

Research Article

Analysis of Compliance with the Principle of Justification for CT Scans Performed in the University Hospitals of Ouagadougou, Burkina Faso

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Abstract

The principle of justification is one of the fundamental principles of radiation protection, and even the most important one, as it is the first that must be considered before any request for an X-ray examination. The objective of this study is to assess compliance with the justification principle for CT scans performed in the University Hospitals of Ouagadougou through an analysis of the relevance of examination requests. This is a descriptive analytical study combining two approaches, a quantitative approach and a qualitative approach, based on 516 CT scans performed between August 1, 2024, and January 15, 2025. The analysis of justification was based on the consistency between the stated clinical indication and the requested CT scan. This conformity analysis was carried out using the “Good Practice Guidelines” (Guide de Bon Usage, GBU) for medical imaging examinations published by the French Society of Radiology (SFR) and the French Society of Nuclear Medicine (SFMN). Overall, 51 out of the 516 examinations (9.88%) in our study were deemed inappropriate. Among these, males were the most represented, accounting for 74%, with a sex ratio of 2.84. Lumbar and brain CT scans were the most affected by inappropriate requests, with respective rates of 23.53% and 19.61%. Spinal syndromes and tumor and/or abdominal masses were the most common inappropriate indications in our sample, representing 45.1% and 17.7% respectively. Physicians who had received training in radiation protection had a relevance rate of 92.88%, compared to 66.66% among those who had not received such training. Training physicians in radiation protection in general, and in the justification principle in particular, therefore appears to positively influence the relevance of X-ray examination requests, with a p-value of 0.036 ($p < 0.05$).

Keywords

Training, Indication, Justification, Relevance, Radiation Protection

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1. Introduction

Radiology emerged in December 1895 with the discovery of X-rays by the German researcher and physicist Wilhelm RÖNTGEN. This discovery revolutionized medicine as a whole and gave birth to a new science: medical radiology. It encompasses all medical diagnostic techniques used on the human body that provide images to physicians, regardless of the technique used for exploration [1]. Among the various techniques, there is the X-ray modality, which uses ionizing X-radiation to produce images of the body for diagnostic, follow-up, or therapeutic purposes [2]. If the use of these X-rays is not properly controlled, it can cause harm to both the patient and the worker, and even to the environment [3].

To mitigate these risks, protective measures have been developed—this is known as radioprotection. It consists of all the measures taken to ensure the protection of humans and their environment against the harmful effects of ionizing radiation. It is governed by regulations with standards at both international [4] and national levels [5]. These regulations are based on three fundamental principles: justification of the examination, optimization, and dose limitation. However, failure by healthcare professionals—particularly prescribing physicians and radiology personnel—to comply with these principles can lead to unnecessary exposure to ionizing X-rays and even radiation-induced damage ranging from simple inflammatory dermatitis to cancer.

Radioprotection therefore represents a major public health issue, especially in a context of increasing use of ionizing X-rays due to the significant strengthening of technical imaging equipment in the University Teaching Hospitals (CHUs) of Ouagadougou. Proper application of radioprotection in this setting relies on adherence to the principle of justification, for which responsibility is shared between the radiologist and the prescribing physician. This principle requires that before requesting any X-ray examination, the prescribing physician must assess the benefit-risk ratio of the exposure. Poor application of this principle can lead to unnecessary exposure to ionizing X-rays.

Indeed, in Lomé (Togo), Adambounou et al. found in their study on the justification of abdomino-pelvic CT scans that only 66.01% of justifications were good, 32.58% were acceptable, and 0.57% were poor. Moreover, indications were inconsistent with the requested CT scan in 3.4% of cases and non-compliant with the Good Use Guidelines (GBU) in 17.28% of cases [6]. In the Central African Republic, Kouandongui et al. found in their study on "prescribers' knowledge of patient radioprotection" that 83.9% of prescribers did not know that a CT scan is more irradiating than a standard X-ray [7]. Similarly, Adambounou et al. reported in their study on "Knowledge and attitudes of Togolese medical prescribers regarding medical irradiation during pregnancy" that about 25% of gynecologists did not know that MRI is non-irradiating and

22.8% did not know that CT scanning involves radiation exposure [8].

The objective of this study is to assess compliance with the principle of justification for CT examinations performed in the University Teaching Hospitals of Ouagadougou, Burkina Faso, between August 1, 2024, and January 15, 2025, through an analysis of the relevance of CT scan requests.

2. Materials and Methods

This was a descriptive and analytical study combining two approaches: a quantitative approach and a qualitative approach. It was conducted using the Good Practice Guide for Medical Imaging Examinations ("GBU"), an electronic application created in 2013 by the French Society of Radiology (SFR) and the French Society of Nuclear Medicine (SFMN). The study involved the four University Teaching Hospitals (CHUs) of Ouagadougou, namely CHU-Yalgado OUEDRAOGO, CHU de Bogodogo, CHU de Tengandogo, and the Charles de Gaulle Pediatric CHU, and covered the period from August 1, 2024, to January 15, 2025.

During this period, all clinical information on CT scan request forms was analyzed using the Good Practice Guide for Medical Imaging Examinations ("GBU"), available at <http://gbu.radiologie.fr/>, developed by the French Society of Radiology and the French Society of Nuclear Medicine, and then classified according to the relevance of the request [9].

The GBU was created in 2013 under the authority of the Nuclear Safety Authority (ASN) and the French National Health Authority (HAS). It is intended for healthcare professionals to assess the appropriateness of performing an X-ray examination.



Figure 1. Interface of the Good Practice Guide for Medical Imaging (gbu.radiologie.fr) (9).

The application analyzes the clinical information and suggests the appropriate medical imaging examinations, ranked

by grade according to the scientific strength of the information provided.

Grade A: Level of relevance solidly established scientifically.

Grade B: Scientific assumptions with an intermediate level of relevance; moderate level.

Grade C: Expert opinion, lower level of evidence or low level of relevance.

The analysis of the clinical information makes it possible to classify X-ray examination requests into two groups: those considered “relevant” and those considered “not relevant.”

1) For relevant requests: These refer to requests in which the clinical information makes it possible to establish compliance between the requested examination and those recommended by the GBU application. They are then classified by grade according to the scientific level defined by the application. Thus:

- a) Grade A: indicates a relevant request
- b) Grade B: indicates a request with moderate relevance
- c) Grade C: indicates a request with low relevance

2) For non-relevant requests: These refer to request forms in which the clinical information does not allow establishing a match between the requested examination and the examinations recommended by the application.

Finally, to assess the impact of radioprotection training on the relevance of X-ray examination prescriptions, all examinations requested by physicians who had received radioprotection training within the past three years were analyzed based on whether their requests were relevant or not. For physicians without training, a sample representing one-quarter of this group also had their requests classified as relevant or not. The results of the two groups were then analyzed through a statistical study using the chi-square test (χ^2) with the following hypotheses.

H_0 (null hypothesis): Training has no impact on the relevance of requests.

H_1 (alternative hypothesis): Training has an impact on the relevance of requests.

Data collection was carried out by ourselves and recorded in Excel 2024. Data processing and analysis were also performed using software Excel 2024 and Epi Info 7.

3. Results

A total of 516 computed tomography (CT) scans were performed during the study period.

3.1. Distribution of Examinations by Sex and Age

Table 1. Distribution of Examinations By Sex.

Sex	Frequency (Number)	Percentage
F	143	27,71
M	373	72,28
Total	516	100

The male sex was the most represented, with 373 examinations out of 516, resulting in a sex ratio of 2.6. The mean age of the patients was 42.63 years, with a range from 6 months to 87 years.

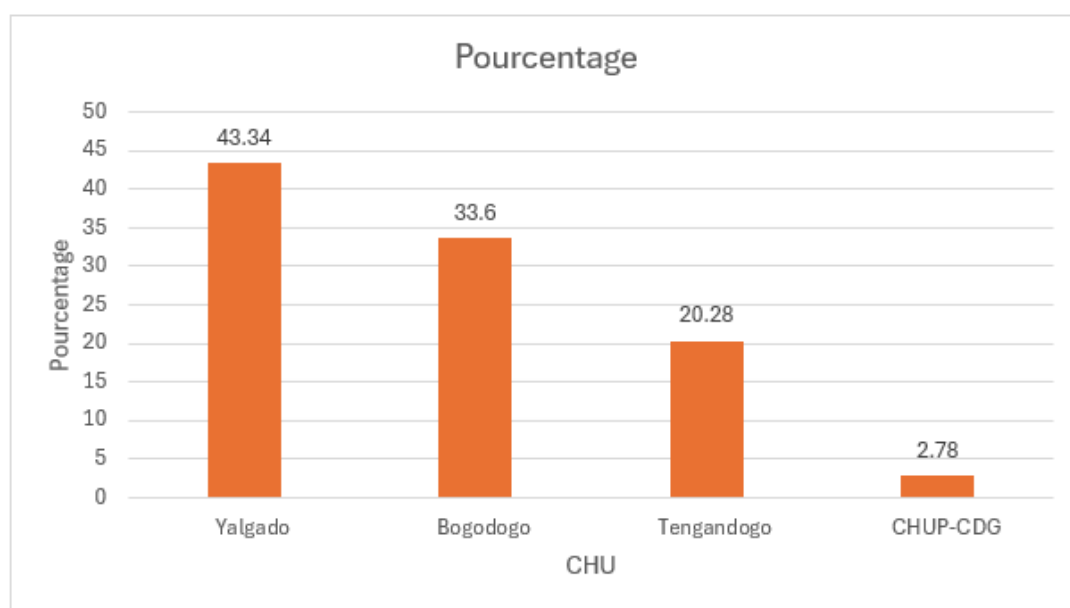


Figure 2. Distribution of Examinations By Healthcare Facility.

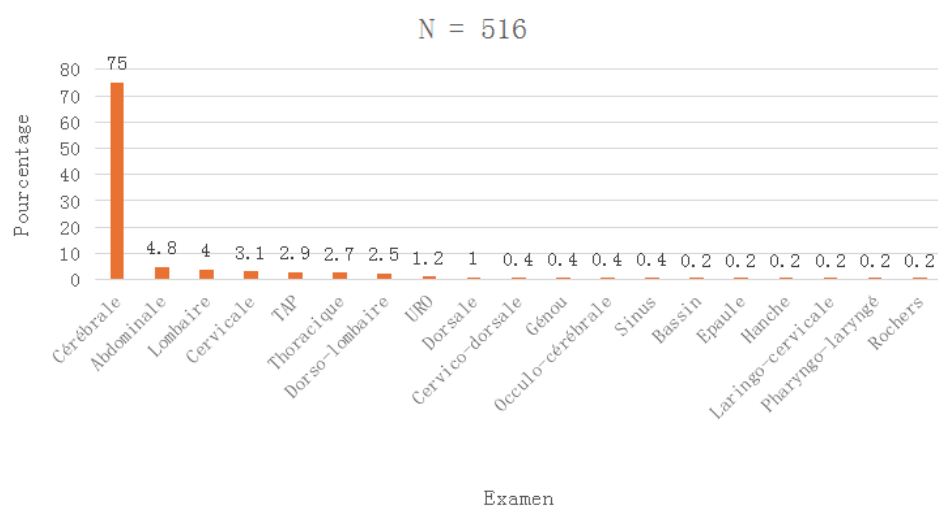


Figure 3. Distribution By Type of Examination.

Table 2. Distribution of Examinations According to Clinical Indications.

Indications	Frequency	Percentage
Headaches, dizziness, or sinusitis	25	4,8
Sudden motor deficit	112	21,7
Pain and spinal syndrome	53	10,3
Pain and limb trauma	5	1
Pain and spinal trauma	1	0,2
Cervical mass or tumor	1	0,2
Abdominal mass, tumor, or trauma	40	7,8
Infectious or tumoral pathology	22	4,3
Congenital pathologies	12	2,3
Ophthalmologic pathologies	10	1,9
ENT (ear, nose, and throat) pathologies	5	1
Psychiatric pathologies	8	1,6
Pulmonary or thoracic pathologies	12	2,3
Renal pathologies	6	1,2
TCE	204	39,5
Total	516	100

Table 3. Distribution of Examinations with or Without Contrast Agent Injection.

PDC	Frequency	Percentage
No	402	77,91
yes	114	22,09
Total	516	100

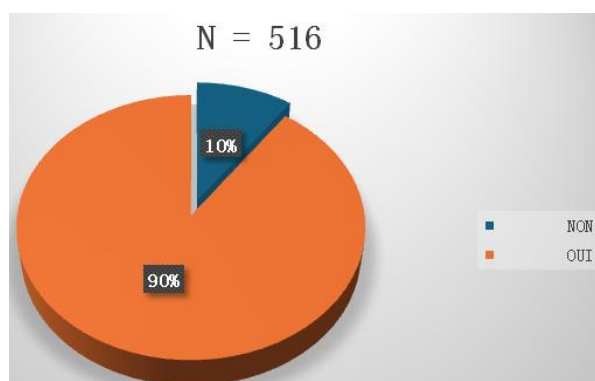


Figure 4. Distribution of Examinations According to Their Relevance with the Principle of Justification.

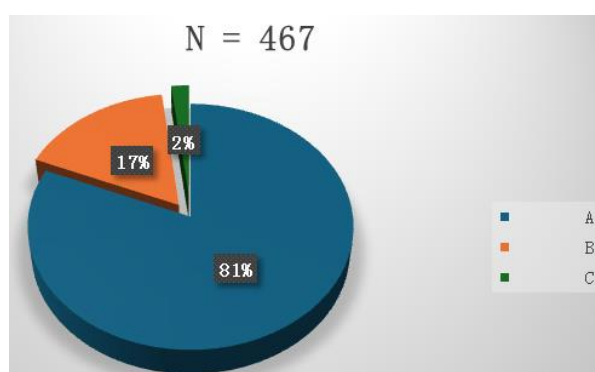


Figure 5. Distribution of Relevant Examinations By Grade.

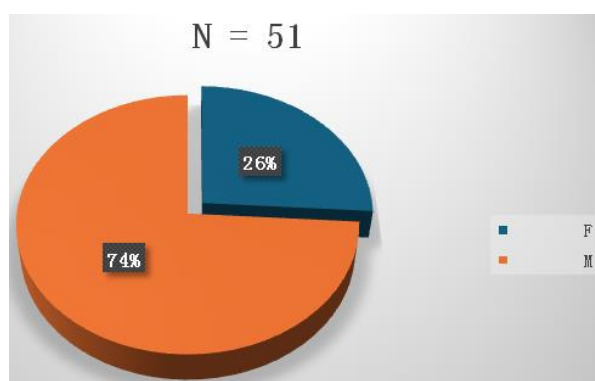


Figure 6. Distribution of Non-Compliant Examinations By Sex.

Table 4. Distribution of Non-Relevant Examinations By Type of Examination.

Features	Effective	Percentage
Lumbar	12	23,53
Cerebral	10	19,61
Abdominal	8	15,69
Cervical	4	7,84
Dorso-lumbar	4	7,84
Dorsal	3	5,88

Features	Effective	Percentage
Cervico-dorsal	2	3,92
Oculocerebral	2	3,92
Thoracic	2	3,92
Shoulder	1	1,96
Knee	1	1,96
Sinus	1	1,96
TAP	1	1,96
Total	51	100

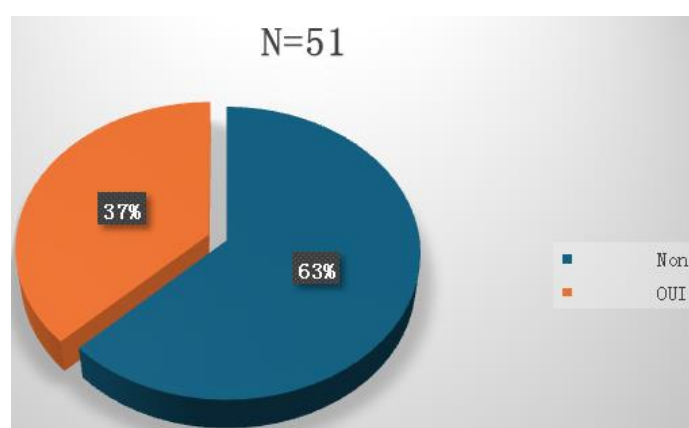


Figure 7. Distribution of Non-Relevant Examinations with or Without Contrast Agent Injection.

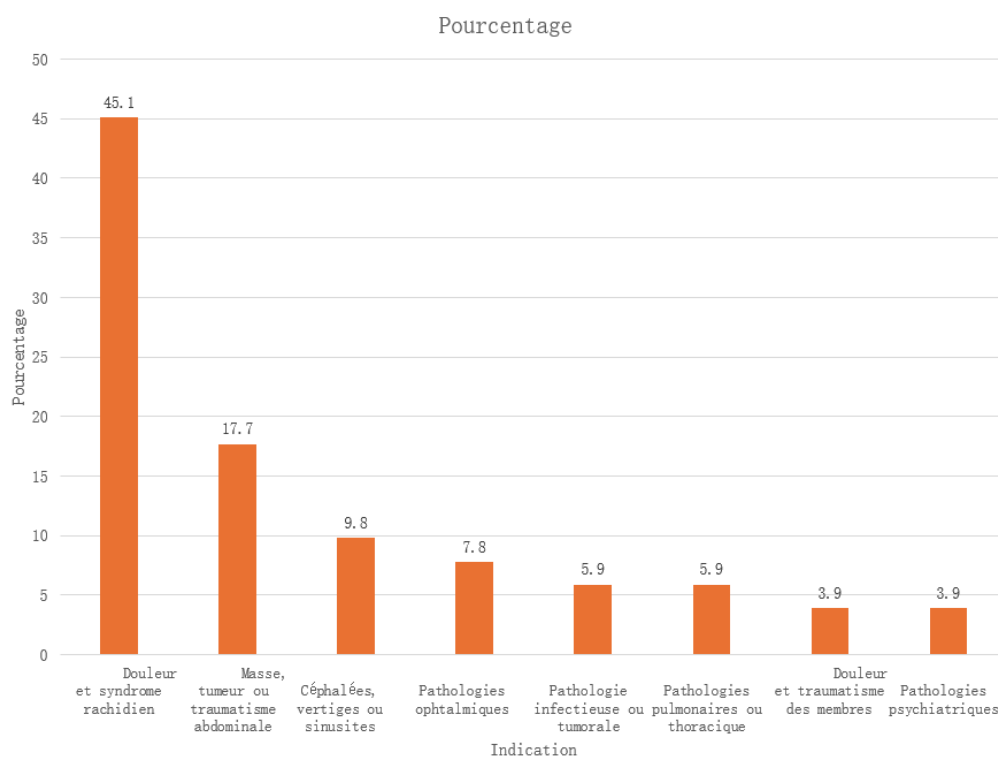


Figure 8. Distribution of Non-Relevant Examinations According to Clinical Indications.

3.2. Evaluation of the Impact of Radioprotection Training on the Relevance of X-ray Examination Requests

A total of 143 X-ray examination requesters agreed to answer our questions regarding the various radioprotection trainings they had received since the beginning of their professional careers. Among these requesters, 13 reported having received at least one radioprotection training, while 130 had not yet received any radioprotection training.

A sample of 49 X-ray examination requesters—including the 13 trained individuals (the total number of trained) and 36 untrained individuals (one-quarter of the total number of untrained)—had their X-ray examination requests analyzed statistically using the chi-square test (χ^2).

Among the 13 trained individuals, 12 had relevant requests and 1 had a non-relevant request. Among the untrained, 24 had relevant requests and 12 had non-relevant requests.

This is summarized statistically as follows:

Table 5. Evaluation of the Impact of Radioprotection Training on the Relevance of CT Scan Requests.

Requesters	Frequency	Pertinence	
		Pertinent	Non pertinent
Trained	13	12	01
Not Trained	36	24	12

Statistical calculation of the chi-square (χ^2):

$$\chi^2 = \text{Somme } ((O-E)^2 / E)$$

Table 6. Evaluation of prescribers trained in radiation protection according to the compliance of CT applications.

Requesters	Effectifs	Pertinence		P. Value
		Pertinent	Non pertinent	
Trained	12	0.99	2.23	0.036
Not Trained	36	0.36	0.81	

1) χ^2 total = 0.99 + 2.23 + 0.36 + 0.81 = 4.39

2) Degree of freedom

3) ddl = (2 - 1)(2 - 1) = 1

P-value

4) χ^2 = 4.39 ; ddl = 1 P-value = 0.036

4. Discussion

4.1. Limitations and Constraints

Our study faced some operational constraints and limitations due to the lack of sufficient literature on the evaluation of the principle of justification based on the analysis of clinical information recorded on CT scan request forms through the GBU.

4.2. Types of Examinations and Patient Sex Ratio and Age

Among the 516 examinations in our sample, 387 were cerebral CT scans, representing 75%. This can be explained by the fact that most CT scan requests come from emergency departments, namely traumatic and medical emergencies. In traumatic emergencies, the majority of requests aim to assess the extent of cranial trauma. For medical emergencies, the goal is to detect the presence or absence of a cerebrovascular accident (stroke) and to determine its type.

Our results are consistent with those of S. S. Traoré et al. [11], who also found cerebral CT scans to be the most requested, though at a lower proportion of 54.44%. The male sex was dominant with a sex ratio of 2.59, which differs from S. S. Traoré et al., who found that female patients were predominant, with a sex ratio of 1.94.

The mean age was 42.64 years, ranging from 6 months to 87 years. These results are similar to those of S. S. Traoré who reported a mean age of 44.03 years with extremes of 11 months and 90 years. However, they differ from K. Adambounou et al., who reported a mean age of 52.4 years with extremes of 6 and 92 years in their study on the justification of thoracic and/or abdomino-pelvic CT scans in Togo [6].

4.3. Analysis of Examination Relevance

Our study identified a total of 51 non-relevant examinations in terms of clinical information out of 516 examinations, representing 9.88% of cases, compared to 465 examinations judged relevant or acceptable, representing 90.12% of cases. Our results, with minor differences, are broadly similar to those of K. Adambounou et al., who found that clinical indications were well formulated in 66.01% of cases, acceptable in 32.58%, and poor in 0.57% (6). They also reported that indications were inconsistent with the requested CT scan in 3.4% of cases and non-compliant in 17.28% of cases.

Among the 51 non-relevant examinations, 12 were lumbar CT scans (23.53% of cases), followed by cerebral CT scans (19.61%). Nineteen of the 51 non-relevant examinations were performed with iodinated contrast agent injection (37.25% of non-relevant cases), representing 3.68% of the total sample.

These results may be explained by the lack of training on

the justification of examinations for prescribers and professionals responsible for performing these examinations, which constitutes unnecessary exposure with risks for patients, radiology technicians, and the environment.

Among non-relevant examinations, the male sex was dominant (74% of cases). Since lumbar and cerebral CT scans are the most affected by non-relevance, patients are exposed to radiation-induced pathologies of organs located in anatomical regions such as the thyroid, lens, prostate, uterus, ovaries, testes, etc. [10].

For non-relevant indications, those related to pain and spinal syndromes were the most represented (45.1% of cases), followed by abdominal tumors, masses, or trauma (17.7%).

Impact of training on request relevance

All clinical information on the request forms of the 13 X-ray examination requesters who had received radioprotection training was relevant in 92.88% of cases. Among untrained requesters, 66.66% of requests were relevant, while 33.34% were non-relevant.

Out of the 49 X-ray requesters surveyed, 13 had received at least one radioprotection training. Analysis of their CT scan requests showed that almost all of their requests were relevant (12 relevant vs. 1 non-relevant). Among the 36 untrained requesters, only 24 had relevant requests, while 12 were deemed non-relevant by the GBU.

Applying the χ^2 test to the observed data yielded a p-value < 0.05 (p-value < 0.036). Since the p-value is less than 0.05, the null hypothesis (H_0) that radioprotection training has no influence on request relevance is rejected, and the alternative hypothesis (H_1) is confirmed.

It can be concluded that radioprotection training for X-ray requesters, particularly on the principle of justification, positively influences the relevance of X-ray examination requests.

Thus, for requests to be relevant and aligned with radioprotection principles, it is essential to train and retrain physicians in radioprotection culture, particularly regarding adherence to the principle of justification.

5. Conclusion

The analysis of the application of the principle of justification for CT scans in the University Teaching Hospitals of Ouagadougou reveals crucial issues for improving the quality of care and protecting patients and workers exposed to ionizing X-rays. Although efforts have been made to raise awareness among medical staff, particularly prescribers, about the need to justify each examination by considering the benefit-risk ratio, gaps still exist in examination prescriptions. Our study showed that, on average, poor prescriptions accounted for 9.88% of cases.

Several factors may explain this situation, but the most important is the insufficient training or retraining in radioprotection for physicians requesting X-ray examinations. It is imperative to enhance continuing education for healthcare professionals, establish guidelines for appropriate prescriptions, and

promote a culture of prescriber responsibility, as training positively and significantly influences the relevance of X-ray examination requests (p-value = 0.036).

In a resource-limited country, rigorous application of the principle of justification is not only an ethical necessity but also essential to ensure the effectiveness and sustainability of a sound healthcare system.

Abbreviations

SFMN	French Society of Nuclear Medicine
GBU	Good Use Guide
CHU	University Hospital Centers
CHUP-CDG	Charles De Gaulle University Pediatric Hospital
ASN	Nuclear Safety Authority
HAS	High Authority for Health
Rayons X	X-ray
SFR	French Society of Radiology
TCE	Traumatic Brain Injury
ORL	Ondonto-Rhino-Laryngology
ENT	Ear, Nose, and Throat
TAP	Thoracic-Abdominal-Pelvic
TDM	CT Scan

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Alphonse Sako Avocefohou: Data curation, Formal Analysis, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Gilles David Houndetoungan: Supervision, Validation, Visualization

Parfait Segla Alohoutade: Supervision, Validation, Visualization

Papin Sourou Montcho: Supervision, Validation, Visualization, Writing – review & editing

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Worou Nicodeme Chabi: Supervision, Validation, Writing – review & editing

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Virgile Ahyi: Supervision, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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