Original Article

Radiation Safety Knowledge and Practice Amongst Doctors in a Teaching Hospital in the Niger Delta Region of Nigeria

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Article Metrics
Date submitted: *6/12/2020*
Date Accepted: *11/03/2021*
Date Published: *4/4/2021*

: https://doi.org/10.46912/wjmbs.35

ABSTRACT

It is important that doctors of the various specialties in a health facility requesting for radiological examinations are knowledgeable about the effect of ionizing radiation. When referring doctors know the amount of radiation their patients receive there will be justification for such investigations in line with the guiding principle of radiation protection – As Low As Reasonably Achievable (ALARA) - to minimize risk to the patient. The objective of this study is to assess the knowledge and practice of radiation protection and safety amongst doctors in a Teaching Hospital in the Niger Delta, Nigeria. This is a cross-sectional descriptive study using a self-administered structured questionnaire among 131 doctors in Delta State University Teaching Hospital (DELSUTH), Oghara. Data was analyzed using the IBM SPSS v.21. Eighty-eight (67.2%) respondents had a good knowledge of radiation safety while 49 (37.4%) of respondents had a good practice of radiation protection and safety. There was an association between the department of respondents (p=0.009), awareness of body parts sensitive to radiation (p=0.005) and their knowledge of radiation safety. Also, there was an association between the department of respondents (p=0.016), their years of experience (p=0.016) and the practice of radiation safety. Knowledge of radiation safety was high while the practice of radiation protection and safety was low amongst respondents. Gender, department of doctor and awareness of body parts that are sensitive to radiation were associated with good knowledge; while department and years of experience was associated with good practice. It is recommended that doctors receive regular updates on radiation hazards, risks and protection in order to reduce the risk of exposure of patients and health workers to unnecessary ionizing radiation.

Keywords: Ionizing Radiation, Doctors, ALARA, Radiation Protection, Safety

INTRODUCTION

Humans are exposed to radiation on a daily basis arising from anthropogenic sources and cosmic radiation. Specifically, patients who are exposed to ionizing radiation for medical indications receive additional doses of radiation. Ionizing radiation can result in stochastic and deterministic effects. Researchers both within and outside Nigeria have previously expressed an increasing concern of the inadequacy of the knowledge of referring doctors on radiation doses incurred by patients during radiological procedures.[1-4]It is pertinent that the doctors of the various specialties in a health facility who request for radiological examinations need to be knowledgeable on the effect of ionizing radiation.[5-8]When referring doctors know the amount of radiation that their patients receive there will be justification for such investigations in line with the guiding principle of radiation protection – As Low As Reasonably Achievable (ALARA) - to minimize risk to the patient.[1,9-12]

A functional Computed Tomography (CT) scanner is a prerequisite for the accreditation of the Residency training program in Radiology. Consequently, many teaching hospitals are acquiring this high dose radiation equipment. Being unaware of the risk of radiation may therefore make a clinician to request for a CT examination for a patient where a plain x-ray examination would have been requested based on clinical details, relevant history, provisional diagnosis and clinical questions to be answered.[12-14]

Medical practice stems around the fundamental teaching *"Primum non nocere"* meaning "*First, not to harm;"*[15] with the ever increasing power, accessibility and size of the radiological "armory" at our disposal it is important not to forget this old statement. Together with improvements in computed tomography (CT) scanning technology, radiation doses per scan have increased by up to 40%.[16] The now conventional multi-detector CT scanners have the potential to expose the patient to higher radiation doses than the older single-detector CT scanners.[17]In the United Kingdom, an estimated 100-250 deaths occur each year from cancers directly related to medical exposure to radiation.[18] In March 2000, the UK Secretary of State issued new regulations that emphasized the importance and dangers of radiation. Despite the small but definite risk to patients' health, investigations utilizing ionizing radiation are an accepted and fundamental part of medical practice.

The aim of this research is to ascertain the level of doctors' knowledge of radiation protection and their knowledge of the radiation doses their patients receive during some common radiological procedures, and also to determine the level of education on radiation that doctors acquire during their post basic medical qualification.

The findings of this research will highlight the importance of doctors being knowledgeable about the possible radiation effects that their patients could experience each time they are exposed to ionizing radiation. The results of this research work will correspondingly proffer solutions that will help to improve the knowledge of doctors on radiation effects and radiation protection for their patients.

MATERIALS AND METHODS

The study was carried out in Delta State University Teaching Hospital (DELSUTH), Oghara which is the only Teaching Hospital in Delta state serving as a referral center for other Government Central hospitals

and private hospitals in the state: as well as neighboring states in the South – South geopolitical zone of Nigeria. Areas of specialty are Surgery, Paediatrics, Radiology, Obstetrics and Gynaecology, Pathology, Emergency Medicine, Family Medicine, Community Health, Anaesthesia and Intensive Care, Psychiatry and Physiotherapy.

The study population comprised doctors of different cadre and specialties excluding doctors in radiology department and non-consenting doctors in other specialties. It is a cross sectional descriptive study which was carried out in 2016 over a duration of 2 months.

Data was collected using a self-administered structured questionnaire which included sections on socio demographic characteristics, awareness, knowledge and practice of the doctors on radiation protection and safety.

In assessing the questionnaires, a correct answer was allotted a mark (i.e.1 mark) while an incorrect answer was given no mark (zero mark). Where the option of "don't know" was ticked it was given no mark. Knowledge was categorized as either good or poor. Good knowledge was graded $\geq$ as 50% of correct responses. Poor knowledge was graded <50% of correct responses. Practice of radiation safety was categorized similarly as good or poor.

The questionnaires were collected, sorted, collated, and analyzed using the IBM Statistical Package for Scientific Solutions (SPSS) version 21. Data was presented in prose and tables as applicable. Statistical significance was set as $p < 0.05$.

As regards ethical considerations, permission was obtained from the Chairman Medical Advisory Committee (CMAC) to use data from the hospital and clearance was obtained from the Health Research Ethics Committee DELSUTH, Oghara. Consent was acquired at the various departments before data collection. Informed consent was obtained from participating doctors. In all, confidentiality of information used in this research was maintained.

RESULTS

Table 1 shows the socio-demographic characteristics of respondents**.** One hundred and thirty-one respondents participated in this study. The mean age of respondents was 35.4 (±7.4) years. Most respondents ranged between 31-40 years in age, 66 (50.4%). Majority of respondents were male, 93 (71.0%). The highest proportion of respondents comprised junior registrars, 51 (38.9%). The highest proportion of respondents came from Internal Medicine (20.6%) followed by Obstetrics and Gynaecology (19.8%) and Surgery (17.6%) departments respectively. The mean years of experience of respondents were 9.3 (±7.7) years. Notably, most respondents had less than 10 years' experience in the practice of medicine 84 (64.1%).

In Table 2, 88 (67.2%) respondents had a good knowledge of radiation safety. There was no association between the age of respondents (p=0.687), gender of respondents (p=0.023), years of experience of respondents (p=0.580) and their knowledge of radiation safety. There was an association between the department of respondents (p=0.009), awareness of body parts that are sensitive to radiation by respondents (p=0.005) and their knowledge of radiation safety. In Table 3, we observe that 49 (37.4%) of respondents had a good practice of radiation safety. There was no association between the age of respondents (p=0.087), gender of respondents (p=0.932) and awareness of body parts sensitive to radiation by respondents (p=0.423) and their practice of radiation safety. However, there was an association between the department of respondents (p=0.016), years of experience of respondents (p=0.016) and their practice of radiation safety.

Table 1: socio-demographic characteristics of respondents (N=131)

Variable	Frequency	Percentage
Age (years)		
= 30	38	29.0
31-40	66	50.4
41-50	21	16.0
51-60	6	4.6
Gender		
Male	93	71.0
Female	38	29.0
Status		
Consultant	25	19.1
Senior Registrar	8	6.1
Junior Registrar	51	38.9
Medical officer	27	20.6
House officer	20	15.3
Department		
Surgery	23	17.6
Family Medicine	11	8.4
Internal Medicine	27	20.6
Ophthalmology	2	1.5
A and E	8	6.1
Anesthesia	7	5.3
Community Medicine	9	6.9
Paediatrics	16	12.2
O and G	26	19.8
Pathology	2	1.5
Years of experience		
<10 years	84	64.1
=10 years	47	35.9

Table 2: Socio-demographic characteristics and knowledge of radiation safety among respondents

Variable	Knowledge of radiation safety n (%)		χ^2 / df	p-value
	Good 88 (67.2)	**Poor 43 (32.8)**		
Age (years)				
= 30				
31-40	25 (65.8)	13 (34.2)		
41-50	47 (71.2)	19 (28.8)	1.480	0.687
51-60	12 (57.1)	9 (42.9)		
	4 (66.7)	2 (33.3)		
Gender				
Male	68 (73.1)	25 (26.7)		
Female	20 (52.6)	18 (47.4)	5.135/ 1	* 0.023
Status				
Consultant	14 (70.0)	6 (30.0)	4.159/ 4	0.385
Senior Registrar	18 (66.7)	9 (33.3)		
Junior Registrar	34 (66.7)	17 (33.3)		
Medical officer	3 (37.5)	5 (62.5)		
House officer	19 (76.0)	6 (24.0)		
Department				
Surgery	17 (73.9)	6 (26.1)		
Family Medicine	7 (63.6)	4 (36.4)		
Internal Medicine	24 (88.9)	3 (11.1)	23.158/ 9	*0.006
Ophthalmology	1 (50.0)	1 (50.0)		
A and E	2 (25.0)	6 (75.0)		
Aneasthesia	1(14.3)	6 (85.7)		
Community Medicine	5 (55.6)	4 (44.4)		
Paediatrics	11 (68.8)	5 (31.2)		
O and G	19 (73.1)	7 (26.9)		
Pathology	1 (50.0)	1 (50.0)		
Years of experience				
<10 years	55 (65.5)	29 (34.5)		
=10 years	33 (70.2)	36 (40.9)	0.307/ 1	0.580
Awareness of the body parts sensitive to radiation				
Yes				
No	36 (83.7)	7 (16.3)		
	52 (59.1)	36 (40.9)	7.949/ 1	*0.005

**Significant at p<0.05*

Table 3: Socio-demographic characteristics and practice of radiation safety among respondents

Variable	Practice of radiation safety n (%)		χ^2 / df	p-value
	Good 49 (37.4)	**Poor 82 (62.6)**		
Age (years)				
= 30	11 (28.9)	27 (71.1)		
31-40	25 (37.9)	41 (62.1)	6.577/ 3	0.087
41-50	8 (38.1)	13 (61.9)		
51-60	5 (83.3)	1 (16.7)		
Gender				
Male	35 (37.6)	58 (62.4)		
Female	14 (36.8)	24 (63.2)	0.007/ 1	0.932
Status				
Consultant	11 (55.0)	9 (45.0)		
Senior Registrar	11 (40.7)	16 (59.3)	5.757/ 4	0.218
Junior Registrar	16 (31.4)	35 (68.6)		
Medical officer	1 (12.5)	7 (87.5)		
House officer	10 (40.0)	15 (60.0		
Department				
Surgery	9 (39.1)	14 (60.1)		
Family Medicine	6 (54.5)	5 (45.5)	21.124/ 9	*0.012
Internal Medicine	7 (25.9)	20 (74.1)		
Ophthalmology	0 (0.0)	2 (100.0)		
A and E	1(12.5)	7 (87.5)		
Aneasthesia	2(28.6)	5 (71.4)		
Community Medicine	2 (22.2)	7 (77.8)		
Paediatrics	3 (18.8)	13 (81.2)		
O and G	18 (69.2)	8 (30.8)		
Pathology	1 (50.0)	1 (50.0)		
Years of experience				
<10 years	25 (29.8)	59 (70.2)		
=10 years	24 (51.1)	23 (48.9)	5.841/ 1	*0.016
Awareness of the body parts sensitive to radiation				
Yes				
No	14 (32.6)	29 (67.4)		
	35 (39.8)	53 (60.2)	0.642/ 1	0.423

*Significant at p<0.05

DISCUSSION

This study shows that while two thirds of respondents had a good knowledge of radiation safety just a third of them had a good practice of radiation protection and safety.

Demographic characteristics of the respondents in this study are similar to findings from the study of *Adhijo et al* in Maiduguri, Nigeria. Their study shows that there were more resident doctors than any cadre of doctors which was attributable to the fact that resident doctors represent the largest number of doctors at the nation's tertiary health institutions of postgraduate medical training.[3]

The usefulness of ionizing radiation especially x-rays in radio diagnosis, radiotherapy and interventional radiology has made the practice of medicine more evidenced based thereby leading to improvement in patient care. Consequently, the need for such diagnostic and interventional modalities has significantly increased in low- and middle-income countries in recent years both in public and private health facilities. The implication of this on patient safety and occupational safety for the health worker safety cannot be overemphasized. However, a starting point would be to assess the level of knowledge of requesting physicians on ionizing radiation, safe doses and radiation protection. [1,5,6,10,12,14]

The hazardous effects of ionizing radiation can broadly be classified as somatic and genetic. Although the amounts of doses used in modern imaging are usually minimal and innocuous, stochastic and deterministic risks exist especially when unnecessary exposures and repeat examinations are requested for. The radiation exposure should be as low as reasonably achievable (ALARA) and hospitals should have an ALARA policy that establishes local exposure limits to effectively minimize total radiation dose.[1,7]

Various researchers have previously expressed an increasing concern about the inadequacy of the knowledge of referring doctors on radiation doses incurred by patients during radiological procedures.[1-4,18,19] When there is a dearth of such knowledge, a doctor may request for a radiological examination that may be unnecessary while the patient receives preventable high doses of radiation putting them at a risk for radiation induced cancers. *Brenner DJ et al*[20] reports that radiation induced cancers were seen in patients who received single or repeated high doses of radiation. Acute radiation exposure ranging between10–50 mSv and 50–100 mSv were reported in their study to have induced cancers. Studies assessing doctors on their knowledge of radiation safety, and awareness of radiation doses received by the patients when referred for radiological procedures utilizing ionizing radiation, has been widely reported as poor by various researchers.[1,3,4,18,19] This study observes that most of the respondents had a good knowledge of radiation safety which could be a reflection of changes in undergraduate curriculum that may have exposed these doctors to knowledge of such diagnostic modalities. No significant association was observed in the knowledge of respondents where respondents were stratified according to years of practice, neither was this seen when respondents were stratified according to age. However, gender, awareness of body parts sensitive to radiation and the department of respondents were associated with a good knowledge of radiation safety. This finding is at variance with the study of *Arslanoglu et al*, [18] who found no statistically significant association of the knowledge of radiation with the gender of the doctors. Data showed that proportionally more respondents in the departments of Internal Medicine, Surgery, Obstetrics and Gynaecology had a

knowledge of radiation safety. This could be a reflection of the frequency with which doctors in such departments made radiological requests. It could also be due to extra training on radiation safety by such specialists. Referral of patients for radiological procedures is mostly done by non-radiologists who need to be knowledgeable about the benefits and risks of these imaging modalities to their patients.

Zewdneh and colleagues[1] in their study reported that doctors who have had formal training about ionizing radiation had a greater awareness of the risks involved, compared to those who had no training. This further demonstrated that residents in radiology were more familiar with radiation doses and risks of radiation than their clinical colleagues from other specialties, which of course, is expected. It is the responsibility of all doctors irrespective of their specialties to keep themselves updated with sufficient and current information about ionizing and non-ionizing radiation as long as they refer patients for radiological procedures. This can be accomplished by expanding the scope of radiation safety courses in the undergraduate medical curriculum; and for the post graduate doctors, enforcement of radiation safety education and continuous medical education (CME) programs. In this study, a large proportion of the doctors had not received any form of update or CME on radiation doses or risk since graduating from medical school.

It has been advocated that the availability of the information or record of radiation dose received by a patient would caution the doctor and assist in preventing some of the unnecessary investigations and repeat examinations that a patient may have undertaken. Radiological data system software for such record of radiation dose received by a patient will be helpful. Sadly, the non-availability of such in most health institutions in developing countries like Nigeria indicate that doctors must, as a necessity, practice the principle of ALARA (as low as reasonably achievable) as they refer patients for radiological investigations that utilize ionizing radiation. On the other hand, imaging modalities utilizing ionizing radiation include plain radiography, computed tomography, fluoroscopy, mammography, radionuclide imaging and radiographic contrast procedures are commonly referred to as 'specials' or 'special radiological procedures'. On the other hand, imaging modalities which do not utilize ionizing radiation include ultrasonography and magnetic resonance imaging (MRI). This basic distinction between these two groups of imaging modalities is emphasized to undergraduate medical students during introductory radiology lectures and it is expected that that this fundamental difference would assist the doctor in making an informed decision on which modality to use as he practices Medicine.

The lack of awareness of doctors that ultrasonography and MRI do not use ionizing radiation has been reported by *Zewdneh et al,*[1] *Shiralkar et al,*[19] and *Arslanoglu et al,*[18] while in the Nigerian literature even lower levels was reported by *Adhijo et al*[3] and *Mohammed et al.*[4] Such ignorance has been described as shocking and surprising. Therefore, a regular update for all doctors in the form of continuous medical education on such a vital subject matter should be encouraged. This will aid doctors in the choice of modality to request for especially in paediatric practice where the use of modalities such as ultrasonography and MRI should be preferred to modalities utilizing ionizing radiation. This is because in children, the probability and risks of children in their lifetime being affected by radiation related cancers is higher due to their expected longer life expectancy. Such knowledge and referring practices will have a positive effect of patient safety.[21]

Notable in history are the hematological malignancies

resulting from the long term effects of exposure to ionizing radiation as recorded in Hiroshima and Nagasaki, Japan; and more recent complex catastrophic disaster at the Fukushima Daiichi Nuclear Power Plant Tsutomu in Japan.[22] It is recommended that the training on the effects of radiation exposure and radiation doses should be incorporated in the orientation programs of house officers and senior house officers as they begin their medical career to improve their knowledge and practice. Data from this survey shows that having practiced for more than 10 years as a doctor was associated with a good practice of radiation protection and safety. This could be a probable consequence of professional experience.

Exposure of radiosensitive organs to ionizing radiation has to be with strict adherence to the ALARA principle both by the imaging staff as well as the referring doctor. These organs include the lens, thyroid, breasts, ovaries and testis. In the Radiology department, these organs are adequately protected using protective devices such as lead aprons, protective goggles, thyroid shields and gloves. Other radiographic techniques and measures are also employed to reduce the radiation dose given to the patients. More importantly the referring doctors and even the patients need to be aware of these radiation safety mechanisms. In this study, there was no association between the awareness of body parts sensitive to radiation by respondents and their practice of radiation safety. This shows that the need for improvement in regular update for doctors on radiation hazards and protection cannot be over emphasized.

CONCLUSION

This study has shown that while the knowledge of radiation safety was high, the practice of radiation protection and safety was low in the respondents. Gender, department of doctor and awareness of body parts sensitive to radiation were associated with good knowledge; while department and years of experience was associated with good practice of radiation safety and protection. It is recommended that doctors receive regular updates on radiation hazards, risks and protection in order to reduce the risk of exposure of patients and health workers to unnecessary ionizing radiation.

Acknowledgment

The authors acknowledge the effort of Dr J. Benjamin-Ohwodede in editing and proofreading this document.

Conflict of Interest: None

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