Original Article

Medical students' knowledge on the use of ionising radiation during medical imaging procedures in Zambia

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ABSTRACT

Purpose: This study aimed to explore and describe the medical students' knowledge on the use of ionising radiation and its harmful effects during diagnostic imaging procedures in Zambia.

Methods: A quantitative cross-sectional design was employed. A census survey of all final year medical students from the University of Zambia (UNZA) was conducted. Data was collected using a structured questionnaire and analysed using STATA version 13 and Graph Pad Prism 5.

Result: The overall results revealed that medical students had inadequate knowledge of the use of ionising radiation. Furthermore, most of the students revealed that the medical school curriculum was inadequate in equipping them with the necessary knowledge required for them to request diagnostic medical imaging procedures utilizing ionizing radiation.

Discussion: The results implied that the knowledge levels of the medical students were insufficient in the use and prescription of imaging procedures. It is suggested that the UNZA medical school curriculum is critically scrutinized and a radiation protection course is included. The inclusion would provide the medical students with the necessary knowledge about ionising radiation in order to prevent unnecessary referrals for diagnostic medical imaging procedures.

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INTRODUCTION

The use of ionising radiation in diagnostic medical imaging procedures has been found to aid in the diagnosis of medical conditions and is an essential component of the patient management process.[1] While its use in diagnostic radiology brings benefits to the patients, the associated risks due to stochastic and deterministic effects make it necessary to protect patients from any potential harm.[1] The potential harm may include effects such as carcinogenesis.[2] Although the potential benefits of using ionising radiation are huge, the risks associated with its use limit its application.[2]

The International Commission on Radiological Protection (ICRP) recommends that no exposure to medical radiation should be allowed unless it is justified and its benefit outweighs the associated radiation risks. [5] This recommendation also applies to Zambia where all medical and dental practitioners must justify the use of ionising radiation on patients based on Zambia Ionising Radiation Protection Regulations (ZIRPR).[6] However, the ZIRPR, do not stipulate the importance of doctors, who refer patients for radiological examinations involving the

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use of ionising radiation, to possess the necessary knowledge in ionising radiation and its associated risks. Possessing such knowledge is essential in the justification for the request of such examinations. Furthermore, Yucel, *et al* [7] *have established* that referring doctors often underestimate the risks associated with ionizing radiation when requesting radiological examinations.

In the Zambian context, during the sixth year of study, University of Zambia (UNZA) medical students undergo a week of clinical attachment in the diagnostic radiology at the University Teaching Hospital (UTH) in Lusaka. During this time, they are trained on image interpretation and provided with an overview of the risks of ionising radiation and malpractices involving radiological requests.

A study by Hagi and Khafaji [5] on Medical students' knowledge of ionizing radiation and radiation protection highlighted that undergraduate medical students are exposed to a 30-hour medical imaging module during their fourth year of study which is also their first year of clinical teaching, and part of this module is dedicated to training the medical students in principles of ionizing radiation, and radiation protection. Hagi and Khafaji [5]further mentioned that a 3-hour lecture covering materials on diagnostic procedures that use ionizing and non-ionizing radiation, as well as radiation protection principles are covered. Contrary to this, in Zambia students who reach their final year of study, are allowed to request radiological examinations under supervision and when they complete their studies they can make radiological requests independently as provided for in the Zambian law. [6] However, no study has been done in Zambia to evaluate whether or not the knowledge on ionising radiation acquired by students after their clinical attachment in the radiology department is sufficient for future practice and safe referrals of patients for radiological examinations. Therefore, this study sought to investigate the final year Zambian medical students' knowledge on the use of ionising radiation and its associated risks.

METHODS

A cross-sectional survey study design was used for this research study. The study was conducted at the School of Medicine, UNZA, Lusaka. The target population was seventh-year (final year) medical students at UNZA. A census approach was taken because of the relatively small number (N=60) of students. The inclusion was restricted to all students who had completed the radiology clinical attachment during their sixth year of study. A pilot study was first undertaken in which five 6th year medical students from the same medical school participated. This was done to ensure the validity, reliability of the questionnaire as a data collection instrument before embarking on the main study.

Data was collected using a self-administered structured questionnaire which was formulated by the researchers based on the literature reviewed. The thematic areas of the questionnaire included demographic data and questions on knowledge, justification, risks and understanding of the use of ionising radiation in diagnostic radiology. The questionnaire was distributed to the final year students during their clinical attachments in the different departments at UTH. The aim and objectives of the research study were explained in detail to the participants. Filling in of questionnaires by participants was done during break time so as not to disrupt normal working hours in departments. The researcher collected the questionnaires immediately after completion.

Generally, data were tested for normality using this Shapiro-Wilk test with significance set at 0.05. For descriptive purposes data that was not normally distributed was described using median with associated interquartile range (IQR) and proportions. Comparisons amongst groups of data were done using Kruskal-Wallis test and a post hoc test done using Dunn's Multiple Comparison Test. To test for association, Fisher's exact test was done. All the analysis and graphical illustration were computed using Stata version 13 (STATA Corp., College Station, TX, USA) and Graph Pad Prism 5

(Graph Pad Software Inc., La Jolla, California, USA).

Ethical clearance was granted by the Faculty Health Sciences, Research Ethics Committee of the University of Johannesburg in South Africa. Further ethical clearance was also granted by the UNZA Research and Ethics Committee to conduct this study in Zambia. Participant consent was obtained by implication by the voluntary completion of the questionnaire. The participants were guaranteed anonymity and did not disclose their identities in the questionnaires. Numbers were allocated to each participant for statistical purposes

RESULTS

Demographics

A total of 58 responses were obtained from the 60 distributed (97% response rate). As shown in Table 1, there were more males [N=48(82.8%)] than females. The majority were in the age category of 25-29 years. Only 6 (10.3 %) had prior qualifications [three (5.2%) were clinical officers, one (1.7%) was a biomedical scientist, one (1.7%) was a dental technician and one (1.7%) was a molecular biologist]. Even if these qualifications were related to human biology, none were in a radiology related field.

Table 1: Participants Demographics

Characteristic	Category	Proportion	Percentage (%)
Gender	Male	48	82.8
	Female	10	17.2
Age	20-24	5	8.6
	25-29	47	81
	30-34	4	6.8
	Above 35	2	3.4
Prior Qualifications	With	6	10.3
	Without	52	89.7

Training factors

To understand the context of the training participants were required to provide an option on factors related to their training. This included evaluating the sufficiency of the time spent on clinical training in radiology and the adequacy of the curriculum. Table 2 shows that the majority felt that neither the time spent in radiology nor the curriculum [N=45(78%) and N=44(75.9) respectively] was adequate.

Table 2: Perspectives of medical students on radiology training

Training factors	Responses	Proportion	Percentage (%)
Sufficiency of time	Yes	13	22
	No	45	78
Adequacy of curriculum	Highly adequate	1	1.7
	Adequate	5	8.6
	Somewhat adequate	7	12.1
	Not adequate	44	75.9
	Not sure	1	1.7

Knowledge of radiation protection

Knowledge on radiation protection was measured using four categories these being; Electromagnetic spectrum, Radiology equipment, Malpractice and Radiation emission from different equipment. In each category, questions were posed and a correct response was allotted a mark. The aggregate mark for each participant in each category was converted to a percentage. Figure 1 shows a Box and Whisker plot for each category. The median scores and associated interquartile ranges for the categories were; 75% (50-100) (Electromagnetic spectrum); 69% (38-85) (Radiology equipment); and 60% (40-80) (Radiation emission). The lowest category was the knowledge level on issues related to malpractice. The general trend for the scenarios given was that the participants felt that none of the scenarios were malpractice when in effect they were.

Using the Kruskal-Wallis test, on the whole, there was a significant difference in performance across the four categories (p<0.001). A post hoc test using Dunn's Multiple Comparison Test, the difference was attributed mostly to the performance in the malpractice category (p<0.001). The difference in the other categories was not significant as shown by the p>0.05.

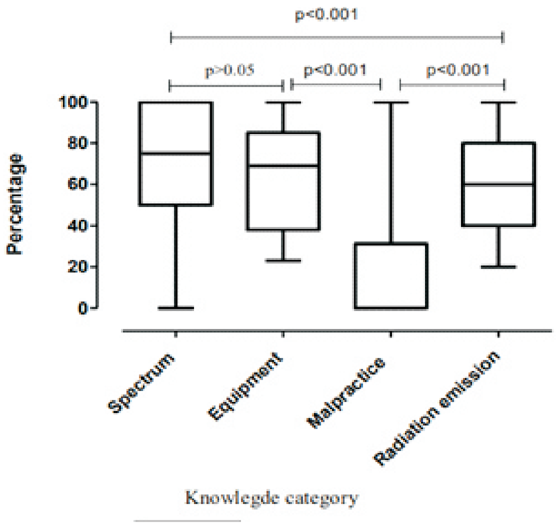

Figure 1: Measured knowledge in radiation protection

The performance of the medical students in the four categories was aggregated to provide a composite score. Figure 2 shows the aggregate score. The median score was 53% (IQR 48.5-66).

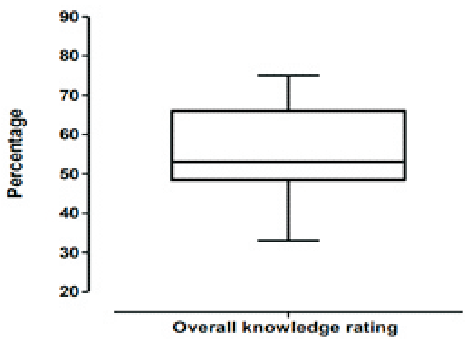

Figure 2: Overall performance

As a way of evaluating their capacity to make informed decisions regarding the justification for requesting radiological examinations, participants were requested firstly if they knew the difference between stochastic and none stochastic effects of radiation, and then to categorise the importance of five factors (radiation dose, impact on diagnosis, impact on treatment, the future health of patients and patient preference) related to justification.

With regard to knowledge on stochastic and non-stochastic effects, a higher number of participants 51 (87.9%) responded that they did not understand the meaning of stochastic and non-stochastic effects. There were only five (8.6%) participants who responded that they knew the meaning of stochastic and non-stochastic effects. When requested to categorise these effects, only one out of the five was able to associate Leukaemia and infertility with stochastic effects respectively.

When the results for categorisation of factors (radiation dose, impact on diagnosis, impact on treatment, the future health of patients) to consider when requesting a radiological investigation, the majority indicated that this was important (With post hoc test showing no statistical difference p>0.05). This was assessed using a Likert scale in which one (1) not important and five (5) very important. The median rating for the first three was 4 (IQR4-5). Generally, there was a statistical difference across all the categories (p<0.001). However, this difference was most pronounced because of the rating for the importance of patient preference as an important factor as illustrated in Figure 3.

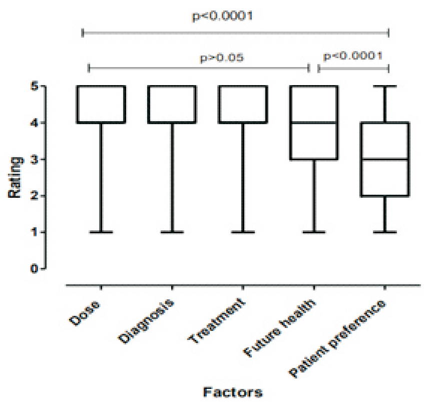

Figure 3: Rating of factors required for informing radiological requests

Association between prior qualification and responses

A Fisher's exact test was done to ascertain the association of prior qualification with responses from the participants. None of the above statements showed a p-value < 0.05 and it was therefore concluded that prior qualifications did not have any influence on knowledge on the use of ionising radiation and its harmful effects.

Factors	**Prior qualification**		
	Yes (n=6)	No (n=52)	P-value*
Factor to consider when referring patients			
Importance of radiation doses	6 (100 %)	41 (78.8 %)	0.583
Impact on the diagnosis	5 (83%)	42 (80.8%)	1.000
Impact on treatment	5 (83%)	42 (80.8%)	1.000
Impact on the future health	6 (100%)	36 (69.2%)	0.173
Patient's preference	3 (50%)	23 (44.2%)	1.000
Meaning of stochastic and non-stochastic	1 (16.7%)	4 (7.7%)	0.433
Appropriate description of examination site	2 (33.4%)	11 *21.2%)	0.608
Use of appropriate diagnostic equipment	1 (16.7%)	19 (36.5%)	0.653
*Fisher's exact test			

DISCUSSION

The increasing use of medical imaging procedures, especially when considering the recent developments in technology, has turned radiation protection into one of the main concerns of the radiological community and patients [1]. Medical doctors are central to the discussion of reducing patient exposure by requesting the appropriate investigation and being able to perform a cost-benefit analysis. [8] This study sought out to measure the knowledge levels of medical students concerning the requirements for radiation protection. In addition, factors associated with the training and knowledge levels like duration of training and adequacy of the curriculum were also explored.

Ricketts *et al.,*[9]states that the medical school curriculum is a major source of radiation risk education for medical students and therefore, there is a need for incorporating more radiation risk and protection education into the medical curriculum. It was interesting to note that the majority of the participants indicated that the duration of their rotation in radiology and the curriculum dedicated to radiology training was inadequate. The study done by Koontz & Gunderman [10] matches the findings of the current study because the Indiana School of Medicine did not address education on ionizing radiation and its associated legislation in the medical school curriculum. In addition, Koontz & Gunderman [10] recommended that incorporating radiation protection into the medical school curriculum could make a significant difference in students' understanding of the content and students expected that such understanding would result in positive practical consequences in terms of patient safety. A study done in British Columbia by **Lee *et al.*** [11] on the implementation of a new undergraduate radiology curriculum, revealed that most medical schools in Canada do not have a formal radiology curriculum for medical students. Lee et *al.,*[11] assert that a structured radiology curriculum is required to improve the quality of radiology teaching for medical students.

A link can be made between the measured knowledge levels on radiation protection and the structure of the training programme in the current study. Furthermore, the inadequacies in terms of time and content dedicated to radiation protection aspects could account for the level of knowledge demonstrated by the participants in this study. Similar findings have been reported in numerous studies which documented that the levels of knowledge among medical students in ionising radiation used in the diagnostic procedure was inadequate [9,11].

According to the study done by Dhai *et al* [12], age and academic qualifications prior to medical school had no measurable effects on knowledge and attitudes and that knowledge is acquired through training and learning in a specific / actual field that one is engaged in. The findings by Dhai *et al* [12] concurs with the findings in the current study because prior qualification/s and age did not have any correlation with the knowledge of the participants.

In terms of specific knowledge areas, correct categorisation of radiation effects by most participants was done inappropriately. Most students did not understand the meaning of stochastic and non-stochastic effects. Students needed to understand the levels of radiation doses and exposure which could cause either stochastic or non-stochastic effects as this would aid the balance between the benefit and risks of referring patients for diagnostic imaging procedures. According to Steiner [13], medical students should be knowledgeable on stochastic and non-stochastic effects because they will have to refer patients for examinations that can potentially expose them to such effects.

CONCLUSION

The study revealed a relatively low level of knowledge concerning radiation protection among final year medical students. Furthermore, most of the participants felt that neither the time nor the curriculum content dedicated to radiation protection was sufficient to equip them for future practice. It is recommended that radiation protection education be mandatory in the medical school and that it should be incorporated in the medical school curriculum.

STUDY LIMITATIONS

The research had the following study limitation:

a) The sample size was restricted to 60 because that was the total number of medical students in the class
b) No similar Research study was done in Zambia, hence referencing was restricted to international authors.
c) Data could not be collected at the same time due to some student's absence from class at the time of Data collection

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