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Awareness of Theatre Team to Radiation Risk From C-Arm During Surgical Procedures: A Case Study of University of Calabar Teaching Hospital in Nigeria

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ABSTRACT

***Purpose**: This study aims to assess the awareness of the theatre team to radiation risk from C-arm as well as their adherence to radiation protection or safety measures in the study Centre.*

***Methods**: A non-experimental descriptive design was adopted for this study and a well-structured 27 item questionnaire was distributed to 52 members of the surgical theatre: Surgeons, Anesthesiologists, Theatre nurses and Radiographers in the selected hospital. Of this sample, 49 respondents returned their questionnaires.*

***Results**. Results from this study reveal a high level (83.67%) of knowledge of radiation risk from C-arm. A greater percentage of the respondents have an average level of knowledge of radiation protection or safety measures: Surgeons (58.8%), Anesthesiologists (50%), and Theatre Nurses (33.3%). Of this percentage on awareness, only 41.1% of Surgeons, 30% of Anesthesiologists, 16.6% of theatre Nurses adhere to these radiation protection/safety measures. This study further reveals a low level of awareness and use of radiation monitoring devices: Surgeons (29.4%), Anesthesiologists (10%), and Theatre Nurses (8.3%). Also, the study shows that the surgical team spends long periods during surgical procedures: 4 hours (24.48%), 6 hours (20.4%), 12 hours (6.12%), thus increasing their susceptibility to radiation effects. The study further affirms that a lesser percentage of the respondents (44.89%) knew the safest positioning of the radiation-emitting tube, meaning that a greater percentage of the respondents don't know the safest position to take during beam-on periods.*

***Conclusion**: This study shows a high level of knowledge of radiation risk, an average level of awareness to radiation protection/safety measures and a poor level adherence of these measures by the theater team.*

INTRODUCTION

The high number of performed procedures involving the use of ionizing radiation increased dramatically in the last decade (Kaur et al., 2015). The use of ionizing radiation in medical imaging is one of the most important diagnostic tools in hospitals and clinics; leading to more accurate diagnosis of diseases and its associated treatment (Nwodo et al., 2020). It is true that ionizing radiation such as x-ray has potential advantages, yet its potential hazards should not be ignored. Ionizing radiation may have an effect on the hematopoietic system, digestive system, central nervous system among many others. it can cause complications such as origin of

various cancers, cataract, shortening of life, infertility and hair loss (Boxall et al., 2009; Chiaghanam & Nwoyi, 2020), hence applying occupational radiation protection is necessary for daily practice.

Diagnostic radiology technology is used to obtain a high-quality image for the patients during surgeries at Operation Theater. The number of diagnostic examinations has risen yearly. Studies have shown that more than millions of radiographic tests are done daily in the world (Roobottom et al., 2010). Surgeons perform complex diagnostic and interventional procedures using the C-arm. The use of radiation during procedures in the operating theatre is very necessary to guide and confirm the location and placement of surgical instrumentations used during surgical procedures (Paolicchi et al., 2016). The Surgical theatre team is frequently exposed to ionizing radiation during surgical procedures because a good number of radiographic images are obtained during the procedures. It is important to ensure low radiation dose by applying the radiation protection and safety principles to the healthcare team (Abdellah et al., 2015). Studies have shown that the orthopedic surgeon approximate dose during Hip procedures is 5μSv with screening time of 25sec/patient and can be up to 250μSv with 10 minutes screening time per patient during Kyphoplasty (Rhea et al., 2016). The International Commission of Radiological Protection (ICRP) recommended Dose Monitoring systems such as TLD and radiation dose limits for operating theatre staff. Hence, radiation should not exceed 20mSv/year (100 mSv in 5 years, not exceeding 50mSv in any one year) (Ramanathan & Ryan, 2015).

The general principle of radiation protection is based on three principles: of justification, optimization (As Low As Reasonably Achievable - ALARA), and dose limitation. This is the foundation of radiation protection strategies. The main principles for radiation protection are time, distance, and shielding Borhani & Mohammad (2003) which should be carefully controlled (Khamtuikrua & Suksompong, 2020). If an equal measure of radiation reaches each organ of the body, the most dangerous is for particular organs such as the thyroid gland, marrow, and genitals, which are called critical organs. The most specific factors in protection against radiation are: 1- raising the distance 2- decreasing the time 3- and using the guided shields (Chiaghanam & Nwoyi, 2020).

Studies have also shown that radiation exposure is reduced drastically for the health workers who work in a good shielded facility, use Lead Apron and thyroid shields during procedures that involve radiation exposures (Sutton et al., 2012). It is of utmost importance for all medical staff (especially those in the surgical theatre where radiation exposure is continuous for longer periods) to have adequate knowledge about radiation physics and radiation hazards in other to adhere to the radiation protection principles and decrease x-ray effects because unexpected and irreversible damages can occur to those who lack knowledge of the principles of radiation protection (Shafi et al., 2016). Hence, the need to assess the awareness of the theatre team to radiation risk from the c-arm during surgical procedures in the selected hospital.

METHODOLOGY

Study Design: The study design adopted for this study was the non-experimental descriptive design. The design was considered appropriate, as it is useful in gathering data about the awareness of the theatre team in the hospital to radiation risk, their adherence to radiation safety measures as well as their knowledge and adherence to the use of Radiation monitoring devices from May – July, 2021. The sample size for this study was an estimated 60 members of the surgical theatre in the hospital comprising of: Surgeons, Anesthesiologists, Theatre Nurses and Radiographers. The Yaro Yamane statistical formula was employed for sample size determination, the sample size (n) will be calculated as:

$$n = \frac{N}{1 + N(e)^2}$$

Where N = population of study

n = Sample size

e = error margin set at 5% (0.05)

I = constant

$$n = \frac{60}{1 + 60(0.05)^2}$$

n =52.17

n =52

The research instrument that was used for this study was a self-developed and well-structured questionnaire which consisted of 27 items with two (2) Sections A and B. Section A was on the socio-demographic data of the respondents while Section B had 22 items that elicited responses on other relevant areas. The one on one method of questionnaire distribution was employed. Out of the sample size of (52), 49 questionnaires were retrieved giving a return rate of 94%.

Statistical Analysis

The obtained data were processed using statistical package for social sciences (SPSS 21) and analyzed using descriptive statistics.

RESULTS AND DISCUSSION

Majority of the respondents were males 29 (59.18%). Out of the 49 participants the highest number of participants was from the age range 33-42. Most of the participants 17 (34.69%) were surgeons and 27 (55.10%) had practiced for 1-5 years with 27 participants (55.10%) having MBBS as their highest level of qualification (Table 1).

Table 1. Socio-Demographics of Respondents

Variables	Frequency	Percentage (%)
Age		
18-22	0	0
23-27	9	18.36
28-32	11	22.44
33-37	12	24.48
38-42	12	24.48
43-47	3	6.12
48 and above	2	4.08
Total	**49**	**100**
Gender		
Male	29	59.18
Female	20	40.81
Total	**49**	**100**
Profession		
Surgeons	17	34.69
Anesthesiologist	10	20.40
Theatre Nurses	12	24.48
Radiographers	10	20.40

Total	**49**	**100**
Duration of Practice		
1-5years	27	55.10
6-10years	18	36.73
11-15years	3	6.12
20years and above	1	2.04
Total	**49**	**100**
Level of Education		
B.Sc.	9	18.36
M.Sc.	2	4.08
Ph.D	0	0
MBBS	27	55.10
RN	11	22.44
Total	**49**	**100**

Table 2. Response to assess the distance of the team from the C-arm during exposure

Meters	Frequency	Percentage (%)
Less than 2meters	16	32.65
2 Meters	12	24.48
5 Meters	14	28.57
10 Meters	7	14.28
TOTAL	49	100

Majority of the respondents 16 (32.65%) replied that they stay at an approximate distance of less than 2meters during each exposure.

Table 3. Response from the respondents relative to their position during beam-on periods

Meters	Frequency	Percentage
Backing the Tube	22	44.89
Facing the Tube	19	38.77
Others (Not Sure)	8	16.32
TOTAL	49	100

Table 3 shows that a greater percentage of the respondents 22 (44.89%) where backing the tube when exposure was taking place. Also, 19 respondents (38.77%) were facing the tube while 8 respondents (16.32%) were not even sure of their position during beam-on periods.

Table 4. Response to assess the maximum time spent by the team during surgical procedure

Maximum Time	Frequency	Percentage
2 hours	3	6.12
3 hours	4	8.16
4 hours	12	24.48
5 hours	7	14.28
6 hours	10	20.40
7 hours	2	4.08
8 hours	2	4.08
9 hours	2	4.08
10 hours	3	6.12
11 hours	1	2.04

12 hours	3	6.12
TOTAL	49	100

Table 4 shows that the maximum time range spent by members of the surgical theatre is 4 to 6 hours with percentages of 24.48%, 14.28%, and 20.40% respectively; though some respondents asserted that they've stayed in the theatre for a period of 12 hours (6.12%).

Table 5. Individual Responses of Respondents

S/N	Variables	Sur. (17)	Anesth. (10)	T.Nurses (12)	Rad. (10)
1.	Awareness of the harmful effects of Radiation	17(100%)	6 (60%)	8(66%)	10(100%)
2.i	Awareness of Radiation protection/Safety measures	10(58.8%)	5(50%)	4(33.3%)	10(100%)
2.ii	Adherence to these radiation safety measures	7(41.1%)	3(30%)	2(16.6%)	7(70%)
3.	Awareness and use of Radiation monitoring devices	5(29.4%)	1(10%)	7(58.3%)	10(100%)
4.	Effective communication between the Radiographer and other members of the theatre to leave radiation field	6(35.2%)	4(40%)	3(25%)	-
5.	Position during Beam-on Periods (i.e. orientation of the tube head with respect to the teams' position) i. Backing the Tube ii. Facing the Tube iii. Others (Not sure)	 8(47%) 5(29.4%) 4(23.5%)	 5(50%) 3(30%) 2(20%)	 7(58.3%) 3(25%) 2(16.6%)	 1(10%) 9(90%)
6.	Level of adherence in keeping off the radiation area during exposures	9(52%)	4(40%)	1(8.3%)	10(100%)
7.i	Knowledge on the use of radiation protection materials	6(35.2%)	3(30%)	4(33.3%)	10(100%)
7.ii	Adherence to the use of these materials	3(17.6%)	1(10%)	2(16.6%)	10(100%)

Sur. – Surgeon

Anesth. – Anesthesiologists

T. Nurses – Theatre Nurses

Rad. - Radiographers

In this study as observed in table 5 most of the respondents (83.67%) are aware of the harmful effects of radiation: Surgeons (100%), Anesthesiologists (60%), Theatre Nurses (66%) and Radiographers (100%). This awareness rate is high when compared to that found among a group of theatre team in Brazil (55.4%) (Pires et al., 2020). Though the respondents are aware of the harmful effects of radiation, the study however shows that they have an average level of awareness to radiation protection or safety measures with exception of Radiographers: Surgeons (58.8%), Anesthesiologists (50%), Theatre Nurses (33.3%), and Radiographers (100%). Of these percentages on awareness, the result of this study further shows that very few of those aware of these radiation protection and safety measures adhere to these measures: Surgeons (41.1%), Anesthesiologists (30%), Theatre Nurses (16.6%) and Radiographers (70%). This is in line with the study carried out in Brazil (Pires et al., 2020).

For Radiation monitoring devices, the study as revealed in table 5 showed that the respondents had low knowledge as only 48.97% acknowledged that they are aware of radiation monitoring devices while 51.02% were not aware. We see that only 29.4% of surgeons, 10% of the Anesthesiologists, 58.3% of Theatre Nurses have knowledge of radiation monitoring devices. Only Radiographers have a high knowledge (100%) of radiation monitoring devices. This is in line with a study conducted in Brazil (Pires et al.,

2020). Risk is seen as the possibility of inducing a genetic defect after irradiation. It is the probability of injury, ailment or death resulting from an activity (ICRP, 2007). Occupational risk associated with radiation exposure may be equaled with occupational risk in other safe industries (NCRP, 1993).

The study also shows that there is no effective communication between the Radiographer and other members of the Theatre team. Table 5 shows that only 35.2% of Surgeons, 40% of Anesthesiologists and 25% of Theatre Nurses positively affirmed that they were asked to stay out of the radiation field during exposure. This may lead to exposure to ionizing radiation to these staff. Ionizing radiation damages living systems by ionizing (removal of electrons), the atoms composing the molecular structures of these systems (Muirhead et al., 2009; Darby, 2005; Darby, 2007; Darby, 2006; HPA, 2009b; Mobbs et al., 2011; Sokolinikov et al., 2008; Watson et al., 2005). Therefore, ionized atom will not bond properly with the molecules necessary for the normal functioning of an organism. This necessitates biological damage in the system.

This study as revealed in table 3 also shows that a percentage of the respondents (44.89%) only knew the safest positioning of the radiation-emitting tube. This implies that a greater percentage of the respondents don't know the safest position to take during beam-on periods. This is in line with the study carried out by Pires et al., (2020) who reported that only 44.2% knew the safest positioning of the radiation-emitting tube. The study revealed that a part of the respondents observe the inverse square law Richard & Arlene (1996) by staying a safe distance from the tube during exposure though about 16 (32.65%) replied being at less than 2meters during exposure.

Further, this study shows that there is a low knowledge on the use of radiation protection materials such as lead apron and thyroid shields by members of the surgical theatre except the Radiographers: Surgeons (35:2%), Anesthesiologists (30%), Theatre Nurses (33.3%) and Radiographers (100%). More so, the degree of adherence to the use of these materials is very low: Surgeons (17.6%), Anesthesiologist (10%), Theatre Nurses (16.6%) and Radiographers (100%). This is however very low when compared to that found among an Asian Operation theatre team (97.2%) (Abuzaid et al., 2019).

CONCLUSION

This study shows that the Theatre team in the selected tertiary hospital had a high level of knowledge of radiation risk, an average level of awareness to radiation protection/safety measures and a poor level adherence of these measures.

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