiol. 2004;231:393-8.
18. Council Directive 97/43/EURATOM of 30 June 1997 on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure. Available at http://ec.europa.eu/energy/nuclear/radioprotection/doc/legislation/9743_en.pdf. Accessed Aug 2010.
19. Lewis C. Full-body CT scans. What you need to know. FDA Consum. 2001;35:10.

Cite this article as: Gour S, Maurya RK, Singh PP, Sharma H, Maravi P. Evaluation of physicians and junior residents' knowledge and awareness of radiation dose and its risks: a cross-sectional survey in tertiary health centre of central India. Int J Res Med Sci 2018;6:99-105.

Appendix -1
Questionnaire

1-Radioactive radiation refers to Ionizing radiation.
a) Yes ☐ b) No ☐ c) Don't know ☐

2-Which of the following radiations will be completely stopped by a piece of paper?
a) Alpha particle ☐ b) Beta particle ☐ c) Gamma Rays ☐ d) None of above ☐

3-What is the SI unit of radioactivity?
a) Bq ☐ b) Roentgen ☐ c) Gray ☐ d) Meter ☐

4- What is the annual whole-body dose limit for public?
a) 1 mSv ☐ b) 0.1 mSv ☐ c)10 mSv ☐ d)20 mSv ☐

5- How much radiation, in milli-Sieverts (mSV), is a person exposed to, on average, every year, from natural background
a) 0.24 ☐ b) 2.4 ☐ c) 24 ☐ d) 240 ☐

6-What is the approximate radiation dose, in (mSv), of a chest x-ray?
a) 0.02 ☐ b) 0.2 ☐ c) 2 ☐ d) 20 ☐ e) I have no idea ☐

7-Which modality exposes to more radiation
a) a single CT scan ☐ b) a single x-ray ☐ c) a single MRI ☐ d) a single USG ☐

8-What is the annual whole body dose limit for radiation worker?
a) 20 mSv ☐ b)30 mSv ☐ c) 1 mSv ☐ d)10mSv ☐

9-What is the annual whole body dose limit for a patient?
a) No Limit ☐ b) 3 mSv ☐ c) 10 mSv ☐ d) 20 mSv ☐

10- Do you explain the risks versus benefits of radiation exposure to patients when obtaining informed consent for examinations involving radiation? (Please circle as appropriate?
a) Always ☐ b) Sometimes ☐ c) Never ☐

11-A radiation dosimeter provides protection from radiation exposure?
a) False ☐ b) True ☐ c) Sometimes ☐ d) Never ☐

12- Which of the following are the basic principles of radiation safety:
a) Shielding ☐ b) Time ☐ c) Distance ☐ d) a, b, c all these three ☐

13-As the distance between medical staff and radiation source increases, the radiation exposure.
a) Increases ☐ b) Remain constant ☐ c) Decreases ☐ d) First increases then decreases ☐

14- Which of the following could be used safely for pregnant women? (you can mark more than one)
a) Ultrasonography ☐ b) CT ☐ c) MRI ☐ d) Mammography ☐

15- X-ray cause cell death by
a) Ionization ☐ b) Penetration ☐ c) Don't know ☐

16- Most sensitive site in a cell
a) DNA ☐ b) Cytoplasm ☐ c) Mitochondria ☐

17-Cells most susceptible to radiation are
a) Highly differentiated cells ☐ b) Primitive cells ☐ c) Don't know ☐

18- What is the name of radiation regulatory body of India?
a) NCRP ☐ b) ICRP ☐ c) AERB ☐

19-Which of the following explains the ALARA principle?
a) As Low as Reasonable Achievable ☐ b) As low as radiation available ☐ c) As low as radiation acceptable ☐

20- The regulation for radiation protection in India is
a) Atomic energy RPR 2004 ☐ b) ICRP 2017 ☐ c) Don't know ☐