Survey to assess the knowledge of nurses on basic radiation protection at the University Teaching Hospital in Zambia

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Background: Nurses provide care to patients undergoing radiological examinations. In this context, nurses can be exposed to ionising radiation which has biological effects on the human tissue. This necessitates the requirement that nurses have knowledge of basic radiation protection.

Aim: This study aimed to assess the knowledge of nurses about basic radiation protection at the University Teaching Hospital (UTH) of Zambia.

Methods: A total of 72 nurses working at UTH completed the online survey on basic radiation protection in March 2022. The survey questionnaire was divided into four domains: regulation and sources of radiation, the biological effect of radiation, the justification principle, and control of external radiation. Data were analysed using descriptive and inference statistics.

Results: The overall performance of nurses on basic radiation protection was below average, with a median score of 40% (IQR 20–60%). The Kruskal–Wallis and Dunn's multiple comparisons statistical tests were performed and found no significant difference in performance across the four domains of basic radiation protection ($p = 0.1969$) contained in the survey questionnaire. Statistical results were considered significant at $p < 0.05$.

Conclusion: Nurses' overall knowledge of basic radiation protection was below average. There is a need to review the nursing curriculum to incorporate basic radiation protection and attach nursing students to radiology departments during their clinical practice.

Keywords: assessment, knowledge, nurses, radiation, radiation protection, Zambia

Prof Nurs Today 2023;27(1):24-29

Introduction

Nurses are part of the healthcare professionals who assist in providing medical imaging services. In the radiology department, nurses work with radiographers and radiologists to book and provide nursing care to patients. In Zambia, nurses also perform intravenous (IV) cannulation and administration of contrast media to patients in medical facilities without a radiologist. Outside the radiology department, nurses assist radiographers in performing mobile radiography in clinical settings such as the intensive care unit (ICU), special care baby units (SCBU), accident and emergency departments, and operating theatres. In all these clinical settings, nurses are exposed to ionising radiation which has biological effects on human tissue. For this reason, the International Commission on Radiation Protection (ICRP)[1] recommends that all healthcare professionals, such as nurses involved in medical imaging examinations using ionising radiation, should undertake basic radiation protection training. Sherer and colleagues[2] define radiation protection as the effective measures employed by healthcare professionals to safeguard patients, personnel, and members of the public from unnecessary exposure to ionising radiation.

In Zambia, the Professional Code of Conduct for Nurses and Midwives requires nurses to be knowledgeable and competent in their area of practice and protect the safety of patients.[3] In the context of this study, this means understanding radiation protection measures used in medical imaging to effectively protect themselves, their patients, and members of the public. In addition, nurses who provide support for diagnostic and interventional procedures using ionising radiation must adhere to the Ionising Radiation Protection Act of 2011 of Zambia.[4] Nurses undertake this role by adhering to established radiation protection control measures during their work: time, distance, and shielding.[5,6] Occupational radiation exposures can be minimised by shortening the length of time in a room where X-radiation is being produced, standing at the greatest distance possible from the X-ray tube, and shielding during X-ray exposure.[5,6]

Globally, several studies have been conducted on the knowledge of nurses regarding radiation protection. These studies have revealed that most nurses have inadequate knowledge about the sources of radiation, types of radiation, biological effects of radiation, control methods for external radiation, and justification principle of radiation protection.[7-10] In the Zambian context, radiation protection knowledge levels are relatively low, as was found in a study of final-year medical students.[11] This was further highlighted in a study by Sichone et al.,[12] in which radiation protection knowledge and skills were evaluated for radiographers; they reported that self-evaluation of radiographers' ability to assess radiation protection was lower than the measured ability. One major factor that negatively affects the knowledge of nurses and other non-radiology personnel regarding radiation protection is a lack of education on this subject. For example, the review of undergraduate diploma and degree nursing curricula in Zambia found no radiation protection component. There was also no evidence of attachment of nursing students to radiology departments during their clinical practice. This can have a negative impact on the knowledge of nurses on this subject. Therefore, this study aimed to assess the knowledge of nurses on basic radiation protection at the University Teaching Hospital (UTH) of Zambia.

Methodology

Study design and setting

This cross-sectional study was conducted on a convenient sample of 212 nurses working at the UTH of Zambia. With 1 655 beds and 250 baby cots, UTH is Zambia's largest public hospital, located in the city of Lusaka. It provides a full spectrum of primary, secondary, and tertiary health and medical services. UTH is the primary clinical training facility for nursing students and other healthcare professionals. It is home to the University of Zambia (UNZA) School of Nursing and Medicine and the Lusaka College of Nursing and Midwifery.

Data collection tool and procedures

Data was collected using an online questionnaire in March 2022. The survey questionnaire was created using Google Forms and developed based on similar previous studies.[7-10] It contained two sections: demographic data (n = 5) and multiple-choice questions on basic radiation protection (n = 10). The areas covered were sources of radiation and regulations, biological effects of ionising radiation, the justification principle, and control measures of external radiation. The drafted questionnaire was piloted on 23 nurses working at UTH.[13,14] There were no major amendments.

With the help of the nursing administrator, a survey link was posted on a WhatsApp group for nurses working at the UTH, which contained 235 members at the time of the study. Pilot participants (n = 23) were excluded by requesting them not to complete the main survey. The link also contained a participant information sheet and electronic consent form. The online administration of the questionnaire offered low cost and provided faster responses. It also minimised contact with participants at the time of the COVID-19 pandemic. The survey link was left open for a month before it was closed for data analysis. A reminder was sent two weeks after the administration of the survey questionnaire to improve the response rate.

Data management and analysis

The data was downloaded from Google Forms to Excel format and exported to STATA statistical software. The standard scoring system was used for multiple-choice knowledge questions: the correct answer was scored 1 point, and the incorrect answer or not sure was scored 0 points. Descriptive statistics were used to present the data with appropriate tables and graphs. To determine the overall percentage performance, a median score was calculated. To determine whether there was any significant difference in performance across the four domains (sources and regulations of radiation, biological effects, justification principle, and control of external radiation), Kruskal–Wallis and Dunn's multiple comparisons statistical tests were performed. Statistical results were considered significant at $p < 0.05$.

Ethical considerations

The researchers adhered to the four ethical principles: autonomy, beneficence, non-maleficence, and justice. To ensure autonomy, full disclosure about the outline of the study was made, and respondents were informed of their right to withdraw at any time with no consequences.[13,14] Respondents also consented through the completion of the online consent supplied with the survey questionnaire. Further, confidentiality and anonymity were maintained. To adhere to beneficence and non-maleficence, the study had no risks associated with the questions contained in the questionnaire. To observe the principle of justice, respondents were treated fairly and equally throughout the research process.

Results

Demographics of the respondents

This survey generated a total of 72 responses. Thirty-seven (51%) of the 72 respondents were female, whereas (35, 49%) were male. The most common age group was individuals under the age of 25 (33, 46%). Regarding the highest educational qualification, the majority of respondents (35, 49%) possessed a diploma. Most respondents (55, 76%) had less than five years of job experience. The demographics sub-analysis is depicted in Table I, which shows the totals in the female and male categories.

Table I: Demographics of the respondents

Variable	Female (*n* = 37)		Male (*n* = 35)	
	n	%	*n*	%
Age (years)				
< 25	18	49	15	43
26–30	10	27	14	40
31–35	6	16	5	14
36–40	1	3	1	3
> 41	2	5	0	0
Highest educational qualification				
Certificate	7	16	3	9
Diploma	16	43	19	54
Bachelors	13	35	11	31
Masters	1	3	1	3
Doctorate	1	3	1	3
Experience (years)				
0–5	26	70	29	83
6–10	8	22	5	14
11–15	2	5	0	0
> 16	1	3	1	3

Respondents' knowledge of basic radiation protection

The questionnaire included ten questions designed to assess nurses' basic radiation protection knowledge. Figure 1 depicts the overall performance of respondents for each question.

The questions were grouped into four domains: sources and regulations of radiation, the biological effect of radiation, justification principle of radiation protection, and control of external radiation.

Sources and regulation of radiation

The survey questionnaire included three questions on radiation sources and regulation in the first domain. Respondents were asked to choose a form of imaging that utilises ionising radiation from a list of three options: ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI). Less than half of the respondents (30, 42%) correctly identified the correct response as CT. Respondents were then asked to mark "Yes," "No," or "Not sure" to a statement on whether objects in the imaging room emit ionising radiation following an X-ray exposure, with a quarter (18, 25%) indicating "No" as the appropriate answer. A question about the organisation responsible for enforcing radiation safety standards in Zambia was asked to assess respondents' awareness of ionising radiation laws and regulations. The majority of respondents (44, 61%) correctly identified the Radiation Protection Authority (RPA).

Biological effect of radiation

The second domain was on the biological effects of radiation on human tissue, which also had three questions. From a choice of four possibilities (bone, gonads, liver, and kidney), respondents were asked to choose the body organ most vulnerable to ionising radiation. Almost half of the respondents (35, 49%) correctly answered the gonads. Respondents were also asked to choose a true statement about the 10-day guideline for women of childbearing age. Only a few respondents (22, 31%) correctly identified "Only in the first 10 days after the beginning of the monthly menstrual period should a radiological examination be allowed" as the true statement. The last question in this section was on the age group most sensitive to ionising radiation from the list of elderly, adolescents, infants, and foetuses. A quarter (26, 36%) of respondents correctly answered the foetus as a correct answer.

Justification principle of radiation protection

The third domain of questions was related to the justification principle of radiation protection. Respondents were asked to indicate the meaning of the justification of the radiological examination. Only a few (27, 38%) respondents selected the correct answer, "Medical exposure should do more good than harm". Respondents were also asked to identify the contents

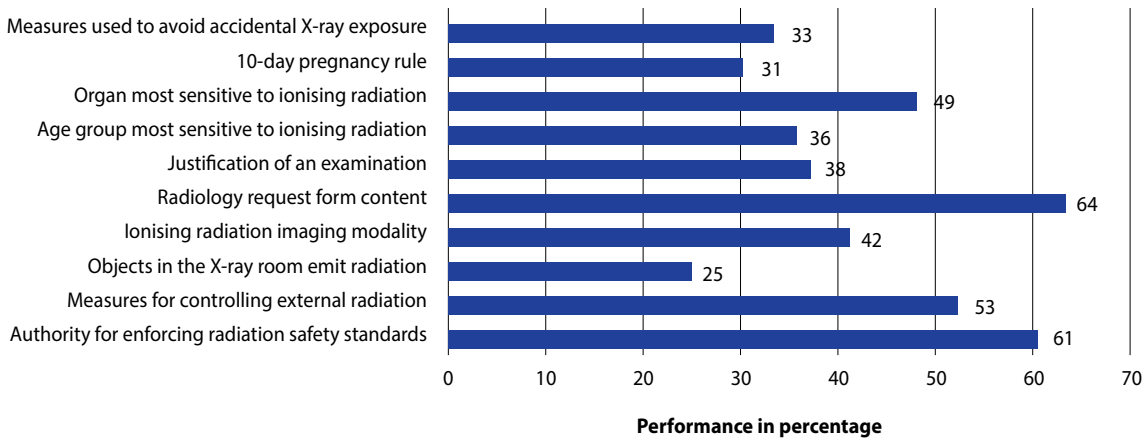

Figure 1: Knowledge of basic radiation protection

of the radiology request form (RRF). The majority (46, 64%) of respondents correctly identified patient information, clinical indication, and examination, as well as referring clinician details (indicated as "all the above" in the survey questionnaire) as information that should be supplied on RRF to justify the medical exposure.

Control of external radiation

The last domain had two questions on the control of external radiation. Respondents were asked to identify the measures that are not used to circumvent accidental X-ray exposure in the radiology department among the three options: interlock doors, X-ray warning signs at the door entrance, and use of radiation monitoring badges. Only a few (24, 33%) of the respondents correctly answered radiation monitoring badges as a measure not used to avoid accidental X-ray exposures to staff and members of the public. Lastly, respondents were asked to identify the measures they utilised to control external radiation in clinical settings. Thirty-eight (53%) correctly identified the right answers as time, distance, and shielding.

Overall performance of respondents in basic radiation protection

The overall percentage performance of survey respondents was not normally distributed when tested using the Shapiro–Wilk test (p = 0.0096). The median score was 40% (IQR 20–60%). The distribution of the overall performance is illustrated in Figure 2.

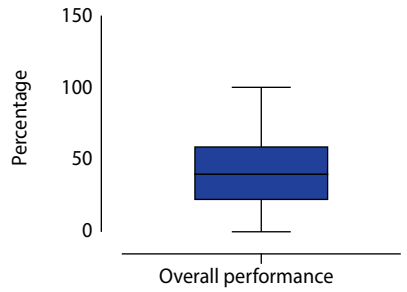

Figure 2: Overall performance in basic radiation protection

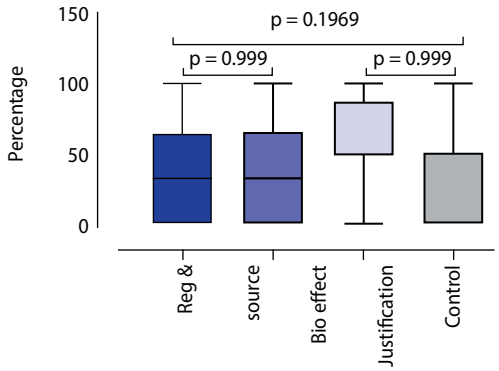

Figure 3: Knowledge in specific domains of radiation protection

Generally, there was no significant difference in performance across the four domains (p = 0.1969) when a Kruskal–Wallis test was used. A posthoc test using Dunn's multiple comparisons test also concluded the same, as seen in Figure 3, where the comparison between justification and control was not significant (p = 0.9999) and regulations and biological effect of radiation (p = 0.9999).

Discussion

The International Commission on Radiological Protection (ICRP) is responsible for making recommendations on the legislation and regulations related to radiation protection. The ICRPs recommendations are used to develop national legislation, such as Zambia's Ionising Radiation Protection Act of 2011.[4] Each country has a statutory body responsible for enforcing radiation protection safety standards. In Zambia, this function is undertaken by the RPA. In our survey, most (44, 61%) of the nurses answered this question correctly. Nurses working in Zambia should know about RPA for reporting incidents of radiation and making consultations.

The medical use of ionising radiation contributes to about 90% of the total exposure of the world population from man-made sources.[15] In our survey, nurses were asked to identify an imaging modality that uses ionising radiation from a list of three modalities: US, CT, and MRI. Less than half (30, 42%) answered CT as the correct answer. US and MRI are non-ionising radiation that uses sound waves and magnetic fields, respectively.[2,15] On whether objects in the imaging room emit X- radiation after exposure, only a few (18, 25%) nurses correctly answered this question. This is a similar score to the study conducted by Anim-Sampong et al.[8] in Ghana, where 25.6% of nurses answered this question correctly. X-radiation is emitted when the radiographer places the button for a short period of exposure. Nurses must be aware of radiation sources to protect themselves and give patients and the general public correct information.

The results of this survey revealed that most nurses' knowledge regarding the biological effects of ionising radiation was below average. In this survey, about (35, 49%) of the nurses did not know that gonads are the most radiosensitive organ in the body. In a South African study by Thambura et al.,[10] more than half (54%) of the nurses also answered this question wrongly. In our survey, most (50, 69%) and (46, 64%) nurses did not know the 10-day rule for females of childbearing age (12–55 years) and the foetus as the age group most sensitive to ionising radiation respectively. The 10-day rule states that whenever possible, one should confine the radiological examination of the lower abdomen and pelvis to the 10-day interval following the onset of menstruation.[16] This is because the foetus is more vulnerable to ionising radiation's biological effects, such as developmental abnormalities.[17] Knowledge of nurses about radiosensitivity is important in protecting patients and foetuses as well as providing correct information to their patients.

To alert individuals to the presence of ionising radiation, a radiology department must have radiation sign(s) posted at the entrance to the imaging room.[18] To prevent persons from entering the imaging room during the X-ray exposure, the imaging room door must additionally feature an interlock device. These measures prevent accidental X-ray exposure to staff and the public. However, radiation monitoring badges worn by radiation workers such as radiographers are for personal monitoring purposes.[15] In our survey, most (48, 67%) of the nurses thought that personnel monitoring badges are used to prevent accidental exposure. This is consistent with a study done in Kuwait by Alotaibi and Saeed, where most (30, 86%) nurses also thought the monitoring badges were the most effective measure of protecting healthcare professionals from external radiation.[7] However, the most effective methods of controlling external radiation are time, distance, and shielding.[2,5,6] In our survey, half (38, 53%) of the nurses knew about these three cardinal radiation protection measures.

Clinicians use the RRF to refer patients for radiological examinations. Clinicians should state the clinical indication and complete all necessary information on the RRF to justify the medical exposure.[18-21] However, (27, 28%) and (46, 68%) of the nurses, respectively, knew about this practice. In Zambia, nurses assist medical doctors, medical licentiate practitioners (MLP), and clinical officers in completing RRFs. Although this role is not within the scope of practice of nurses in Zambia, nurses sometimes refer patients for imaging examinations, especially in rural areas where there is a shortage of medical doctors. Thus, it is vital that nurses know about the justification of radiological examinations. In radiation protection, justification of a radiological examination (also known as medical exposure) means that the benefits of exposing a patient to radiation should outweigh the associated risks and hazards.[2,18,19] This involves clinical assessment of the patient and considering other alternative imaging examination which does not use ionising radiation, such as US and MRI.

This research study found no significant difference in the performance of nurses across the four domains of basic radiation protection: sources of radiation and regulations, the biological effect of ionising radiation on the body, the justification principle of medical exposures, and control of external radiation. Because nurses in this study lacked expertise in all areas, the relevance of this finding is that all four domains should be included when designing any nursing curriculum to incorporate fundamental radiation protection.

Conclusion

The overall degree of awareness of nurses concerning basic radiation protection was below average. Based on the survey findings, it is suggested that basic radiation protection be included in the undergraduate nursing curriculum in Zambia. This includes assigning nursing students to radiology departments for clinical practice. The Radiological Society of Zambia (RSZ) and Radiation Protection Officers (RPO) in each medical facility should hold frequent lectures on this subject to nurses and other non-radiology employees to teach knowledge about fundamental radiation protection applicable to medicine. This will provide them with basic knowledge of the subject, allowing them to safeguard themselves, their patients, staff, and members of the public from unnecessary radiation exposure.

Acknowledgements

The researchers acknowledge the Lusaka Apex Medical University Bio-Medical Research Ethics Committee (LAMUBREC) and UTH Senior Medical Superintendent for granting permission to conduct this survey. The authors also thank the nursing administrator (matron) and all nurses working at UTH who participated in this survey.

Conflict of interest

The authors declare no conflict of interest.

Funding source

None

Ethical approval

The Bio-Medical Research Ethics Committee at the Lusaka Apex Medical University approved this study (Ref. 00004-22). Permission to conduct the research was also sought and obtained from the UTH Senior Medical Superintendent.

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