RADIATION PROTECTION PRACTICES AMONG SOME DIAGNOSTIC FACILITIES IN RIVERS STATE, NIGERIA

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Abstract— **Despite detrimental health effect (DHE) of ionizing radiation, they are still beneficial for diagnosis and therapy of ailments under strict adherence to principles of radiation protection. Reported DHE of radiation often arises from unsafe practices among operators. The aim of the study was to assess level of radiation protection culture among diagnostic facilities in Nigeria. This pilot study was conducted among 50 Radiographers from eight diagnostic centres in Port-Harcourt, Rivers State, one of the largest cities in Nigeria. Structured questionnaire was used to collect data on socio-demographic and radiographic practices, which include availability of radiation protection/monitoring devices, design of X-ray room, quality control test and others. Their responses were analysed with SPSS 20.0 and results were presented in Tables. All (100%) respondents had university degree in radiography and 30% frequently participated in radiation protection courses. Radiation protection devices available in all the facilities are: Lead Apron (47.6%), Gonad shield (22.9%), Lead glass (10.5%), Lead glove (13.3%), thyroid shield (5.7%) and 84% used monitoring devices (personnel dosemeter). Only 84% of the respondents had rooms suitably designed for X-ray units. While 80% of the respondents hardly repeat X-ray procedures, only 60% had routine quality control test performed on their X-ray units. All engaged the services of radiation safety adviser/officers. Adherence to radiation protection practices by some of these centres was below the recommended standard, due to non-availability or insufficient radiation protection/ monitoring devices. Diagnostic centres should therefore comply strictly with radiation protection guidelines in order to reduce DHE of radiation on humans.**

Keywords— Ionizing radiation, separated by commas, principles of radiation protection, radiation practices, detrimental health effect, radiation protection

I. INTRODUCTION

Ever since the discovery of X-rays by Wilhelm Conrad Roentgen in 1985 and the recent advancement in imaging technology for solving arrays of health challenges, the use of ionizing radiation in the field of medicine has been on the increase [1].

The wide use of ionizing radiation is medicine is not without health hazards. Some of these hazards were reported a few months after X-ray discovery and from these and other findings were conclusion drawn that X-rays have deleterious biological effects on humans. These effects include microscopic damage to living tissues, skin burn, radiation sickness at high exposures and statistically elevated risk of cancer at low exposures [2].

When patients undergo X-ray examinations, millions of photons pass through their bodies. These ionizing photons have potential to damage any molecule through ionization but the damage to DNA in the chromosomes of the exposed medium is of particular importance [3].

Radiographers in the early days of X-ray discovery mostly died of cancer as a result of over exposure to ionizing radiation and their lack of adequate knowledge of radiation protective devices and measures [4]. The realization of these harmful effects of ionizing radiation gave rise to the principles of radiation protection, which aims at promoting adequate protection of the Operators of X-ray units /Radiographers, the patients, who undergo medical X-ray examinations, the general public and the environment from the harmful effects of ionizing radiation [5]. The main goal of radiation protection is to limit human exposure to ionizing radiation to a degree that is reasonable and acceptable in relation to the benefits gained from the activities involving the exposure.

The negative effects of ionizing radiation can be reduced through filtration of X-ray beam, field size trimming/collimation, shielding with the use of appropriate lead apron, gonad shield, lead-lining of the walls, which has to do with the standard X-ray room design. It has been reported that formal training or refresher courses in radiation protection for handlers/operators of X-ray units greatly helped in reducing radiation exposure to medical staff and patients [6].

Radiographers play a major role in medical X-ray examinations of patients, and their level of radiation protection practices is a key to achieving radiation exposure that is as low as reasonably achievable, ALARA principle [3].

There are established regulations that govern the use of ionizing radiation in medicine but some health professionals, X-ray operators, technicians, radiographers, etc. are either unaware of these regulations or are not compliant [7]. The knowledge, awareness and adherence to

these regulations are germane to reducing the level of exposure to ionizing radiation and its associated deleterious consequences [8].

Also, most studies in medical X-ray examinations were usually focused on the protection of the workers only [9] but it is imperative also for radiation facilities to provide safety measures that will protect patients undergoing medical X-ray examinations [10].

This study aims at assessing the level of radiation protection practices among radiation facilities at eight diagnostic centres located in one of the largest cities in Nigeria, Port-Harcourt Rivers state, as a pilot study. The findings from this study would enhance accreditation of X-ray facilities and eradicate unethical use of X-rays for medical examinations of patients in Nigeria.

II. MATERIALS AND METHODS

This pilot and prospective cross-sectional study was conducted in eight diagnostic facilities, randomly selected in one of the largest cities in Nigeria, Port-Harcourt city, Rivers State from September-December 2022. The target population of this study is the X-ray Operators/ Radiographers in these diagnostic centres, namely: University of Port-Harcourt Teaching Hospital (UPTH), Rivers State Teaching Hospital (RSTH), Government House Clinic (GHC), Image Diagnostic Centre (IDC), RNZ Occupational Hospital (RNZOH), Shawsand Diagnostic Centre (SMC), Save a Life Mission Hospital (SALMH), Georges Diagnostic Centre (GDC). Fifty Radiographers, who consented to participate and returned the filled questionnaires were included in the study and their distribution among the centres was: UPTH (13), RSTH (18), GHC (3), IDC (3), RNZOH (3), SMC (2), SALMH (2), GDC (3).

The semi structured questionnaire used for data collection consists of two sections namely, A and B. While section A contained four questions on socio-demographic data of the respondents, section B contained twenty different questions on radiographic practices in relation to radiation protection. To facilitate data quantification and analysis, the respondents' responses to the questions in the questionnaires were used. These were analysed with statistical package, SPSS version 20.0 and the results were presented in table of frequency and percentages.

III. RESULTS

The respondents' socio-demographic data, which include their sex, age, academic qualification and years of experience in radiation practices, are presented in Table 1. The distribution of Radiographers, who returned the filled questionnaires, among the selected diagnostic centres, is presented in Table 2. The level of adherence of the selected diagnostic facilities with the principles of radiation protection in terms of the availability of protective devices for both patients and operators, type of protective devices used for shielding patients during medical X-ray examination, appropriateness of the design of the room that housed X-ray unit and other safety measures put in place for protection of both patients and the personnel from scattered radiation are presented in Table 3.

Table 1: Socio-demographic characteristics of the Radiographers (n = 50)

Characteristics	Frequency (n)	Percentage (%)
Sex		
Female	20	40
Male	30	60
Age Group		
20 – 29	14	28
30 – 39	19	38
40 – 49	13	26
50 and above	4	8
Academic Qualification		
B.Sc.	37	74
M.Sc.	11	22
Ph.D.	2	4
Work Experience		
≤ 5 years	25	50
6 - 10 years	13	26
11 - 20 years	7	14
> 20 years	5	10

Table 2: Distribution of Radiographers among the Diagnostic Centres

Diagnostic Centres	Frequency (n)	Percentage (%)
University of Port-Harcourt Teaching Hospital (UPTH)	13	26
Rivers State Teaching Hospital (RSTH)	18	36
Government House Clinic (GHC)	3	6
Image Diagnostic Centre (IDC)	6	12
RNZ Occupational Hospital (RNZOH)	3	6
Shawsand Medical Centre (SMC)	2	4
Save A Life Mission Hospital (SALMH)	2	4
Georges Diagnostic Centre (GDC)	3	6

Table 3: Level of adherence to radiation protection practices among Radiographers

Radiation Protection Practices	Frequency (n)	Percentage (%)
What are the radiation protection devices available in your facility?		
Lead Apron	50	47.6
Gonad Shield	24	22.9
Lead Glass	11	10.5
Lead Gloves	14	13.3
Thyroid Shield	6	5.7
In what investigation do you use gonad shield?		
Chest X-ray	22	40.7
Abdominal X-ray	24	44.4
Pelvis	7	12.9
Children Examination	1	2
How often do you give lead apron to persons supporting patients during examination?		
Always	44	88
Occasionally	2	4
When I remember	1	2
Not at all	3	6
What personnel monitoring devices do you use in your facility?		
Film Badge	5	10
TLD	28	56
OSL	3	6
Instadose	6	12
Is your facility originally designed for Radiology department/to house X-ray machine?		
Yes	42	84
No	4	8
Not sure	12	24
The X-ray room is designed with what material?		
Lead-lined wall	50	40
Lead-lined doors	50	40
Concrete walls	24	20
The operators' cubicle is designed with what material?		
Concrete wall	50	50
Lead screen	50	50
How long does a patient stay in the waiting room?		
Less than 30 minutes	36	72
More than 30 minutes	5	10
Up to an hour	2	4
Depending on investigation	7	14
Do you encounter repeat cases while working?		
Frequently	1	2
Occasionally	8	16
Rarely	40	80
Not at all	1	2
What is/are the possible causes of repeat?		
Processing Fault	1	2
Poor radiographic technique	5	10
Un-cooperative patient	42	84
Error in exposure factors	2	4
How often is quality control test done on your facility?		
Routinely	30	60
Occasionally	13	26
When it is convenient	1	2
Rarely	5	5
None	1	2
What type of quality control test is carried out?		
Beam quality test	20	14
Radiation leakage test	50	35
Light beam alignment	50	35
Timer accuracy	21	15
Have you ever attended training and/or refresher courses on radiation protection?		
Frequently	15	30
Seldom	22	44
Never	9	18
No response	4	8
Do you close the X-ray room door during exposure?		
Yes	50	100
No	-	-
Do you ask female` patients of reproductive age about their menstrual cycle before exposure?		
Frequently	20	40
Rarely	25	59
When I remember	5	10
Do you have radiation safety adviser/officer?		
Yes	50	100
No	-	-
Do you have survey meter at your facility?		
Yes	50	100
No	-	-
Do you have radiation warning signs/notices and caution light at the facility		
Yes	50	100
No	-	-

IV. DISCUSSION

The implementation of the standard procedures recommended for radiation protection practices in the diagnostic facilities are vital for safety of the radiation workers, the patients and the general public [11]. In this study, among the respondent Radiographers, there were more male 30 (60%) than the female 20 (40%) and most (38%) of them were in the age range of 30 – 39 years. This agrees with the study conducted by Mohammed et al., [12], where majority of the Radiographers reported in their study were male and the highest age group reported was 30 - 39 years. It was observed in this study that none of the respondents were below 18 years of age. This complies with the regulations of the international radiation protection organization, which states that anyone below the age of 18 years should not be permitted to operate radiation facilities [11].

In terms of work experience, those with work experience under 5 years were more (50%) than those (10%) with work experience of 20 years and above. This means that majority of them are new generation Radiographers with few years of experience in radiation practices. Most (74%) of the respondents had B.Sc. Radiography as their minimum qualification. This is quite impressive as diploma in Radiography used to be their minimum qualification for employment.

This was in agreement with a study conducted by Kyei et. al., where most practicing radiographers were university graduates [7]. Regarding training and refresher courses in radiation protection, 18% had never attended training, 44% seldom attended and 30 % attended frequently. This is in line with the findings by Mohammed et al., [12], where two-third of respondents surveyed have never attended radiation protection training/refresher courses.

It is highly recommended that every necessary radiation protection device is available in a diagnostic facility. Ascertaining the availability of radiation protection devices, it was made known from the responses that lead aprons 50 (47.6%) were very much available and 44 (88%) of the respondents always provide lead aprons to the persons supporting the patient when the need arises but availability of radiation protection devices like lead glove 14(13.3%), gonad shield 24 (22.9%), thyroid shield 6 (5.7%), lead glass11 (10.5%) were inadequate in some centres.

Also, from this study, it was observed that some of the centres that had gonad shield, did not know when to use it. Gonad shield is recommended for use on patients during medical diagnostic X-ray procedures when the gonads lie within or close to the primary X-ray field. It is also recommended when the clinical objective of the examination is not compromised and when the patient has a reasonable reproductive potential [13].

Availability of personal monitoring device is very important because it provides a means of detecting the radiation dose absorbed by workers. It ensures that the incident of radiation leakage is kept on check [14]. Having assessed the availability of monitoring devices, it was noted that majority of the respondent 42(88%) had monitoring devices and were read as at when due while some did not have monitoring devices. This agrees with the findings of Eboh et al., [15], that 93% of staff in their study were provided with personnel radiation monitoring devices.

The design of X-ray rooms is very important due to the nature and properties of X-ray; the X-ray rooms must be properly designed to prevent radiation leakages. From this present study 42 (84%) of the respondents revealed their centres were built for X-ray practices, 6 (12%) of the radiographers were not sure and 2 (4%) indicated that their centres were never built for X-ray practices but was converted. This is in contrast with the study conducted by Okeji et. al, [16], where it was reported that there was inadequacy in the design of the majority of diagnostic centres they considered.

Proper shielding of X-ray facility to absorb scattered radiation during exposure is very crucial for protection of workers, other patients or the visitors that may be present in the adjacent rooms, waiting areas or nearby offices. The following number of radiographers indicated that their X-ray facility was equipped with lead-lined wall 50 (40.3%), lead-lined doors 50 (40.3%), cubicles with concrete wall 50 (50%) and lead-lined cubicles 50 (50%). This is similar to the findings by Eboh et al. [15].

Repeat of X-ray exposure should be avoided as much as possible in compliance with "ALARA principle". Majority of the responses to the cause of repeat was non-cooperative patients, 42 (84%), followed by poor radiographic techniques, 15 (30%). This agrees with the report by Eze et al, [17], where the repeat cases were attributed mainly to lack of patient co-operation and lesser degree to processing fault, poor radiographic technique and lack of trained operators. With respect to how often the radiographers encountered repeat cases, majority, 40 (80%), responded that they rarely experienced it while, 8 (16%), experienced it occasionally.

The code of practice in medical diagnosis of the National Radiation Laboratory (NRL) requires that each X-ray facility has an appropriate quality control programme in radiation protection. This is to ensure that radiation doses emanating from the X-ray unit for patients' exposure are kept as low as reasonably achievable. Majority of the respondents, 30 (60%), acknowledged that quality control was done routinely on their X-ray units, 13 (26%) responded occasionally, 5 (10%) indicated rarely and 1 (2%) indicated when it is convenient. Regarding the type of quality control performed on the diagnostic units, 47 (94%) indicated radiation leakage, 29 (54%) highlighted light beam alignment, 21 (42%) responded timer accuracy, while 20 (40%) revealed beam quality.

With respect to the engagement of radiation protection officers/advisers by the facility, all respondents were positive. This result is in contrast with the report of Okaro et al., [14], where radiation protection personnel are hardly available at the centres they considered.

Other radiation protection measures undertaken by all the respondents, 50 (100%), was the closing of the X-ray rooms during radiation exposure. While 20 (40%) of the respondents always ask the female patients, of reproductive age, about their menstrual cycle before exposure, 25(50%) rarely asked and 5 (10%) usually asked when they remembered.

Lastly, all the respondents 50 (100%) affirmed that they had survey meter, radiation warning signs/notices and caution lights in their facilities.

V. DISCUSSION

Ionizing radiation can be detrimental to human health if the principles of radiation protection are violated. In this study, the adherence to the principles radiation protection by all the facilities considered was fairly satisfactory. This was due to unavailability and inadequate use of radiation protective devices for patients and staff. Other factors are irregular refresher/training course in radiation protection for Radiographers and some of the Operators were not provided with monitoring devices while at work. To achieve optimal radiation practices, these facilities should improve on their

existing radiation protection procedures, measures and devices.

REFERENCES

1. Maharjan S., Parajuli K., Sah Suraj and Poudelu (2020). Knowledge of radiation protection among radiology professionals and students. European journal of radiology.
2. Abdulrahman A. A. and Sunil K. (2018). Assessment of radiation protection practices among University students Buraydahi, Saudi Arabia. Journal of dental and medical sciences ISSN: 2279-0853 vol. 17 issue 3.
3. Abuzaid M.M., Elshami W., Shawki M and Salama D. (2019). Assessment of compliance of radiation safety and protection at the radiology department. International Journal of Radiation Research vol. 17, No. 2.
4. Fiagbedzi E. Gorleku P.N. Nyarko S. Asare A. and Ndede G.A. (2022). Journal of Radiation Medicine and proection vol. 3 issue 3
5. Durrani A.U., Hoti K.K., Muddassar M., Inyat N., Rabbani M. and Abbas S. N. (2020). Assessment of Radiation Protection Practices in Abbas Institute of Medical Muzaffrabad. Health Science Journal ISSN179-8081 Vol. 14 No.3:715.
6. Frane N., Megas A., Stapleton E., Gangz M. and Bitterman A.D. (2020). Radiation Exposure in Orthopedics.Volume 1 Issue1 pages e0060.
7. Kyei, K.A., Antwi, W.K.,and Suapim, J.B. (2015). Evidence-Based Practice in Radiography: Attitudes, Beliefs, Knowledge and Practices of Radiographers in Ghana. Journal of Radiology, 4(1), 1-5.
8. Dewi D. E. O., Veldhuizen A. G., Burgerhof J. G. M., Purnama I. K. E., and Van-Ooijen P. (2010). Reproducibility of Standing Posture for X-Ray Radiography: A Feasibility Study of the Balance Aid with Healthy Young Subjects. Annals of Biomedical Engineering, 38(10), 3237-3245.
9. Breitenstein B. D, and Seward J. P. Ionizing radiation (2001). Wald PH and Stave GM. Physical and Biological Hazards of the Workplace. 2nd. New York: John Wiley and Sons Inc; 2001. 227-41.
10. Brennan T.A., Leape L.L., and Laird N.M. (1991). Incidence of adverse events and negligence in hospitalized patients: results of the Harvard Medical Practice Study. The New England Journal of Medicine, 7; 324:370-6
11. ICRP (1992). Recommendations of the International Commission on Radiological Protection, Ionizng Radiation Fact Sheet Series No.4, ICRP Publication 40, Annals of the CRP, 60-69
12. Mohammed A. Robinson E.D. Agboje A.A. and Nzotta C.C. (2020). Assessment of radiation safety measures in some selected radio-diagnosis centers in Gombe State, North-Eastern Nigeria
13. McKenney, S., Gingold, E., and Zaidi, H. (2019). Gonadal shielding should be discontinued for most diagnostic imaging exams.Medical physics, 46(3), 1111-1114.
14. Okaro, O., Ohagwu, C., and Njoku, J. (2010). Evaluation of personal radiation monitoring in radiodiagnostic centers in South-Eastern Nigeria. African Journal of Basic and Applied Sciences. 2, 49-53.
15. Eboh K. (2001). Evaluation of Patient Awareness of Radiation in Radio-Diagnostic Center in 3 Teaching Hospitals in Nigeria. An Unpublished B.Sc. Project.
16. Okeji M.C., Anakwue A.M. and Agwuna K. 2010 Radiation Exposure from diagnostic radiography: an assessment of X-ray beam collimation practice in some Nigerian Hospitals," Internet Journal of Medical Update-EJOURNAL, Vol. 5.
17. Eze C.U., Abonyi L.C., Njoku J., Irurhe N.K., and Olowu O. (2013). Assessment Radiation Protection Practices Among Radiographers in Lagos. Nigerian Medical Journal 56(2): 386-391.

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