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Study on Compliance with Radiation Protection Rules in the Medical Imaging Department of Pr Bocar Sidy Sall Hospital of Kati (Mali)

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Abstract

Objective: Evaluate the level of compliance with radiation protection rules in the medical imaging department of the University Hospital Center (CHU) of Kati. Methodology: This was a cross-sectional and descriptive study carried out in the medical imaging department of Pr Bocar Sidy Sall (BSS) Hospital of Kati. A questionnaire was developed and sent to the staff of the medical imaging department. The assessment focused on the radiation protection of personnel, radiation protection measures for patients, the delimitation and signage of zoning as well as the application of radiation protection principles. Results: Twenty-one people participated in the study, 90% of whom were men. The 30 - 39 age group was predominant with 61.90%. 33.33% of the staff knew the principles of radiation protection; 86% of our sample knew the basic rules of radiation protection. The majority of the staff in the imaging department (61.90%) had a perfect knowledge of protective equipment. For 76% of our workforce, the limits of the radiation doses received are regulated in Mali. 76% of those surveyed have not taken any additional training in radiation protection. The doors are closed during the X-ray examination for 76.19% of the respondents and 95% of the staff put themselves behind the sealed screen during the examination. For 81% of the respondents, the design of the premises met radiation protection standards. 62% of practitioners have a dosimeter and 80% of them wear it during their shift. For 62% of our sample, the

change of the dosimeter is quarterly. The systematic request for DDR (date of last menstrual period) in women and the adaptation of the delivered dose to the patient's morphology was only carried out by 65% of practitioners. The majority of staff (81%) did not benefit from medical surveillance, while for 55% of respondents the level of radiation protection in the establishment was average. Conclusion: This study enabled us to highlight the shortcomings in terms of radiation protection within the imaging department of the CHU Kati.

Keywords

Radiation Protection, Compliance, X-Rays, Dosimetry

1. Introduction

Radiation protection is the set of measures implemented for the protection of persons against the recognized or potentially harmful effects of ionizing radiation. Applied to the medical world, they concern first patients and then professionally exposed staff and finally extend to the public and the environment [1].

The ICRP (International Commission on Radiological Protection) is the international reference body whose various works have enabled the elaboration of the main principles of radiation protection which will be included in Community (Euratom) and national regulations. The protection system is based on three main principles: justification, optimization and limitation of doses [2] [3] [4] [5].

Radiation protection is a challenge for all countries, especially those in sub-Saharan Africa. The implementation of radiation protection remains approximate because of the lack of information, the absence of appropriate professionals, the non-existence and/or weakness of radiation protection control and inspection services [6].

The Society of Radiologists of Francophone Black Africa (SRANF), aware of the lack of training in the field, organized during its annual congress in Cotonou (Benin) in 2019, a postgraduate training in radiation protection for users of ionizing radiation.

The Malian Radiation Protection Agency (AMARAP) was created by Ordinance 02-060/P-RM of 5 June 2002 [7]. Its mission is to develop the elements of the national policy in the field of radiation protection and to ensure the control of sources of ionizing radiation and the management of radioactive waste. Work has been carried out in Mali on the evaluation of the radiation protection knowledge of the personnel of the radiology department, highlighting radiation protection deficiencies [3] [8] [9]. However, no study has been carried out on the subject at the University Hospital Center (CHU) Pr Bocar Sidy Sall of Kati hence the interest of this work which had the main objective of evaluating the level of compliance with radiation protection rules in the medical imaging department.

2. Methodology

Our study was carried out in the Medical Imaging Department of Pr Bocar Sidy Sall Hospital in Kati.

2.1. The Type and Period of Study

We conducted a descriptive cross-sectional study conducted for a period of forty-five days from January 16, 2020 to February 29, 2020 in the medical imaging department of the CHU BSS of Kati.

2.2. The Study Population

The study concerned the workers and trainees of the medical imaging department of the CHU BSS.

Inclusion criteria: were retained (included) in the study, all workers and trainees of the medical imaging department of the CHU BSS of Kati present at the time of the study and having agreed to participate.

Non-inclusion criteria: All workers and trainees from the medical imaging department of the CHU BSS de Kati who were absent at the time of the study and workers and trainees who did not agree to participate were not included.

2.3. Data Collection

The data were collected through the use of two tools: a questionnaire addressed to the staff of the medical imaging department and an observation grid.

2.4. Data Analysis

Our data was entered on Word 2016 software and data analysis was performed in Excel 2016 spreadsheet and Epi info 7.

2.5. Consent

All participants in the study were provided with detailed information on the objectives and modalities of implementation. They were only asked to answer questions after obtaining their oral consent. Anonymity and confidentiality were respected through the codification of identification data, the realization of the entry by the researcher and the restriction of access to these data to the research team.

3. Results

3.1. Epidemiological Aspects

Our questionnaire was distributed in person to the 21 workers working in the medical imaging department of the BSS University Hospital of Kati.

1) The qualification of the respondents: Table 1 shows a summary of the distribution of respondents according to their occupational qualifications. Trainees were the most representative with 47.62% of cases.

Table 1. Distribution of respondents according to their occupational qualifications.

Profile	n	%
AM and TSS specialized in imaging	4	19.04
Maneuvers	2	9.52
Trainees (FMOS, INFSS, DES)	10	47.62
TSS	1	4.76
Radiologists	3	14.29
Secretary	1	4.76
Total	21	100

Note: n = number.

2) Gender:

The male sex was predominant in our study with 90% and the sex ratio is 9.5 in favor of men.

3) Age: **Figure 1** shows that the group of 30 - 39 years old was dominant with 61.90%.

3.2. Administrative and Organizational Measures for Radiation Protection

1) Knowledge of the fundamental principles of radiation protection: **Table 2** shows a Distribution of respondents according to knowledge of the basic principles of radiation protection. 52.38% of respondents had a low knowledge of the basic principles of radiation protection.

2) Knowledge of the regulation of doses received during radio exposure in Mali: **Figure 2** shows the limits of doses received during occupational radiation exposure were recognized as regulated in Mali for 76% of respondents.

3) Limitation of radio exposure to service: Radio exposure to the service was limited according to 90% of respondents.

4) Radiation protection targets: **Figure 3** shows the radiation protection targets were: DATR, public and environment for 16 respondents.

5) Administrative measures with regard to pregnant or breastfeeding staff: **Figure 4** shows that pregnant or breastfeeding professionals were relocated to another position in the service for 57.14% of respondents.

6) Existence of rules of procedure: **Figure 5** indicates that for 43% of the respondents, there were no rules of procedure for radiation protection.

7) Area plan: **Figure 6** shows that for 52%, there was no posted service plan with traffic areas and source locations.

8) Radiation protection training: **Figure 7** shows 76% of respondents had not received any additional training in radiation protection.

9) Radiation protection actors: **Figure 8** indicates that all respondents had cited radiology personnel as actors in radiation protection.

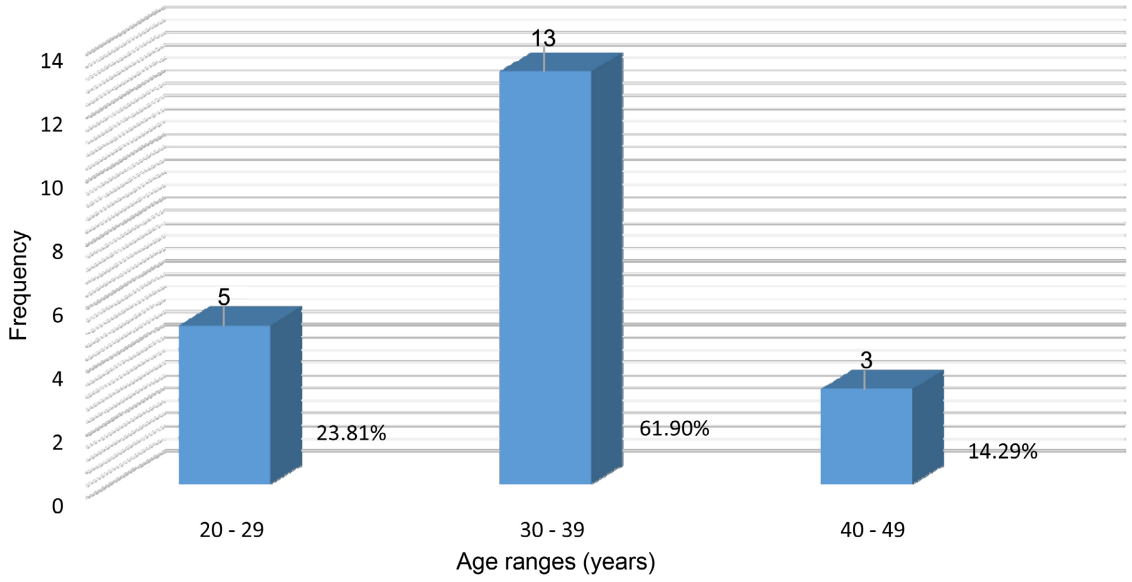

Figure 1. Distribution of respondents by age.

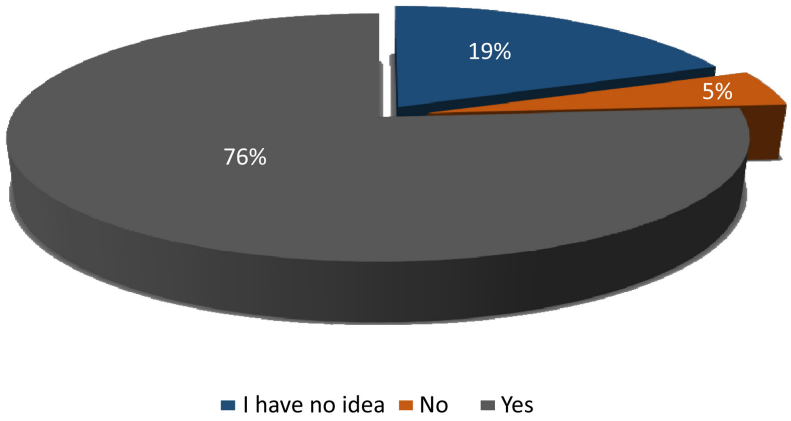

Figure 2. Distribution of respondents by level of knowledge about dose regulation.

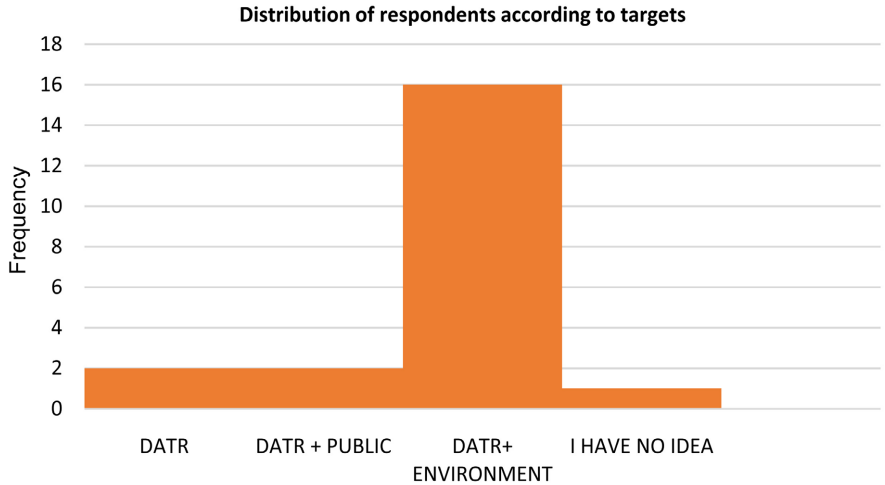

Figure 3. Distribution of respondents by target. Note: DATR worker directly exposed to ionizing radiation.

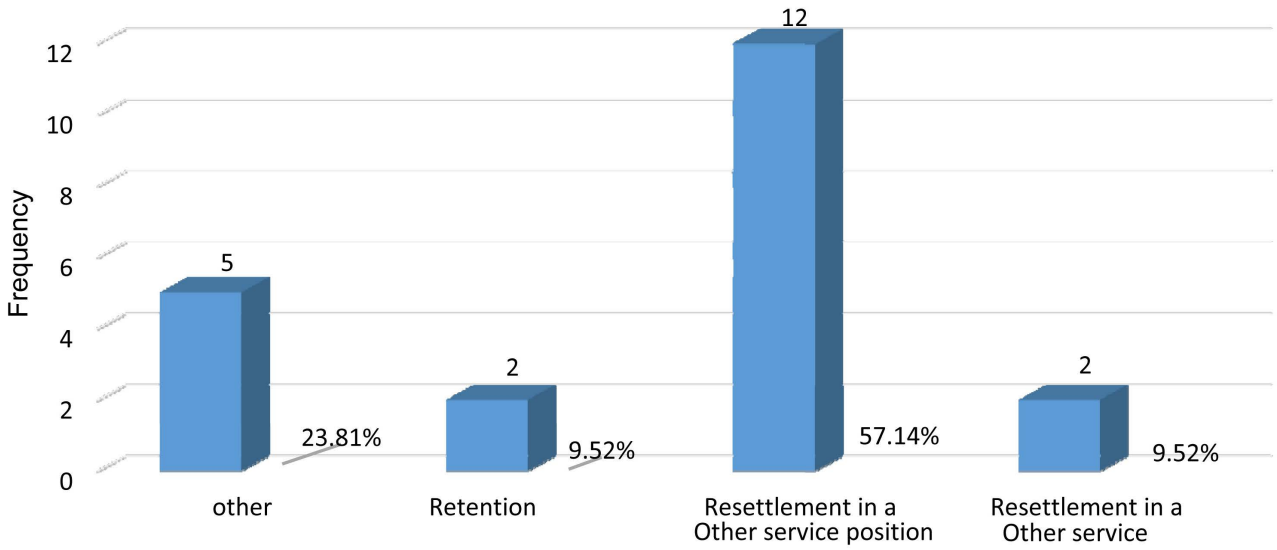

Figure 4. Distribution of respondents by administrative status.

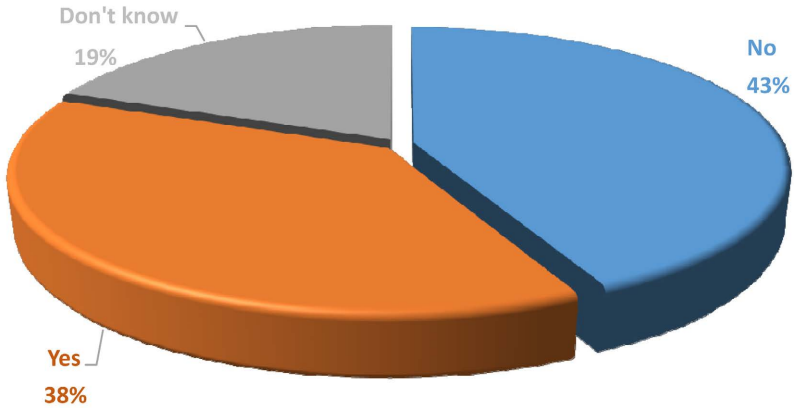

Figure 5. Distribution of respondents according to the rules of procedure according.

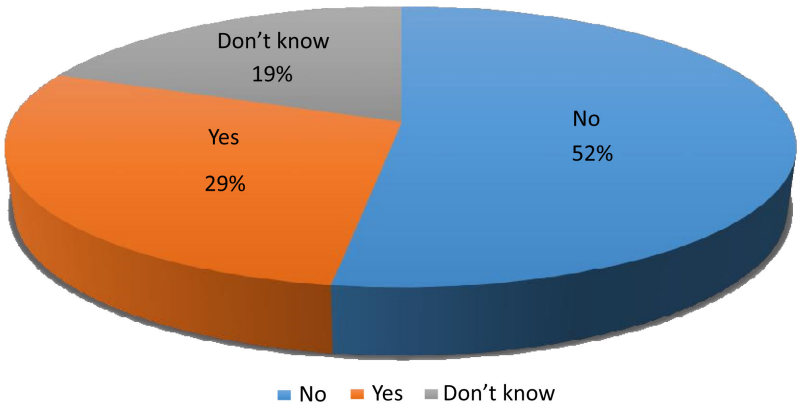

Figure 6. Distribution of respondents according to area plan.

10) Radiation protection structures: **Figure 9** shows 81% of respondents, the structure that deals with the determination of radio exposure in Mali was AMARAP.

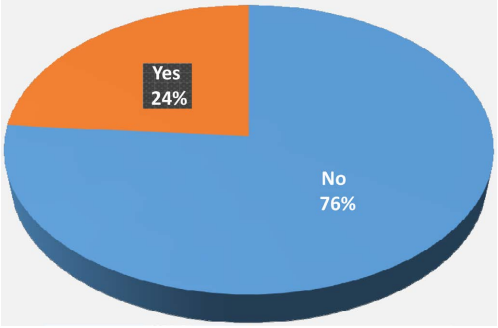

Figure 7. Distribution by radiation protection training.

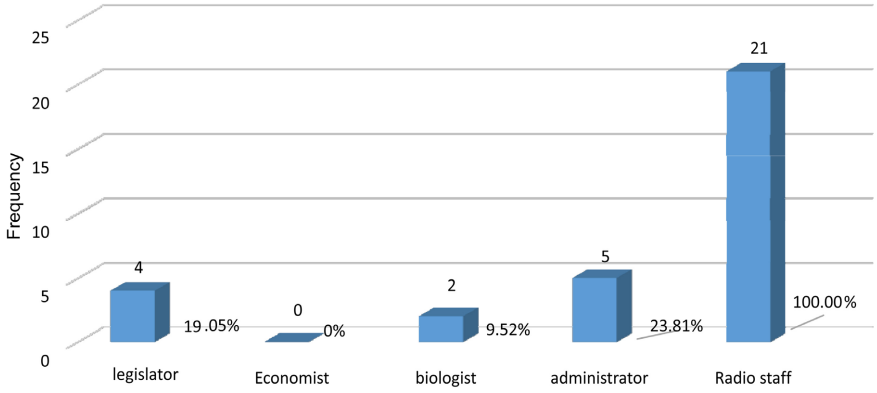

Figure 8. Distribution of respondents according to radiation protection actors.

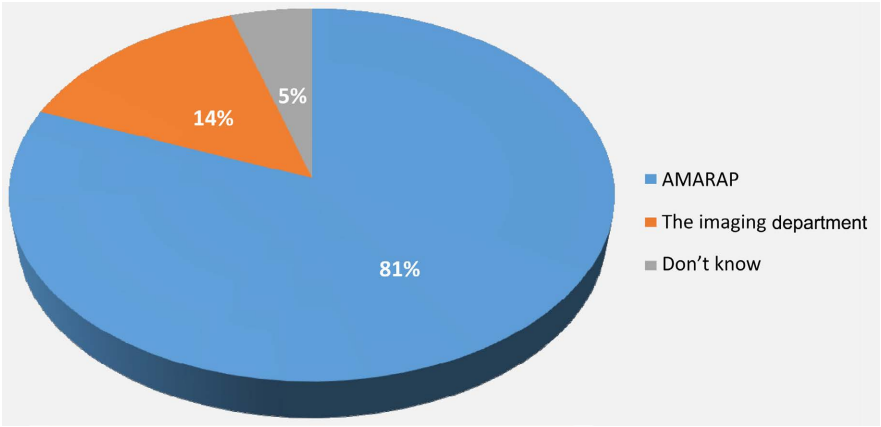

Figure 9. Distribution of respondents according to the structures of radiation exposure in Mali.

Table 2. Distribution of respondents according to knowledge of the basic principles of radiation protection.

Level of Knowledge	n	%
Good	7	33.33
Weak	11	52.38
I have no idea	3	14.29
Total	21	100

3.3. Basic Principles of Worker Health Monitoring

1) Categories: Figure 10 shows that for 53% of workers had no idea about their classification in category A or B.

2) Technical measures: Figure 11 among technical radiation protection measures, dosimetric monitoring came first with 85.71%.

3) Protection of sensitive organs: Figure 12 shows that the leaded cover was used for the protection of sensitive organs according to 48% of respondents.

4) Closing the doors: Table 3 indicates the doors and exits were systematically closed during the examination for 76.19% of the respondents.

5) Using of the diaphragm: Table 4 shows that the diaphragm was systematically used according to 52.38% of respondents.

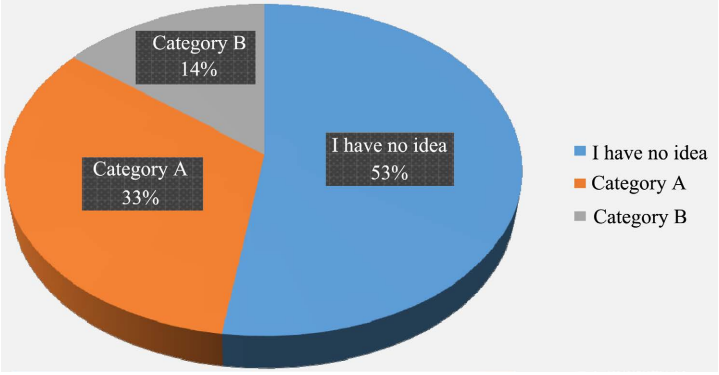

Figure 10. Distribution of respondents by category.

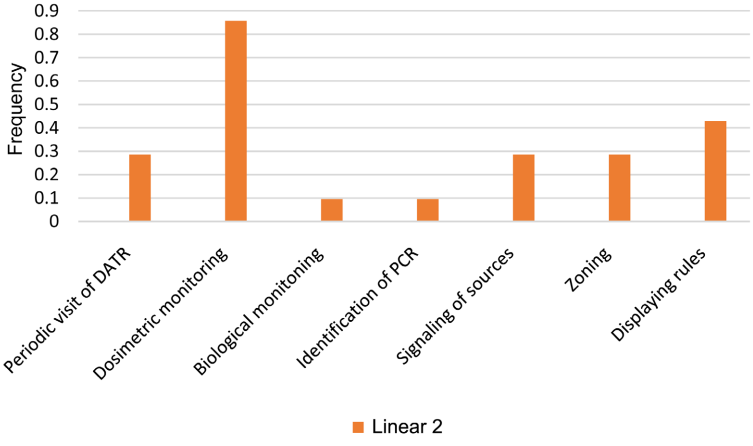

Figure 11. Distribution by technical radiation protection measures.

Table 3. Distribution of respondents by closing of doors and exits.

Closing doors and exits	n	%
From time to time	1	4.76
Never	4	19.05
Systematically	16	76.19
Total	21	100

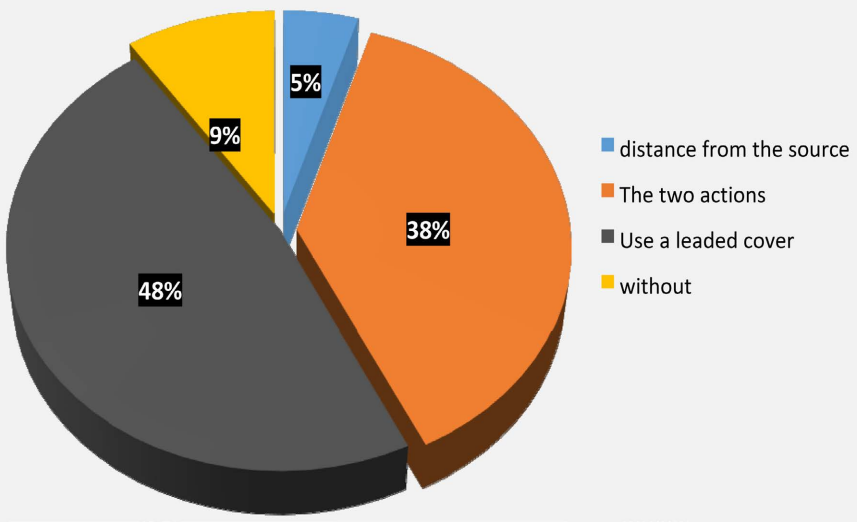

Figure 12. Distribution of respondents according to the protection of sensitive organs.

Table 4. Distribution of respondents by diaphragm use.

Use of the diaphragm	n	%
from time to time	3	14.29
Never	7	33.33
Systematically	11	52.38
Total	21	100

6) Behavior during exams: 95% of the respondents put themselves behind the sealed screen during the examination.

7) Existence of a Competent Person in Radiation Protection: **Figure 13** shows, for 52% of the respondents, there were no person competent in radiation protection in the establishment.

8) Basic rules of radiation protection: **Table 5** shows that more than the majority of respondents were aware of the basic rules of radiation exposure.

9) Radiation protection equipment: **Table 6** indicates that for the majority of respondents were aware of the protective equipment of a radiology room.

10) The layout of the premises: **Figure 14** shows that According to 81% of respondents, the design of the department's premises complied with the recommended radiation protection standards.

11) Wall building materials: **Figure 15** shows that for 42% of respondents, the construction materials for the walls of a radio room were lead.

12) Door construction materials: **Figure 16** shows that the door of a radiology room was made of wood and lead according to 42% of respondents.

13) Existence of quality control of installations: According to 57% of the respondents there was quality control of the installations.

14) Existence of preventive maintenance of devices: For 52% of the respondents there was a preventive maintenance plan for the devices.

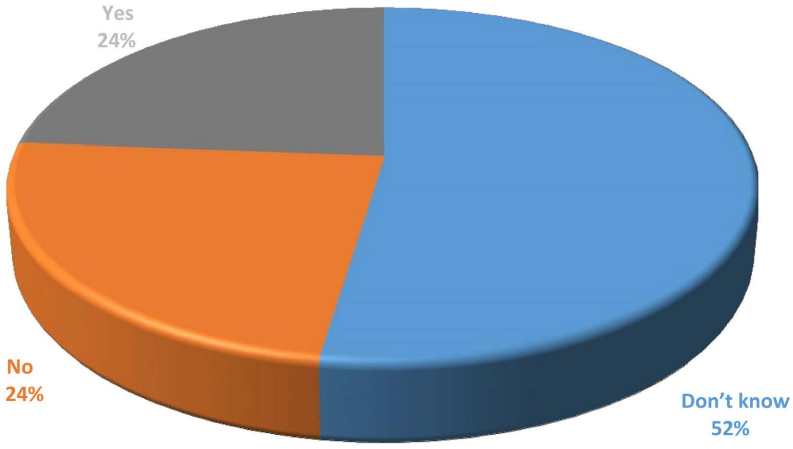

Figure 13. Distribution of respondents according to the existence of PCR. Note: PCR = Person competent in radiation protection.

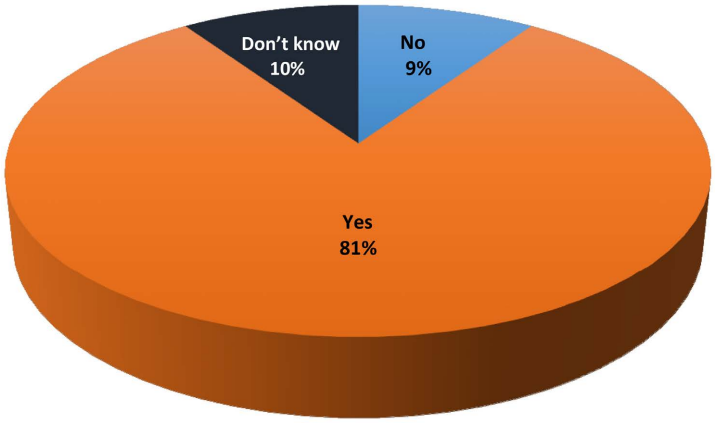

Figure 14. Distribution of respondents by layout of premises.

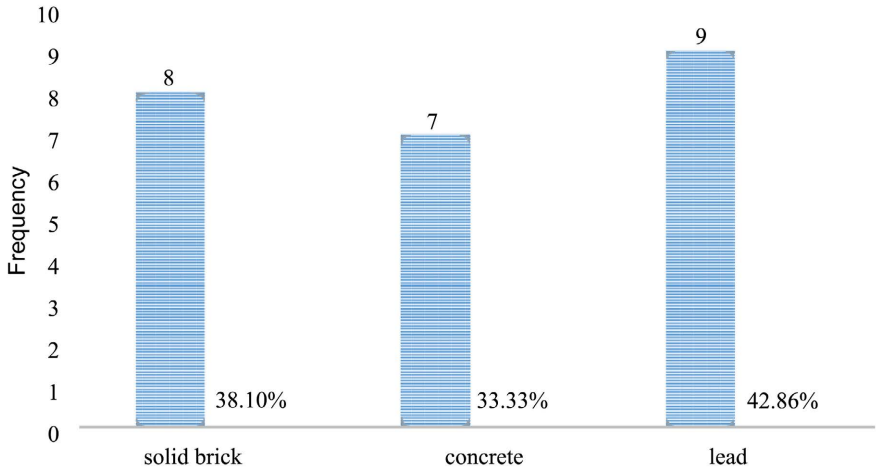

Figure 15. Distribution of respondents by building materials.

15) Standards of radio-exposure of DATR in Mali: The majority (61.90%) of respondents had no idea of the standards applied in Mali for DATR in the context of global radio exposure.

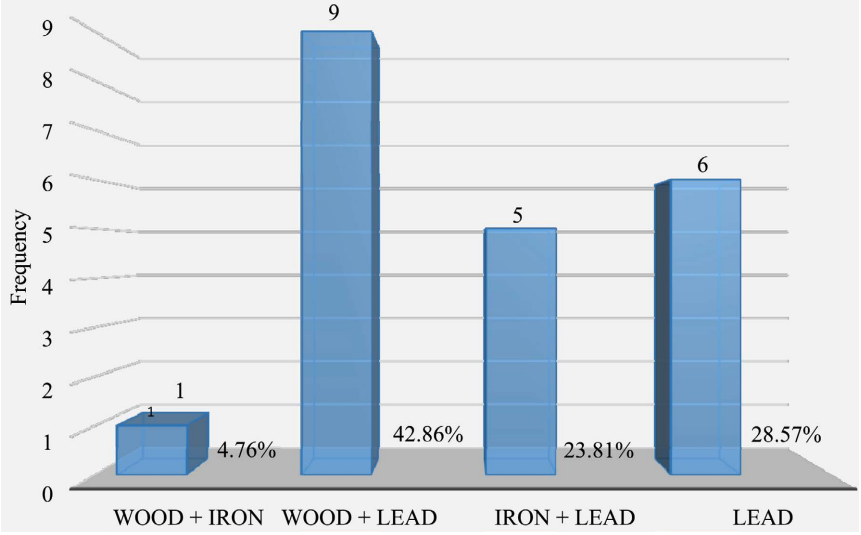

Figure 16. Distribution of respondents by door materials.

Table 5. Distribution of respondents according to knowledge of the basic rules of radiation protection.

Knowledge of Basic rules of radiation protection	Yes		No		Total	
	n	%	n	%	n	%
Time	20	95.24	1	4.76	21	100
Distance	19	90.48	2	9.52	21	100
The screen	15	71.43	6	28.57	21	100

Note. n = number.

Table 6. Distribution of knowledge of basic rules according to knowledge of radiation protection equipment.

Knowledge of equipment	Yes		No		Total	
	n	%	n	%	n	%
Leaded deck	19	90.48	2	9.52	21	100
Leaded glove	12	57.14	9	42.86	21	100
Gonad cache	15	71.43	6	28.57	21	100
Leaded bezel	12	57.14	9	42.86	21	100
Leaden screen	20	95.24	1	4.76	21	100
Thyroid cache	16	76.19	5	23.81	21	100

Note. n = number.

16) Special medical surveillance: The 81% of workers did not benefit from special medical surveillance by the occupational physician.

17) Level of radiation protection of the establishment: **Figure 17** shows that according to 55% of the workers, the level of radiation protection in the establishment was average.

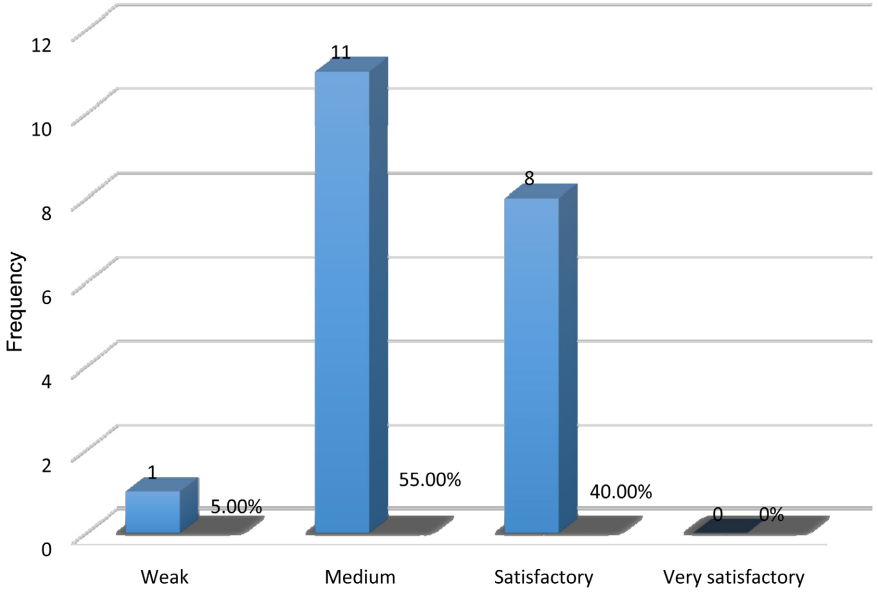

Figure 17. Distribution of respondents by level of radiation protection in the establishment.

3.4. Observation of Radiation Protection Measures

1) The personnel protection plan: Table 7 indicates that respondents used radiation protection equipment in the majority of cases

2) The patient protection plan: Table 8 shows radiation protection measures for patients were not applied by the majority of respondents.

3) The protection plan for accompanying persons: Table 9 shows radiation protection measures for companions were not applied in the majority of cases.

4) The Plan Delimitation and Signage of the Zones

In this regard, we noted the absence of indicator lights or traffic signs, irradiation pictograms on the doors of radiology rooms and delimitation of appropriate areas (public area, a monitored area, controlled areas).

4. Discussion

4.1. Socio-Demographic and Professional Profile of the Study Population

Twenty-one (21) medical imaging professionals participated in our study. Male sex was predominant with 90% of cases. This result is different from that of Smani J. [10] who had found a majority of women (54.3%) in her study in Morocco. In the study carried out in six countries of French-speaking sub-Saharan Africa, the female predominance was reported with 61.54% [11]. Female staff remain under-represented in radiology departments in Mali, probably linked to the fear of the risk of ionizing radiation for women of childbearing age. The majority of our workforce (61.90%) was in the 30 - 39 age group; consistent with that of Smani J. [10] which had found in his study a frequency of 62.9% of the age groups between 20 - 29 years and 30 - 39 years.

Table 7. Distribution of respondents by using of radiation protection equipment.

Materials	Yes		No		Total	
	n	%	n	%	n	%
The leaden screen	17	100	0	0	17	100
The leaded deck	17	100	0	0	17	100
Available accessories	2	11.76	15	88.24	17	100
Possession of dosimeter	13	61.90	8	38.10	21	100
Dosimeter port	10	76.92	3	23.08	13	100

Table 8. Distribution of respondents according to radiation protection measures of patients.

Measurements	Yes		No		Total	
	n	%	n	%	n	%
Patient informed of risks	1	5.88	16	94.12	17	100
Request for last mentrual period	6	35.29	11	64.71	17	100
Adaptation of the delivered dose	6	35.29	11	64.71	17	100
The device is diaphragm	0	0	17	100	17	100
Protection of gonads and pregnancy	5	29.41	12	70.59	17	100
Completion of the one-time exam	11	64.71	6	35.29	17	100

Table 9. Distribution of respondents according to the radiation protection measures of the companions.

Measurements	Yes		No		Total	
	n	%	n	%	N	%
Closing doors during x-ray	0	0	17	100	17	100
Closing doors during scanning	17	100	17	0	17	100
Protection of accompanying persons if present	10	58.8	7	41.2	17	100

Students in training (doctors in specialization (DES) of radiology or students manipulators of electroradiology) were the most representative with 47.62%. Our data are similar to those published by Akanni D.W.M.M *et al.* [11], which had found 47.25% of doctors in specialization and 38.46% of manipulators. On the other hand, they differ from the results of Koné A. [8] in Mali, which found 70% manipulators. This difference could be explained by the training vocation of the medical imaging department of the University Hospital Pr Bocar Sidy SALL of Kati.

4.2. Knowledge of the Fundamental Principles of Radiation Protection

In our study, 52.38% of respondents had little knowledge of the fundamental

principles of radiation protection. This result is different from the data from the study by Koné A. [8] and Somboro C. [3] who each found a rate of 35%. The low level of knowledge of the fundamental principles of radiation protection of exposed workers is reported in the literature [11] [12]. The poor mastery of radiation protection concepts provided in training courses could be the explanation.

4.3. Knowledge of the Regulations of Doses Received during Radiation Exposure in Mali

The limits of the doses received during occupational radiation exposure were recognized as regulated in Mali for 76% of the respondents; which is significantly higher than the 20% found by Smani J. [10] in Morocco. This regulation stipulates that the exposure of any worker to ionizing radiation or of the public must be strictly restricted so that the doses received are always below the limits set.

Measures to limit exposure to ionizing radiation in the service were taken for 90% of respondents. This was in line with the data of Somboro C. [3] which had also found 90%. The targets of radiation protection were: THE DATRs, the public and the environment for 16 respondents or 76% of the cases. Somboro C. [3] in his study had found a similar result of 70%.

4.4. Administrative Measures in Respect of Pregnant or Lactating Staff

Manipulators or doctors specializing in pregnant radiology were redeployed to another position in the service for 57.14% of respondents. These data were similar to those of Koné A's study. [8] which found a rate of 50%. National regulations stipulate that any woman assigned to a controlled area or a supervised area must inform her employer and the occupational physician of her state of pregnancy as soon as she becomes aware of it. To ensure the protection of the fetus against the harmful effects of ionizing radiation, the employer must adapt, as appropriate, the working conditions to the physical state of the pregnant woman so that the effective dose to the fetus does not exceed the dose limits for the public.

There were no internal regulations for radiation protection according to 43% of the staff; this is different from the result of Smani J. [10] who noted the absence of internal radiation protection regulations for the proper use of the permitted dose limits in all respondents. Operators shall establish in writing, in language comprehensible to employees and other persons concerned, the rules and procedures necessary to ensure an appropriate level of protection and safety for all such persons.

For 52%, there was no posted service plan specifying traffic areas and the location of radiation sources, while differently only 14.3% of respondents reported having a posted service plan specifying traffic area and the location of sources in Smani J.'s study [10]. While this does not affect the staff of the service, it may pose a problem for outsiders. Seventy-six percent (76%) of respondents had not received any additional radiation protection training. This figure is worrying, es-

pecially since national regulations require all operators to provide radiation protection training adapted to the risk involved. In their work in Cameroon, Neossi GM *et al.* [13] reported that 61% of respondents had already received additional training in radiation protection.

All respondents had cited radiology personnel as actors in radiation protection, this is different from the result of Somboro C. [3] which in its study had found that only 37% of practitioners knew that radiology and radiotherapy personnel are the actors of radiation protection. This rate tells us that radiology professionals know that they are the first actors in their own protection and that of users.

4.5. The Radiation Protection Organ Shall

For 81% of the respondents, AMARAP (Malian Radiation Protection Agency) is the structure that deals with the determination of radiation exposure in Mali. This result is consistent with those of Somboro C. [3] and Koné A. [8] who had each obtained 90%. AMARAP is the regulatory body, which ensures throughout the national territory the control of sources of ionizing radiation and the management of radioactive waste. This rate, while good, must not lose sight of the need for the agency to strengthen the initial and continuing training of nursing staff and public information activities in the field of radiation protection.

4.6. The Fundamental Principles of Worker Health Surveillance

Among the technical measures of radiation protection, dosimetric monitoring came in first place with 85.71%. Somboro C. [3] had classified the technical measures in order of importance as radiation protection measures according to the respondents, and also the monitoring by dosimetry of the DATR (directly assigned to work under radiation) came in first place with 20%. This demonstrates the importance of dosimetric monitoring for staff.

In our study, 33% of respondents were classified as category A, 14% category as B and 53% were without an opinion. Our results are different from those of Mbo Amvene J. *et al.* [12] who in their study, had obtained respectively 7.1% and 32.1% for categories A and B. In addition, 60.7% of their workforce had no idea. This difference is explained by the small sample size of our study. The classification of personnel exposed to ionizing radiation in category A or B depends on the doses they are likely to receive and the analysis of workstations. For the protection of sensitive organs, 48% of respondents used a leaded cache. This rate is different from that of Somboro C. [3] which found 60% of the cases.

4.7. The Existence of a Competent Person in Radiation Protection (PCR)

For 52% of the respondents, there was no person competent in radiation protection (PCR) in the establishment. Our result is different from that of Guiegui CP *et al.* [14] in Cameroon, who noted the existence of a PCR according to 60.8% of respondents. In Côte d'Ivoire, Kouassi YM *et al.* [15], 50% of the establishments

were not registered with the Central Service for Protection against Ionizing Radiation (SCPRI) and 83.3% did not have a person competent in radiation protection. In Mali, according to the regulations, any public or private establishment, holder of an authorization, is required to designate, at the request of the Regulatory Body, a qualified expert in radiation safety as responsible for radiation protection. These different data largely explain shortcomings in radiation protection in our countries.

4.8. Radiation Protection Equipment

In our study, as in that of Koné A. [8], the majority of respondents had a perfect knowledge of the protective equipment of a radiology room. The design of the service premises complied with the radiation protection standards recommended by 81% of our workforce. In the study of Smani J. [10] In Morocco, 93.5% of staff felt that the design of the work premises probably did not meet the standards. In literature, Mbo Amvene J. *et al.* [12] in its series also reported that for 94.4% of respondents the design of conventional radiology premises does not meet the recommended radiation protection standards. A quality control of the facilities was carried out according to 57% of our workforce (n = 21). Our result is significantly lower than that of Smani J. [10] which reported a rate of 85.3% in its series. Operators are required, according to the regulations, to establish and implement a control program adapted to the risks associated with the sources under their responsibility. The majority (61.90%) of respondents in our study had no idea of the standards applied in Mali regarding DATR as part of a global radiation exposure. This result is similar to that of Somboro C. [3] which had found that more than half of the staff were unaware of the standard, which is 20 mSv per year on average over five consecutive years, this result may reflect the poor mastery of radiation protection concepts taught. The exchange of the dosimeter was done quarterly for 62% of the respondents, which is in line with that of Koné N. [9] which in his study had revealed that the exchange of the dosimeter was also done quarterly. In our series, 81% of workers did not benefit from any special medical supervision from occupational medicine. These data are consistent with those reported by Kouassi YM *et al.* [15] in Côte d'Ivoire. In their study, only 24% of staff had undergone periodic medical follow-up. In Burkina Faso, Tapsoba T-L. *et al.* [16] also made the same finding in their study. They noted the absence of a hiring medical examination or periodic medical examination of staff exposed to radiation in the services. In Mali, according to regulations, the employer is required to ensure the medical surveillance of exposed workers. The lack of asafety culture in our countries could be the explanation. Such monitoring shall be based on the general principles applicable to occupational medicine and shall take into account past or existing conditions of exposure to other toxic chemicals or other physical conditions involving a potential risk. The level of radiation protection in the establishment was considered average by 55% of the staff in our study. This result differs from that obtained by Koné N. [9] which noted in its study a satisfactory level of radiation protection

at the Mali Hospital for 57% of respondents.

4.9. Compliance with Radiation Protection Measures

Our entire workforce was behind the leaded screen when carrying out the exams; the leaded apron was used whenever necessary. On the other hand, accessories (leaded glasses and thyroid cover) were underused by 12% of workers. 62% of staff had a dosimeter and 80% of workers wore a dosimeter during working hours. Our results are consistent with those of Koné A. [8]. Radiation protection measures for patients were not applied by the majority of respondents. 94% of workers did not inform the patient of the risks associated with X-rays. The demand for the date of the last menstrual period in women of childbearing age was not systematic and no practitioner used the diaphragm when taking X-ray images. In the series by Koné A. [8], 90% of the staff did not eliminate the possibility of pregnancy; which is close to our result. On the other hand, he reported that in 90% of cases the part to be X-rayed was well diaphragmed.

Concerning the radiation protection measures of the accompanying persons,a single practitioner closed the door of the room at the time of the X-ray on the other hand, it was systematically closed at the time of the scan and the accompanying person was protected if his presence was necessary by 58.8% of the practitioners. This result differs from that of Koné A. [8] which noted that in 100% of cases the technician closed the door at the time of the examination and that only 60% of them protected the accompanying person in case his presence in the room was necessary. The lack of closure of the radiology room in our study would be explained by the absence of a lock and handle on the door of the standard X-ray room.

In the study by Hamoun H *et al.* [17] in Tunisia, 22% of health care workers were not aware of the means of personal protection against ionizing radiation and 25% (n = 49) were unaware of the health effects of low doses of ionizing radiation. On the delimitation and signalling aspect of the zones, we noted the absence of indicator lights and traffic signs, irradiation pictograms on the doors of the radiology rooms and the delimitation of the appropriate areas (public area, a monitored area and controlled areas). Our results are in line with those of Koné A. [8] in Mali and Mbo Amvene J *et al.* [12] in Cameroon.

5. Limitations of this work

The low sampling and the monocentric nature are the main limitations of this work. Despite its shortcomings, this study has highlighted the low level of radiation protection knowledge of the staff of our radiology department as well as the inadequacies in the safety standards of the installations, the monitoring of professionals exposed to ionizing radiation and the protection of users.

6. Conclusion

This study allowed us to highlight the shortcomings in radiation protection within

the imaging department of the University Hospital Pr Bocar Sidy SALL in Kati. She also highlighted the need to strengthen the initial and continuing training in radiation protection of radiologists and manipulators in order to ensure optimal protection against X-rays for health professionals, patients and their companions. Also, a closer collaboration AMARAP -imaging services would be the guarantee of better security for all.

Conflicts of Interest

The authors declare that they have no conflict of interest.

References

[1] Colleges of Teachers of Radiology of France Medical Imaging, National Colleges of Teachers of Biophysics and Nuclear Medicine (2015) Medical Imaging-Radiology and Nuclear Medicine. 2nd Edition, Elsevier Masson, Paris, 3-5.

[2] Belaroussi, L. (2013) Self-Training Kit in Radiation Protection for Occupational Physicians. Thesis Med, Mohamed V University, Rabat.

[3] Somboro, C. (2017) Evaluation of the Radiation Protection Knowledge of the Staff of the Radiology and Radiotherapy Services of the Mali Hospital in Bamako. Mémoire Med, INFSS, Bamako, 44p.

[4] Jimonet, C. and Metivier, H. (2007) Competent Person in Radiation Protection: Principles of Radiation Protection-Regulation. 1st Edition, EDP Sciences, Paris, 96-312.

[5] Soussan, M. (2010) Radiologie. 1st Edition, Éditions Vernazobres-Grego, Paris.

[6] Yomi, J., Guekeme, J., Tagni, Z.D., Juimo, A.G. and Gonsu, F.J. (2003) Radiation Protection in the Health Facilities of the City of Yaoundé. *JAIM*, **1**, 109-119.

[7] Primature (Republic of Mali): Ordinance No. 02 - 060 / P-RM of 05 June 2002 Establishing the Malian Radiation Protection Agency, General Secretariat of the Government, Bamako, 2002: 1

[8] Koné, A. (2016) Evaluation of the Knowledge and Practice of the Radiology and Nuclear Medicine Staff of the CHU du Point G. Mémoire Med, INFSS, Bamako, 44p.

[9] Koné, N. (2015) Practice of Radiation Protection at the Hospital in Mali. Mémoire Med, INFSS, Bamako, 34p.

[10] Smani, J. (2013) Study of the Observance of the Rules of Radiation Protection in Conventional Radiology in Segma Hospitals in the Marrakech Region Tensift Alhaouz. Mémoire Med, IFCS, Rabat, Morocco, 37p.

[11] Akanni, D.W.M.M., Savi de Tové KM, Damien, B.G., Kiki, S.M., Adjadohoum, S.B.M.G., Yekpe-Ahouansou, P. and N'zi, K.P. (2020) Knowledge of Radiation Protection of Workers Exposed to Ionizing Radiation in a Medical Environment in French-Speaking Sub-Saharan Africa. *Radiation Protection* (*PCR*), **56**, 43-48.

[12] Mbo Amvene, J., Djonyang, B., Mballa Amougou, Ngaroua, Nko'o Amvene S. (2017) Compliance with Radiation Protection Rules in the Imaging Services of Hospitals in the Far North of Cameroon. *Health Science Disease*, **18**, 83-87.

[13] Neossi, G.M., Bayiha, M.J., Alpha, Z.F. and Moifo, B. (2018) Evaluation of the Level of Implementation of Radiation Protection in the Regional Medical Imaging Centers of Cameroon. *JAIM*, *Yaoundé*, **10**, 138-147.

[14] Guiegui, C.P., Owona, L.J., Aka, I.N.A., Manga, L.J., Arnaud, N., *et al.* (2018) Com-

pliance with Radiation Protection Measures in a Public Hospital Environment in Yaoundé in 2016. *Radiation Protection* (*PCR*), **28**.

[15] Kouassi, Y.M., Wognin, B., N'gbesso, R., Yeboue-Kouamé, Y.B., Tchicaya, A.F., Alla, D. and Bonny, J.S. (2005) Study of Compliance with Radiation Protection Rules in Hospitals in Abidjan. *Archives of Occupational Diseases and the Environment*, **66**, 369-374. https://doi.org/10.1016/S1775-8785(05)79108-6

[16] Tapsoba, T.L., Ouattara, T.F., Belemlilga, H.G.L., Sanon, H., Bamouni, Y.A., Ouédrago, V. and Cissé, R. (2010) Application of X-Ray Protection Rules in the Radiology Departments of Ouagadougou. *Nuclear Medicine*, **34**, e9-e12. https://doi.org/10.1016/j.mednuc.2010.07.011

[17] Hamoun, H., Abbes, D., Anis Hamoun, K., Attia, N. and Hammou, A. (2015) 3. Collèges des Enseignants Radiologie de France Imagerie Médicale, Collèges National des Enseignants de Biophysique et de Médecine Nucléaire: Imagerie Médicale-Radiologie et Médecine Nucléaire, Elsevier Masson, 2ème édition, Paris, pp. 3-5.