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KNOWLEDGE ON IONIZING RADIATION AMONG NON-RADIOLOGIST CLINICIANS AT KENYATTA NATIONAL HOSPITAL – KENYA
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ABSTRACT

Background: **Low dose ionizing radiation used in diagnostic imaging has the potential to cause detrimental health effects. Knowledge of the requesting clinician on ionizing radiation will deter inappropriate and unjustifiable imaging requests.**
Objective: **To document the knowledge of ionizing radiation (IR) among the teaching hospital non-radiologist clinicians.**
Design: **Cross-sectional survey.**
Setting: **Kenyatta National Hospital (KNH), the largest teaching and referral hospital in Nairobi, Kenya.**
Subjects: **A total of 170 non-radiology hospital clinicians were recruited into the study after ethical approval and informed consent using simple random sampling method over a six-week period in August -October 2013.**
Results: **Health workers with ionizing radiation (IR) training were more likely to correctly identify all the imaging modalities that use IR compared to those without IR training (50.9% versus 27.5%; OR = 2.83, 95% CI 1.35-5.91). There was significant heterogeneity in knowledge across the cadres ($p < 0.0001$). Those with formal IR training were able to identify that an abdominal CT has the highest radiation dose compared to those with no formal training (69.8% vs 37.1% p= < 0.001). Length of professional experience, field of clinical training, and formal training in IR of the clinicians had no influence on their knowledge of IR doses. With respect to organ sensitivity only 42% of participants correctly rated bone marrow as a very sensitive organ.**
Conclusions: **The results from this study show that health workers lack the basic knowledge on ionizing radiation doses and its harmful effects. This is likely to impact negatively on their attitude and practice. The implications here are serious for the patient as they are possibly being exposed to unnecessary radiation and its attendant risks which include carcinogenesis.**
Recommendations: **To bridge this knowledge gap, there is need to increase awareness about ionizing radiation through continuous medical education,**

development of imaging referral guidelines and incorporating modules on medical radiation and its risks during the clinicians' training programs.

INTRODUCTION

The World Health Organization (WHO) launched the Global initiative on Radiation Safety in the Health Care Setting in December 2008 with the aim of mobilizing the health sector on the safe use of medical imaging (1). The report from this initiative published in March 2010 clearly stated that the low dose ionizing radiation (IR) used in diagnostic imaging had the potential to cause detrimental health effects (2). The different biological effects of IR are classified as deterministic versus stochastic, acute versus delayed, high dose versus low dose and somatic versus hereditary and/or in-utero effects (3). By the year 2012, five billion medical imaging examinations had been performed worldwide, of which 50% involved the use of ionizing radiation (IR) (4).

Hendee et al (5) from their study gave five reasons for excessive usage of medical imaging. These included availability of medical insurance and lack of appropriateness criteria and referral guidelines. Where referral guidelines were available, these authors noted that the clinicians did not know about them or ignored them altogether. The study unveiled a scenario where duplication of imaging studies was done because physicians disregarded or mistrusted previous patient images. They cited self-referral seen in patients who came for annual body CT scans just to check that they had no tumors. The authors finally concluded that defensive medicine, where diagnostic or therapeutic measures were applied principally to safeguard against possible litigation, led to many non-beneficial tests to patients.

The Kenyatta National Hospital is the oldest and largest teaching and referral hospital at the apex of Kenya's public healthcare system. Its bed capacity is 1800 with an over 200% bed-occupancy at any given time. Data from the Hospital medical records of 2011/2012 showed that 80% of the imaging studies performed utilized ionizing radiation (IR) (6). This study was carried out to determine the knowledge of the non-radiology clinicians on IR as this would directly impact on their attitude and practice. To our knowledge there has been no study done locally to evaluate non-radiology clinician's knowledge on IR.

It is against this background that we set out to determine the level of knowledge on IR among the teaching hospital non-radiologist clinicians in terms of the imaging modalities that use IR, relative radiation dose to the patient depending on the study requested and the health risks associated with IR. We also determined the effect of age, gender, years of experience and category of clinician on knowledge in IR. This paper is part of a study on knowledge, attitude and practice of IR among non-radiology clinicians.

MATERIALS AND METHODS

A cross-sectional survey of clinicians' knowledge on ionizing radiation at Kenyatta National Hospital (KNH) was carried out over a six-week period from August – September 2013. KNH is one of the tertiary referral hospitals in Kenya that functions as the teaching hospital of the University of Nairobi (UoN) medical school. Ethical approval was granted by KNH-UoN Ethics and Research Committee. The clinicians were selected using simple random sampling and consisted of consultants, medical officers, postgraduate residents and clinical officers deployed in the wards and outpatient clinics. Consultant radiologists,

radiology residents, radiographers and sonographers were excluded from the study.

The sample size was calculated to be 170 clinicians using Fisher et al method (9). The survey questionnaire covered the following thematic areas; clinician's demographics, level of education and competencies, knowledge on IR doses used in commonly requested for examinations, cancer risk from IR and radiosensitivity of different organs and subtypes of people. The questions were closed to allow for quantitative analysis. The participants were asked to consider the IR dose from a chest radiograph as a unit which could be used to roughly estimate the doses from other imaging studies that use IR, such as CT abdomen. This method has been popularized by Picano and The Royal College of Radiologists as it simplifies the whole concept of radiation doses to the patient to the non-radiologist physician (7,8). The radiation doses for the different radiological examinations were based on the latest National Radiation and Protection Board data (10,11). The participants were further requested to indicate whether they had received any training on radiation protection during their formal training in the various medical institutions.

To determine the validity of the questionnaire, a pilot study was administered to first-year residents of the Radiology Department, University of Nairobi to ascertain the proper interpretation of the questions, assess for comprehension difficulties, and identify the reactions of the respondents, potential problem questions and to assess if the length of time taken to administer the questionnaire was reasonable. Alterations were made to the questionnaire based on the pre-test outcome. The Questionnaire was then administered to the study participants in the presence of the investigators to avoid referring to a text, another doctor or Internet. Prior to answering the questions, informed consent was taken. All the collected data was treated as confidential.

The sample size of 170 comprised 32.7% of the hospital clinicians using data from the Ministry of Health Republic of Kenya12. Data was analyzed using descriptive statistics, frequency distributions, Chi square tests, significance tests and SPSS 17. Sampling ended once the sample size was achieved.

RESULTS

The various clinical cadres of the 170 study participants are shown in Table 1.

Table 1:

Table showing distribution of Clinicians that participated in the study

Clinician cadre	n	%
Consultants	25	14.7
Residents	66	38.8
Medical officers	21	12.4
Clinical officers	58	34.1
Total	170	100

The male to female ratio showed an almost equal distribution of 1:1.02 (Males: 84, Females 86). The mean age of the participating health workers was 35.8 years (SD 6.9) with median age in years was 35.3 (IQR 7.5, Q1 31, Q3 38.5). Regarding the clinicians' knowledge on which imaging modalities used IR and which ones did not, the overall misclassification was 65.9% (Table 2).

Table 2:
Table showing correct identification of radiological imaging techniques that use ionizing radiation and techniques that do not use ionizing radiation (n=170)

	n	%
Techniques using IR		
Conventional radiography (X Ray)	159	93.5
Computed tomography (CT)	148	87.1
Fluoroscopic studies (Barium)	151	88.8
Radionuclide Imaging (RNI)	143	84.1
Techniques not using IR		
Ultrasound	125	73.5
Magnetic resonance imaging	72	42.4
Correct classification of all 6 imaging techniques	58	34.1

The knowledge difference was significant amongst the different cadres with p-values of < 0.002. The highest heterogeneity was seen between the consultants and the clinical officers (p<0.0001) compared to between consultants and medical officers (p=0.47) (Table 3). There was no difference in response between the genders across the cadres (p=0.27).

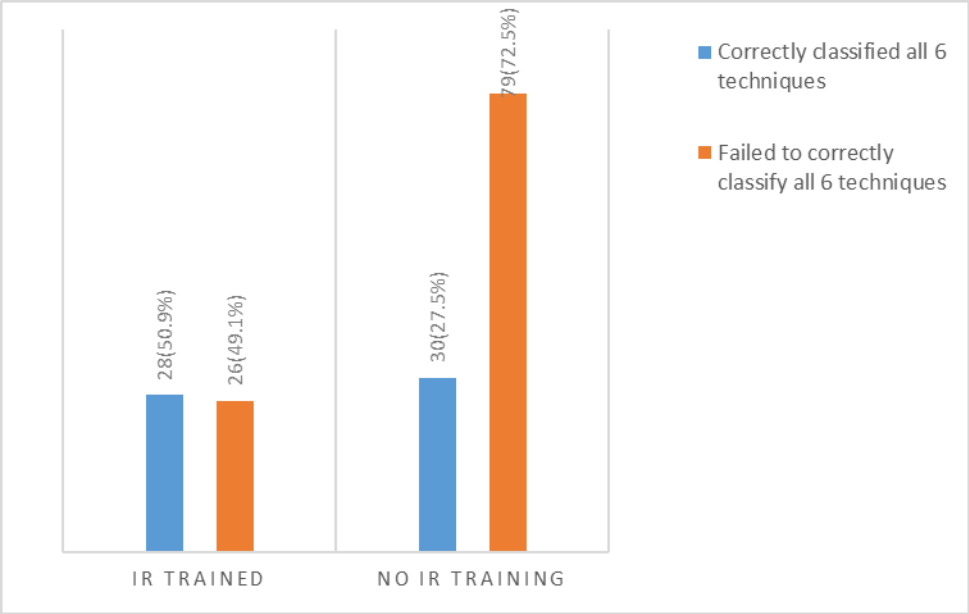
Table 3:
Table showing responses by different cadre of clinicians on which imaging modality has the highest radiation dose

Imaging technique with highest radiation dose	**Category of clinician n (%)**				
	Consultant	**Resident**	**MO**	**CO**	***Chi-square test p-value***
Abdominal CT (correct)	19(76.0)	45(68.2)	10(43.5)	5(8.9)	*< 0.0001*
Abdominal X-ray/ US or MRI (Incorrect)	6(24.0)	18(27.3)	13(56.5)	47(83.9)	*< 0.002*

There was strong evidence that formal training in IR was associated with correct classification of all six imaging modalities. The odds of correct classification with IR training was 2.83 times the odds without IR training (95%CI: 1.36, 5.91; p=0.002) Figure 1.

Figure 1:

Bar chart showing correct classification of imaging modalities that use ionizing radiation comparing the clinicians with formal IR training (n=53) and those without formal IR training (n=109)



Regarding the approximate IR dose of a chest radiograph (CXR), 90.4% of those with formal training and 93.5% of those with no formal training incorrectly answered this question. There was no significant difference in knowledge between clinicians with and without formal IR training regarding radiation dose from a CXR (p = 0.49). However, when identifying which imaging techniques had the highest radiation dose; 69.8% of those with formal training answered correctly that CT abdomen had the highest radiation dose compared to 37.1% of clinicians with no formal training (p= < 0.001).

All the cadres of clinicians uniformly performed poorly when estimating the radiation dose on imaging different body parts (p>0.05). Most of the clinicians rated gonads as more sensitive to IR than bone marrow (164 vs 72) and most did not know the risk of cancer induction from a single abdominal CT scan (Table 4).

Table 4:

Table showing KNH health workers' knowledge on risk of cancer induction from abdominal CT scan

	n	**%**
Risk of inducing cancer from abdominal CT		
Below correct risk	7	4.1
Correct risk (1 in 2000)	7	4.1
Above correct risk	58	34.1
Did not know	98	57.7
Total	170	100

DISCUSSION

Findings from this study can be related to studies from elsewhere which show that generally senior consultants scored higher in the knowledge-based questions compared to junior doctors (13). One study from Australia led to policy change in the hospital whereby requests for investigations involving high dose radiation had to be authorized by a senior non-radiology consultant (13). Compared to our participants, studies from Europe, Turkey and Hong Kong had more clinicians who correctly indicated that MRI and US do not use IR (14-16). However, our participants performed better than clinicians from a similar study carried out in Nigeria where only 14% and 20% of the clinicians from the Nigerian study correctly responded that MRI and US respectively do not use IR (17). The author attributed their findings to the wide unavailability of MRI and US in the study locality.

Gender difference on IR knowledge was reported in two studies where it was found that more males than female study participants indicated that MRI uses IR (13,14). These authors attributed knowledge disparity to the fact that men were more interested in the technical aspect of things than women (13,14). In contrast our study showed that there was no significant difference in the responses from the male and female participants (p=0.27).

This study has shown that health workers with no IR training were significantly less likely to correctly identify all the techniques that use IR and less likely to identify those studies that lead to high radiation exposure. This observation has been strongly supported by several studies which have shown that formal education in IR provides clear advantages as such a clinician is better placed to classify studies that used IR, estimate the dose of IR for different imaging studies and therefore make appropriate decisions when requesting for imaging studies (13,18,19).

There was no significant difference between the clinicians with formal training and those without, regarding the radiation dose estimate from CXR, a finding supported by several other studies (5, 19–22). This is of concern as a CXR is the commonest radiological examination requested for by clinicians. All participants scored poorly when estimating the radiation dose on imaging different body parts ($p > 0.05$). Similar lack of knowledge on IR dose has been reported in other studies (13,16,19,23-25). Several studies have reported contrasting results indicating that the seniority of the clinician did not necessarily translate to improved knowledge on radiation dose (13,19). However, the senior doctors were more likely to respond correctly to questions on radiation dose where there was regular use of referral guidelines (13).

Our study has shown that most of the participants (95.8%) either wrongly predicted the life time risk of inducing cancer from a single abdominal CT scan or were non-committal. This effectively means that a clear majority of the non-radiology clinicians are requesting for CT scans without any idea of its potential hazards! Similar findings have been reported in studies in the USA (26) and Ethiopia (19). In this study, only 42.3% of the clinicians correctly rated bone marrow as a very radiosensitive organ while less (10.6%), responded that there was increased risk of developing leukemia or lymphoma. This is in sharp contrast to a study done in Hong Kong which reported that 94% (59/63) of

health workers were aware of the increased risk of developing leukemia (27).

CONCLUSION

In conclusion this study has shown that non-radiology clinicians at KNH lack adequate knowledge on ionizing radiation doses. There is significant knowledge gap between the different cadres. Clinicians with formal training have some advantage over those with no formal training about certain aspects of IR knowledge.

STUDY LIMITATIONS

Limitations of the study include the sampling method which resulted in more residents being sampled compared to the other cadres due to their larger numbers in KNH. Some clinicians refused to participate because they felt unknowledgeable about IR. Despite these limitations, the study has shown that there is great heterogeneity in knowledge across the cadres with the largest difference being seen between the consultants and the clinical officers. As a result, we recommend that only senior non-radiology clinicians should authorize all request forms that require the use of high dose ionizing radiation. Imaging referral guidelines in form of a pocket booklet for easy portability or online for easy referencing should be made available either through the Ministry of Health or professional associations and that training curricula in all cadres should be revised to include or strength the content on radiation protection and safety.

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