ORIGINAL RESEARCH

Assessment of Doctor's Level of Knowledge on Radiation Protection with Respect to CT Examinations at Mzuzu Central Hospital

Blessed Kondowe[1], Brave Kadoko Nyirenda[1], Elijah Ndlovu Kampala[1], Zhe Liu[2], Jin Shang[2]*

1. Mzuzu Central Hospital, Radiology department, P/Bag 209, Luwinga, Mzuzu, Malawi.
2. The First Affiliated Hospital of Xi'an Jiaotong University, Department of Medical Imaging, Shaanxi Province, Xi'an City, PR China.

***Correspondence: Jin Shang**; E-mail:shangjin01@qq.com

Abstract

Background

Radiation protection is the most important practice in medical imaging, and referring physicians responsible for requesting radiological examinations, including computed tomography (CT), must be aware of and compliant with it in order to minimize future carcinogenic risks. This study aimed at assessing medical doctors' level of knowledge on radiation protection with respect to CT examinations at Mzuzu Central Hospital (MCH).

Methods

A cross-sectional study was conducted at MCH in July 2019. A questionnaire was used to collect relevant data from CT medical doctors. All medical doctors registered with the Medical Council of Malawi (MCM) were included in the study. The purposive sampling method was used due to the small number of medical doctors at the facility. Statistical Package for the Social Sciences (SPSS) version 20.0 was used for descriptive analysis. Categorical variables were expressed as frequencies and percentages.

Result

Out of 24 medical doctors, 23 (95.8%) of them were aware of radiation protection, and 21 (87.5%) were involved in CT examination prescription at MCH. However, 11 (45.8%) of the medical doctors are not aware that more medical radiation is contributed by CT scans. Similarly, the study found that 13 (54.2%) of the doctors do not always consider radiation protection principles of justification and as low as reasonably achievable (ALARA) when prescribing CT examinations. Furthermore, 20.8% of the medical doctors do not know the role of non-radiation imaging modalities like magnetic resonance imaging (MRI) and ultrasound scanning (USS).

Conclusion

Much as the majority of the medical doctors are aware of radiation protection, most of them are not aware that CT scanners emit more radiation than general x-rays, with 54.2% adhering to fundamental principles of radiation protection. About 20.8% of the doctors are not conversant with the role of non-radiation imaging modalities like MRI or USS and when to use them.

Keywords: Computed tomography, radiation protection, carcinogenic effects, ALARA principle, knowledge.

Introduction

Radiological imaging is a major global source of medical radiation exposure to patients, with computed tomography (CT) among the largest contributors[1,2]. Each chest CT can produce an average dose of 8 mSv compared to an average of 0.02 mSv produced for one chest X-ray[2,3]. This high radiation dose poses carcinogenic risks to patients undergoing CT examinations, which calls for referring physicians and radiology staff to jointly stick to radiation protection principles of justification, optimization, and application of dose limits to minimize the risk. Ionizing radiation used in medical diagnosis is known to be associated with biological effects that induce cancer[4–6]. Therefore, radiation protection practices should always be applied to avoid unnecessary radiation exposure to patients, staff, and the general public to keep these effects to a minimum while maintaining diagnostic image quality[7,8]. However, previous studies have shown poor knowledge about radiation protection practices and effects of radiation among physicians referring patients for radiological examinations[6,9–11].

Radiation protection is an important practice that referring physicians responsible for prescribing radiological examinations should be aware of and compliant with if future carcinogenic risks that come due to exposure to ionizing radiation are to be minimized[12]. Many referring physicians have little to moderate knowledge on the importance of radiation protection to patients when requesting radiological examinations, including CT, and this promotes noncompliance with its practice[6,9]. This low knowledge level and noncompliance results in overutilization of CT examinations, thereby subjecting patients to unnecessary ionizing radiation doses[11,12].

Published papers have shown that 20–40% of CT scans could be avoided if clinical decision guidelines are followed and non-radiation-generating imaging modalities like MRI and USS are employed where necessary[2,8]. Different studies indicate that very little is known among medical doctors about radiation protection, its potential cancer risks, and the importance of using alternative imaging modalities like MRI and USS[13].

https://dx.doi.org/10.4314/mmj.v37i3.1

Table 1. Demographic and radiation protection variables labelling

Variable name	Variable label	Variable label definition
Demographic variables		
ID	Patient Identification number	
Gen	Gender	0=Male, 1=Female
M	Male	
F	Female	
Ag grp	Age group	0=21-40 years, 1=41-50 years, 2=51-60years
Yong	Young aged Doctors	
Mdl	Middle aged Doctors	
Old	Old aged Doctors	
Exp	Years of Experience	0=1-3 years, 1=4-10 years, 2= >10 years
Lttl exp	Little experience	
Exp	Experienced	
Mor exp	More experienced	
Radiation protection characteristics		
RP Knwdg	Radiation protection knowledge	0=Yes, 1=No
Y	Yes	
N	No	
CT Rad	CT radiation knowledge	0=Yes, 1=No
Y	Yes	
N	No	
CT Rq	CT request involvement	0=Yes, 1=No
Y	Yes	
N	No	
RP in Univ	Learning RP in the university	0=Yes, 1=No
Y	Yes	
N	No	

https://dx.doi.org/10.4314/mmj.v37i3.1

Table 1 Cont....

Non-Rad mod	Awareness about non-radiation imaging modalities like MRI and USS	0=Yes, 1=No
Y	Yes	
N	No	
RP in Cur	RP inclusion in medical university curriculum	0=Yes, 1=No
Y	Yes	
N	No	
RP in CPD	RP inclusion in CPDs	0=Yes, 1=No
Y	Yes	
N	No	
Rad risks	Awareness about radiation risks like cancer.	0=Yes, 1=No
Y	Yes	
N	No	
Att RPwksp	Attending radiation protection workshops	0=Yes, 1=No
Y	Yes	
N	No	
Frq	Frequency of use of attending RP workshops	0=Never, 1=Sometimes, 2=Always, 3=None
Nev	Never	
Smtms	Sometimes	
Alws	Always	
Non	None	
Info shr	Information sharing with patients during CT request	0=Yes, 1=No
Y	Yes	
N	No	
Pt Rq inv	Patient involvement in decision making regarding CT examinations	0=Never, 1=Sometimes, 2=Always, NA=3
Nev	Never	

https://dx.doi.org/10.4314/mmj.v37i3.1

Table 1 Cont....

Smtms	Sometimes			
Alws	Always			
NA	NA			
RP Prples	Application of justification and ALARA principles	0=Never, 3=NA	1=Sometimes,	2=Always,
Nev	Never			
Smtms	Sometimes			
Alws	Always			
NA	NA			
Frq	Frequency of use of MRI/USS	0=Never, 3=NA	1=Sometimes,	2=Always,
Nev	Never			
Smtms	Sometimes			
Alws	Always			
NA	NA			

Table 2. Demographic characteristics

Study variables	Classifications	Number (%), n = 24
Gender	Male/Female	14(58.3)/10(41.7)
Age group	Young/Middle/old	21(87.5)/1(4.2)/2(8.3)
Years of Experience	Little/Experienced/more Experienced	14(58.3)/3(12.5)/7(29.2)

Mzuzu Central Hospital (MCH) has a CT machine donated by the Chinese government and installed in 2021. This development served as the basis to conduct this study, which aimed to assess doctors' level of knowledge on radiation protection with respect to CT examinations at Mzuzu Central Hospital.

Materials and Methods

Study design and setting

A cross-sectional study design was employed. The study was carried out at Mzuzu Central Hospital, where all CT scans are routinely prescribed in northern Malawi.

Target population

The targeted population included all senior, junior, and internee medical doctors registered with the Medical Council of Malawi (MCM) working at MCH. Ethical approval was obtained from the MCH Research Committee and the National Health Sciences Research Committee (NHSRC) approval number 19/05/2319.

Sampling

The study used the purposive sampling method due to the small sample size available. There were 28 qualified medical doctors working at MCH and registered with MCM during the time of study. However, one opted out, two were on holiday, and another one was outside the country for further studies, making a total sample size of 24 doctors who took part in the study.

Data collection and analysis

Data was collected through hand-delivered questionnaires, and the participants voluntarily signed the consent forms. The questionnaires were collected after two weeks. The questionnaire had two sections; the first section covered sociodemographic characteristics such as gender, age range, and work experience, with the second section covering radiation protection knowledge, non-radiation-producing modalities, associated carcinogenic risks due to medical radiation, and radiation protection principles. Annexes A and B are the consent form and study questionnaire, respectively.

https://dx.doi.org/10.4314/mmj.v37i3.1

Table 3: Radiation protection related characteristics

Study variables	Classifications	Number (%), n = 24
Radiation protection knowledge	Yes/No	23 (95.8)/1 (4.2)
More radiation from CT scan	Yes/No	13 (54.2)/11 (45.8)
CT request involvement	Yes/No	21 (87.5)/3 (12.5)
Learn about radiation protection while at the university	Yes/No	17 (70.8)/7 (29.2)
Awareness about non-radiation imaging modalities like MRI or USS	Yes/No	19 (79.2)/5 (20.8)
Necessity for radiation protection inclusion in the curriculum of medical students	Yes/No	19 (79.2%)/5 (20.8%)
Inclusion of radiation protection in CPDs	Yes/No	4 (16.7)/20 (83.3)
Awareness that medical radiation is associated with cancer risks	Yes/No	24 (100)/0 (0)
Attending RP workshops	Yes/No	2 (8.3)/22 (91.7)
Frequency of attending RP workshops	Frequently/Occasionary /once/none	0 (0)/2 (8.3)/0 (0)/22 (91.7)
Information sharing with patients	Never/Sometimes/Always/NA	13 (54.2)/9 (37.5)/2 (8.3)/0 (0)
Patients' involvement in CT request	Never/Sometimes/Always/NA	13 (54.2)/9 (37.5)/2 (8.3)/0 (0)
Application of radiation protection principles like ALARA.	Never/Sometimes/Always/NA	13 (54.2)/6 (25)/3 (12.5)/2 (8.3)
Frequency of use of MRI or USS	Never/Sometimes/Always/NA	1 (4.2)/9 (37.5)/10 (41.6)/4 (16.7)

The collected data was labeled differently depending on the type of variables. For sociodemographic characteristics, for gender, "male" was coded as 0 and "female" was coded as 1. In the same vein, for age group and work experience, "young-aged doctors" was coded as 0, "middle-aged doctors" was coded as 1, "old-aged doctors" was coded as 2, "little experience" was coded as 0, experienced was coded as 1, and "more experienced" was coded as 2, respectively.

On radiation protection characteristics, we developed another binary score for questions 1 to 9 where "yes" was coded as 0 and "no" was coded as 1. Question 10 was about the frequency of attendance at radiation protection workshops, and numbers ranging from 0 to 3 were developed for labelling frequency of attendance, where "never" was labelled as 0, "sometimes" was labelled as 1, "always" was labelled as 2, and "none" was labelled as 3. Questions 11 to 13 were assessing compliance with radiation principles where similar labeling was used and "never" was labeled as 0, "sometimes" was labeled as 1, "always" was labeled as 2, and "not applicable" was labeled as 3 (see Table 1). These scoring systems were used for the purpose of identification only and not superiority of numerical values. The collected data was entered using Microsoft Excel and then transferred into Statistical Packages for Software Sciences (SPSS) version 20.0 for analysis. Descriptive statistics were presented using frequencies and percentages.

https://dx.doi.org/10.4314/mmj.v37i3.1

Results

Demographic characteristics

Out of 24 respondents, 14 (58.3%) were males and 10 (41.7%) were females. In the age group, 21 (87.5%) of the respondents were in the young age group, 1 (4.2%) in the middle age group, and 2 (8.3%) in the old age group. On work experience, 14 (58.3%) had little experience, 3 (12.5%) were experienced, and 7 (29.2%) were more experienced (see Table 2).

Radiation protection characteristics.

Out of 24 medical doctors, 23 (95.8%) were aware of radiation protection, and 21 (87.5%) were involved in CT examination prescription at MCH. However, 13 (54.2%) were not aware that CT scans expose patients to higher radiation. Similarly, 17 (70.8%) of the medical doctors learned about radiation protection while at the university, and 19 (79.2%) were aware of non-radiation imaging modalities like MRI/US. In the same vein, 19 (79.2%) supported the necessity for radiation protection to be included in the curriculum of medical students, and 20 (83.3%) said that radiation protection is not included in continuing professional development (CPD) that are conducted at MCH. On attending radiation protection workshops, 22 (91.7%) had never attended any radiation protection-related workshop, and 2 (8.3%) occasionally attended the workshops.

On awareness that medical radiation is associated with carcinogenic risks, the study found that all 24 (100%) medical doctors were aware. The study found that 13 (54.2%) of medical doctors do not share radiation protection information with patients/guardians or involve them in decision-making during CT examination prescription, 9 (37.5%) sometimes share and involve them, and 2 (8.3%) always share and involve the patients/guardians. On application of radiation protection principles of justification and as low as reasonably achievable (ALARA), 13 (54.2%) did not apply the guidelines. Similarly, 10 (41.6%) of the medical doctors used MRI and USS as alternative modalities where necessary (see Table 3).

Discussion

Ionizing radiation has become increasingly utilized in medical practice. The International Commission on Radiological Protection (IRCP) recommends the application of fundamental principles of justification, optimization of protection, and application of dose limits with regard to medical exposure of patients and guardians[14]. In diagnostic and interventional procedures, justification and management of the patient dose commensurate with the medical task are the appropriate mechanisms to avoid unnecessary exposure[14]. However, most medical practitioners, including medical doctors responsible for requesting CT examinations, are not very knowledgeable about these fundamental principles. This knowledge gap leads to the prescription of unjustified radiological procedures that may result in unnecessary radiation exposure to patients. Therefore, all health workers responsible for radiological examinations should be well versed in and compliant with the fundamental principles of radiation protection1.

This study assessed doctors' level of knowledge on radiation protection when prescribing CT examinations. Our study found that 95.8% of the medical doctors are aware of general medical radiation and 87.5% are involved in CT examination prescription at MCH. However, the study found that 47.8% of medical doctors are not aware that CT scans contribute more medical radiation as compared to other radiation imaging modalities. Our findings are in line with a study conducted in two Nigerian tertiary hospitals that found a low level of knowledge of ionizing radiation from CT scan examinations among requesting physicians[15.] In general, many published studies show that many referring physicians have low knowledge of medical radiation from radiological examinations[1,6,16,17].

Most colleges and universities do not have radiation protection and safety modules in their curriculum for medical doctors. This is evidenced in our study, as 29.2% of medical doctors indicated that they did not learn anything about radiation protection while at the university, and 20.8% are not even aware of alternative non-radiation imaging modalities like MRI and USS. Our findings are in line with a study conducted at Suez Canal University Hospital in Egypt, which revealed that 88.8% of physicians didn't receive any radiation safety training in their career[16]. Our study has also shown that 79.2% of the medical doctors recommend the introduction of radiation protection modules in the curriculum of medical students. Additionally, this study found that radiation protection and safety topics are not discussed during CPD at MCH. This finding also agrees with a study conducted at Suez Canal University Hospital in Egypt, where it is reported that radiation protection is not included in CPD sessions. Similarly, just like our study findings, other studies also show that the majority of the medical doctors do not have the opportunity to attend radiation protection workshops[16].

It is important for radiological examination prescribers to be aware of carcinogenic effects from medical radiation for them to properly justify the requested radiological examination5. According to our study findings, all medical doctors are aware that medical radiation is associated with potential carcinogenic effects like cancers. However, 54.2% of the medical doctors do not apply radiation protection principles or engage patients and guardians in decision-making when prescribing CT examinations, possibly due to little knowledge about the dangers of medical radiation. This defeats ICRP's fundamental principle of justifying medical exposure to patients and guardians. For example, a study conducted in Jordan and the Middle East to evaluate the knowledge of referring physicians on radiation dose and its impact on vulnerable patients found that only 43.7% of the respondents were aware of the acronym "ALARA"10. Another study conducted in Tanzania found that around 70% of physicians reported being unaware of the ALARA principle[6]. This is a worrisome development because radiation protection stems much from optimization of protection, application of dose limits, and justification, and the latter relies on referring physicians. Therefore, the radiation protection module is supposed to be covered at the undergraduate level by medical students.

According to Hussain and friends, reduction in unnecessary CT screening leads to reduction of radiation exposure risks, and they recommend the use of MRI or USS where applicable to minimize this risk[18]. In this aspect, our study found that only 41.6% of medical doctors always use MRI or USS as alternative modalities where necessary. This practice leads to unnecessary radiation exposure to patients undergoing CT examinations and exposes them to high potential carcinogenic risks associated with medical radiation.

https://dx.doi.org/10.4314/mmj.v37i3.1

Conclusion

Much as the majority of medical doctors are aware of radiation protection and involved in requesting CT scan examinations, some of them are not aware that CT scanners emit more medical radiation than general x-ray examinations. Similarly, most doctors who refer patients for CT scans at Mzuzu Central Hospital do not adhere to fundamental principles of radiation protection and are not aware of when to use non-radiation imaging modalities like MRI or USS to substitute radiation-producing modalities. This increases the potential carcinogenic risk to patients getting CT scans.

Limitations

The study was single-centered with a small sample size.

Recommendations

A similar study is required to include a larger sample and more study centers, including medical training institutions.

Acknowledgements

None

References

1. Amaoui B, Safini F, Lahlou L, El Fahssi M, Abbaoui S, Semghouli S. Physicians' knowledge about radiation protection of patients during prescription of CT scan procedures in Morocco. Radiat Med Prot. 2023;4(1). doi:10.1016/j.radmp.2023.02.004

2. Rehani MM, Applegate K, Bodzay T, et al. Accounting for radiation exposure from previous CT exams while deciding on the next exam: What do referring clinicians think? Eur J Radiol. 2022;155. doi:10.1016/j.ejrad.2022.110468

3. Kim YY, Shin HJ, Kim MJ, Lee MJ. Comparison of effective radiation doses from X-ray, CT, and PET/ CT in pediatric patients with neuroblastoma using a dose monitoring program. Diagnostic Interv Radiol. 2016;22(4). doi:10.5152/dir.2015.15221

4. Malone J. Report of a consultation on justification of patient exposures in medical imaging. Radiat Prot Dosimetry. 2009;135(2). doi:10.1093/rpd/ncp107

5. Ma S, Kong B, Liu B, Liu X. Biological effects of low-dose radiation from computed tomography scanning. Int J Radiat Biol. 2013;89(5). doi:10.3109/09553002.2013.756595

6. Najjar RH, Alsulaiman AM, Alraddadi JS, et al. Assessment of Physicians' Knowledge and Awareness About the Hazards of Radiological Examinations on the Health of Their Patients at a Tertiary Care Hospital, Riyadh, Saudi Arabia. Cureus. Published online 2022. doi:10.7759/cureus.27479

7. Bitterman. NFA. Radiation Safety and Protection - StatPearls - NCBI Bookshelf. WIREs Water. 2023;2(1).

8. Malone J, Guleria R, Craven C, et al. Justification of diagnostic medical exposures: Some practical issues. Report of an International Atomic Energy Agency Consultation. Br J Radiol. 2012;85(1013). doi:10.1259/bjr/42893576

9. Hobbs JB, Goldstein N, Lind KE, Elder D, Dodd GD, Borgstede JP. Physician Knowledge of Radiation Exposure and Risk in Medical Imaging. J Am Coll Radiol. 2018;15(1). doi:10.1016/j.jacr.2017.08.034

10. Rawashdeh M, Saade C, Ibnian A, et al. Referral physicians' knowledge of radiation dose: A cross-sectional study. Open Access Maced J Med Sci. 2020;8(E). doi:10.3889/oamjms.2020.4727

11. Moifo B, Tene U, Moulion Tapouh JR, et al. Knowledge on Irradiation, Medical Imaging Prescriptions, and Clinical Imaging Referral Guidelines among Physicians in a Sub-Saharan African Country (Cameroon). Radiol Res Pract. 2017;2017. doi:10.1155/2017/1245236

12. Maharjan S, Parajuli K, Sah S, Poudel U. Knowledge of radiation protection among radiology professionals and students: A medical college-based study. Eur J Radiol Open. 2020;7. doi:10.1016/j.ejro.2020.100287

13. Sakafu L, Kiango V, Khasim Z, et al. Radiation safety in an era of diagnostic radiology growth in Africa: Lessons learned from Tanzania. Clin Imaging. 2023;102. doi:10.1016/j.clinimag.2023.08.006

14.ICRP. Radiological Protection in Medicine. ICRP Publication 105. Ann. ICRP 37 (6). ICRP. Published online 2007.

15. Paulinus SO, Udoh BE, Archibong BE, et al. Requesting physicians' knowledge of X-radiation exposure from computed tomography scan examinations: A case study of two Nigerian tertiary hospitals. Calabar J Heal Sci. 2020;3. doi:10.25259/cjhs_9_2019

16. Abdellah RF, Attia SA, Fouad AM, Abdel-Halim AW. Assessment of Physicians' Knowledge, Attitude and Practices of Radiation Safety at Suez Canal University Hospital, Egypt. Open J Radiol. 2015;05(04). doi:10.4236/ojrad.2015.54034

17. Ekpo EU, Adejoh T, Akwo JD, et al. Diagnostic reference levels for common computed tomography (CT) examinations: Results from the first Nigerian nationwide dose survey. J Radiol Prot. 2018;38(2). doi:10.1088/1361-6498/aaaaf8

18. Hussain S, Mubeen I, Ullah N, et al. Modern Diagnostic Imaging Technique Applications and Risk Factors in the Medical Field: A Review. Biomed Res Int. 2022;2022. doi:10.1155/2022/5164970