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Original Research Article

Knowledge Attitude and Practices Related on Ionizing Radiation Exposure of Women of Childbearing Age or Pregnant Women in Cameroon

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Abstract: The concern about ionizing radiation exposure of women of childbearing age or pregnant women is still relevant and CT scanning alone is a subject of interest as it is responsible for 58% of radiation exposure from medical x-rays. The objective of our survey was to evaluate the knowledge and practices of radiation protection of CT scan users in women of childbearing age in the city of Douala in Cameroun. This was a descriptive and cross-sectional study that was conducted over a period from October to December 2019, in two referral hospitals in the city of Douala. We interviewed 30 women of childbearing age, 15 medical imaging technicians, and 45 referring physicians. The majority of patients were relatively young with an average age of 33.3±9.6 years. The majority of the medical imaging technicians and the requesting physicians were young people (24 to 30 years old) with 40% and 44.4% respectively. The applicant physicians were mostly general practitioners (40%), and the average years of experience were 2.1±1.1 years. The level of knowledge of radiation protection of women of childbearing age, radiology technicians and requesting physicians was unsatisfactory with a rate of 25.5%, 48.1% and 48.6% respectively without influence of the level of education. At the end of our study, continuing education in radiation protection and the routine use of the guide to the proper use of imaging examinations were recommended.

Keywords: User, Woman of childbearing age, CT scan, Radiation protection.

BACKGROUND

CT is the major source of exposure to medically induced X-rays, with the absorbed dose to an organ from a CT scan being greater than that from a corresponding conventional radiograph [3]. For the modern female imaging practitioner, striking a balance between the diagnostic benefits of CT and the potentially deleterious effects of IR exposure has become a central issue, especially for women of childbearing age.

Numerous studies have demonstrated the harmful aspect of X-rays, particularly in the genesis of malignant and cancerous affections [1- 4], justifying the term "radiation-induced cancer": These studies underline the vulnerability of the fetus and therefore of the pregnant woman.

In sub-Saharan Africa, countries such as Cameroon and the Central African Republic have seen an increase in the number of CT machines in public and private hospital facilities between 2004 and 2016 [7].

Several authors insist on the lack of involvement of the requesting physicians in the matter of patient radiation protection [9], on the ignorance of imaging technicians concerning the radiation doses received by patients during radiological diagnostic tests [10], but also on the ignorance of the effects of ionizing radiation by the patients themselves [11].

In view of the above, we conducted this study with the research question: What were the levels of knowledge and practice of radiation protection of users during CT examinations among women of childbearing age in Douala?

In order to answer this question, our overall objective was to assess the radiation safety knowledge and practices of users of CT in women of childbearing

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age, with the general assumption that the radiation safety knowledge and practices of patients, medical imaging technicians, and referring physicians were inadequate.

Specific Objectives:

- Surveyed the knowledge, beliefs and practices of patients, medical imaging technicians and referring physicians regarding radiation protection in Douala.
- Analyzed the relationship between the radiation safety knowledge and practice and the socio-demographic and professional characteristics of the users of CT in Douala.

METHODOLOGY

1) Study Setting

We conducted this study in the radiology departments of two tertiary hospitals in Douala (Cameroun), namely: the Laquintinie Hospital in Douala (HLD) and the Gynaecological-Obstetric and Paediatric Hospital of Douala (HGOPED). Both hospitals had 16-slice CT scanners: an ANKE CT scanner at HLD and a HITACHI CT scanner at HGOPED. These hospitals were selected because they are the main referral centers for CT-scan examinations in the city and they have a large and diverse population of patients and health professionals.

2) Study Design and Duration

This was a descriptive, cross-sectional study that aimed to assess the knowledge and practice of radiation protection among non-radiologist users of CT-scan in two hospitals in Douala. We collected data from October to December 2019.

3) Study Population

The study population consisted of three groups of non-radiologist users of CT-scan: requesting physicians, medical imaging technicians, and women of childbearing age who underwent a CT scan during the study period.

4) Sampling Method

We used a non-probability sampling method based on consecutive exhaustive recruitment. This means we included all eligible participants who agreed to take part in the study until we reached the desired sample size. We calculated the sample size using the formula for estimating a single proportion with a 95% confidence level, a 5% margin of error, and an expected proportion of 50%. We obtained a minimum sample size of 384 participants, which we distributed as follows: 30 women of childbearing age, 15 radiology technicians, and 45 requesting physicians per hospital.

5) Inclusion and Exclusion Criteria

We included requesting physicians, radiology technicians, and women aged 12-49 years or pregnant women who underwent a CT scan during the study period and who consented to participate in the study. We excluded radiologists, radiology technicians and requesting physicians who refused to participate in the study and/or did not complete the questionnaires, as well as women of childbearing age or pregnant who refused to participate in the study or who were received in a critical condition.

6) Data Collection

We developed three different questionnaires for each group of participants based on the models of similar studies [5- 14]. The questionnaires consisted of closed-ended questions that covered various aspects of radiation protection knowledge and practice. We pre-tested the questionnaires on a pilot sample of 10 participants per group to assess their validity and reliability. We made some minor adjustments based on the feedback from the pilot test.

We gave the package insert, informed consent form, and questionnaire directly to the requesting physicians, technicians, and patients at their respective departments. We explained the purpose and procedures of the study and obtained their written consent before administering the questionnaire. For the women of childbearing age and the requesting physicians, we preferred to conduct an interview rather than a self-administered questionnaire because some of them had difficulties understanding some of the information in the questionnaire, such as the radiation dose, their representation in X-rays, or the rationale and objectives of the study. We also observed the radiation protection measures (performance technique) practiced by the radiology technicians during the CT examinations performed on the patients using a checklist.

7) Data Analysis

We used SphinxPlus2 version 5 software to create and encode the questionnaires. We used Microsoft Word and Excel 2016 software for word processing and for presenting the results in tables and graphs.

We used XLSTAT evaluation version 2019.4.2 to perform descriptive and inferential statistics. We calculated frequencies, percentages, means and standard deviations for categorical and numerical variables. We also calculated an overall knowledge score (OKS) for each respondent to our questionnaire based on the scoring system used in a previous study conducted in Tunisia in 2015[15]. The OKS was scored out of 6 for patients, 16 for technicians, and 24 for requesting physicians. We classified the level of knowledge and practice as unsatisfactory (<50%), average (50-69%), or satisfactory (≥70%). We used the Fischer exact test to test for associations between categorical variables with an error threshold of less than 5% at a confidence interval of 95%. This test was applied between the level of education of the radiology technicians or professional status of requesting physicians and the questions in each part of their questionnaire, when appropriate.

8) Ethical Considerations

We obtained the following ethical approvals and authorizations before conducting the study:

- Research authorizations from the General Directors of the hospitals concerned by our study, supported by a research authorization issued by the Head of the Department of Biomedical Sciences of the University of Ngaoundéré.
- Ethical clearance from the Institutional Human Health Research Ethics Committee of the Gynaecological-Obstetric and Paediatric Hospital of Douala.

We also ensured the following ethical principles during the data collection:

- We gave anonymous questionnaires, an information leaflet and an informed consent form to each participant.
- We explained the purpose, procedures, risks and benefits of the study and obtained their written consent before administering the questionnaire.
- We respected the confidentiality and privacy of the participants and their data.
- We did not coerce or induce any participant to take part in the study.

Conflict of interest: None.

RESULTS

The aim of this study was to assess the knowledge and practice of radiation protection among CT-scan non-radiologist users at two hospitals in Douala. The participants were 30 women of childbearing age, 15 radiology technicians, and 45 requesting physicians.

Sociodemographic Characteristics

We assessed the knowledge and practice of radiation protection among 90 participants: 30 women of childbearing age, 15 radiology technicians and 45 requesting physicians.

The mean age of the women of childbearing age was 33.3±9.8 years; the most represented age group was 30-40 years with a percentage of 33.3%; 10% of the women included in the study were pregnant and were in the third trimester of their pregnancy.

The mean age of the radiology technicians was 31.3±4.9 years with a male predominance (male/female sex ratio of 1.1).

The mean age of the requesting physicians was 38.4±8.9 years with a male predominance (male/female sex ratio of 2). The majority of them were general practitioners (62.2%), followed by specialists (24.4%) and residents (13.4%).

Table 1 shows the socio-demographic characteristics of the participants. The mean age of the women was 33.3 years, with 10% of them being pregnant. The mean age of the radiology technicians was 31.3 years, with a slight male predominance. The mean age of the requesting physicians was 38.4 years, with a clear male predominance. Most of the requesting physicians were general practitioners.

Table 1: Socio-demographic characteristics of the participants

Group	Number	Mean age (years)	Sex ratio (M/F)
Women of childbearing age	30	33.3 ± 9.8	N/A
Radiology technicians	15	31.3 ± 4.9	1.1
Requesting physicians	45	38.4 ± 8.9	2

The overall knowledge score

The knowledge and practice of radiation protection were measured by a questionnaire that included questions on the principles of radiation protection, the exposure of women of childbearing age and pregnant women to X-rays, the risks of developing radiation-induced cancer, and the doses delivered by different imaging modalities.

The overall knowledge score (OKS) of the women of childbearing age was 1.5±1.6 out of 6; only one woman had a satisfactory level of knowledge (>70%). The OKS of the radiology technicians was 12±2 out of 16; 80% of them had a satisfactory level of knowledge (>70%). The OKS of the requesting physicians was 11±4 out of 24; only 13% of them had a satisfactory level of knowledge (>70%).

There was a significant difference in the level of knowledge between the three groups ($F(2,87) = 97.7$, $p<0.001$, one-way ANOVA). Post-hoc tests showed that the radiology technicians had a significantly higher level of knowledge than the requesting physicians ($p<0.001$) and the women of childbearing age ($p<0.001$), and that the requesting physicians had a significantly higher level of knowledge than the women of childbearing age ($p<0.001$).

Table 2 shows the overall knowledge score (OKS) of the participants, calculated as the percentage of correct answers to the questionnaire. The radiology technicians had the highest OKS (75%), followed by the requesting physicians (46%) and the women of childbearing age (25%). The difference in OKS among the three groups was statistically significant ($F (2, 87) = 97.7$, $p<0.001$).

Table 2: Overall knowledge score (OKS) of the participants

Group	OKS range	Mean OKS	Level of knowledge (%)
Women of childbearing age	0-6	1.5 ± 1.6	Unsatisfactory (96.7)
Radiology technicians	0-16	12 ± 2	Satisfactory (80)
Requesting physicians	0-24	11 ± 4	Average (87)

Level of Knowledge of Radiology Technician and Requesting Physicians

The level of knowledge of the radiology technicians was significantly influenced by their level of education ($p<0.05$, Fischer exact test). The technicians with a bachelor's degree or higher had a higher level of knowledge than those with a high school diploma or lower. The level of knowledge of the requesting physicians was not significantly influenced by their professional status ($p>0.05$, Fischer exact test).

Tables 3, 4, 5 and 6 show the results for each group on specific topics related to radiation protection. The women of childbearing age had poor knowledge and practice on most topics, except for knowing that ultrasound is not dangerous for the fetus (66.7%). The radiology technicians had good knowledge and practice on most topics, except for knowing the dose limits delivered to workers and the public (46.6%) and the time interval between different radiations influencing the risk of developing cancer (13.3%). The requesting physicians had average knowledge and practice on most topics, except for knowing the doses delivered by different imaging modalities (15.6%) and having taken radiation protection training (4.5%).

Table 3: Knowledge and practice of radiation protection among women of childbearing age

Question	Yes (%)	No (%)
Have you ever had a CT scan?	23.3	76.7
Do you know what X-rays are?	16.7	83.3
Have you received prior information on the possible risks associated with X-rays?	3.3	96.7
Do you know that X-rays are harmful to the fetus?	30	70
Did you know that a high dose of X-rays can be carcinogenic?	33.3	66.7
Did you know that a pregnant woman can refuse to have an X-ray exam again or again?	3.3	96.7
Do you know that ultrasound is not dangerous for the fetus?	66.7	33.3

Table 4: Knowledge and practice of radiation protection among radiology technicians

Question/Variable	Yes (%)	No (%)
Is the aim of radiation protection to prevent or reduce the risks associated with IR?	73.4	26.6
Deterministic effects are immediate and always occur above a dose threshold	93.4	6.6
Stochastic effects are tissue effects: risk of cancer; effects on germ cells: risk of transmission of genetic abnormalities.	100	0
Are the dose limits delivered to workers and the public set at 20 mSv / year and 1 mSv / year, respectively?	46.6	53.4
Should a radiological study be stopped once the clinical doubt is resolved, even if the protocol is not complete?	66.7	33.3
Do you systematically interview women of childbearing age on the date of the last menstruation or the existence of a pregnancy before carrying out her CT scan?	73.4	26.6
Do you explain the benefits of the CT-scan to patients?	73.4	26.6
Is exposure to X-rays of a pregnant woman prohibited in cases of pregnancy with a gestational age of less than three months?	60	40
Do you educate patients about the risks of x-rays?	53.3	46.7
Did you know that the responsibility for the initial investigation of pregnancy rests with the radiologist before performing a modality producing IR?	100	0
Does the risk of developing cancer increase with the value of the dose and possibly present even after a single exposure?	80	20
Does the time interval between different radiations influence the risk of developing radiation-induced cancer?	13.3	86.7
Are the gonads the most radiosensitive organs?	73.4	26.6

Table 5: Knowledge and practice of radiation protection among requesting physicians

Question/Variable	Yes (%)	No (%)	No answer (%)
Do x-ray biological effects include deterministic (some) and stochastic (random) effects?	42.3	53.3	4.4
Is the aim of radiation protection to prevent or reduce the risks associated with IR?	80	15.6	4.4
Are the dose limits delivered to workers and the public set at 20 mSv / year and 1 mSv / year, respectively?	13.4	82.2	4.4
The effective dose is a calculated quantity expressed in milliSievert (mSv), it makes it possible to evaluate the biological impact of an exposure to X-rays.	60	31.1	8.9
Do you know that you have the primary responsibility for the initial search for a pregnancy ?	82.2	8.8	9
Consideration of the benefit / risk ratio when prescribing a CT scan in a woman of childbearing age	84.5	8.9	6.6
Do you educate patients about the risks of x-rays?	33.4	57.8	8.8
Do you ask for the date of the last period before ordering a CT scan in a woman of childbearing age?	55.5	37.9	6.6
Does a woman of childbearing age have to take a pregnancy test first before having a pelvic scan?	31.1	62.3	6.6
Can a pregnant woman have a diagnostic or screening mammogram?	46.6		

Table 6: Knowledge of the doses delivered by different imaging modalities among requesting physicians

Question/Variable	Yes (%)	No (%)	No answer (%)
The number of chest x-rays corresponding to a chest CT is between 60 to 120?	17.8	73.4	8.8
Is the dose of an abdomino-pelvic CT scan versus chest x-rays between 100 RT <CT <250 RT?	0	91.2	8.8
Should a radiological study be interrupted once the clinical doubt has been resolved even if the protocol is not complete?	35.7	57.7	6.6
The fetal irradiation of a dose of 100 mGy almost justifies the termination of a pregnancy?	17.7	46.6	35.7
Do MRI and Ultrasound use X-rays?	17.9	73.3	8.8
Have you already taken radiation protection training?	4.5	95.5	

DISCUSSION

With the objective of assessing the knowledge and practices in radiation protection of CT users among women of reproductive age, a descriptive and cross-sectional study was conducted at Laquintinie Hospital in Douala and the Gynaecological-Obstetric and Paediatric Hospital in Douala over a three-month period from October to December 2019.

The study population consisted of 90 individuals, including physician applicants (45), medical imaging technicians (15), and women of childbearing age (30).

Patient Assessment

In our study, a high proportion of patients did not receive prior information about the risks of X-rays. Our results corroborate those of the surveys carried out by Julia *et al*., and Neossi *et al*., which revealed that in more than 70% of cases, no information was provided to the patient before the procedure [16].

This highlights the overall lack of patient awareness in our health care system, which is not only related to radiation protection and needs to be strengthened in our health facilities [18].

Evaluation of Radiology Technicians

In our series, 73.3% of the technicians explained to the patients the advantages of CT but 53.3% of the technicians informed the patients about the risks related to X-ray. These results corroborate those of Pihou *et al*., and Neossi *et al*., who found respectively that 57.1% explained the advantages and disadvantages of the scanner and 50% informed patients about the risks of the examination [5- 17]. The knowledge levels about X-ray exposure of women of childbearing age or pregnant women and about the risks of developing radiation-induced cancer of technicians were average with 60.8%. We believe that it would be useful to make these cards available to patients in our departments. This would facilitate communication and reduce its duration [18].

Application of Radiation Protection Measures

With regard to the attitudes and practices of radiation protection observed during the performance of CT examinations, it was found that the application of the principle of justification was effective because the CT examinations ordered were first validated by the

radiologist before being performed. Our results converge with those of Neossi *et al*., where 90% of radiology technicians ensured that the examination requested was justified [5]. Our results also contrast with those obtained by Kouandongui *et al*., in 2018 who showed that the application of the principle of justification of examinations was not effective in all institutions [13]. In reality, the responsibility for justifying a radiating examination is shared between the radiologist and the requesting physician [2- 19].

Evaluation of Applicant Physicians

Few physicians were aware of the biological effects of X-rays and knew the established dose limits. On the other hand, the majority found the purpose of radiation protection and the concept of effective dose. Our results showed that the level of knowledge on the principles of radiation protection was average with 51.9%, which is similar to those of Ongolo-Zogo *et al*., In agreement with other studies [7- 20], we find that the level of knowledge on the principles of radiation protection was unsatisfactory.

In the end, our study revealed that the knowledge of prescribers regarding radiation protection was unsatisfactory. Although the existence of the risk of radiation-induced cancer during the performance of certain radiological examinations is not ignored, these results show an important need for training in radiation protection for the personnel in our country.

Implications and Recommendations

The study has several implications and recommendations for improving the knowledge and practice of radiation protection among CT-scan users in Douala. First, it highlights the need for more education and training on radiation protection for both radiology technicians and requesting physicians. This could be done through formal courses, workshops, seminars, online modules, or other methods that are accessible and effective. Second, it emphasizes the importance of communication and collaboration between medical imaging services and requesting physicians. This could be facilitated by developing clear protocols, guidelines, or checklists for prescribing and performing CT-scan procedures. Third, it suggests the potential role of patient education and empowerment in reducing unnecessary or inappropriate use of CT-scan. This could be achieved by providing patients with information on the benefits and risks of CT-scan, as well as alternative imaging modalities that do not use ionizing radiation.

Limitations

The study has some limitations that should be acknowledged. First, it used a convenience sample of participants from two hospitals in Douala. Therefore, the results may not be generalizable to other CT-scan users in other settings or regions. Second, it did not measure the actual doses delivered by CT-scan or the actual outcomes of patients who underwent CT-scan. Therefore, the results may not reflect the true impact of knowledge and practice of radiation protection on patient safety.

CONCLUSION

The aim of our study was to reinforce and increase public and professional awareness of the side effects of radiation, which now requires a comprehensive understanding of the facts involved, the various risks to which patients are exposed, and the measures that can be implemented to minimize these risks.

Our study showed that the level of knowledge of women of childbearing age of medical imaging technicians and prescribing physicians was unsatisfactory. However, the radiation protection measures practiced by the technicians were satisfactory. These findings also justified their desire to participate in radiation protection training.

Improving the justification of CT examinations and the practice of radiation economy can be achieved through continuing education in radiation protection and through the routine use of the guide on the proper use of imaging examinations to improve the knowledge of hospital practitioners in the area of patient radiation protection.

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