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### THE PRACTICE AND IMPLEMENTATION OF RADIATION MONITORING OF RADIOGRAPHERS IN TERTIARY HOSPITALS IN SOUTHEASTERN NIGERIA: A REASSESSMENT

<sup>1</sup>Onwuzu Sobechukwu W I, <sup>1</sup>Abonyi, Obinna E, <sup>1</sup>Sunday David C, <sup>1</sup>Ozioko Anthony C, <sup>1</sup>Umeugochukwu Chinagorom M, <sup>1</sup>Ugwu Vincent U, <sup>2</sup>Onwuzu, Ifunanya S\*.

<sup>1</sup>Department of Medical Radiography and Radiological Sciences, University of Nigeria Enugu Campus, Nigeria.

<sup>2</sup>Department of Radiography and Radiation Sciences, Evangel University, Akaeze, Nigeria.

\*Corresponding author: +2348104518200; elo.sylvia@evangeluniversity.edu.ng

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#### ABSTRACT

**Background:** Radiation monitoring is an essential radiation safety practice that helps to determine the cumulative radiation dose absorbed by radiographers, ensuring that it does not exceed permissible limits. Failure in practice and implementation of radiation monitoring exposes radiographers to stochastic effects of radiation exposure, increasing the hazard radiation workers are exposed to.

**Objective:** To reassess the practice and implementation of radiation monitoring of radiographers working in south-eastern tertiary hospitals in Nigeria.

**Methods:** This was a cross-sectional survey involving 102 radiographers from 5 selected South-Eastern tertiary hospitals. Proportional stratified random sampling was used to select the radiographers from each tertiary hospital while a semi-structured questionnaire in line with the specific objectives was used as the method for data collection. Information obtained from the respondents were related to established radiation monitoring requirements and tables were used for data presentation.

**Results:** With a perfect response rate from the 102 respondents, personnel radiation monitoring was available to only 31% (n = 32) of the respondents with 59% (n = 19) using Thermoluminescent dosimeters. Even though a majority (71.9%, n=23) wore their dosimeters daily, only half (50%, n = 16) of those monitored had routine device retrieval and feedback of reading at the appropriate time. Employees did not demand radiation monitoring history from the radiographers before employment and only 10% (n = 3) of those monitored claimed they had dosimetry records. Lastly, only 6.3% (n = 2) radiographers have been on leave as a direct result of over exposure to radiation.

**Conclusion:** Personnel radiation monitoring practices of radiographers in South-Eastern tertiary hospitals still remain below internationally acceptable standards. Comparing the findings of this study with a similar study carried out 10 years ago, there has been little improvement in radiation monitoring of radiographers. The management of tertiary health institutions should ensure that personnel monitoring devices are made available to radiographers, and stricter rules should be placed on the daily wearing of dosimeters.

## INTRODUCTION

The use of radiation for diagnostic and therapeutic reasons in the medical sector has made the radiology department vital in the overall provision of radio-diagnostic services. Shorter hospital stays, the obviation of exploratory surgery, better cancer detection and treatment are just a few of the immediate benefits of medical imaging<sup>1,2</sup>. Due to the daily growth in diagnostic procedures, the yearly per caput effective dose has doubled globally during the last decade<sup>3</sup>. Radiation, which is widely applied in the diagnosis and treatment of diseases, pose an occupational health risk for the health worker<sup>4</sup>. Previous studies disclosed that medical radiation workers constituted the highest number of occupational radiation workers, with over 2.3 million of them estimated worldwide<sup>5,6</sup>. This implies that radiographers are among the high-risk population considering their work proximity with radiation-generating equipment.

Consequent upon the stochastic and non-stochastic effects radiation workers are susceptible to, radiation protection concepts and recommendations for personnel safety have been devised by institutions like the International Atomic Energy Agency (IAEA)<sup>7</sup>. In Nigeria, the Nigerian Nuclear Regulatory Authority (NNRA), established by the national safety and radiation protection act 1995 of the Federal Government of Nigeria, is charged with the responsibility of registering, licensing and enforcing nuclear safety of radiological protection equipment in Nigeria<sup>8</sup>. Radiation doses received by employees working in radio-diagnostic centers must be closely monitored to ensure their safety<sup>9</sup>. The International Commission on Radiation Protection (ICRP) established dose limits for occupational exposure in 1977 to ensure that the dangers associated with occupational exposure are minimal<sup>10</sup>. For radiographers, measuring doses absorbed at regular intervals is a means to keep track of the effective dose absorbed, ensuring that they remain within acceptable occupational limits<sup>9</sup>. Radiation monitoring using suitable devices is useful as it prevents the dose limits of radiographers (20 mSv/yr) from being exceeded<sup>10</sup>. These devices are expected to be worn daily during work hours, and should be retrieved for reading after a specified period. The values obtained should be made known to the employees, used for planning of radiographic duty schedule, and recorded for future reference<sup>9</sup>.

Furthermore, through regular review, the effectiveness of dose optimization strategies can be assessed from the results of individual monitoring<sup>11</sup>.

In South eastern Nigeria, a ten-year old study demonstrated non-compliance with radiation monitoring practices and implementation in some tertiary hospitals<sup>9</sup>. The aim of this study is to reappraise the situation to determine (1) the current state of radiation monitoring for radiographers, (2) to find out if there has been an improvement in the poor practices earlier reported. Findings from the research will be of benefit to radiation monitoring teams and other radiological health management policy making bodies when drafting working documents on radiation monitoring guidelines for south eastern hospitals.

## MATERIALS AND METHODS

This prospective cross-sectional study involved 102 diagnostic radiographers from five (5) tertiary hospitals in southeast Nigeria. This sample size was selected from a population of 137 radiographers working in the hospitals, and using a formula for sample size determination with an error margin of 5%<sup>12</sup>. A 15-item semi-structured questionnaire, adopted from a previous study<sup>9</sup> but with additional questions to capture some aspects of this study, was designed to assess the state of personnel monitoring from the respondents (appendix A). Reliability of the questionnaire was determined by calculating the Cronbach alpha on a pilot study involving 10 participants. The alpha value was above 0.70 showing a very good level of internal consistency. Simple random sampling was used to distribute questionnaires to the number of radiographers proportionately sampled from the individual hospitals. The questionnaires were distributed physically in hard copies, while respondents unable to fill theirs at that time requested for the soft copy via Google forms. Data was analysed using SPSS v 25 and results were presented in tables.

## RESULTS

All questionnaires sent out were satisfactorily filled and recovered from the respondents, giving a 100% return rate. The distribution of the demographics of the 102 respondents are shown in Table 1. Half of the respondents (50%, n = 51) have worked in the radiography department for less than a year with 20.6 % (n = 21) having worked for more than 10 years. All the hospitals studied provided radiation monitoring services to the radiation

workers. More than half of the respondents (68.6%, n = 70) did not have any form of radiation monitoring device, but two out of five hospitals provide radiation monitoring for all the staff (Table 2). The hospitals that did not monitor radiographers requested for prior dosimetry record from 3.9% (n = 4) of the respondents only (Table 2). Out of those that were monitored, staff with more years of service had radiation monitoring devices more than the new ones. They used mostly thermoluminescent dosimeters, wore the device daily and mostly when they were in the diagnostic room (Table 3). Respondents with thermoluminescent dosimeters had their device regularly monitored, and majority had their devices retrieved and read quarterly, and

were provided with the results of the readings. Only two of those monitored have had to go on leave due to high radiation dose values. The respondents reported they spent up to 7 hours in the diagnostic room, and more of the respondents that had no radiation monitoring device spent more time in the diagnostic room than those that were monitored. Though the respondents were monitored, 56.3% (n = 18) did not have a functional dosimetry record in the hospital, and the hospitals that monitored radiographers did not request for prior dosimetry record from 30.4% (n = 31) of the respondents (Table 4).

Table 1: Demographics of the Respondents (n=102)

Variables	Frequency (102)	Percentage (%)
Gender		
Female	38	37.3
Male	64	62.7
Age (years)		
21-30	51	50.0
31-40	35	34.3
41-50	13	12.7
51 and above	3	2.9
Educational Qualification		
BSc.	81	79.4
PGD	11	10.8
M.Sc.	10	9.8
Years of practice (years)		
<1	51	50.0
1-3	16	15.7
4-6	11	10.8
7-9	3	2.9
10 and above	21	20.6

Table 2: Comparison of years of service and work hours with use of radiation monitoring

		Do you have a monitoring device?			
		Yes		No	
		N	N (%)	N	N (%)
Name of Hospital	COOUTH	4	3.9	0	0.0
	FETHA	8	7.8	27	26.5
	NOHE	9	8.8	0	0.0
	UNTH	9	8.8	23	22.5
	NAUTH	2	2.0	20	19.6
	Subtotal	32	31.4	70	68.6
Years of service	Less than 1 year	4	3.9	47	46.1
	1 - 3 years	2	2.0	14	13.7
	4 - 6 years	4	3.9	7	6.9
	7 - 10 years	2	2.0	1	1.0
	More than 10 years	20	19.6	1	1.0
	Subtotal	32	31.4	70	68.6
Consecutive hours spent working in diagnostic room	Less than 3 hours	3	2.9	0	.0
	3 - 4 hours	17	16.7	23	22.5
	4 - 6 hours	12	11.8	23	22.5
	7 or more hours	0	0.0	24	23.5
	Subtotal	32	31.4	70	68.6
Dosimetry record requested prior to employment	Yes	0	0.0	4	3.9
	No	31	30.4	62	60.8
	Not sure	1	1.0	4	3.9
	Subtotal	32	31.4	70	68.6

Table 3: Device type and the practice of radiation monitoring among respondents issued with device

		N	N %
Device used	Film badge	10	31.3
	Pocket Ionization Device	3	9.4
	Thermoluminescent Dosimeter	19	59.4
How often do you use the device	Daily	23	71.9
	Weekly	3	9.4
	Monthly	3	9.4
	Don't have one	1	3.1
	Don't use it	2	6.3
When do you use the device	Hospital premises	1	3.3
	Diagnostic room	29	96.7

Table 4: Implementation of radiation monitoring in hospitals

		N	N (%)
How often is the device retrieved for read	Weekly	1	3.1
	Biweekly	2	6.3
	Monthly	9	28.1
	Quarterly	15	46.9
	Annually	5	15.6
	Subtotal	32	100.0
How often are you provided with outcome of the reading	Weekly	1	3.1
	Biweekly	1	3.1
	Monthly	5	15.6
	Quarterly	15	46.9
	Annually	9	28.1
	Biannually	1	3.1
Subtotal	32	100.0	
Leave recommended due to high exposure	Yes	2	6.3
	No	30	93.8
	Subtotal	32	100.0
Do your hospital have a functional dosimetry record	Yes	3	9.4
	No	18	56.3
	Not sure	11	34.4
	Subtotal	32	100.0

## DISCUSSION

Ten years, ago, Okaro et al<sup>9</sup> evaluated personnel radiation monitoring in tertiary hospitals in South Eastern Nigeria and found out that only 40% of them provided radiation monitoring to its staff. Radiation workers that were monitored were assessed fairly regularly every quarter, and it took up to 3 years for fresh supplies of radiation monitoring devices to be provided. They also reported that there were no available past radiation monitoring records of staff, and such information was not requested during employment of new staff. Ten years after their study, our findings demonstrate that improvement in radiation monitoring and implementation has been marginal. Thankfully, all the hospitals studied now provided radiation monitoring services, but not all radiographers working in the hospitals were issued with radiation monitoring devices. More than half of the respondents had no radiation monitoring device and only two hospitals issued a device to all the radiography staff, a trend which has largely remained unchanged for 10 years<sup>9</sup>. It could be argued that this situation may be peculiar to South Eastern hospitals as similar studies in other regions

of the country revealed better radiation monitoring practices and implementation policies. For instance, in some selected north eastern hospitals, up to 85.2% of their radiation workers had monitoring devices<sup>13</sup> and were monitored as at when due, while another study in Jos recorded a compliance level of 86.5% among radiation workers studied<sup>14</sup>. Another North Eastern study even placed the compliance level at 95%<sup>8</sup>. Even a similar study in Ghana revealed that only 8% of the respondents were not issued with radiation protective devices<sup>7</sup>. Radiation monitoring practices remains poor in South Eastern hospitals, and little effort has been made, both by the radiation workers and hospital management, to improve radiation monitoring and implementation practices.

We also report that the likelihood of having a radiation monitoring device was proportional to the length of years spent in service, with staff more than 10 years in service more likely to be issued with radiation monitoring than their newer colleagues. Since all the hospitals studied did not have a standard policy on radiation monitoring as

shown in the lack of dosimetry records for most radiographers and not requesting for past dosimetry records of new employees, it is less likely for them to arrange for new staff to be issued radiation monitoring devices. Our findings indicate that staff without radiation monitoring spent longer hours in diagnostic rooms when compared to those that were monitored. Additionally, there was an inverse relationship between the use of radiation monitoring and the length of time radiographers worked in the room. This may be attributed to a higher awareness level among monitored radiographers which made them conscious of the length of time they spent working in the diagnostic room, or due to a functional radiation monitoring policy in the hospital. A particular study<sup>14</sup> which sought to determine the relationship between the presence of radiation monitoring policy and the disposition of radiation workers towards radiation monitoring revealed that staff who had radiation monitoring devices were more likely to remember to use them and had a positive attitude towards utilization of radiation monitoring. This indicates that the presence of radiation monitoring policies increased the consciousness of staff towards limiting their exposure to radiation and reducing the length of time spent working in the diagnostic room.

The United States Nuclear Regulatory Commission in specifying the duration for the retrieval of monitoring devices recommended that TLDs, film badges, and pocket ionisation chambers should be retrieved quarterly, monthly and daily respectively, and the results of the reading for not more than 2 weeks after the device was retrieved<sup>15</sup>. Nevertheless, this study observed that the periods of retrieval was exceeded in 31.2% (n = 10) of the radiographers monitored, irrespective of the dosimeter used. Out of 19 TLDs, only 2 exceeded the retrieval period, half of the film badges were retrieved as at when due, and none of the film badges were retrieved at the appropriate time. The TLDs had the higher likelihood to be read at the appropriate time than other methods of radiation monitoring, a finding which has previously been observed since they are reusable and stored radiation absorbed over a longer period of time<sup>13</sup>. We are of the opinion that South Eastern hospitals uniformly adopt TLDs rather than film badges and pocket ionization chambers, since it will make quarterly reading possible and encourage consistency and sustainability of the exercise. Half of the respondents were provided

with the outcome of the readings at the appropriate time, and Botwe<sup>7</sup> had attributed the delays and absence of feedback to radiographers to the lack of knowledge by the proper authorities to report radiation safety problems. Although keeping dosimetry records is an essential part of radiation monitoring, further results from this study revealed that dosimetry records were not demanded from the radiographers before employment by their current employee. Over 91% (n = 93) of the respondents were not asked about their dosimetry records before employment. This was similar to the findings of Nwokeoji and Avwiri<sup>16</sup> who found out that over 80% of participants in their study were not asked for their dosimetry records before employment and a slight majority (n=18, 56%) claimed they didn't have dosimetry records. These findings suggest that while very few radiographers in South Eastern were monitored, the radiation dose history of those monitored were not kept, which defeated the aim of monitoring the radiographers in the first place.

An important issue in individual monitoring is ensuring that the dosimeters are worn by the monitored personnel when they are within the hospital premises and are working in the diagnostic room<sup>11</sup>. Hence, the compliance of radiographers is key in ensuring a successful monitoring exercise. This study reported 71.9% compliance among monitored radiographers in wearing their dosimeters each time they go to the diagnostic room or are in the hospital premises. However, there was no marginal improvement in this number as a similar percentage was earlier reported<sup>13</sup>. Most of the radiographers wore their TLDs only when they entered the diagnostic room, indicating that background radiation while in the department was not monitored. This finding implies that the amount of dose detected by some of the dosimeters is not a measure of the true value of the dose absorbed by the radiographers due to non-compliance to the practice of radiation monitoring by the personnel.

## CONCLUSION

The practice and implementation of radiation monitoring of radiographers which entails every radiographer having an individual monitoring device, wearing it daily, retrieving it as at when due, getting feedback at the right time, availability of dosimetry records, remains poor in south eastern tertiary hospitals. This has shown marginal improvement in what was obtainable 10 years ago

and are yet not at par with international regulation and requirements. There is a need for monitoring and professional radiography bodies to step in and ensure optimal compliance of radiation monitoring of radiographers in south eastern tertiary hospitals.

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