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EVALUATION OF NURSING TEAM ACTIVITIES TO ENSURE STAFF AND PATIENT SAFETY IN A NUCLEAR MEDICINE AND PET/ CT LABORATORY IN BRAZIL

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Abstract: Comfort, proper guidance and preparation for exams, and patient safety are the main focus of nursing care for those undergoing scintigraphic or PET/CT exams in a nuclear medicine service. These activities must be monitored for radiological safety to ensure radiation protection for the nursing team. OBJECTIVES: (a) To evaluate the dosimetry of the nursing staff before (2018 and 2019) and after (2022 and 2023) the installation of PET/CT equipment and two other gamma cameras in a nuclear medicine service; (b) To describe the administrative and care activities of the nursing staff in a nuclear medicine and PET/CT laboratory; (c) To correlate dosimetry with the activities performed by the nursing staff, proposing actions to reduce the team's exposure to ionizing radiation. METHODOLOGY: A survey of doses was conducted using the dosimetry reports of all members of the nursing team in two time windows, from 2018 to 2019 (before the pandemic, in an old laboratory), and from 2022 to 2023 (after the pandemic, in a new nuclear medicine laboratory equipped with PET/CT equipment). A survey will be conducted of all activities performed by the nursing team before and after the installation of PET/CT equipment. A statistical correlation will be performed between the activities before and after PET/CT with the dosimetry recorded for the nursing team. EXPECTED RESULTS: Evolutionary dosimetric analysis between two moments of a Nuclear Medicine Service, in which new radiopharmaceuticals and new hybrid imaging technology equipment (X-rays and Gamma rays) were incorporated. Analysis of the activities performed by the nursing team that offered the highest and lowest radioactive exposures in a working day.

Keywords: Nursing, Nuclear Medicine, Dosimetry, Radiation Protection, Nursing Activities.

INTRODUCTION

The role of nursing in *nuclear* medicine *and PET/CT.*

The nursing team plays a crucial role in the field of nuclear medicine, PET/CT, and radioisotope treatments (de Melo Belo, Reis, and Pereira 2023). They are involved in various tasks, including patient preparation, quality and safety management, radioisotope administration, patient monitoring during procedures, and care before and after radiopharmaceutical administration (Vijayakumar et al. 2006). The main challenges in this field include promoting the safety of patients and occupationally exposed individuals (OEIs), knowing how to act in radiological emergencies, and respecting ethical principles at work (Acauan et al. 2022). The multidisciplinary nature of nuclear medicine highlights the importance of patient-centered practice and communication (Giannoula et al. 2020), but also the harmonious work between all actors involved in a nuclear medicine service. Mapping nursing care for patients undergoing nuclear medicine procedures provides a systematic approach to care and should be the subject of research (Fernández Sola, Granero Molina, and Aguilera Manrique 2009). A safe working environment for nurses in the medical imaging field includes radiation protection and safe processes for patients and IOEs (Sarnese 2023; Hart 2006).

Safety in *the work* .

The International Atomic Energy Agency (IAEA) promotes a culture of quality in all processes in the field of nuclear medicine (Dondi et al. 2013). Work safety with radiation and accidental exposure are constant concerns, including quality assurance and adherence to regulations and reference levels in radiation protection (Marengo et al. 2022). For nursing staff, continuous training is necessary, recommending specific content for each field of practice, diagnosis, or therapy (Badawy et al. 2016). Nuclear medicine presents a high risk of occupational exposure for nurses, especially in relation to radiation. This is due to the handling of radioactive materials, patient positioning, and the potential for contamination. The implementation of protective measures, such as reducing exposure time, increasing the distance from the radioactive source, and shielding, can help minimize this risk (Jönsson 2021). Studies have found that the average annual personal dose for medical staff in nuclear medicine is below the national limit (Adliene et al. 2020). However, the average annual dose for nursing staff has been little investigated. The use of radiation safety training and protective measures reduces radiation exposure (Piwowarska-Bilska et al. 2011). In this context, further research is needed to fully understand the risks and develop effective risk management strategies in this field.

Procedures in medicine *and nucle*

Nuclear medicine encompasses a variety of diagnostic procedures, including scintigraphic examinations such as bone, thyroid, liver, kidney, brain, heart, and lung scintigraphy (Noßke et al. 2006). These procedures use radiopharmaceuticals to assess organ function and diagnose diseases. The radiation exposure of patients undergoing nuclear medicine examinations has been studied to estimate the frequency and dose that are safe for these procedures (Villoing et al. 2017). The most common imaging modalities in nuclear medicine are single photon emission computed tomography (SPECT) and positron emission tomography (PET) ("Nuclear Medicine Imaging" 2018). These modalities can be dedicated or in hybrid equipment coupled with X-ray computed tomography (CT). The effective doses of Radiopharmaceuticals for SPECT and PET diagnostic examinations vary widely, with the highest doses observed in hybrid SPECT/CT and PET/CT examinations, ranging from 0.5 to 49.1 millisieverts (mSv) (Camacho López et al. 2011). Cardiac PET has a low radiation exposure of 3.7 mSv, while SPECT has a higher exposure of 12.8 mSv (Desiderio et al. 2018). Routine SPECT/CT hybrid imaging protocols have an average patient exposure of 7 mSv (Rausch et al. 2016), and whole-body PET/CT has an average effective dose of 14 mSv, with diagnostic CT contributing 42% of the total dose (Li et al. 2019). These doses can be compared to the average annual effective dose from background radiation of about 3 mSv (Mettler et al. 2008). However, it is worth noting that these techniques have evolved over time, with changes in the types of procedures and radionuclides used. The use of high-efficiency SPECT cameras can reduce the radiation dose to 1 mSv (Einstein et al. 2014).

Radiation doses for *working ph*

The number of SPECT and PET scans can impact the radiation dose for workers. The highest doses are received during the administration of radiopharmaceuticals and patient preparation (Fathy et al. 2019). However, doses are generally within acceptable occupational health guidelines, and the use of protection can further reduce the dose (Roberts et al. 2005). The additional radiation exposure in SPECT/CT compared to SPECT alone is generally considered acceptable (Larkin et al. 2011). Therefore, the increasing use of PET/CT and SPECT/CT has raised concerns about radiation exposure, leading to a focus on dose management (Mattsson and Söderberg 2011). Studies have demonstrated reductions in radiation doses for staff and patients, including the use of lower activity in PET/CT imaging and optimization of CT acquisition parameters (Alenezi and Soliman 2015). Nevertheless, there is a clear need for ongoing radiation protection measures in PET/CT facilities (Walsh, O'Connor, and O'Reilly 2014).

SCIENTIFIC JUSTIFICATION

The rationale for conducting this study is based on the crucial importance of nursing in the field of nuclear medicine and PET/CT. Nurses are responsible for preparing and monitoring patients, administering radiopharmaceuticals, and managing quality and safety. Radiation exposure poses a significant risk to these professionals, making continuous training and the implementation of effective protective measures, such as reducing exposure time and using shielding, essential. Diagnostic procedures such as SPECT and PET, especially when combined with CT, involve varying doses of radiation, which reinforces the need for advanced techniques to minimize this exposure. There is a lack of studies investigating the annual dose received by nursing staff and risk control strategies. This study aims to fill this gap by developing effective risk management strategies and optimizing safety practices, with the goal of improving the effectiveness of care and ensuring a safe environment for both professionals and patients. Thus, we hope to contribute significantly to the advancement of practices in the field of nuclear medicine, promoting safer clinical practice focused on nursing professionals and, consequently, on patients.

OBJECTIVES

General Objective

To evaluate the professional activities and radioactive exposure of nursing staff in a nuclear medicine and PET/CT laboratory.

Specific Objectives

2.1 To evaluate the dosimetry of the nursing staff before (2018 and 2019) and after (2022 and 2023) the installation of PET/CT equipment and two other gamma cameras in a nuclear medicine service.

2.2 To describe the main diagnostic procedures of a public nuclear medicine service, comparing the periods before (2018 and 2019) and after (2022 and 2023) the expansion and installation of a new laboratory;

2.3 Associate the dosimetry of the nursing team with the number of diagnostic procedures performed and with the activities performed by the nursing team in the two periods.

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CASE STUDY AND TION METHODS

Sign of the study

Retrospective observational study in which we will compare the doses absorbed in chest and wrist dosimeters of nursing staff before and after the change of location, the introduction of new technology (PET/CT), and the daily increase in the number of scintigraphic examinations.

Radiometric survey and number of scintigraphic ex

The personal dosimetry of four members of the nursing staff who experienced the old and new nuclear medicine laboratories at HCFMRP-USP was surveyed. The dosimetry was recorded monthly by the company METROBRAS (MRA, Ribeirão Preto, SP, Brazil).

The number of scintigraphic examinations acquired within two time windows during 24 months before (2018-2019) and 24 months after (2022-2023) the relocation of the nuclear medicine laboratory and the start of operation of the PET/CT equipment were surveyed.

Survey of nursing activities

The activities performed by the nursing team will be obtained by following the activity roll previously published for the national context (see Figure 1). This is a *checklist* composed of activities divided into direct care interventions, associated administrative activities, and personal activities (Cruz and Gaidzinski 2013). The rationale is to ascertain whether some activities performed by nurses favored higher dosimetry. Or, conversely, whether new radiation protection practices and procedures reduced dosimetry, even though there was an increase in the number of scintigraphic or PET/CT exams. In previous studies, addressing not nuclear medicine but brachytherapy, which also uses radioactive sources for treatment, a positive correlation was found between the number of patients seen by the nursing team and the dosimetry recorded over a year of activities (Cobb, Kase, and Bjarngard 1978).

nd statistical analysis

To understand the nursing sample investigated, and the number of activities performed, number of exams and modalities performed, we will adopt descriptive statistics, using frequency tables, histograms, mean, median, standard deviation, and variance.

To investigate whether the PET/CT routine added a radiation dose different from the previous dose before PET/CT, we will perform a simple linear regression, where we have a binary variable (activity performed: yes/no) and a continuous variable (radiation dose).

To compare the average radiation dose (in millisieverts) between nursing teams before and after the move to the new laboratory (groups before versus after), we will perform a t-test for independent samples.

RESULTS

Evaluation of personal dosimetry

Below we present the preliminary results of personal chest and wrist dosimetry recorded for the nursing team of the Nuclear Medicine Service at HCFMRP-USP. The

Direct Patient Care Interventions

No.	Activity		No.	Activity	
1	Telephone follow-up		T5	Patient admission care	
2	Medication administration		16	Verify term of free informed consent	
3	Emotional support to patient/family		17	Post-anesthesia care	
4	Assistance with exams pre - Assistence with exams infra - Assistance with exams post-		18	Delegate technical duties to personnel	
			20	Staff development	
5	Assistance in self-care: feeding		21	Protocol/ care protocols development	
6	Assistance with hygiene/dressing/grooming		21	Documentation	
7	Health assessment		22	Case management	
8	Vital signs assessment		23	Sensory information	
9	Pain control		24	Shift change handover	
10	Neurological control		25	Promotion of family involvement	
11	Infection control		26	Promotion of exercise	
13	Control of the environment, worker safety				
14	Care for patients in intercurrences				

No.	Associated Administrative Activities		No.	Personal Activities	
27	Administrative meeting		41	Eating/hydrating	
28	Supervision of professionals		42	Elimination	
30	Inter-hospital transport		43	Socialization	
31	Exchange of health care information		44	Rest	
31	Verification of emergency beds		45	Answering personal phone calls	
32	Verification of supply control		46	Solving personal unit problems	
33	Print and file		47	Access the internet for personal interest	
34	Clean and organize workbenches		48	Being late	
35	Request technical assistance/maintenance		49	Study and adjust the work schedule	
36	Drug allocation		50	Participate in nuclear medicine training	
37	Locate companions				
38	Leave unit to provide various referrals				
39	Locate physician				
40	Coordinate with the physicist responsible for radioprotection				

FIGURE 1 - List of nursing activities in a diagnostic imaging department. Activities are divided into direct care interventions, associated administrative activities, and personal activities (Cruz and Gaidzinski 2013).

Team	CHEST * 2018-2019	WRIST * 2018-2019	CHEST * 2022-2023	WRIST * 2022-2023
Nursing #1	2.71	5.85	0.37	1.71
Nursing #2	0.98	2.86	0.56	2.69
Nursing #3	0.00	0.29	0	0
Nursing #4	0.55	0.40	0	0
AVERAGE	0.77	1.63	0.19	0.86
TOTAL	4.24	9.40	0.93	4.40

CAPTION: * Average dosimetry measurements in millisieverts (mSv).

TABLE 1 - Comparative dosimetry values in millisieverts (mSv) for nursing staff between 2018/2019 and 2022/2023, dichotomized between chest and wrist.

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dosimetry measurements were performed by Metrobrás (Metrobrás - Metrologia Das Radiações Ionizantes Ltda, Jardinópolis, SP, Brazil).

Table 1 shows the comparative dosimetry values for four nurses monitored in two time windows, the first between 2018-2019 and the second between 2022-2023. The figures reveal higher average dosimetry (5.85 mSv) for Nurse #1's wrist dosimeter in the 2018-2019 period, when there was only one gamma camera in operation in the previous nuclear medicine laboratory. Some dosimetry results were zero, not exactly due to the absence of radioactive exposure, but possibly because the dosimeter measurements showed doses below the recording level.

Another finding was that the highest average dosimetry (1.63 mSv) and the highest total dosimetry (9.40 mSv) were observed in the nursing team for wrist dosimeters. On the other hand, chest dosimeters had the lowest rates in both recording periods.

TABLE 1 shows a 53.00% reduction in the average dose (in mSv) recorded in the wrist dosimetry of nursing staff between the periods 2018-2019 (average dose of 9.40 mSv) and 2022-2023 (average dose of 4.40 mSv). A smaller reduction of 25.00% was observed for chest dosimeters between 2018-2019 (average dose of 0.77 mSv) and 2022-2023 (average dose of 0.19 mSv).

Graphs 1 and 2 below illustrate the findings in Table 1 and show the reduction in average and total doses for the group of nursing professionals in two time windows, 2018-2019 versus 2022-2023.

GRAPH 3 below illustrates the data in TABLE 1, highlighting the dispersion in average doses, notably in pulse dosimetry for the years 2018-2019. Nursing members #1 and #2 obtained higher absorbed doses in the wrist dosimeters in the years 2018-2019, which decreased in the years 2022-2023. Nursing member #3 presented doses below the registration levels (zero level in the graph) in three of the four periods evaluated. A possible explanation would be that nursing member #3 did not frequently participate in radiopharmaceutical injections or, as a non-compliance, did not wear the wrist and chest dosimeters as often as necessary. Retrospective studies suggest, however, that there is no way to recover this information with accuracy. Future studies may measure these variables and reveal the possible causes of such dispersions.

Qualitative analysis of *scintigraphic* examinations

TABLE 2 shows the types of scintigraphic examinations performed in 2018, 2019, 2022, and 2023. As can be seen, the largest number of examinations was whole-body scintigraphy, which is used to investigate metastases from different neoplasms, mainly breast and prostate cancer. Next are myocardial scintigraphy exams, which are usually performed in two shifts on the same day, with myocardial perfusion scintigraphy at rest in the morning and physical or pharmacological stress scintigraphy in the afternoon.

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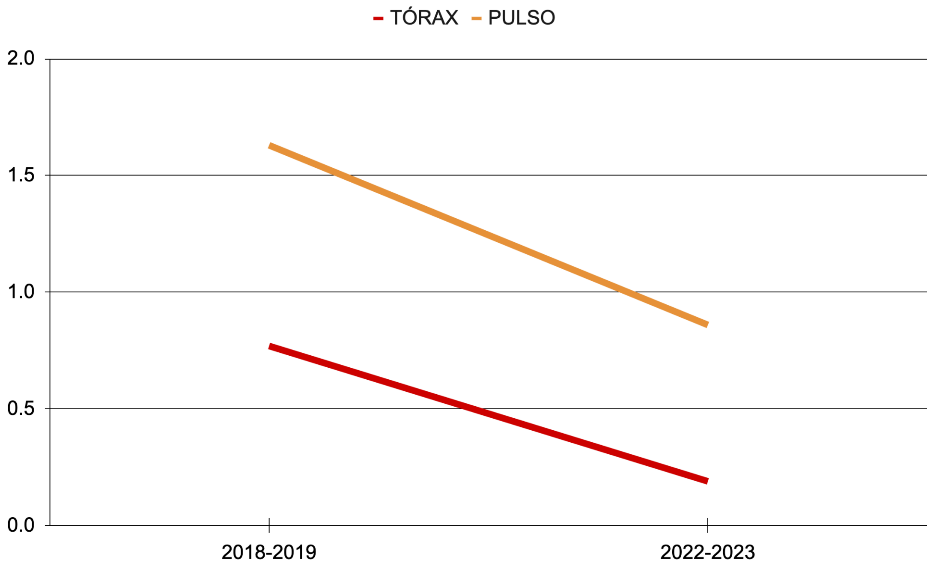
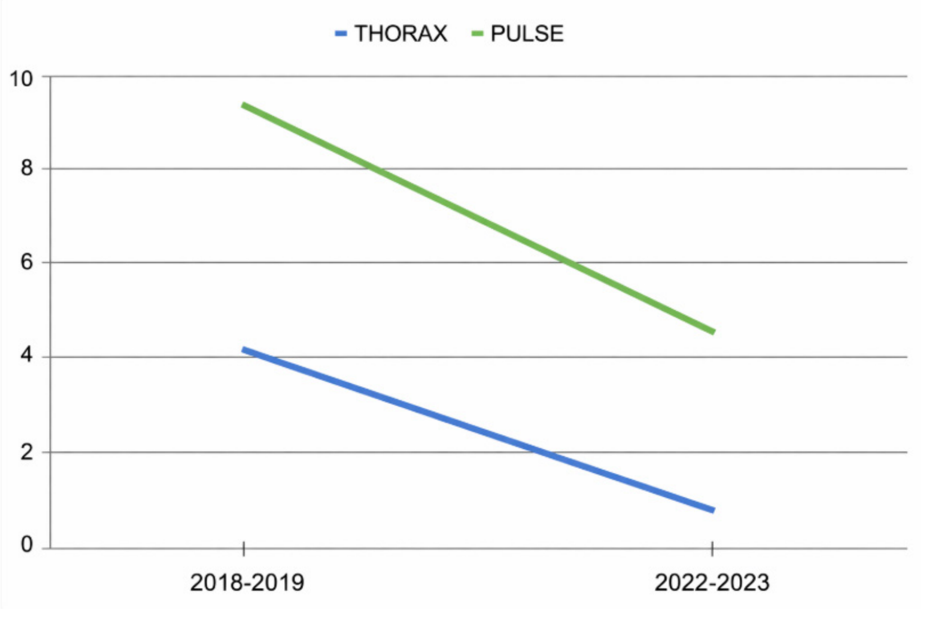
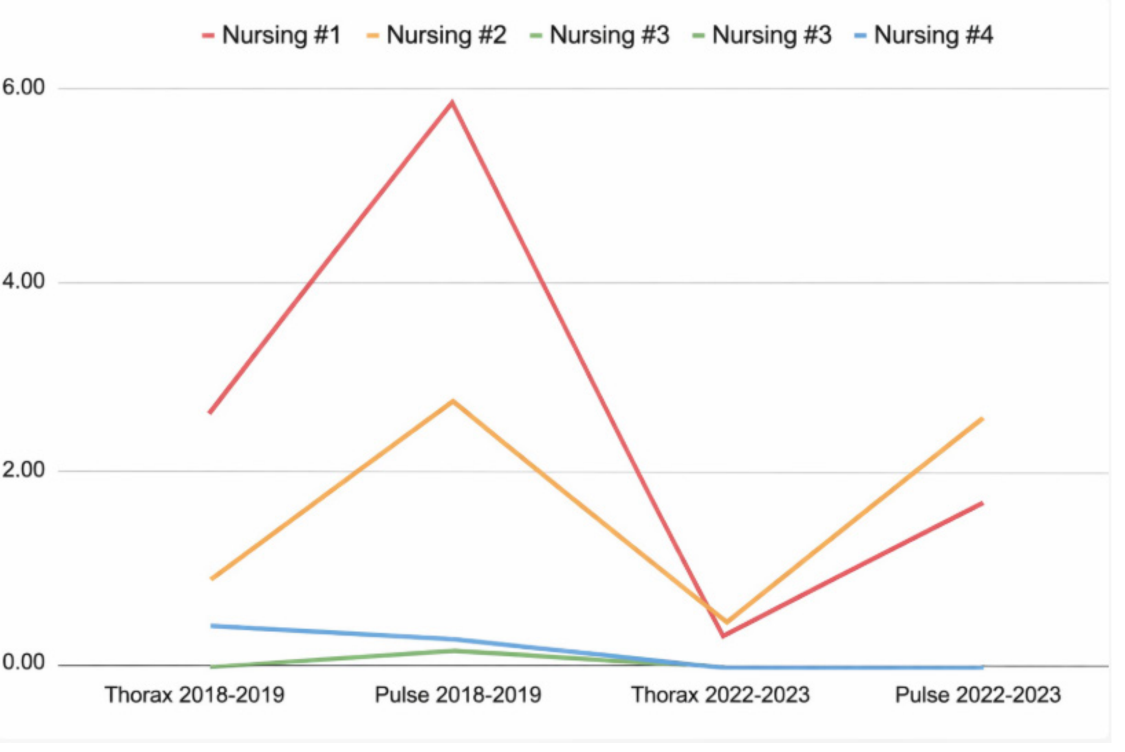


GRAPH 1 shows the reduction in AVERAGE DOSES absorbed by the nursing team (n=4) between the periods 2018-2019 *versus* 2022-2023. Dosimetry data from Metrobras.



GRAPH 2 shows the reduction in TOTAL DOSES absorbed by the nursing team (n=4) between the periods 2018-2019 *versus* 2022-2023. Dosimetry data from Metrobras.



GRAPH 3- Line graph showing the averages of the personal chest and wrist dosimetry records of the nursing team in the periods 2018-2019 versus 2022-2023. Dosimetry data from the company Metrobras.

TESTS	2018	2019	2022	2023	TOTAL
Whole body bone mass	1396	1554	1207	1651	5808
Myocardial [99mTc]Tc-SESTAMIBI	845	854	347	552	2598
Static renal	187	174	107	175	643
Parathyroid	200	200	89	130	619
Thyroid uptake and mapping	156	163	95	107	521
Cerebral SPECT [99mTc]Tc-ECD	159	200	1	14	374
PCI - I-131	94	108	64	47	313
Lymphoscintigraphy	65	71	78	69	283
Pulmonary perfusion	117	139	0	22	278
Basal renal dynamics	112	83	42	37	274
Renal dynamics with diuretic	87	31	18	57	193
Myocardial necrosis research	15	21	69	67	172
I-131 Thyroid Treatment Plummer	46	50	32	35	163
Renal dynamics captopril	50	54	9	20	133
Myocardial Thallium-201	33	30	24	10	97

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Gastroesophageal emptying	1	36	29	18	84
Thyroid mapping with [99mTc]Tc	17	20	12	13	62
Cerebral SPECT [99mTc] Tc-TRODAT-1	0	50	0	5	55
[131I]I-MIBG	15	19	9	8	51
Thyroid Cancer Therapy	16	21	6	7	50
PCI - Octreotide	14	16	0	0	30
Renal with octreotide	9	1	10	9	29
Digestive bleeding survey	13	7	1	7	28
GALIO-67	10	13	2	2	27
Gallbladder	12	13	0	0	25
Myocardial Gallium-67	2	9	1	5	17
Liver and spleen	3	2	0	4	9
Gastroesophageal reflux	2	1	2	0	5
Cerebrospinal fluid fistula research	2	2	1	0	5
Myocardial ventriculography	2	2	1	0	5
Lacrimal ducts	3	1	0	1	5
Meckel's diverticulum search	1	0	2	1	4
Pulmonary with Gallium-67	1	1	1	0	3
PCI - [99mTc]Tc-SESTAMIBI	1	0	0	1	2
Cerebral SPECT THALLIUM-201	0	1	0	1	2
Salivary glands	0	0	0	2	2
Right/left shunt investigation	1	0	0	0	1
Radiosynovectomy	0	1	0	0	1
Peritoneal/pleural communication research	0	0	1	0	1
Pulmonary aspiration	0	1	0	0	1
TOTAL	**3687**	**3949**	**2260**	**3077**	**12973**

TABLE 2 - Types of scintigraphic examinations performed in 2018, 2019, 2022 and 2023.

Quantitative analysis of scintigraphic examinations

In 2018, 3,989 scintigraphy exams were performed, and in 2019, 3,901 were performed. In 2022, 2,319 scintigraphies were performed, and in 2023, 3,120 exams were performed. The number of exams performed in the first period (2018 and 2019) was higher than in the second period (2022 and 2023), as shown in Table 2 and Graph 4 below. In summary, in the 2018-2019 period, there were 7,890 scintigraphies, and in the 2022-2023 period, there were 5,439 scintigraphies. The month of the year with the highest number of scintigraphic exams in both periods was April, and the month with the lowest number was December.

KEY: Capital letters correspond sequentially to the months of the year: J, January; F, February; M, March; A, April; M, May; J, June; J, July; A, August; S, September; O, October; N, November; D, December.

Distribution of the number of scintigraphic examinations throughout the year.

Descriptive analysis of *PET/CT* scans .

In 2022, 941 PET/CT scans were performed, and in 2023, 1,398 scans were performed (see CHART 5). These numbers were the result of the sum of exams from four modalities: whole-body oncological PET/CT [18F]FDG, whole-body non-oncological PET/CT [18F]FDG, cardiological PET/CT [18F]FDG, and neurological PET/CT [18F]FDG. There was a 49% increase in demand for this new type of molecular imaging in just one year. The month with the highest demand was August, and the month with the lowest demand was February.

DISCUSSION

Evaluation of personal dosimetry

Previous studies show that updating and expanding the infrastructure of nuclear medicine services can result in a significant reduction in radiation exposure for healthcare professionals. For example, a study by Antic et al. (2014) highlighted that the introduction of modern equipment and the optimization of operating procedures reduced the radiation dose received by workers by 40% (Antic et al. 2014).

A series of studies highlights the critical role of safety protocols and ongoing training in reducing radiation exposure in medical settings. Many of them emphasize the importance of these factors in minimizing exposure to ionizing radiation. This is further supported by Kamal (2023), who highlight the effectiveness of safety protocols and training in reducing radiation exposure in specific medical procedures and among healthcare professionals (Kamal, Khan, and Sadiq 2023).

The variability in individual dosimetry observed in this study is consistent with the literature. Some studies have highlighted significant variability in individual dosimetry in nuclear medicine, with factors such as the type and frequency of tasks performed, methods and assumptions used, and the type of procedure all contributing to this variation (Murray and Memmott 2023). This variability is further underscored by differences in radiation exposure between different roles in the field, with radiology technicians and nursing staff often recording

Scintigraphies	J*	F	M	A	M	J	J	A	S	O	N	D	TOTAL
2018	321	273	386	392	368	312	327	385	348	327	285	265	3989
2019	335	340	237	362	325	329	348	360	320	360	323	262	3901
2022	91	114	191	265	242	197	245	264	178	207	133	192	2319
2023	232	209	311	258	269	242	257	259	291	319	262	211	3120
Subtotal	**979**	**936**	**1125**	**1277**	**1204**	**1080**	**1177**	**1268**	**1137**	**1213**	**1003**	**930**	**13329**
PET/CT	J	F	M	M	M	J	J	A	S	O	N	D	
2022	110	59	61	58	66	43	118	87	90	94	71	84	941
2023	90	88	125	106	110	109	128	137	133	131	127	114	1398
Subtotal	**200**	**147**	**186**	**164**	**176**	**152**	**246**	**224**	**223**	**225**	**198**	**198**	**2339**
TOTAL	1179	1083	1311	1441	1380	1232	1423	1492	1360	1438	1201	1128	15668

TABLE 2 - Number of scintigraphic and PET/CT exams performed in the two periods, before (2018-2019) and after (2022-2023) the inauguration of the new Nuclear Medicine Service at HCFMRP-USP.

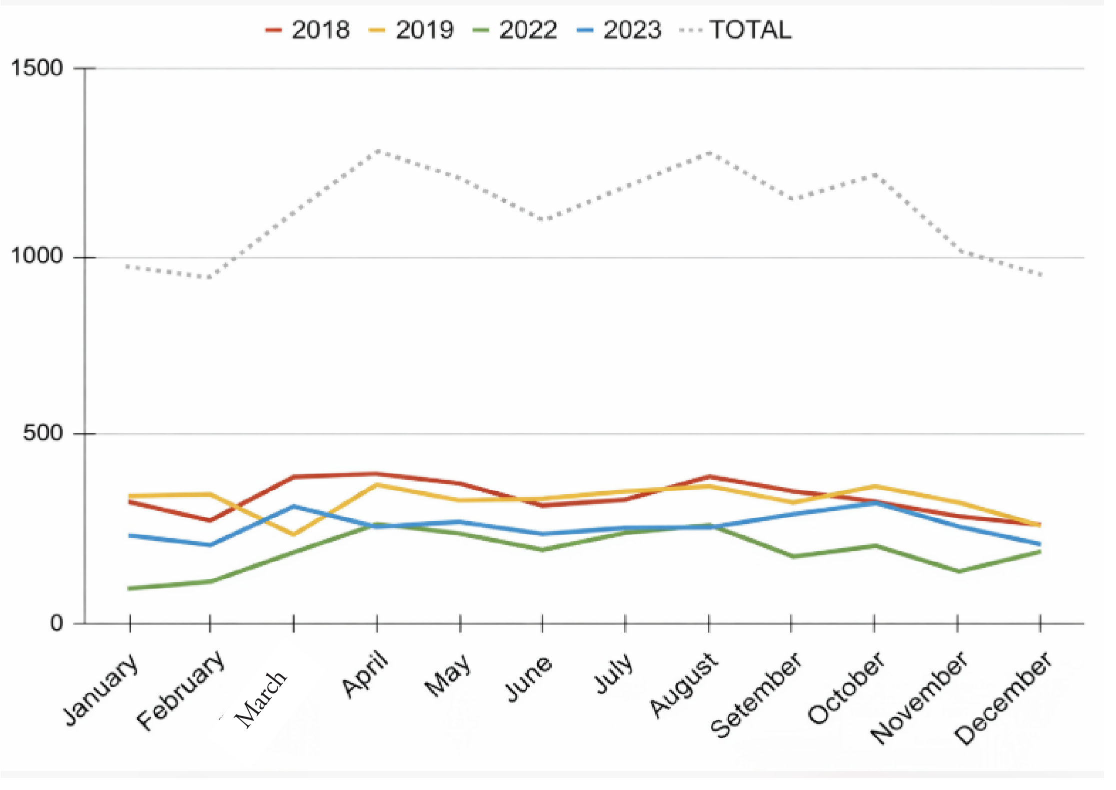
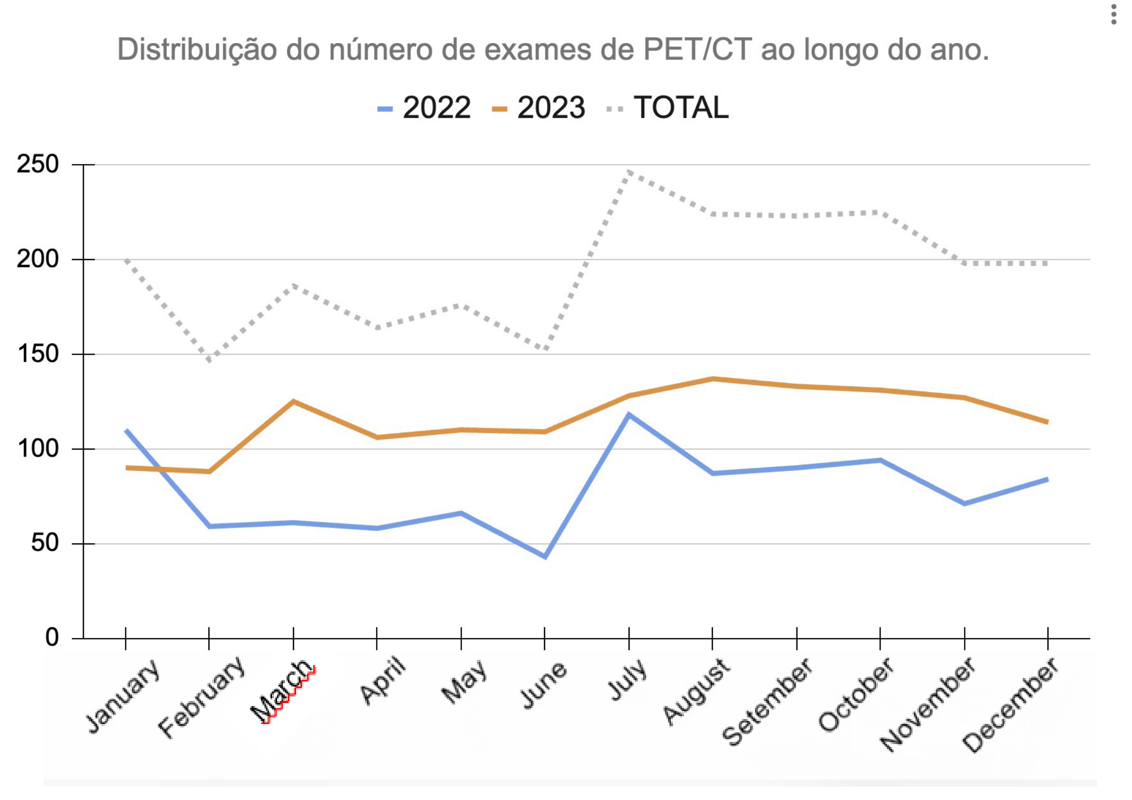


CHART 4 - Distribution of the number of scintigraphic examinations stratified by the months of the year in which they were performed, and broken down by the years 2018, 2019, 2022, and 2023. A total of 13,329 scintigraphic examinations were performed.



GRAPH 5 - Distribution of the number of PET/CT exams stratified by the months of the year in which they were performed, and individualized by the years 2022 and 2023. In total, 2,339 PET/CT exams performed. The dotted line shows the total profile, month by month, of PET/CT exams, showing the highest number in July and the lowest in February.

the highest doses (Alves da Silva et al. 2019). There is a clear need for a more standardized approach to dosimetry in nuclear medicine, with the aim of reducing this variability and ensuring worker safety.

In the field of radiation dosimetry, non-compliance with the use of personal dosimeters has been identified as a significant problem. Reasons for non-compliance include personal inconvenience, lack of adequate instructions for use, and lack of a safety culture (Qureshi, Ramprasad, and Derylo 2022). Inconsistent placement of dosimeters, especially under or over protective aprons, has also been observed (Noh et al. 2023). Despite these challenges, studies have shown that dosimetric accuracy is generally within acceptable tolerances (Balter et al. 2004).

Studies also emphasize the importance of ongoing training and education programs for workers exposed to radiation. Kamal (2023) demonstrated a reduction in radiation exposure through enhanced protection strategies and personalized safety measures (Kamal, Khan, and Sadiq 2023). In this vein, Vassileva et al. (2022) highlight the need to improve knowledge and practice of radiation safety measures among healthcare professionals, including the implementation of annual recertification courses, radiation protection education in training curricula, and international guidance on radiation protection education and training (Vassileva et al. 2022).

Qualitative analysis of scintigraphic examinations

Qualitative analysis of scintigraphic examinations performed between 2018 and 2023 reveals important trends in clinical practice, highlighting the crucial role of whole-body bone scintigraphy and myocardial scintigraphy. Bone scintigraphy, predominant due to its application in the investigation of neoplastic metastases, especially of the breast and prostate, presented had an increase. myocardial scintigraphy [99mTc]Tc-SESTAMIBI, essential for the evaluation of cardiac perfusion, also showed significant variations, with a peak in 2019 and a reduction in 2022, possibly reflecting changes in diagnostic practices or the availability of PET/CT. Other modalities, such as static renal and parathyroid scintigraphy, were moderately frequent, while more specific tests, such as right/left shunt investigation and radiosynovectomy, were rare. The sharp reduction in the total number of exams in 2022 can be attributed to the COVID-19 pandemic, suggesting a significant impact on healthcare activities, followed by a recovery in 2023, indicating a gradual return to normal operations. The COVID-19 pandemic had a significant impact on nuclear medicine, leading to a decline in diagnostic procedures, including bone, myocardial, lung, thyroid, and sentinel lymph node scintigraphy (Freudenberg, Dittmer, and Herrmann 2020). Despite this, there has been a steady increase in the use of bone scintigraphy, particularly for non-metastatic indications (Srivastava et al. 2023). The pandemic has also affected the importation of radiopharmaceuticals, leading to a decrease in the number of scintigraphic examinations (Noamen et al. 2023).

Quantitative analysis of scintigraphic examinations

Analysis of scintigraphy data from 2018 to 2023 reveals a significant variation in the number of exams, highlighting a notable drop after the inauguration of the new Nuclear Medicine Service at HCFMRP-USP. A number of factors may have contributed to this decline, including changes in demand, decreased operational capacity, and various clinical conditions, as previously described (Pozzo et al. 2014). The COVID-19 pandemic likely played an important role, as it led to an overall reduction in nuclear medicine procedures, including scintigraphy (Giammarile et al. 2021). This impact was particularly pronounced in Latin America, where the volume of procedures decreased by 79% in June 2020. (Giammarile et al. 2021). The pandemic also affected breast cancer screening in Brazil, with a 44% reduction in exams in 2020 (Furlam, Gomes, and Machado 2023). The transition to a new Nuclear Medicine Service may have further exacerbated these challenges, leading to a decrease in the number of scintigraphy exams.

In contrast, there was a significant increase in PET/CT exams, evidencing an expansion in service capacity and a possible preference for more accurate and specific exams. In 2022, 799 PET/CT exams were performed, and in 2023, 1,398, totaling exams in these two years. This increase suggests that the new Nuclear Medicine unit is attracting greater demand for advanced exams, indicating an improvement in the quality of care provided. The ability to perform more complex and detailed exams may be contributing to more accurate diagnoses, providing better outcomes for patients. The change in the care profile, with a growing trend toward the use of PET/CT scans, reflects the new technological and operational capabilities of the service, highlighting the importance of monitoring this data over the coming years to assess the long-term impact of the new infrastructure and adjust care strategies as needed.

Descriptive analysis of PET/CT scans.

The descriptive analysis of PET/CT exams performed between 2022 and 2023 reveals important trends in the use of this molecular imaging technology at our diagnostic center. The significant 43% increase in the number of exams performed, from 941 in 2022 to 1,508 in 2023, highlights the growing demand and importance of this type of exam in modern clinical practice (see CHART 5). This expansion can be attributed to several factors, including greater awareness of the benefits of PET/CT scans, technological advances, and possibly an increase in the number of cases requiring this type of diagnosis (Martella, Lenzi, and Gianino 2023).

The monthly distribution of exams highlights interesting seasonal patterns. August was the month with the highest demand, while February had the lowest number of exams performed. This pattern may be related to seasonal factors, vacations, and peak periods in disease diagnosis and treatment. Additionally, the aggregate monthly profile, represented by the dashed line in CHART 5, indicates a general upward trend in exams throughout the year, with a peak in July and a decrease in February. This profile is consistent for both 2022 and 2023, suggesting an established and possibly predictable trend in the use of PET/CT services.

The stratification of PET/CT exams into four specific modalities—whole-body oncological PET/CT [18F]FDG, whole-body non-oncological PET/CT [18F]FDG, cardiological PET/CT [18F]FDG, and neurological PET/CT [18F]FDG—also offers valuable insights into the clinical application of this technology.

This growth in demand for PET/CT scans has significant implications for operational capacity and resource planning at our center. The need to increase the availability of equipment, trained professionals, and auxiliary resources is evident to accommodate the nearly 50% increase in annual exams. In addition, analyzing monthly demand peaks can help optimize exam scheduling and resource allocation to ensure efficient, high-quality care. Finally, PET/CT equipment began operating in 2022, after a period of recovery from the COVID-19 pandemic, whose significant impact on PET/CT utilization was notably felt in 2020 and 2021 (Adin et al. 2021).

CONCLUSIONS

The objective of evaluating the dosimetry of the nursing team before (2018 and 2019) and after (2022 and 2023) the change of location and the installation of PET/CT equipment and two other gamma cameras, we concluded that despite the increase in the number of exams, there was a 53% reduction in the average dose recorded in pulse dosimetry and a 25% reduction in chest dosimetry between the periods 2018-2019 and 2022-2023. This demonstrates that the installation of new, modern equipment contributed to a significant reduction in the radioactive exposure of nursing staff.

The objective of describing the main diagnostic procedures in our laboratory, comparing the periods (2018 and 2019) and versus (2022 and 2023), our study revealed that bone scintigraphy remains the most commonly performed exam, especially for the investigation of metastases in neoplasms. On the other hand, the demand for PET/CT exams that began in 2022 increased by 49% between 2022 and 2023, reflecting the expansion of the laboratory and the introduction of diagnostic modalities through new radiopharmaceuticals.

The goal of ensuring the safety of patients and nursing staff the studies also emphasize the importance of ongoing training and education programs for workers exposed to radiation. Kamal (2023) demonstrated a reduction in radiation exposure through enhanced protection strategies and personalized safety measures, highlight the need to improve knowledge and practice of radiation safety measures among healthcare professionals, including the implementation of annual recertification courses, radiation protection education in training curricula, and international guidance on radiation protection education and training (Vassileva et al. 2022).

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