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Review Article

Status Report on Radiation Protection in Radiology Departments in the Kindia Region, Guinea

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Abstract: *Objectives*: To take stock of staff, premises and personal protective equipment in radiology departments in the Kindia region. *Methodology*: Cross-sectional, descriptive study conducted in March 2023, including all radiology departments and cabinets in the Kindia region. We reported on the characteristics of working conditions for the staff directly involved in radiation work (age, sex, qualifications, radiation protection training, duration of working under radiation, number of examinations per year), radiology rooms and equipment (room surface area, door manufacturing materials, building construction materials, illuminated signage at hall entrances, leaded shield), the use of personal radiation protection equipment (leaded apron, cap, thyroid protector, leaded goggles and gloves), the availability of dosimetric monitoring resources and the type of radiology equipment available. Results: 8 radiology departments and practices were surveyed, including 5 public (62.5%) and 3 private (35.5%). 21 medical and paramedical staff working directly under ionizing radiation, including 16 manipulators (76%), 2 physicians acting as radiologists (9.5%), one senior radiology technician (4.8%) and no radiology physicians. The average age of the staff was 32 (28-45), of whom 86% were male. The average number of years working with radiation was 4 years (2-7 years). 57% of staff had received radiation protection training, including 42.9% on the Internet, 9.5% post-graduate training and 4.8% initial training. 50% of the halls had a surface area of $30m^2$, 25% had a surface area of 24 m^2 and 25% had a surface area of $18m^2$. 62.25% of the doors were made of wood with lead and 62.5% of the walls were solid brick with concrete lining. There were no illuminated signs at the entrance to the halls. All departments had lead aprons, only one had a thyroid protector, and none had a dosimeter. The lead apron was the most commonly used personal protective equipment (86%), followed by leaded gloves (29%) and thyroid protectors (4.8%). 37.5% of departments had a bone-lung x-ray table only, 37.5% a bone-lung x-ray table and a mobile radio, and 25% a mobile radio only. *Conclusion*: The practice of radiation protection in health facilities in the Kindia region suffers from a number of shortcomings, including non-compliance with construction standards, the virtual absence of qualified radiology staff and a very low level of training in radiation protection. The use of personal protective equipment against X-rays is very limited, consisting mainly of leaded aprons.

Keywords: Radioprotection, Kindia, Ionizing, Radiation

1. Introduction

The medical use of ionizing radiation can cause adverse biological effects in staff directly assigned to work with radiation (DARW), patients, and anyone in the vicinity of the X-ray room [1, 2].

The observance of radiation protection, which is the set of rules, procedures, means of prevention and monitoring aimed at preventing or reducing the harmful effects of ionizing radiation, will protect man and the environment from the harmful effects of ionizing radiation while allowing them to be used. [3].

Several African countries continue to equip their hospitals which are ionizing radiation source without having or implementing an appropriate national legislative and regulatory framework for the application of recommendations issued by international specialized bodies such as the International Commission on Radiological Protection (ICRP), the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO) [2, 4]. The IAEA's "Safety Standards" series recommends that workers' knowledge of the fundamentals of radiation protection and safety, their level of training, and their skills and abilities to perform specified tasks safely, should be assessed and found to be adequate, prior to any unsupervised assignment [2, 5].

In the Central African Republic, Songrou et al in 2019 reported that more than half of staff (63.2%) had never been introduced to radiation protection before working in a radiodiagnostic department [6].

SAVI et al found that radiation risk signs were inadequate in most cases, and no radiology department in northern Benin in 2022 had delimited zones according to exposure levels. [3].

The Republic of Guinea has no training schools for radiologists or radiology technicians. In 2020, the country had just 8 radiologists, all practicing in the capital Conakry, and 12 senior radiology technicians, 3 of whom were assigned to the provinces. [7]. It also lacks a national radiation protection agency and nuclear laws to regulate the use of ionizing radiation in medical practice. [7].

The kindia health district recorded 2,743 road accidents in 2020, the second most common reason for hospitalization after malaria, and 1,515 radiology examinations were carried out in public health facilities in the same year. [7]. This situation prompted the present study, the aim of which was to take stock of the staff, premises and personal protective equipment (PPE) in radiology departments in the kindia region.

2. Methodology

Study setting: The study took place in the public and private radiology departments and clinics of the Kindia health district in the Republic of Guinea. This is the closest administrative region to the capital Conakry, at 150 km away. It comprises 5 prefectures (Kindia, Telémelé, Coyah, Dubréka and Forécariah). According to data the Republic of Guinea Ministry of Health’s 2021 Health Statistics Yearbook, [7] the population of the Kindia health district is estimated at 1,916,277, with ratios of one doctor per 39,914 inhabitants, one nurse per 34,231 inhabitants and one technical health agent per 18,662 inhabitants. The region recorded 2,743 road accidents, the second most common reason for hospitalization after malaria. 1,515 radiology examinations were carried out in public health facilities in the same year. [7].

Type and population of study: This was a cross-sectional, descriptive study carried out in March 2023. We included all medical and paramedical staff directly involved in radiation work in all radiology departments and practices in the region. We defined as:

Radiologist: Doctor with a specialized diploma in radiology and medical imaging.

Physician acting as radiologist: a general practitioner who does not hold a specialist diploma in radiology and who works as a radiologist in a medical facility.

Senior radiology technician: Para-medical staff holding a senior technician's diploma or a bachelor's degree in radiology.

Manipulator: Paramedical staff (nurse or health technician) who does not hold a higher technician's diploma or license in radiology, working in a radiology department or clinic as a radiology technician.

Assistant, manipulator: a caregiver assisting the manipulator or senior radiology technician in carrying out radiology examinations.

Data collection: We reported the characteristics of working conditions for personnel directly assigned to radiation work (age, gender, qualifications, radiation protection training, number of years working under radiation, number of examinations per year), radiology halls and equipment (room surface area, door manufacturing materials, building construction materials, illuminated signs at room entrances, leaded shield), the use of personal radiation protection equipment (leaded apron, cap, thyroid protector, leaded goggles and gloves), the availability of dosimetric monitoring resources and the type of radiology equipment available.

3. Results

Of the 8 radiology departments and clinics surveyed, 5 were public (62.5%) and 3 private (35.5%).

3.1. Inventory of Staff Directly Involved in Radiation Work (DARW)

Of the 21 medical and paramedical staff working directly under ionizing radiation, there were no radiologists. The characteristics of DARW personnel are described in Table 1.

Table 1. *Situation of DARW personnel in the Kindia administrative region, 2023.*

Charasteristics	WORKFORCE N = 21	PERCENTAGE
Age in years		
21-39 years	15	71
40-65 years	6	29
Median age and IQR[1]	32(28-45)	
Gender		
Female	3	14
Male	18	86
Professional qualifications		
Assistant manipulator	2	9.5
Manipulator	16	76
Physician acting as radiologist	2	9.5
Senior Radiology Technician	1	4.8
Radiologist	0	
Year under ionizing radiation (median and IQR)[1]	4 (2-7)	

Charasteristics	WORKFORCE N = 21	PERCENTAGE
Number of examinations (mean ±SD)[2]	110 ±54	

[1]IQR= interquartile range
[2]SD= Standard deviation

3.2. Radiation Protection Training for DARW Personnel

12 staff (57%) had taken radiation protection training, including one in initial training, 9 on the internet and 2 in post-graduate courses.

19 DARW staff (90.5%) wanted to take radiation protection training.

3.3. Inventory of Radiology Rooms and Equipment

No radiology departments or clinic had CT or mammography equipment. The characteristics of the radiology rooms and equipment are shown in Table 2.

Table 2. *Status of radiology rooms and equipment.*

FEATURES	N = 8	PERCENTAGE
Room area in m^2		
18	1	25
24	2	25
30	4	50
Door manufacturing equipment		
Lead-free metal	2	25
Lead-free wood	1	12,5
Wood with lead	5	62,5
Wall construction materials		
Lead-free hollow brick	3	37,5
Solid brick with concrete lining	5	62,5
Illuminated signage at hall entrance	0	0
Screen with leaded glass	5	62,5
RADIOLOGY EQUIPMENT		
Mobile radio only	2	25
Lung bone radiology table only	3	37,5
Lung bone radiology table + mobile radio	3	37,5

3.4. Inventory of PPE Use by DARW Staff

Table 3. *Status of use of radiation protection PPE by DATR staff.*

CHARASTERISTICS	N = 21	PERCENTAGE
Leaded apron	18	86
Leaded thyroid cover	1	4.8
Sealed gloves	6	29
Leaded Gonad Guard	2	9.5
Skirt plombe	2	9.5
Leaded glasses	2	9.5
Leaded bonnet	2	9.5
Dosimeter	0	0

PPE= Personal Protective Equipment
DARW = Directly Assigned to Radiation Work

4. Discussion

We carried out a descriptive cross-sectional study in March 2023 on 8 health facilities (5 public and 3 private) with radiology services in the administrative region of Kindia, in order to take stock of the staff directly assigned to work under radiation (DAWR) and the radiology equipment.

During the course of our study, 21 personnel directly involved in radiation work were surveyed, with a median age of 32. This relatively young average age is similar to that of Ongolo et al. [2] in Cameroon, who found an average age of 38.8. This could be explained by the high number of young workers who were more accessible.

The predominance of male personnel is consistent with that found by Songrou et al. [6] in the Central African Republic, which was 72%, and contrary to that of Kokou A et al. [1] in Benin, who reported a female predominance of 66.54%. This male predominance is thought to be due to the easier access of men to the workplace in our context, in relation to sociological facts.

The average working life of the staff directly involved in the radiation work in our study was 4 years. The predominance of staff with less than 5 years' experience in radiology departments in Africa is already known, with proportions ranging from 47.1% in Mali [8] to 63.9% in Cameroon [2]. This similarity may be due to the fact that health realities in sub-Saharan countries are superimposable.

We found no radiologists and only one senior radiology technician (4.8%) working in the Kindia region. This low level of qualification of personnel working directly under ionizing radiation is different from that reported by Ongolo et al. [2] in Cameroon, who found 9.6% radiologists, 39.8 resident radiology physicians and 34.9% senior radiology technicians. This difference can be explained by the lack of training schools for radiologists and radiology technicians in Guinea on one hand, and the fact that our study was carried out in the provinces, on the other.

Only one staff member (4.8%) had taken radiation protection training as part of their initial training; 42.85% stating that he discovered the concept of radiation protection on the Internet, and over 90% wanted to take further and qualifying training in radiation protection. This contrasts with Songrou et al. [6] and Ongolo et al [2] who respectively reported that 36.8% and 72% of respondents had taken radiation protection training as part of their initial training. However, 79.5% of Ongolo et al. [2] stated that they had never received any further training or refresher courses in radiation protection after their initial training. Indeed, assigning staff with no knowledge of radiation protection to a department using ionizing radiation is contrary to IAEA recommendations, which require anyone working with ionizing radiation for medical purposes to have ongoing training in radiation protection. [5].

The majority of our radiology rooms (75%) had a minimum surface area of $25m^2$ recommended by Ivorian legislation. [9]. This result is similar to those reported by SAVI et al. [3] in northern Benin in 2017 and Kouassi et al. [9] in Abidjan in 2005, who respectively found 78.3% and 80% of rooms with a surface area greater than or equal to 25 m^2. Note that a small room of less than $25m^2$ limits compliance with radiation protection measures, free circulation of patients and staff, and ease of equipment maintenance.

Three doors (37.5%) were unsealed, two of them metalic and one wooden. Also 37% of the walls were made of hollow bricks with no concrete lining or leaded shield, compared with 100% leaded doors and 100% armoured walls in Kouassi's study in Abidjan. [9]. Non-compliance with radiology room construction standards encourages the spread of ionizing radiation outside the rooms, exposing staff, patients and accompanying persons.

The premises of the radiodiagnostic departments in our study had no signage and/or delimitation of zones, as in studies carried out in the northern regions of Benin [3] and northern Cameroon [10]. These results differ from those of Ongolo-Zogo [2], who found that 73.1% of imaging departments in the city of Yaoundé had signage at the entrance to the examination room. In principle, all radiology room entrances should have a light signal activated automatically when the X-ray tube is switched on [3, 11]. The absence of light signals increases the risk of worker's exposure to X-rays.

All departments had at least one lead-coated apron, and only one department had a thyroid protector. The lead-coated apron was the most widely used personal protective equipment (86%), followed by lead-coated gloves (29%) and thyroid protectors (4.8%). Other personal protective equipment (thyroid protector, gonad protector, leaded skirt, protective goggles and leaded cap) was not widely available. These were absent in all the health facilities surveyed in northern Cameroon in 2017 [10]. Tapsoba et al [12] found leaded gloves, thyroid protectors and leaded goggles in 58.8%, 82.3% and 5.88% of wards respectively [12]. This personal protective equipment has never been inspected for physical integrity, contrary to international radiation protection standards, which recommend periodic inspection of the effectiveness and conformity of such equipment [13].

We noted a total absence of dosimetric and medical monitoring of the staff. Mbo Amvene et al [10] reported the same situation in radiology departments in the far north of Cameroon in 2017. SAvi et al [3] found that dosimetric monitoring was effective in only one facility in northern Benin with a CT scanner, and was carried out only at the time the examinations were performed. In principle, all workers exposed to X-rays should benefit from medical and dosimetric monitoring. Depending on their activity and level of exposure, this may involve either a passive or active dosimeter. The accumulation of doses received helps the occupational physician to anticipate the occurrence of radiation-induced pathologies. It is also based on biological examinations [14]. Even low-dose exposures are likely to have adverse effects on the worker [3, 15].

5. Conclusion

The practice of radiation protection in health facilities in the Kindia region suffers from a number of shortcomings, including the quasi-absence of qualified radiology staff and the very low level of training in radiation protection. The use of personal protective equipment against X-rays is very limited, consisting mainly of leaded aprons.

The absence of a regulatory authority for the medical use of ionizing radiation has paved the way for the installation of radiology units that do not comply with construction standards and practical measures for the radiation protection of workers exposed to ionizing radiation.

A nationwide study should enable general documentation of radiation protection in Guinea, so that corrective measures can be taken to raise the level of radiation protection for workers in the field of diagnostic radiology.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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