

**Title:** Cancer Patient Experience in a Nuclear Medicine Department: Comparison between Bone Scintigraphy and <sup>18</sup>F-FDG PET/CT

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## **Cancer Patient Experience in a Nuclear Medicine Department: Comparison between Bone Scintigraphy and $^{18}\text{F}$ -FDG PET/CT**

**Objective:** To assess the anxiety level in cancer patients undergoing nuclear medicine (NM) exams scans and to identify how professionals can improve patient experience.

**Methods** 94 patients undergoing a  $^{99\text{m}}\text{Tc}$  hydroxymethylene diphosphonate Bone Scintigraphy ( $^{99\text{m}}\text{Tc}$ -HDP BS) or a Positron emission tomography/Computed Tomography ( $^{18}\text{F}$ -FDG PET/CT) completed two Scan Experience Questionnaires and the State Anxiety Inventory (STAI-S) prior to the scan and after image acquisition.

**Results:** Before the exam, the mean anxiety levels were higher for the  $^{99\text{m}}\text{Tc}$ -HDP BS patients compared to the  $^{18}\text{F}$ -FDG PET/CT group. For the post-scan STAI-S mean score, the opposite is true.

Both groups experienced a reduction in levels of anxiety after the scan ( $^{99\text{m}}\text{Tc}$ -HDP BS - STAI score pre-scan = 51.75, and post-scan = 36.70;  $^{18}\text{F}$ -FDG PET/CT - STAI-S score pre-scan = 44.67, and post-scan = 38.82).

The greatest anxiety factor for the  $^{99\text{m}}\text{Tc}$ -HDP BS group was the duration of the exam -  $5.34 \pm 2.08$  (mean  $\pm$  SD), while for the  $^{18}\text{F}$ -FDG PET/CT group it was the result -  $5.40 \pm 1.80$  (mean  $\pm$  SD).

**Conclusion:** Patients undergoing NM exams in an oncological context revealed significant anxiety levels prior to and after their scans. However, the  $^{99\text{m}}\text{Tc}$ -HDP BS and  $^{18}\text{F}$ -FDG PET/CT have different triggers. It is of extreme importance that healthcare professionals are aware of these peculiarities and adjust their procedures accordingly.

**Keywords:** Anxiety;  $^{99\text{m}}\text{Tc}$ -HDP Bone Scintigraphy;  $^{18}\text{F}$ -FDG PET/CT; Oncology; Nuclear Medicine; Patient concerns

**Introduction:**

Nuclear Medicine (NM) has been playing an increasingly important role in the diagnosis, staging, prognosis, therapy, treatment planning and re-staging of various malignant neoplasms (1). 2-deoxy-2-[fluorine-18]fluoro-D-glucose Positron emission tomography/Computed Tomography low dose scans ( $^{18}\text{F}$ -FDG PET/CT) and Bone Scintigraphy (BS) are the most common Nuclear Medicine (NM) exams used in cancer patients.  $^{18}\text{F}$ -FDG PET/CT is an imaging modality that enables the detection of primary tumours and metastases by visualization of the increased glucose consumption of malignant tissue. BS is a highly sensitive diagnostic NM imaging technique that uses a radiotracer to evaluate the distribution of active bone formation in the skeleton related to malignant and benign disease (2). Although these exams currently constitute a "quasi-routine" for these patients, they are not devoid of psychological impact. It is known that they can trigger anxiety reactions, because in addition to the disease (at the stage of diagnosis, staging or possible remission) there are concerns about radiation, the duration of the examination, the fear of the need to be alone in the image acquisition room, the size of the equipment (particularly in claustrophobic patients), possible positioning discomfort, the injection and the comprehensibility of the procedures (3). Anxiety is an emotion characterized by apprehension and somatic symptoms of tension, such as muscle tension and increased heart and respiratory rate (4). It is a complex reaction that results from various situations perceived by patients as a risk. The perception of risk alone is highly dependent on different constructions of danger and vulnerability (5). Anxiety is a state commonly experienced by patients in several fields of medical care, but it is more prevalent in oncological contexts (6, 7).

The contribution of medical imaging to the diagnosis can be compromised in cases of highly anxious patients since possible movements and muscular tension can reduce image quality by producing motion artifacts and influencing biodistribution particularly in  $^{18}\text{F}$ -FDG PET/CT (8). Recent research has pointed out that providing adequate information and establishing a relationship of trust with health professionals, considering the "mental noise" often experienced by patients with high levels of anxiety, are key factors in the overall patient experience and satisfaction (9).

Regarding PET/CT, Vogel et al. (10) detected that 59% of the patients experienced high levels of anxiety before the scan and revealed abnormal  $^{18}\text{F}$ -FDG uptake in tissues. Similarly, Pifarré et al. (11) found that almost two-thirds of the patients who underwent PET/CT were anxious and noticed higher levels of anxiety in patients who performed the scan at the initial stage of the disease. Abreu et al. (12) and Grilo et al. (13) observed substantial anxiety before and after  $^{18}\text{F}$ -FDG PET/CT scan in oncological patients. However, in Abreu sample (12), patients felt more anxious prior to the scan, whereas in Grilo's study (13) the anxiety increased after the patients left the uptake room.

Considering BS, Leckie (14) found that patients who received standard information experienced a high degree of anxiety prior to the scan.

Although these studies have demonstrated that cancer patients experience anxiety during the  $^{18}\text{F}$ -FDG PET/CT (11-13) and BS (14), it is not yet clear which moments or procedures might influence state anxiety levels, as well as, what are the potential predictors of exam-related anxiety.

**Aim:** To assess anxiety levels in cancer patients undergoing Bone Scintigraphy and  $^{18}\text{F}$ -FDG PET/CT before and after the mentioned exams and to identify the main determinants of anxiety state.

## **Methods:**

### Participants

This cross-sectional prospective study was carried out via the collection of questionnaires from cancer patients attending a NM department in Lisbon between June and September of 2018, with a clinical indication to perform  $^{99\text{m}}\text{Tc}$  hydroxymethylene diphosphonate BS ( $^{99\text{m}}\text{Tc}$ -HDP BS) or  $^{18}\text{F}$ -FG PET/CT. The non-probabilistic sample included individuals over the age of eighteen with an oncological pathology and a cognitive ability to answer questions and participate freely in the study.

### Procedure

#### **Procedure**

The study was authorized by the Ethics Council of the hospital and by the National Data Protection Commission.

At the time the examination was scheduled, all patients received oral and written information about the preparation and duration of the exam.

The  $^{99\text{m}}\text{Tc}$ -HDP BS group was informed that no preparation was required, and as to the duration of the examination. The day before the scan, the NM department contacted by phone each patient to confirm their appointment and to answer any question the patients had regarding the exam procedure.

The  $^{18}\text{F}$ -FDG PET/CT group was informed that they should fast for 4-6 hours prior to the scan, should not practice exercise the day before the scan, and as to the duration of the examination. The day before the scan, each of the mentioned group's patients was contacted by phone by the NM department to confirm their presence, to ensure they received and understood the exam's preparation, and to clarify any concerns that patients had.

On the day of the exam, all the eligible patients were informed of the purpose of the study, and the protection of their data was guaranteed. Data collection was initiated after the patients signed the informed consent form. During the completion of the pre and post-scan questionnaires, one of the researchers was always present to explain doubts that arose to the patients.

After filling out the pre-scan questionnaire, the patients started the normal procedures of the NM Department.

In  $^{99\text{m}}\text{Tc}$ -HDP BS, before tracer injection, the technologist explained the purpose of the examination and the expected benefits. The patient was informed about how the examination was to be performed and discussed any limitations. Unless contraindicated, patients should have been well hydrated and instructed to drink at least a liter

of water during the time between injection and imaging (about 2 hours). All patients were instructed to empty the bladder frequently during the time between injection and delayed imaging as well as immediately before the scan. It was also mentioned that, after injection of the radiopharmaceutical, the patient could leave the NM Department and return only at the scheduled time to collect the images. In these cases, patients' social distance education was provided.

In  $^{18}\text{F}$ -FDG PET/CT studies (15), patients were requested to drink water before starting the exam (+/- 400 mL) and to void their bladder to ensure a sufficiently low concentration of  $^{18}\text{F}$ -FDG in the urine (fewer artifacts) and for radiation safety reasons. The technologist also informed patients that during the injection of  $^{18}\text{F}$ -FDG and the subsequent uptake phase, they must remain lying down or recumbent and silent to minimize  $^{18}\text{F}$ -FDG uptake in muscles and brain. The patients were kept resting in a warm environment during the 30 – 60 min before the  $^{18}\text{F}$ -FDG injection, continuing throughout the subsequent uptake period and examination, to minimize the  $^{18}\text{F}$ -FDG accumulation in brown fat (approximately 60 minutes). All patients were taught to empty the bladder immediately before the beginning of the scan.

Once the image collection was completed and the image quality was evaluated, the date of delivery of the report was agreed with the patient.

After the examination, the patients completed the post-scan questionnaire.

#### Measurement instruments

To assess the degree of anxiety, we used the Portuguese version (16) of the Spielberger State Anxiety Inventory (STAI-S) (17). (STAI-S) evaluates how the patient feels in a specific situation or moment (e.g. I feel calm; I am angry) and it reflects the anxiety patients experience at a particular moment or situation. Participants are asked to rate themselves on each item based on a 4-point Likert scale, ranging from 'not at all' to 'very much so'. In the end, the scores obtained in each test range from 20 to 80; higher values indicate increased anxiety levels.

The patients completed two questionnaires adapted from a previously used instrument for a study with cancer patients undergoing an  $^{18}\text{F}$ -FDG PET/CT (12,13) at different phases: prior to the scan, before any contact with the technologist (pre-scan) and immediately after image acquisition (post-scan). The pre-scan questionnaire included demographic information (age, gender, and academic degree), exam information (e.g. identification of the procedure name and the reason why it was prescribed: "initial staging of cancer", "treatment results" and "assess cancer recurrence"), the patient's perspective on information provided the day before the scan (e.g. evaluation of its suitability and usefulness in a 7-point Likert scale in which higher values represented a more positive judgment) and a 9-item self-report questionnaire on patient concerns (e.g. "radiation involved", "not knowing the purpose of the exam"; "immobilization and/or positioning during examination", "exam result", "duration of procedure", "discomfort/pain during the procedure", "lack of knowledge about the procedure", "body exposure during procedure" and "injection of the radiopharmaceutical"). Patients answered each concern in a 7-point Likert scale ranging from

*No concerned* (1) to *Very concerned* (7). These questions regarding patients' concerns about exam were also based on a Portuguese instrument used with cancer patients undergoing radiation treatment (18).

The pre-scan questionnaire collected the patients' perspective on the information provided by the professionals before the procedure (e.g. evaluation of its comprehensibility and usefulness, and existing doubts about the scan) and patient satisfaction with care and satisfaction with the information provided by the NM Department. Patients answered each question in 7-point Likert scale, in which higher values represented a more positive judgment.

### Statistical analysis

The data was analysed in the statistical software SPSS®, version 22.0 for Windows®. Schnitzer, the Shapiro-Wilk test was applied. The results were considered significant at a 5% significance level.

The statistical analysis carried out was as follows:

- To compare the subjective perception of anxiety between pre-scan and post-scan, the t-test was used for two paired samples (comparing STAI-S questionnaires).
- To study the relationship between two variables, the Pearson correlation coefficient (when the normality assumption was verified) or Spearman correlation coefficient (when it was not verified) was used.
- To test whether the distribution of a qualitative variable is identical between the two groups, we used the chi-square test (when the assumptions of applicability were verified) or the chi-square test by Monte Carlo Simulation (when the assumption was not verified).
- For the comparison of the two independent groups, the t-test (when the normality assumption was verified) or the Mann-Whitney test (when the normality of the sample was not verified) was used.
- Multiple regression analysis using the Stepwise method was used to identify predictors for high levels of anxiety. Thus, as a dependent variable the STAI-S pre-scan was considered, and as independent variables, the questions raised with the highest concerns, such as the radiation, exam result, position and duration of the exam, radiopharmaceutical injection and comprehensibility, were considered. The Gauss-Markov conditions were verified for the model. It was also verified that there is no multicollinearity.

## Results:

### Demographic and clinical characteristics

From the 121 completed questionnaires, 27 were excluded due to their lack of response to at least 60% of the questions. The sample, therefore, consists of 94 patients: 42 patients underwent a  $^{99m}\text{Tc}$ -HDP BS and 52 patients a  $^{18}\text{F}$ -FDG PET/CT. The mean age of the patients included in this study was  $62.33 \pm 11.9$  for the  $^{99m}\text{Tc}$ -HDP BS group and  $59.2 \pm 14.4$  for the  $^{18}\text{F}$ -FDG PET/CT. A total of 90.4 % knew the reason why the NM scan was prescribed.

The primary reason that led individuals to be subjected to these scans was an initial staging of cancer, which represented 78.6% of the  $^{99m}\text{Tc}$ -HDP BS group and 59.6% of the  $^{18}\text{F}$ -FDG PET/CT group. Patients who had previously undergone the examination classified their experience as neither very easy nor very difficult (Table 1). With the above characteristics, the two groups do not differ significantly ( $p > 0.05$ ) as shown in Table 1.

### **Patient anxiety and scan-related concerns**

A mean of the STAI-S scores pre and post-scan was obtained for the  $^{99m}\text{Tc}$ -HDP BS group and the  $^{18}\text{F}$ -FDG PET/CT group. Between the two groups, statistically significant differences in STAI-S levels were detected in the pre-scan ( $t_{47.973}=3.786$ ,  $p < 0.001$ ) (Table 2). It is noticeable that the STAI-S levels were higher for the  $^{99m}\text{Tc}$ -HDP BS group when compared to the  $^{18}\text{F}$ -FDG PET/CT group before undergoing the scan. Regarding the post-scan questionnaire, no statistically significant differences were detected in STAI-S levels between the two groups ( $t_{70}=-0.768$ ,  $p=0.445$ ), although the STAI-S levels were higher in the  $^{18}\text{F}$ -FDG PET/CT group.

There was a significant reduction in STAI-S levels from pre to post-scan in both groups ( $t_{11}=2.450$ ,  $p=0.032$  for the  $^{99m}\text{Tc}$ -HDP BS group and  $t_{33}=5.252$ ,  $p < 0.001$  for the  $^{18}\text{F}$ -FDG PET/CT group).

With respect to the evaluation of the degree of anxiety in the  $^{18}\text{F}$ -FDG PET/CT group, significant correlations of moderate to strong intensity were detected in the positive direction between STAI-S pre-scan and post-scan ( $r=0.670$ ,  $p < 0.001$ ), while in the  $^{99m}\text{Tc}$ -HDP BS group none of these correlations were verified.

No statistically significant differences between genders were detected in either group or among the different age groups or levels of education in the STAI-S pre-scan for both studies ( $p > 0.05$ ).

No statistically significant differences were found between the STAI-S pre-scan in patients undergoing the exam for the first time and those who had previous experience in both groups ( $U=184$ ,  $p=0.370$  for  $^{99m}\text{Tc}$ -HDP BS group and  $U=485$ ,  $p=0.990$  for  $^{18}\text{F}$ -FDG PET/CT group).

When analysing correlations between the patients' evaluation of their previous experiences and the STAI-S pre and post-scan, no correlations were found among the  $^{99m}\text{Tc}$ -HDP BS group. However, for the  $^{18}\text{F}$ -FDG PET/CT group a significant correlation of moderate to strong intensity was detected in the positive direction between their previous experience and STAI-S pre-scan ( $r_s=0.634$ ;  $p < 0.001$ ) (Table 3).

On a 7-point Likert scale for the  $^{99m}\text{Tc}$ -HDP BS group, the greatest concern factor was the duration of the exam with  $5.3 \pm 2.1$  (mean  $\pm$  SD), while for patients who had the  $^{18}\text{F}$ -FDG PET/CT the main concern was the result of the exam with  $5.4 \pm 1.8$  (mean  $\pm$  SD) (Table 3).

In the  $^{18}\text{F}$ -FDG PET/CT group the following significant correlations of moderate intensity in the positive direction were found with the STAI-S pre-scan: radiation involved ( $r_s=0.352$ ;  $p=0.010$ ), the result ( $r_s=0.306$ ;  $p=0.026$ ), duration of the procedure ( $r_s=0.399$ ;  $p=0.004$ ), body exposure ( $r_s=0.328$ ;  $p=0.018$ ) and the radiopharmaceutical injection ( $r_s=0.341$ ;  $p=0.013$ ) (Table 3).

## Patient experience

With regard to the patients' overall satisfaction levels with the NM department, 85.7% of the total sample classified the experience of the department itself as highly satisfactory.

A large percentage of patients that experienced the  $^{18}\text{F}$ -FDG PET/CT ( $n=44$ , 84.6%), as well as those patients who had the  $^{99\text{m}}\text{Tc}$ -HDP BS ( $n=41$ , 97.6%), confirmed that the information provided on the day before the procedure (by phone) and on the day of the exam, prior to the scan, was completely comprehensible ( $6.00\pm 1.26$  for  $^{99\text{m}}\text{Tc}$ -HDP BS and  $5.69\pm 1.26$  for  $^{18}\text{F}$  FDG PET/CT and  $6.20\pm 1.08$  for  $^{99\text{m}}\text{Tc}$ -HDP BS and  $6.14\pm 1.03$  for  $^{18}\text{F}$  FDG PET/CT, respectively) and useful ( $5.65\pm 1.43$  for  $^{99\text{m}}\text{Tc}$ -HDP BS and  $5.82\pm 1.50$  for  $^{18}\text{F}$  FDG PET/CT and  $6.13\pm 1.36$  for  $^{99\text{m}}\text{Tc}$ -HDP BS and  $6.10\pm 1.24$  for  $^{18}\text{F}$  FDG PET/CT, respectively) (Table 4).

When asked if there was any topic they would like to see explained in more detail, both groups felt it would be beneficial to address issues such as the radiation involved (13.5% for  $^{99\text{m}}\text{Tc}$ -HDP BS and 7.1% for  $^{18}\text{F}$ -FDG PET/CT 7.1%). For  $^{99\text{m}}\text{Tc}$ -HDP BS, the duration of the exam (7.1%) and for  $^{18}\text{F}$ -FDG PET/CT the preparations for the exam (7.7%) were also relevant concerns that should be discussed prior to the procedure.

In the  $^{99\text{m}}\text{Tc}$ -HDP BS group, the following significant correlations of moderate intensity in the positive direction were found with the overall satisfaction: suitability ( $r_s=0.457$ ;  $p=0.003$ ) and utility ( $r_s=0.483$ ;  $p=0.002$ ) of the information provided by phone the day before the procedure, usefulness ( $r_s=0.696$ ;  $p<0.001$ ), suitability ( $r_s=0.655$ ;  $p<0.001$ ) of the information provided on the day of the exam, prior to the start of the procedures, and the dignity and respect felt during the procedures ( $r_s=0.520$ ;  $p=0.001$ ) (Table 5). Regarding the information provided, there was a significant positive correlation between comprehensibility and STAI-S ( $r_s=0.709$ ;  $p=0.049$ ).

In the  $^{18}\text{F}$ -FDG PET/CT group, the following significant correlations of moderate intensity in the positive direction were found with the overall satisfaction: usefulness ( $r_s=0.349$ ;  $p=0.015$ ), suitability ( $r_s=0.369$ ;  $p=0.010$ ) of the information provided on the day of the exam, prior to the start of the procedures, and the dignity and respect felt during the procedures ( $r_s=0.650$ ;  $p<0.001$ ) (Table 5). In regard to the information provided, there is a significant negative correlation between comprehensibility and STAI-S ( $r_s=-0.386$ ;  $p=0.015$ ) (Table 4).

## Predictors of patient anxiety before $^{99\text{m}}\text{Tc}$ -HDP BS and $^{18}\text{F}$ -FDG PET/CT procedures

To identify predictors for the pos-scan anxiety, STAI-S was considered as a dependent variable and as independent variables the questions raised with the highest concerns, such as the radiation burden, exam result, patient positioning and duration of the exam, radiopharmaceutical injection and comprehensibility of the indications given by the professional, were considered.

In the  $^{99\text{m}}\text{Tc}$ -HDP BS group, only the body exposure during the examination was identified as a regressor, and it was verified that for each additional level of concern relating to this question, the levels of anxiety increase, on average by 1.288 (Table 6). This model explains 34.1% of the variation in anxiety levels.



In the  $^{18}\text{F}$ -FDG PET/CT group, the radiation involved in the scan and the duration of the exam were identified as regressors; this model explains 29.7% of the variation in pre-scan anxiety levels. It has been found that for each additional level of concern relating to the examination involving radiation and the duration of the exam, an increase in anxiety levels of an average of 1.824 and 1.242 occurs, respectively (Table 6).

### **Discussion:**

We evaluate the overall experience of cancer patients undergoing two specific imaging exams:  $^{99\text{m}}\text{Tc}$ -HDP BS and  $^{18}\text{F}$ -FDG PET/CT, and to assess the level of anxiety felt by patients in these two groups.

#### Patients anxiety and demographic data

When the two groups of patients (who underwent a  $^{99\text{m}}\text{Tc}$ -HDP BS or an  $^{18}\text{F}$ -FDG PET/CT) were considered separately, no differences in anxiety levels were found among different age groups, gender or level of education. Previous studies assessing the state of anxiety in cancer patients who perform medical imaging and radiation treatment also find no differences considering demographic data (11, 12, 13, 18).

#### $^{99\text{m}}\text{Tc}$ -HDP BS and $^{18}\text{F}$ -FDG PET/CT anxiety levels

Prior to the exam, we found significant differences between anxiety levels for the  $^{99\text{m}}\text{Tc}$ -HDP BS and the  $^{18}\text{F}$ -FDG PET/CT groups. The mean state anxiety values were 51.75 and 44.76 respectively. Similar studies that also assessed anxiety through STAI-S encountered lower values. In Leckie's study (14) BS patients who received standard information revealed anxiety mean value of 46.0. Regarding  $^{18}\text{F}$ -FDG PET/CT, Grilo et al (12) found 31.1 anxiety mean values before Spanish cancer patients underwent the exam. Analogous studies that evaluated cancer patients' anxiety prior to radiation treatment (18, 19) and chemotherapy (20) presented more moderate values than those observed in our study.

#### $^{99\text{m}}\text{Tc}$ -HDP BS and $^{18}\text{F}$ -FDG PET/CT related concerns

With respect to exam-related concerns, exam duration was the main trigger of anxiety in patients who underwent a  $^{99\text{m}}\text{Tc}$ -HDP BS. For patients in the  $^{18}\text{F}$ -FDG PET/CT group, the results of the exam were the major source of concern. In both cases, the variables are independent of the patients' familiarity with the procedures. Since the sample is composed exclusively of oncological patients, it is noteworthy that anxiety levels during subsequent experiences might not be inferior. Both scans are often performed for staging, response to therapy assessment or to evaluate possible recurrence, which implies that there may be a setback at any time (21).

Only in the  $^{18}\text{F}$ -FDG PET/CT group, higher scores for previous experience of that exam (more negative experiences) were associated with higher STAI-S scores before the beginning of the exam (more anxious). These results are consistent with other studies, verifying that past experiences, whether satisfactory or not, deeply affect a patient's conception of the procedure (9, 22).

#### $^{99\text{m}}\text{Tc}$ -HDP BS and $^{18}\text{F}$ -FDG PET/CT predictors of anxiety

Unexpectedly, *body exposure* during the examination was the only anxiety predictor identified among cancer patients who underwent  $^{99m}\text{Tc}$ -HDP BS (this explains 34.1% of the variation in anxiety levels). On the day before the exam, patients were contacted to confirm their appointment and to clarify any doubts about the procedure that they might be experiencing at that moment. However, the details of the procedure were not explained thoroughly if the patient did not ask specific questions. Some patients may have anticipated that the exam would necessarily include a phase in which their body would be exposed (undressed). Bahrami al. (23) study identified body image disturbance in most of the cancer patients, irrespective, of the type and duration of illness. Additionally, other studies involving cancer patients treated surgically revealed dissatisfaction with appearance (24) and embarrassment about their body changes in relation to the disease (25). This data allowed us to hypothesize that in the BS group patients had body image concerns, nonetheless further discussion is needed. We need to understand exactly how “body exposure concern” affects patients emotionally and the reason why this predictor of anxiety appears exclusively in the  $^{99m}\text{Tc}$ -HDP BS examination.

In the  $^{18}\text{F}$ -FDG PET/CT group, the *radiation* involved in the scan and the *duration of the exam* were identified as predictors (this explains 29.7% of the variation in anxiety levels). The word “radiation” often evokes fear in patients, family members, and health professionals. Radiation is perceived as a risk. This perception has several sources, including public information on actual biological risks from exposure to radiation (26). A recent study evaluating patient knowledge and communication preferences concluded that there is a substantial difference between patients’ expectations and current practices for providing information about medical imaging utilizing ionizing radiation (22). One of the main objectives of risk communication in health care is to ensure patients and/or caregivers are provided with the information they need in a way that they can understand (27). In our sample  $^{18}\text{F}$ -FDG PET/CT group, patients who assessed the information as less comprehensive experienced more state anxiety. Both groups mentioned that it would be beneficial to further address issues such as the radiation burden involved. It is imperative to obtain a better understanding of the population’s knowledge about radiation and to demystify it, as it remains a great source of concern and ultimately it would be a starting point to create communication guidelines for cancer patients in NM. Similarly, with previous studies (12, 13) the mean anxiety levels for both groups decreased after the scan had been performed. Interestingly, after the scan, the  $^{18}\text{F}$ -FDG PET/CT group was revealed to be slightly more anxious than the  $^{99m}\text{Tc}$ -HDP BS patients. In addition, higher anxiety scores in the  $^{18}\text{F}$ -FDG PET/CT patients prior to the scan were associated with higher post-scan STAI-S. Considering that the result of the exam was the main concern for the  $^{18}\text{F}$ -FDG PET/CT group, it seems that the patient’s uncertainty about the results (28) and the awareness that they may determine future treatments and/or the course of the disease (12, 13) hindered further reduction in anxiety levels for this group (12).

Patients satisfaction with information provided and with NM department

The questionnaires also allowed us to pinpoint the fact that a large proportion of the patients who underwent  $^{18}\text{F}$ -FDG PET/CT as well as  $^{99m}\text{Tc}$ -HDP BS considered the information provided before the examination to be completely comprehensible and therefore were very satisfied with the department. Such results are supported by previous studies correlating the information provided with the overall satisfaction with the department (12, 14, 29). This is

associated not only with the fact that a more knowledgeable patient tends to be more cooperative, thus making it a smoother process, but also granting the technologist the opportunity to establish a relationship of trust (30). It is also verified that levels of anxiety can be diminished with signs of support and care shown by the professionals involved in the procedure, as well as the dignity felt by the patient (14).

#### Practical implications for professionals

Our study shows that although the lines of communication were good, it is always possible to improve and facilitate troublesome procedures such as the injection and positioning (30) and providing the information that patients truly need (31). Although more studies are needed to better understand the variance that remains unexplained in exam-related anxiety predictor models, present research offers significant contributions for NM departments. Data encourage healthcare professionals to look for a more effective means of preparing patients and to adjust the timing and level of detail of the information provided on each of the exams. With respect to the timing dimension, the high levels of anxiety revealed on arrival at the NM department on the day of the exam (pre-scan questionnaire) support the suggestions of some authors (32, 33) to provide information to patients before the day of the exam and invited the NM department to look for a more effective means of preparing patients prior to the day of exam. Patients need enough and direct information to better understand the procedures and decrease scan unpredictability (14, 34).

For patients who have had  $^{99m}\text{Tc}$ -HDP BS it seems necessary to provide more detailed information on the duration of the examination and body exposure during the uptake of images before the day of the scan. To minimize concerns about the duration of the exam, NM department professionals should emphasize that the patient may be accompanied by relatives in the two hours between the injection and imaging and may even leave the NM department. About body exposure, providing a link with virtual imaging in which the patient has the opportunity to visualize what will happen during the uptake of images (e.g. no need to be undressed) might minimize their expectations and moderate the anxiety triggered by this feature. Educational videos deliver information in a consistent manner (35) and have proved to yield positive outcomes regarding cancer patient information prior to the procedures (35-37).

To minimize the two identified predictors of exam-related anxiety in  $^{18}\text{F}$ -FDG PET/CT patients, it may be helpful for NM department to provide patients with a written information leaflet or a link to a slides presentation (e.g. Power Point®). These practices entail minimal costs, do not disrupt the department's workflow and have proved to be useful in improving understanding of the scan procedure (14, 19, 33). Both materials should include detailed information about the radiopharmaceutical, discuss misconceptions concerning radiation use and specify what the patient will do during the time he/she remains at the NM department. In addition, the concerns related to the exam results revealed by patients who underwent the  $^{18}\text{F}$ -FDG PET/CT scan must not be disregarded. Promoting patient-centered oncology care (24), especially during anamnesis (e.g. considering patients' previous exam experiences), and offering a safe, calm, enlightened and supportive environment (11, 19) will allow the patient to feel well cared for and understood (24, 38). Suggesting simple cognitive and relaxation strategies will also lead to a reduction in anxiety levels (33).

#### Study limitations

We encountered several limitations during the study. Firstly, our sample size was small and only included patients related to one NM department. A larger sample that includes oncological patients followed up in different health services would allow for more impactful results. Secondly, self-reporting questionnaires are the most common methodology for studying subjects such as anxiety and patient experience, but they are not without issues. The patients' understanding of the items is one of the main apprehensions. In our study, all patients were told that during the completion of the questions they could clarify any doubts with one of the researchers present in the same room. However, this did not prevent interpretations emerging that differed from those of the authors. Furthermore, the questionnaires allowed us to know whether patients would like to have more information about the examination (e.g. radiation, duration), but they did not reveal the specific information that patients would like the NM department to provide. Further research including these data is required. Thirdly, in view of the patients' questionnaires suboptimal participation (a large number of questionnaires were eliminated due to being incomplete), we can hypothesize that some patients found them too long or arduous to complete (especially the post-scan questionnaire, after the patient has spent hours at the NM department). This observation highlights the importance of working on smaller but psychometric robust questionnaires that could bring relevant information without excessively burdening the patients.

**Conclusion:**

The patients in our sample revealed their major sources of anxiety, especially prior to their prescribed scans. The group that underwent a  $^{99m}\text{Tc}$ -HDP BS proved to be more anxious when compared to the  $^{18}\text{F}$ -FDG PET/CT group. The main concern presented by the  $^{99m}\text{Tc}$ -HDP BS group was the duration of the exam, while the body exposure during the examination was the only predictor of exam-related anxiety. For the  $^{18}\text{F}$ -FDG PET/CT group, the main concern was the exam result, whereas the radiation involved in the exam and the duration of the exam were identified as significant predictors of exam-related anxiety. The acknowledgment of specific anxiety concerns and anxiety predictors enables NM department professionals to create more in-depth information to give to patients and to adjust methods of communication to provide information for each of these two NM exams.

## References:

1. Almuhaideb A, Papathanasiou N, Bomanji J. 18 F-FDG PET/CT imaging in oncology. *Ann Saudi Med.* 2011;31:3.
2. Wyngaert TV, Strobel K, Kampen WU, et al. The EANM practice guidelines for bone scintigraphy. *Eur J Nucl Med Mol Imaging.* 2016;43:1723–1738.
3. Dauer LT, Thornton RH, Hay JL, Balter R, Williamson MJ, St Germain J. Fears, feelings, and facts: interactively communicating benefits and risks of medical radiation with patients. *AJR Am J Roentgenol.* 2011;196:756–761.
4. American Psychological Association. APA Dictionary of Psychology. Available at: <https://dictionary.apa.org/anxiety>. Accessed February 8, 2020.
5. Sandman PM. *Responding to community outrage: strategies for effective risk communication*. American Industrial Hygiene Association; 1993. Available at: <http://psandman.com/media/RespondingtoCommunityOutrage.pdf>. Accessed February 4, 2018.
6. Perry L, Burgess M. *Communication in Cancer Care* (pp. 27-45). United Kingdom, Blackwell Publishing, 2002, 27-45.
7. Mathers SA, McKenzie GA, Robertson EM. A necessary evil: The experiences of men with prostate cancer undergoing imaging procedures. *Radiography.* 2011;17:284–291.
8. Ahmad S. Physiological uptake in FDG PET simulating disease. *Biomed Imaging Interv J.* 2006; 2:e59.
9. Acuff SN, Bradley YC, Barlow P, Osborne DR. Reduction of patient anxiety in PET/CT imaging by improving communication between patient and technologist. *J Nucl Med Technol.* 2014; 42:211–217.
10. Vogel WV, Valdes RA, Tijs TJ, Gillies MF, van Elswijk G, Vogt J. Intervention to 382 lower anxiety of 18F-FDG PET/CT patients by use of audiovisual imagery during the 383 uptake phase before imaging. *J Nucl Med Technol.* 2012; 40: 92-8.
11. Pifarré P, Simó M, Gispert JD, Pallarés MD, Plaza P, Martínez-Miralles E. Pruebas de diagnóstico por la imagen: ¿generan ansiedad?. *Rev Esp Med Nucl Imagen Mol.* 2011; 30: 346–50.
12. Abreu C, Grilo A, Lucena F, Carolino E. Oncological patient anxiety in imaging studies: the PET/CT Example. *J Cancer Educ.* 2017;32:820–826.
13. Grilo A, Vieira L, Carolino E, et al. Anxiety in cancer patients during 18 F-FDG PET/CT low dose: a comparison of anxiety levels before and after imaging studies. *Nurs Res Pract.* 2017; 3057495:1–9.
14. Leckie J. The effects of informational intervention on state anxiety and satisfaction in patients undergoing bone scan. *Nuclear medicine communications.* 1994;15:921–927.
15. Boellaard R, Delgado-Bolton R, Oyen WJ, et al. FDG PET/CT: EANM procedure guidelines for tumour imaging: Version 2.0. *Eur. J. Nucl. Med. Mol. Imaging.* 2015; 42:328–354.

16. Silva D. O inventário de estado-traço de ansiedade (STAI) [The state-trait anxiety inventory (STAI)], in *Avaliação Psicológica: Instrumentos Validados Para a População Portuguesa (Psychological assessment: validated instruments for the Portuguese population)*. Coimbra, Portugal: Quarteto Editora; 2003.
17. Spielberger D, Gorsuch RL, Lushene PR, Vagg PR, Jacobs GA. *Manual for the State-Trait Anxiety Inventory (Form Y)*. Palo Alto, CA: Consulting Psychologists Press, 1983. <http://www.mhshelps.com/download/State%20Trait%20Anxiety%20Inventory%20Sampler%20Set%20Instrument%20and%20Scoring%20Guide.pdf>. Accessed September 19, 2018.
18. Grilo AM, Gomes AI, Monsanto F, Albino D, Augusto C, Pragana C. First day of radiotherapy for women with breast cancer: predictors of anxiety. *Support Care Cancer*. 2019; 28:1241-1248.
19. Schnitzler L, Smith SK, Shepherd HL, et al. What information is communicated by radiation therapists to patients during education sessions on the first day of treatment? *European Journal of Cancer Care*. 2018; 11:e12911.
20. Schneider A, Kotronoulas G, Papadopoulou C, et al. Trajectories and predictors of state and trait anxiety in patients receiving chemotherapy for breast and colorectal cancer: Results from a longitudinal study. *European Journal of Oncology Nursing*. 2016;24:1-7.
21. Khalil A, Faheem M, Fahim A, et al. Prevalence of depression and anxiety amongst cancer patients in a hospital setting: a cross-sectional study. *Psychiatry J*. 2016; 2016:1–6.
22. Andersson C, Johansson B, Wassberg C, Johansson S, Sundin A, Ahlstrom HI. Assessment of whether patient's knowledge, satisfaction and experience regarding their 18F-Fluoride PET/CT examination affects image quality. *J Nucl Med Technol*. 2016; 44: 21-25.
23. Bahrami M, Mohamadirizi M, Mohamadirizi S, Hosseini SA. Evaluation of body image in cancer patients and its association with clinical variables. *J Educ Health Promot*. 2017; 6:8.
24. Ellis MA, Sterba KR, Brennan EA, et al. A Systematic Review of Patient-Reported Outcome Measures Assessing Body Image Disturbance in Patients with Head and Neck Cancer. *Otolaryngol Head Neck Surg*. 2019; 160:941-954.
25. Fingeret MC, Hutcheson KA, Jensen K, Yuan Y, Urbauer D, Lewin JS. Associations among speech, eating, and body image concerns for surgical patients with head and neck cancer. *Head Neck*. 2013;35:354–360.
26. Kuroda Y. Current State and Problems of Radiation Risk Communication: Based on the Results of a 2012 Whole Village Survey. *PLoS Curr*. 2017;9:ecurrents.dis.84670981063d27f0a7c41b959fca70ec. Published 2017 Feb 24. doi:10.1371/currents.dis.84670981063d27f0a7c41b959fca70ec
27. Peck D, Samei E. How to understand and communicate radiation risk. *Image wisely Org*. 2010:1–23. Available at: [http://www.imagewisely.org/~media/ImageWisely\\_Files/Medical\\_Physicist\\_Articles/IW\\_Peck\\_Samei\\_Radiation\\_Risk.pdf](http://www.imagewisely.org/~media/ImageWisely_Files/Medical_Physicist_Articles/IW_Peck_Samei_Radiation_Risk.pdf). Accessed March 15, 2018.

28. Thorpe S, Salkovskis PM, Dittner A. Claustrophobia in MRI: the role of cognitions. *MagnReson Imaging*. 2008;26: 1081–1088.
29. Reyes-Pérez M, Rodrigo-Rincón MI, Martínez-Lozano ME, et al. Evaluación del grado de satisfacción de los pacientes atendidos e nun Servicio de Medicina Nuclear. *Rev. Esp. Med. Nucl. Imagen*. 2012;31:192–201.
30. Kaya E, Ciftci I, Demirel R, Cigerci Y, Gecici O. The effect of giving detailed information about intravenous radiopharmaceutical administration on the anxiety level of patients who request more information. *Ann Nucl Med*. 2010;24:67–76.
31. Munn Z, Jordan Z. The effectiveness of nonpharmacologic interventions to reduce anxiety and increase patient satisfaction and comfort during nuclear medicine imaging. *J Med Imaging Radiat Sci*, 2014; 45: 47-54.
32. Clarke SE, McKillop JH, Prescott MC, Williams ED. Information for patients and staff concerning nuclear medicine. *Nucl Med Commun*. 1992; 13: 271–281.
33. Grey SJ, Price G, Mathews A. Reduction of anxiety during MR imaging: a controlled trial. *Magn Reson Imaging*. 2000;18:351–355.
34. Munn Z, Jordan Z. The patient experience of high technology medical imaging: A systematic review of the qualitative evidence. *Radiography* . 2011;17:323–31.
35. Williams K, Blencowe J, Ind M, Willis D. Meeting radiation therapy patients informational needs through educational videos augmented by 3D visualisation software. *Journal of Medical Radiation Sciences*. 2017; 64:35–40.
36. Stewart-Lord A, Brown M, Noor S, Cook J, Jallow O. The utilisation of virtual images in patient information giving sessions for prostate cancer patients prior to radiotherapy. *Radiography*. 2016;22:269-273.
37. Sule-Suso J, Finney S, Bisson J, et al. Pilot study on virtual imaging for patient information on radiotherapy planning and delivery. *Radiography*. 2015;21:273–7.
38. Ramlaul A, Vosper A. Patient Centred Care in Medical Imaging and Radiotherapy. London: Churchill Livingstone, 2013:307. ISBN139780702046131

Table 1 – Sociodemographic and clinical characteristics of cancer patients included in the sample

Variables		<sup>99m</sup> Tc-HDP BS				<sup>18</sup> F FDG PET/CT			p	
		N (%)	Minimum	Maximum	Mean± SD	N (%)	Minimum	Maximum		Mean± SD
<b>Gender</b>	Female	27(64.3)				24(46.2)			0.079 <sup>*</sup>	
	Male	15(35.7)				28(53.8)				
<b>Age</b>			40	84	62.33±11.9		29	85	59.2±14.4	0.270 <sup>**</sup>
<b>Educational qualification</b>	No qualifications	0(0)				1(1.9)				0.788 <sup>***</sup> 95% C.I. = (0.780, 0.796)
	Compulsory Education	15(35.7)				19(36.5)				
	Professional Technical School	9(21.4)				14(26.9)				
	Bachelor Degree	15(35.7)				13(25.0)				
	Masters	3(7.1)				5(9.6)				
<b>Is it your first time undergoing this exam?</b>	No	9(21.4)				13(25.0)				0.684 <sup>*</sup>
	Yes	33(78.6)				39(75.0)				
<b>How do you classify the previous experience?</b>			1	6	3.4±1.6		1	7	3.2±1.8	0.583 <sup>****</sup>
<b>Reason to perform the exam</b>	Initial staging of cancer	33(78.6)				31(59.6)				0.319 <sup>***</sup> 95% C.I. = (0.309, 0.328)
	Treatment results	2(4.8)				8(15.4)				
	Assess cancer recurrence	5(11.9)				5(9.6)				
	Does not know	4(9.6)				5(9.6)				

<sup>\*</sup>Chi-square test. <sup>\*\*</sup>t-test. <sup>\*\*\*</sup> Chi-square test by Monte Carlo simulation and 95% Confidence Interval for p value (95% C.I.=lower limit, upper limit).

<sup>\*\*\*\*</sup>Mann-Whitney test.



Table 2– STAI-S scores pre and post scan in both groups

Group		Group Statistics			Test Statistics		
		Mean	Standard Deviation	Standard Error Mean	t	df	p
<b>STAI-S pre-scan</b>	<sup>99m</sup> Tc-HDP BS	51.75	3.77	1.09	3.786	47.973	0.000*
	<sup>18</sup> F-FDG PET/CT	44.67	10.00	1.52			
<b>STAI-S post-scan</b>	<sup>99m</sup> Tc-HDP BS	36.70	12.12	2.11	-0.768	70	0.445
	<sup>18</sup> F-FDG PET/CT	38.82	11.33	1.81			

Table 3. Descriptive measurements of patients' concerns about MN exam and correlations with STAI-S pre-scan

Patients NM Exam Concerns	<sup>99m</sup> Tc-HDP BS				<sup>18</sup> F FDG PET/CT			
	Mean±SD	Minimum	Maximum	Correlation with STAI-S pre scan	Mean±SD	Minimum	Maximum	Correlation with STAI-S pre scan
Radiation involved	3.33±1.76	1	7	0.182	3.027±2.05	1	7	0.352*
Not knowing the purpose of the exam	2.85±1.84	1	7	-0.073	2.257±1.69	1	7	0.035
Immobilization/positioning	2.53±1.95	1	7	0.084	2.88±2.13	1	7	0.263
Exam Result (diagnostic)	2.85±1.96	1	7	0.065	5.40±1.80	1	7	0.306*
Duration of the scan	5.34±2.08	1	7	-0.043	3.64±2.06	1	7	0.399**
Discomfort/pain during the scan	3.49±1.90	1	7	-0.026	2.92±1.95	1	7	0.217
Lack of knowledge about the scan	3.24±2.17	1	7	0.070	2.96±2.06	1	7	0.122
Body exposure during scan	3.17±1.99	1	7	0.338*	3.04±2.10	1	7	0.328*
Injection of the radiopharmaceutical	2.55±1.76	1	7	0.016	3.58±2.09	1	7	0.341*

\* Correlation statistically significant &lt; 0.05 level. \*\* Correlation statistically significant &lt; 0.01 level.

Table 4- Patient's general satisfaction, evaluation of the information provided prior to the scan and correlations with STAI-S pre

Patients appraisal of the information provided prior to the scan		<sup>99m</sup> Tc-HDP BS				<sup>18</sup> F FDG PET/CT			
		Mean±SD	Minimum	Maximum	Correlation with STAI-S pre scan	Mean±SD	Minimum	Maximum	Correlation with STAI-S pre scan
Procedure Information - day scan	comprehensibility	6.00±1.26	3	7	0.579	5.69±1.26	2	7	-0.386*
	useful	5.65±1.43	2	7	0.709*	5.82±1.50	1	7	-0.144
Procedure Information - day before	suitability	6.20±1.08	4	7	0.520	6.14±1.03	4	7	-0.237
	useful	6.13±1.36	1	7	0.404	6.10±1.24	1	7	-0.162
MN Department	Dignity and respect during the procedures	6.85±0.95	1	7	-	6.80±0.63	4	7	-0.52
	Satisfaction	6.68±1.23	1	7	-	6.53±1.30	1	7	0.227

\* Correlation is significant at the 0.05 level.

Table 5 – Correlations<sup>a</sup> of patients' overall satisfaction with the information provided on the day of the exam and the day before the exam

			Procedure Information - day scan	Procedure Information - day before	MN Department		
			Utility	Suitability	Utility	Dignity and respect during the procedures	Satisfaction
<b><sup>99m</sup>Tc- HDP BS Group</b>	Procedure Information - day scan	Comprehensibility	,831**	,504**	,497**	,164	0,655**
		Utility		,633**	,581**	,093	0,696**
	Procedure Information - day before	Suitability			,944**	,197	,457**
		Utility				,189	,483**
	MN Department	Dignity and respect during the procedures					,520**
<b>PET/CT</b>	Procedure Information - day scan	Comprehensibility	,847**	,296	,155	,430**	0,369**
		Utility		,444**	,270	,122	0,349*
	Procedure Information - day before	Suitability			,547**	-,136	-,224
		Utility				-,139	-,218
	MN Department	Dignity and respect during the procedures					0,650**

a. Spearman correlation coefficient. \*\*. Correlation is significant at the 0.01 level (2-tailed). \*. Correlation is significant at the 0.05 level (2-tailed).

Table 6: Model of multiple regression analysis to identify patients' anxiety regressors pre-scan

Group		Model	$\beta$	R <sup>2</sup> Change	Adjusted R <sup>2</sup>	F Change
<sup>99m</sup> Tc-HDP BS		(Constant)	47.183*			
	1	Exposure of the body during the exam	1.282**	0.407	0.341	6.186*
<sup>18</sup> F-FDG PET/CT		(Constant)	37.519			
	1	Exam involves radiation	2.219*	0.258	0.238	13.212*
		(Constant)	34.292			
	2	Exam involves radiation	1.824*	0.075	0.297	4.174*
		Duration of the exam	1.242*			

\* Significant model: p<0.05 level. \*\* Significant model: p<0.01 level.