Profile of patients referred for computed tomography, likely to be explored by scintigraphy imaging in a country with no nuclear medicine service: The case of Togo

Original Article

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ABSTRACT

Introduction: Describe the profile of patients referred for computed tomography (CT) likely to be scanned with scintigraphy imaging in Togo**.**

Methods: Prospective study carried out from May 15 to August 15 2020 including patients referred for non-traumatic CT scans (excluding strokes) in all the radiology centres in Togo with operational CT scans. The good practice guide of the French Societies of Radiology (SFR) and Nuclear Medicine (SFMN) was used as a reference for case selection.

Results: A total of 328 patients, representing 14.6% of those referred for non-traumatic CT scans (excluding strokes) were concerned. The sex ratio was 0.74 and the average age 50.58 ± 19.02 years. The patients had a health insurance in 50% of cases and were civil servants in 62.5% of cases. They mainly came from the cardiology (6.7%) and oncology departments (6.1%). Most common explorations were chest-abdomen-pelvis CT scans (36.3%) and thorax angiography CT (22.9%). Pulmonary embolism (24.1%), breast and prostate cancer extension assessment (18.3%) were the most frequent indications. Scintigraphy was indicated mainly (85.37%) as a second line of exploration. The most concerned fields of nuclear medicine were nuclear oncology (26.2%), cardio-pneumology (25%) and nuclear neurology (20.1%). Scintigraphy imaging was of a better or the same grade of recommendation as CT scan in 53.7% of cases, and of a lower or the same dose class as CT scan in 90.2% of cases.

Conclusion: A significant number of patients referred for CT scans in Togo were likely to be explored by scintigraphy imaging, hence the need to create a nuclear medicine department there.

Key words: Scintigraphy imaging; Nuclear medicine; Computed tomography; Radiation protection; Togo

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INTRODUCTION

Medical imaging is an important pillar in the diagnostic process in medical practice. It includes both non-irradiating and irradiating techniques, which are divided into radiological imaging (conventional radiology and computed tomography) and scintigraphy imaging (conventional scintigraphy and tomoscintigraphy on the one hand and positron emission tomography on the other) [1]. Scintigraphy imaging is one of the three components of Nuclear Medicine, which is a medical specialty using radioisotopes in unsealed sources. The other two components of Nuclear Medicine are internal vectorized radiotherapy and radioimmunoassay.

While computed tomography (CT), a morphological imaging technique, allows a precise study of anatomical lesions due to its high resolution, scintigraphy imaging is renowned for its sensitivity and its early detection of functional, metabolic and even molecular anomalies several weeks before the appearance of anatomical lesions [2]. CT and scintigraphy imaging each have well-established indications from various guidelines and are complementary for certain pathologies or clinical situations [3]. Scintigraphy imaging is essential in the treatment of many pathologies, both for their early diagnosis and for their follow-up, and it is poorly irradiating, contrary to misconception [4]. Unfortunately, nuclear medicine is very poorly developed in sub-Saharan Africa where few countries have a functional nuclear medicine service. According to a survey we conducted in 2015 in Togo, a country that does not yet have a nuclear medicine service, nearly 80% of Togolese doctors felt that the lack of a nuclear medicine service in Togo is an obstacle to adequate patient care [5]. In the absence of a nuclear medicine service in Togo, patients with clinical conditions that should be explored with scintigraphy imaging are rather explored by morphological imaging techniques such as CT scan. It is for this purpose that we have undertaken this work, with the general objective of describing the profile of patients referred for CT scan who are likely to be explored by scintigraphy imaging in Togo.

METHODS

This was a multicentre prospective study carried out over a period of three months, from May 15 to August 15 2020 in all the health facilities with an operational CT unit in Togo (West African French speaking country). Included in the study were patients who had performed a non-traumatic CT scan, with a radiologist report and whose clinical indication or result was likely to be explored by scintigraphy imaging. Patients who had a non-traumatic CT scan but who had stroke as clinical indication were not included in the study. Informed consent was obtained from the patients included in this study. Approval was also obtained from the heads of concerned health facilities as well as the radiation protection commission of the Togolese Ministry of Health. Data collection was based on patient interviews, CT scan request forms and CT scan reports.

The parameters studied were the type of CT scan performed, the socio-demographic data of the patients, and the characteristics of the scintigraphy imaging likely to be requested. The guide for the proper use of medical imaging examinations from the French Radiology Society (SFR) and the French Society of Nuclear Medicine and Molecular Imaging (SFMN) was used as a reference to select the CT indications likely to be explored by scintigraphy imaging. It was also used to select the level of intention, the grade of recommendation of the examinations (grade A for indications with established scientific proof, grade B for indications with a scientific presumption, grade C for indications with a low level of evidence, grade AE for indications based on expert agreement) and the dose class of the examination (less than one mSv for class I, between one and five mSv for class II, between five and ten mSv for class III, and greater than ten mSv for class IV) [3].

The data were processed and analysed using Epidata 3.1, R-Studio version 3.4.4 and Microsoft Excel version 2016. The results were tested by the Chi2 test; and significance was objectified if $p < 0.05$.

RESULTS

Types of CT scans and socio-demographic characteristics of patients

Type of CT scans performed by patients

A total of 4434 CT scans were performed during the study period with 2247 non-traumatic cases (excluding strokes). Among those cases, 328 met our selection criteria with an inclusion rate of 14.6%.

The most common CT scan performed was the chest-abdomen-pelvis CT scan followed by the thoracic angiography CT (Table 1).

Gender and age of patients

The sample consisted of 188 (57.3%) female and 140 (42.7%) male with a sex ratio of 0.74.

The mean age of the patients was 50.58 ± 19.02 years with extremes of 2 and 92 years. These patients were divided into 28 children (under 18 years old), or 8.5% of cases, 197 adults (18-65 years old), or 60.1% of cases and 103 elderly people (over 65 years old), or 31.4% of cases.

Table 1: Distribution of patients according to the type of CT scan requested

Type of CT scan	Number	%
Chest-abdomen-pelvis CT scan	119	36.3
Thoracic CT angiography	75	22.9
Brain CT scan	65	19.8
Abdominal CT scan	26	7.9
Thorax CT scan	9	2.7
CT Urography	9	2.7
CT thoracic and lumbar spine	5	1.5
Lumbar spine CT scan	4	1.2
Pelvic CT scan	3	0.9
Cervical spine CT scan	2	0.6
Cervical and thoracic spine CT scan	2	0.6
CT lower extremity	2	0.6
CT scan of the thigh	2	0.6
Craniofacial CT scan	2	0.6
Thoracic spine CT scan	1	0.3
CT brain and orbits	1	0.3
Sinus CT scan	1	0.3
Total	**328**	**100**

Table 2: Breakdown of patients by department of origin.

Department of origin	Number	%
Cardiology department in University Hospitals	22	6.7
Oncology - CHU SO	20	6.1
Neurology department in University Hospitals	15	4.6
External service of the University Hospitals	14	4.3
Urology department - CHU SO	14	4.3
Gynaecology department in University Hospitals	13	4
Gastroenterology and Hepatology department in CHU campus	12	3.7
University Hospitals' Emergency Department	9	2.7
Pneumology - CHU SO	7	2.1
Internal medicine department in University Hospitals	6	1.8
Surgery department - CHU SO	6	1.8
Rheumatology department - CHU SO	5	1.5
ICU - CHU SO	4	1.2
Neurosurgery department - SO University Hospital	3	0.9
ENT departments in University Hospitals	3	0.9
General medicine departments in University Hospitals	2	0.6
Ophthalmology departments in University Hospitals	2	0.6
Paediatric departments in University Hospitals	2	0.6
Dermatology departments in University Hospitals	1	0.3
Geriatric department - CHU campus	1	0.3
Military wing - CHU SO	1	0.3
Stomatology department - CHU SO	1	0.3
Traumatology departments in University Hospitals	1	0.3
No information	164	50
Total	**328**	**100**

CHU SO: Sylvanus Olympio University Hospital

Profession and health insurance of patients

Civil servants in the private and public sectors were in majority, 205 (62.5%), followed by pensioners, 76 (23.2%) and learners (pupils and students), 34 (10.4%). Five patients (1.5%) were unemployed. The profession was not informed in 8 patients (2.4%).

Half of the patients (188) had health insurance, the other half did not.

Referring centres and services

More than half of the patients were from university hospitals with a total of 170 (51.1%); 116 (35.3%) were from private clinics. The remainder of patients (12.8%) came from the country's other public health structures (dispensaries, peripheral heath centres, and regional hospitals).

The main referring services were Cardiology and oncology (Table 2).

Clinical profile of patients and dose classes of scintigraphic examinations that may be requested

Indications likely to be explored with scintigraphy imaging

The scintigraphic examinations likely to be requested were selected for 305 patients, or 93% of the cases, based on the clinical indications of the requested CT scans. For the remaining 23 patients (7%), scintigraphy imaging was selected on the basis of the findings in the CT scan's report.

In accordance with the guide for the proper use of medical imaging examinations, the majority of indications were second-line indications of nuclear medicine; the most frequent indications were pulmonary embolism, brain tumors, breast cancer and prostate cancer (Table 3).

Table 3: Distribution of pathologies according to intention levels.

	First intention		Second intention		Total	
	n	**%**	**n**	**%**	**n**	**%**
Pulmonary embolism	0	0	79	28.2	79	24,1
Brain tumour	0	0	52	18.6	52	15.9
Breast Cancer	0	0	38	13.6	38	11.6
Prostate cancer	22	45.8	0	0	22	6.7
Hepatocellular carcinoma	0	0	13	4.6	13	4
Pancreatic head cancer	0	0	12	4.3	12	3.7
Soft tissue tumour	0	0	11	3.9	11	3.4
Bone tumour	10	20.8	0	0	10	3
Hydronephrosis	9	18.8	0	0	9	2.7
Dementia	0	0	9	3.2	9	2.7
Endometrial cancer	0	0	7	2.5	7	2.1
Kidney tumour	0	0	7	2.5	7	2.1
Lymphoma	7	14.6	0	0	7	2.1
Ovarian tumour	0	0	6	2.1	6	1.8
Colon cancer	0	0	6	2.1	6	1.8
Cervical cancer	0	0	6	2.1	6	1.8
Chronic epilepsy	0	0	5	1.8	5	1.5
Gastric adenocarcinoma	0	0	4	1.4	4	1.2
Spinal compression	0	0	4	1.4	4	1.2
Broncho-pulmonary cancer	0	0	3	1.1	3	0.9
Lomboradiculalgia	0	0	3	1.1	3	0.9
Osteitis and osteomyelitis	0	0	3	1.1	3	0.9
Spondylodiscite	0	0	3	1.1	3	0.9
Testicular cancer	0	0	2	0.7	2	0.6
Bladder tumour	0	0	2	0.7	2	0.6
Hip pain	0	0	2	0.7	2	0.6
Laryngeal cancer	0	0	1	0.4	1	0.3
Thyroid neoplasia	0	0	1	0.4	1	0.3
Nephroblastoma	0	0	1	0,4	1	0.3
Total	**48**	**100**	**280**	**100**	**328**	**100**

Chi2 test (p-value = 0.067)

Table 4: Distribution of intention levels according to nuclear medicine fields.

	First intention		Second intention		Total	
	n	%	n	%	n	%
Nuclear Oncology	17	19.8	69	80.2	86	26.2
Nuclear Cardiopneumology	0	0	82	100	82	25
Nuclear Neurology	0	0	66	100	66	20.1
Nuclear Uronephrology	31	56.4	24	43.6	55	16.8
Nuclear Gastroenterology and hepatology	0	0	22	100	22	6.7
Nuclear Rheumatology	0	0	11	100	11	3.4
Nuclear Traumatology	0	0	3	100	3	0.9
Nuclear Pediatrics	0	0	2	100	2	0.6
Nuclear Endocrinology	0	0	1	100	1	0.3
Total	**48**	**14.6**	**280**	**85.4**	**328**	**100**

Chi2 test (p-value = 1.818)

Table 5: Distribution of recommendation grades by dose classes in scintigraphy imaging.

	Grade A		Grade B		Grade C		Total	
	n	%	n	%	n	%	n	%
Class I	0	0	0	0	9	25	9	2.8
Class II	9	12	167	77	13	36.1	189	57.6
Class III	25	33.3	23	10.6	0	0	48	14.6
Class IV	41	54.7	27	12.4	14	38.9	82	25
Total	**75**	**100**	**217**	**100**	**36**	**100**	**328**	**100**

Chi2 test (p-value = 3.037)

Fields of nuclear medicine concerned

The most concerned fields of nuclear medicine were nuclear oncology, followed by nuclear cardio-pneumology and nuclear neurology; nuclear oncology and nuclear uronephrology were the only fields where the indication for scintigraphy imaging was first-line (Table 4).

Recommendation grades and dose classes for scintigraphic examinations that may be requested

The grades of recommendation for the scintigraphy imaging examinations likely to be requested were 22.9% grade A, 66.1% grade B and 11% grade C; these scintigraphic examinations were of dose class II in more than half of the cases (Table 5).

Scintigraphy imaging was of a better or the same recommendation grade as CT in 53.7% of cases, and of a lower or the same dose class as CT in 90.2% of cases (Table 6).

DISCUSSION

Nuclear medicine is poorly accessible in developing countries, particularly in Sub-Saharan Africa, where many countries, such as Togo, have no nuclear medicine service [6]. This study, which to our knowledge is a first in a country without a nuclear medicine service, is timely, as it will allow us to estimate the degree of need for the creation of a nuclear medicine service in Togo. The guide for the proper use of medical imaging examinations from the French Radiology Society (SFR) and the French Society of Nuclear Medicine and Molecular Imaging (SFMN) was used because of the lack of a validated guide to the proper use of medical imaging examinations in French-speaking sub-saharan African countries such as Togo. We have not included trauma and stroke in the study because even if stroke and trauma can be indications for scintigraphy imaging, the selection of these cases, which are rare even in countries with a highly developed nuclear medicine service, could not be easy for us and would be very debatable. Moreover, according to the French guide for the proper use of medical imaging examinations, which has served as a reference, in the absence of a validated guide for the countries of French-speaking Africa, CT is only indicated for cerebrovascular accidents (transitory or constituted) in specific cases [3]. MRI, unless contraindicated, remains the medical imaging examination indicated for strokes [3].

Our study shows that 14.6% of patients referred for non-traumatic CT scans (not including stroke) in Togo were likely to be scanned by scintigraphy imaging.

Table 6: Comparison of grades of recommendation and dose classes of CT and scintigraphic examinations likely to be requested.

	Number	%
Comparison of recommendation grades		
Scintigraphy grade better than CT scan grade	114	34.8
Scintigraphy grade lower than CT scan grade	152	46.3
Scintigraphy grade equal to CT scan grade	62	18.9
Comparison of dose classes		
Scintigraphy dose lower than CT scan dose	133	40.5
Scintigraphy dose higher than CT scan dose	32	9.8
Scintigraphy dose equal to CT scan dose	163	49.7
Total exams	**328**	**100**

This non-negligible percentage shows that a significant number of patients are not be adequately managed due to the lack of nuclear medicine services available in the country. Both children and adults were concerned by scintigraphy imaging, with a high proportion of patients over 50 years of age. The same observation was made by other African authors who published earlier studies related to scintigraphy imaging [7, 8]. The predominance of female patients (sex ratio = 0.7) found in our study can be explained by the high frequency of gynaecological and mammary cancers in Africa [9]. In Togo, as in many African countries, there is no social security or health insurance system for all, and the relatively high cost of scintigraphy imaging examinations compared to radiological imaging examinations may reduce the accessibility of these examinations to patients. In this regard, it is comforting to note that half of the patients in our sample had health insurance and that most of them were working. These patients could therefore have the financial means to afford the scintigraphy imaging examination that might be requested if it was available in Togo. The majority of patients (51.8%) came from Togo's university hospitals. This result is close to that of Tapsoba et al. who found in their study on the first six months of operation of the nuclear medicine service in Burkina Faso in 2012 that 60% of scintigraphy imaging prescriptions came from doctors practicing in university hospitals [10]. For the patients included in our study, the most frequent requesting services were cardiology (6.7%) and oncology (6.1%). This result confirms the current importance of nuclear medicine examinations in the management of oncology and cardiology patients. The most concerned CT scans in our study were the thoraco-abdominal CT scan (32.6%) followed by the thoracic angiography CT (22%) carried out respectively for neoplasia (primary or secondary) and pulmonary embolism. The clinical indications for primary or secondary neoplasia also concerned other types of CT scans in our sample, such as cerebral CT scans (19.2%). This is the reason why nuclear oncology was the field of nuclear medicine most concerned by the patients in our study. The preponderance of nuclear oncology had also been observed in 2013 in Benin (a country bordering Togo that does not also have a scintigraphy imaging service) where more than two thirds of patients evacuated abroad due to the unavailability of diagnostic and therapeutic nuclear medicine had a cancerous pathology [11]. The important role of nuclear medicine in the management of neoplastic pathologies found in our work, such as prostate and breast cancer, is well established. Indeed, compared to CT, ^{18}F-fluorodeoxyglucose positron emission tomography ([^{18}F]FDG PET) has the advantage of excellent sensitivity in the search for metastatic bone disease [3, 12]. In addition, [^{18}F]FDG PET is widely used for the diagnosis of local recurrences, lymph node involvement and in distant metastases. With the new devices dedicated to breast cancer, [^{18}F]FDG PET ensures an early diagnosis of breast cancer with a good correlation with histological data [13, 14]. A recent study carried out in 2018 in France by Fleury et al. on 300 patients monitored for breast or prostate cancer confirms that conventional bone scintigraphy coupled with CT scan ensures the detection of bone metastases with a diagnostic accuracy close to 100% [15].

For pulmonary embolism, ventilation/perfusion scintigraphy allows early diagnosis in the acute phase with excellent negative predictive value [16]. Although the thoracic angiography CT occupies an important place in the diagnostic algorithms for the confirmation of pulmonary embolism, it cannot be performed in certain patients with a contraindication to the CT scan, such as subjects with renal insufficiency, severe renal pathology or intolerance to contrast agents [3, 17]. In these specific cases, perfusion lung scintigraphy may be an alternative diagnostic confirmation procedure [3]. In pregnant women, perfusion lung scintigraphy is the technique of choice for the diagnosis of pulmonary embolism because of its low irradiation compared to CT

pulmonary angiography [18]. The concordance between single-photon emission computed tomoscintigraphy for pulmonary perfusion and ventilation and the CT pulmonary angiography for the diagnosis of pulmonary embolism is 92-96%, with a sensitivity of 85-95% and a specificity of 90-98% for the scintigraphic examination [19]. According to the guidelines for the proper use of FSR and FSNM, the lung scintigraphy performed in the initial phase serves as a reference for the diagnosis of a possible subsequent recurrence of pulmonary embolism and for monitoring the effectiveness of anticoagulant treatment [3].

In addition to nuclear oncology, nuclear uronephrology was the field in which the indication for scintigraphy imaging was of first intention. Indeed, scintigraphic explorations allow an in-depth study of renal function and urinary tract drainage [20, 21]. They have a high diagnostic performance in the detection of silent kidneys with a better positive predictive value than radiological techniques [22].

The grades of recommendation for scintigraphic examinations likely to be requested in our study were satisfactory in the majority (89%) of cases with 22.9% grade A (based on established scientific evidence) and 66.1% grade B (based on level 2 scientific presumptions). These results show that the request for these scintigraphic examinations would be in line with the principle of justification underlying any exposure of patients to ionising radiation. Comparison of the recommendation grades of CT scans performed with those of scintigraphy imaging examinations likely to be requested shows that the scintigraphy imaging was of a better or identical recommendation grade to that of the CT scan performed in the majority (53.7%) of cases. It is therefore obvious that the availability of a nuclear medicine service in Togo would contribute to better compliance with the principle of justification of irradiating examinations, justification being the first fundamental principle of radiation protection. The request for these scintigraphic examinations would thus be more justified than that for CT scans, particularly in the first-line indications of scintigraphy imaging noted in our study.

With regard to dose classes, we noted that the scintigraphy imaging likely to be requested for patients was in the majority of cases of dose class II (1-5 mSv). This result confirms that these scintigraphic examinations are weakly irradiating, contrary to misconceptions. Indeed, practicing physicians, particularly those in Africa, often have a misconception that scintigraphic examinations are highly irradiating, more irradiating than all radiology examinations [5]. This is therefore the reason why they are not very enthusiastic about nuclear medicine, particularly paediatric nuclear medicine.

Comparison of the dose classes of CT scans performed with those of scintigraphy imaging examinations that may be requested reveals that scintigraphy imaging was in a dose class less than or equal to that of CT in 90.2% of cases. It therefore follows that the creation of a nuclear medicine service in Togo will make it possible to optimise the radiation doses of these patients and will contribute to better compliance with the second principle of radiation protection, which is the optimisation of doses. However, it is important to remember that scintigraphy imaging is not a substitute for CT, but rather a complement to radiological imaging, and therefore the availability of a nuclear medicine service in Togo does not exclude that these patients, depending on their clinical context, may benefit from both scintigraphy imaging and CT in their medical management. In addition to a better diagnostic exploration of patients, the creation of the nuclear medicine service through its therapeutic component (Radionuclide therapy) particularly its personalized therapeutic approach represented by nuclear theranostics, will contribute also to a better therapeutic management of many cancers in Togo. The advent of a nuclear medicine service in Togo will therefore not compete with radiology services but rather strengthen the arsenal of medical imaging techniques and promote a better patient care in Togo.

CONCLUSION

This prospective multi-centre study carried out in Togo, a country without a nuclear service, shows that a significant proportion of patients referred for CT scans in the country were likely to be scanned, particularly for second-line scintigraphy. These patients of various socio-clinical profiles were dominated by older patients. The nuclear medicine fields concerned were mainly oncology and nuclear cardiology. These scintigraphy imaging examinations that may be requested would contribute to better compliance with the principles of patient radiation protection, justification and optimisation of doses. The creation of a nuclear medicine service in Togo is therefore strongly desired for a better medical care of patients.

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