

# Experiences of Nuclear Medicine Technologists Working in PET/CT Facilities in Gauteng Province, South Africa

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The introduction of PET/CT requires staff training, redesign of patient workflow, new skills, problem-solving abilities, and adjustments to radiation protection protocols. When PET/CT was introduced in the U.K., nuclear medicine technologists (NMTs) encountered challenges in defining their roles and unfamiliarity with the new technology and the new working procedures. Since the introduction of PET/CT in South Africa, the experiences of NMTs with this hybrid imaging device have not yet been described. Therefore, the aim of this research study was to explore and describe the experiences of NMTs working in PET/CT facilities in Gauteng Province, South Africa. **Methods:** This study had a qualitative, exploratory, descriptive design and used a phenomenologic research approach. Semistructured interviews were conducted to collect data until data saturation was reached. A software program was used to manage the codes, categories, and themes. Nine NMTs participated in the study: 5 from public hospitals and 4 from private hospitals. Their age range of 27–58 y provided the ideal heterogeneity for sharing experiences in working in PET/CT facilities. **Results:** Two overarching themes emerged from the categories: the perspectives of NMTs working in PET/CT facilities and the PET/CT challenges encountered by NMTs. The results suggest that NMTs experience joy and fulfillment from working in PET/CT facilities and regard PET/CT as the future of nuclear medicine. However, NMTs also experience a gap in PET/CT training and are concerned about the high radiation exposure associated with PET/CT imaging and about the lack of psychologic support. **Conclusion:** Although the NMTs enjoy working in PET/CT, they desire additional clinical training and psychologic support. Since radiation exposure in PET/CT is higher than in general nuclear medicine, radiation monitoring is imperative to minimize exposure to NMTs and patients.

**Key Words:** PET/CT; nuclear medicine technologists; PET/CT training; high radiation doses

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**P**ET/CT is a fusion of physiologic (PET) and anatomic (CT) imaging for diagnosis and management of disease (1). Over the past decade, the use of hybrid imaging modalities combining PET or SPECT with CT, MRI, or ultrasound has

increased (2) and represents an area of rapid growth with important professional implications (3).

In the U.K., PET/CT has redefined working practices in nuclear medicine departments and changed the role of nuclear medicine technologists (NMTs), thus creating opportunities and challenges (4,5). PET/CT created a sense of insecurity and uncertainty for some NMTs, whereas others embraced the new technology (4). Similarly, in the United States, the introduction of clinical PET/CT resulted in NMT challenges such as the need for access and training (6). In The Netherlands, although medical imaging technologists were keen to learn and explore the technology, some were concerned about the risk of hiding behind the technology and neglecting the patient (7).

In South Africa, PET/CT imaging is performed by NMTs, whose primary role is to provide the best care for patients while performing diagnostic and therapeutic procedures in line with the standards of the Health Professions Council of South Africa (5). PET/CT was first introduced in South Africa in 2005 in a private nuclear medicine department in Gauteng, one of the 9 provinces in South Africa, with 12 subsequent installations across the country as of 2022. Currently in South Africa, PET/CT is performed by NMTs who are qualified in both nuclear medicine and diagnostic radiography (dual qualification) or in nuclear medicine only (single qualification). In Gauteng, PET/CT imaging in public hospitals is managed, on a rotational basis, by the same NMTs who work in conventional nuclear medicine departments. In private hospitals, most NMTs are specifically employed either for PET/CT imaging or for general nuclear medicine. Aarts et al. (7) found that keeping up with the constant developments and changes in technology requires employees to be flexible. Therefore, the aim of this research study was to explore and describe the experiences of NMTs working in PET/CT facilities in Gauteng Province, South Africa.

## MATERIALS AND METHODS

This study adopted a qualitative phenomenologic research approach that was explorative and descriptive in design (8). Ethical approval for the study was granted by the Institutional Review Board, Faculty Research Ethics Committee, University of Johannesburg (REC-01-56-2019). The heads of the nuclear medicine departments also granted permission to invite their PET/CT NMTs to participate in interviews. All participants signed informed consent documents for the interviews and for audio recording.

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NMTs registered with the Health Professions Council of South Africa working in public or private hospital PET/CT facilities made up the population of this study. The NMTs were purposely recruited from the Gauteng Province. At the time of data collection, there were 64 NMTs: 27 working in the public sector and 37 in private nuclear medicine facilities. Of the 37 NMTs in private nuclear medicine departments, 10 were specifically employed in PET/CT facilities, and of the 27 NMTs in the public sector, 20 rotated between nuclear medicine and PET/CT facilities within their departments. Nine NMTs participated in the study: 5 from public hospitals and 4 from private hospitals. The ages of the NMTs ranged from 27 to 58 y old, providing heterogeneity in working experience and representing an ideal cohort to share their experiences with regard to working in PET/CT facilities.

At the time of data collection, there were 4 private and 3 public sector PET/CT facilities in Gauteng; however, the participants were from 2 private and 1 public sector PET/CT facilities. Once permission to conduct the study was granted, the researcher delivered information letters and study consent forms to the participating nuclear medicine departments by either email or a visit to the workplace. NMTs without PET/CT experience, community service NMTs, and students were excluded from the study. Nine NMTs participated in the study: 5 from public and 4 from private hospitals. Individual in-depth interviews were conducted in a private room at the NMTs' workplaces at times suitable for the researcher and the NMTs. "What is your experience regarding working in a PET/CT facility?" was asked as the opening question, followed by, "What is your experience regarding the PET/CT training you received?", "What are your thoughts on PET/CT as an imaging modality?", and "What challenges have you experienced working in a PET/CT facility?" When necessary, probing questions were used to further explore issues raised (9).

An audio recorder was used to record the interviews, with each participant granting permission to be recorded before each interview. A backup recorder was used if the first recorder failed (10). After each interview, the data were transcribed by a professional transcriber. Data saturation was reached after the ninth participant had been interviewed. During the interviews, the researcher took field notes on nonverbal communication (11). The assignment of the codes, categories, and themes was facilitated by ATLAS.ti software, version 8 (ATLAS.ti Scientific Software Development GmbH). The researcher divided the text into sentences or paragraphs to assign labels or codes and then grouped the codes into categories, which resulted in the main theme (12).

## RESULTS

The results are presented under 2 themes, the first being the perspectives of NMTs working in PET/CT facilities and the second being the PET/CT challenges encountered by NMTs (Table 1). The first theme resulted from 3 categories, namely, PET/CT hailed as the future of nuclear medicine, personal gratification from PET/CT, and PET/CT training. The second theme resulted from 2 categories, namely, lack of psychologic support and high radiation doses. The categories are supported by verbatim quotations.

### Theme 1: The Perspectives of NMTs Working in PET/CT Facilities

*Category 1: PET/CT Hailed as the Future of Nuclear Medicine.* In this category, NMTs acknowledged and hailed PET/CT as the future for nuclear medicine imaging. The

**TABLE 1**  
Themes and Categories Emerging from Semistructured Interviews

Theme	Category
Perspectives of NMTs working in PET/CT facilities	PET/CT hailed as future of nuclear medicine
	Personal gratification from PET/CT
	PET/CT training
PET/CT challenges	Lack of psychologic support
	High radiation doses

hardware coupling of anatomy and function in PET/CT, according to Saif et al. (13), has resulted in great advances in the evolution of molecular imaging.

"PET/CT is the future of nuclear medicine, especially because of the new radiopharmaceuticals, the tracers that are coming, so when you have PET/CT, you have the future." (NMT 3, Public Hospital)

"PET/CT is the future and I feel it is a disadvantage for those [NMTs] only doing general nuclear medicine." (NMT 2, Public Hospital)

*Category 2: Personal Gratification from PET/CT.* Participants expressed feelings of personal gratification from their role in PET/CT and experienced love and fulfilment from being part of the PET/CT team. However, participants also revealed that working in a PET/CT facility can be demanding, despite their enjoyment of the work. The sense of fulfilment came mainly from being part of the medical team that contributed toward patient treatment.

"I think personally for me, it's fulfilling in a way that, you are part of the team that's going to plan this patient's treatment because remember with PET/CT we mostly do oncology patients and based on what we find it would be for their treatment purposes. I enjoy it. I really do enjoy it." (NMT 6, Public Hospital)

"From my personal point of view, I do enjoy PET/CT but yes, it does get very strenuous, at times, and also a bit overwhelming at times but I enjoy the challenge." (NMT 5, Public Hospital)

"Working in PET/CT is exciting, it is very exciting and it is an eye opener." (NMT 8, Private Hospital)

*Category 3: PET/CT Training.* Because the number of PET/CT scanners had increased, NMTs strongly recommended that all NMTs receive training in PET/CT imaging, whether they are doing PET/CT imaging or not. They also believed that this training was necessary because all NMTs should be able to work with PET/CT scanners.

"I think that because there are more PET scanners around, I feel that everybody, all radiographers in nuclear medicine should be trained on PET scanning." (NMT 1, Private Hospital)

NMTs also found that a lack of PET/CT training limited them in their nuclear medicine positions because doctors expected them to have some background knowledge of PET/CT.

“I would say it is a bit frustrating because some doctors will come to the nuclear medicine department, and they want you to explain exactly what happens with PET/CT but if you have not been properly trained then you have some limitations.” (NMT 9, Public Hospital)

NMTs felt that PET/CT training should be implemented before they are assigned to work in PET/CT departments and that the training days should be sufficient and adequate. NMTs also felt that PET/CT training should be ongoing and that on-site technical support should be available for a certain period after training.

“I think training should be enough days, not just three days. I think it’s better when the person who trains you stays with you for the two weeks, and then you scan patients with that person so that when problems arise, then they are able to assist you.” (NMT 4, Private Hospital)

NMTs revealed that they were trained in PET/CT by application specialists and colleagues from another province, who taught them only the basics. These NMTs were dissatisfied with this level of training because they felt ill prepared to perform their daily PET/CT duties.

“Two radiographers from Cape Town came to Johannesburg to come to train us on what they knew about the PET/CT machine, so just the basics, entering the patient, injecting, what to expect, and what the machine is supposed to be doing.” (NMT 3, Public Hospital)

“I got very little training. When the PET scanner was installed, an applications specialist came from the States. So, I got very little training. So, [PET/CT] had just been installed, he was here for two weeks.” (NMT4, Private Hospital)

Participants were also aware of the need to stay up to date with PET/CT through continuing professional development (CPD) activities. However, some participants stated that being scheduled to work even on weekends hindered their attending these programs. Furthermore, NMTs employed in private practice found it difficult to attend CPD programs without taking time off from work and therefore seemed to prefer CPD via an online platform.

“I think a CPD seminar is crucial, whereby somebody informs us about the PET/CT scanning.” (NMT 5, Public Hospital)

“I know that one can attend CPD programs but I think in terms of attending then you’ll have to take leave so an online CPD point program would be better.” (NMT 7, Private Practice)

## Theme 2: PET/CT Challenges

*Category 1: Lack of Psychologic Support.* In this category, participants revealed that because patients routinely

return to the PET/CT department for follow-up scans, emotional bonds are often created between the NMTs and the patients. When patients do not respond positively to their treatments, the NMTs experience negative psychologic effects and feel the need for regular psychologic support.

“Most of the patients that are referred to PET/CT departments are cancer patients, some of them become rude because they are not accepting that they have cancer, psychologically this affects us. Some patients come for six months, three months and yearly scans and then we find out that the patient has died, this plays with your psychology because you get used to the patients they come regularly for scans and often become friends, because we create bonds.” (NMT 2, Public Hospital)

“[PET/CT] Patients are mostly oncology patients. We need psychological support on regular basis to deal with all the patients that we have, some of them are dying, some of them have just been diagnosed, and they take it out on everybody.” (NMT 4, Private Hospital)

*Category 2: High Radiation Doses.* NMTs highlighted their concerns about high radiation exposure, regarding this issue as a challenge. The area of concern for some participants was the high energy of the radiotracer, whereas for others it was the number of PET/CT patients scanned daily. Furthermore, some participants advocated that NMTs from the general nuclear medicine department should be rotated into the PET/CT department so that the radiation dose is shared among colleagues. Some participants seemed less informed about the radiation safety protocols.

“In PET/CT the energy of the radiopharmaceuticals that are used [is] way higher than in your normal nuclear medicine department and the department that I was in we did an average of about 7 patients from Monday to Friday. I feel that is just a lot of radiation, even though you do not produce the radiopharmaceutical, but you still get to handle it, to measure it, you still need to inject it into the patient, and when the patients have been injected, you still need to prepare them and get them to the imaging room.” (NMT 8, Public Hospital)

“You are exposed more to radiation when you are in PET than when you are in general nuclear medicine because we use <sup>18</sup>F-FDG. We work in pairs at PET, so we share the radiation; we reduce that even by not spending more time with the patients. We also isolate the patients after the injections, so that’s how we try and reduce the radiation.” (NMT 9, Public Hospital)

“I think we need to find out what is a safe number of patients we can do per day, because remember the energy of the radiation is so high and in public sometimes, we can push it and you can do up to 10 patients. We share the dose between two radiographers so in that regard it would be nice to know what dosage each radiographer is allowed, what’s a safe dose.” (NMT 6, Public Hospital)

Participants also expressed concern about their colleagues’ disregard for radiation safety protocols.

"I've seen colleagues, drawing up all the  $^{18}\text{F}$ -FDG from the lead container, draw it up in a syringe, put it in the workstation, and then draw from there, I mean that's just negligence. [You're] just exposing yourself too much, it's a lot of radiation." (NMT 6, Public Hospital)

"In terms of radiation dose, ... it's a high energy area, so you'll find certain radiographers you know, at the end of the day, will have a much higher radiation dose, or exposure to themselves than others out there." (NMT 2, Public Hospital)

## DISCUSSION

Because the literature on NMTs' work experiences in PET/CT facilities was so minimal, literature from nursing and other health care professions was incorporated into this study to support the identified findings.

NMTs hailed PET/CT as the future of nuclear medicine. A study by Griffiths (14) found that—on the basis of referrals of patients with a wider range of clinical pathologies, including most cancers—use of PET/CT is evolving. In this study, the findings were similar to some of Griffiths' findings.

Britton (15), in a study on the lived experiences of radiographers in Gauteng, South Africa, found that radiographers reported personal gratification from providing care to their patients. Similarly, in this current study the NMTs expressed feelings of personal gratification from being part of the PET/CT team responsible for managing patient treatment. A qualitative study was conducted at the University of Pittsburgh Medical Center on nurses' perspectives on the personal and professional impact of providing palliative care in oncology settings. All interviewed nurses reported feelings of personal and professional fulfilment and satisfaction when providing services to their patients. They also acknowledged that interacting with oncology patients could be strenuous and tiring at times. However, deeper relations with patients led to an overall sense of personal and professional fulfilment (15). Similarly, in this current study participants communicated feelings of fulfilment and joy from being part of the team responsible for oncology patient management.

Feldenzer et al. (16) claimed that PET has opened a new era in clinical medicine due to advances in molecular and cell biology but warned that high-end technology such as PET can be useful only if the NMTs operating the equipment are trained to optimize use of the technology (16). Grigoryan et al. (17) agreed, saying that NMTs are the pillar of any nuclear medicine department. Therefore, NMT training is crucial to ensure quality care in PET/CT facilities.

A combination of oncology clinicians' personal attributes and aspects of their work contributes to emotional stress and burnout (18). Furthermore, the psychologic distress and burnout experienced by health care providers could have major consequences if not acknowledged and monitored (18). The NMTs reported that the emotional bonds created with their oncology patients resulted in negative psychologic effects. Lawrence (19) reported that radiotherapists'

emotional exhaustion resulted in burnout, which was more prevalent in the public hospital setting. In this current study, NMTs indicated that interacting with oncology patients had a negative psychologic effect.

Adelstein (20) asserted that in the United States between 1984 and 2008, nuclear medicine procedures increased from 6 to 18 million, and an increase of 10% per year was observed in CT, resulting in a 50% increase in exposure of patients to radiation. The author emphasized the importance of protecting NMTs and patients from high radiation exposure (20). Furthermore, radiation exposure from fusion imaging such as PET/CT is not only from the nuclear medicine radiotracer but also from the CT component. A study by Lundie et al. (21) revealed that most of the radiation exposure of NMTs occurred during handling of  $^{18}\text{F}$ -FDG and the injection procedure; assisting and checking on the patient also produced some increase in radiation exposure (21). The study also revealed that the radiation dose to NMTs can be reduced considerably if they are knowledgeable and aware of the risks. In this study, the NMTs also expressed concern about the high radiation dose they perceived was received by NMTs exposed to PET/CT.

This study had some limitations. PET/CT is a multidisciplinary imaging technology that involves other types of health care providers besides NMTs, such as nurses and diagnostic radiographers, but this study reported the experiences of only NMTs. In addition, because of time constraints and a limited budget, the study focused on the experiences of NMTs only in Gauteng Province.

## CONCLUSION

The study revealed that NMTs experience joy and fulfillment from working in a PET/CT facility but are concerned about the lack of psychologic support while working with oncology patients. Their emotional distress should be investigated and psychologic support provided, such as inclusion of psychologic dynamics in the curricula of NMTs. Further, NMTs expressed concern about potentially being subjected to high radiation exposure due to inadequate safety protocols, and some NMTs who were unnecessarily exposed to PET/CT showed a lack of knowledge about safety practices that could be a result of limited education on managing radiation related to PET/CT radiopharmaceuticals. Therefore, it is recommended that ongoing in-house training on radiation hazards be provided to NMTs working in PET/CT facilities, such as in the form of PET/CT radiation awareness workshops (20). In addition, the clinical training provided in PET/CT facilities was reported as inadequate. Collaboration between training institutions and public and private nuclear medicine departments should facilitate CPD activities to meet the training needs of NMTs.

## DISCLOSURE

No potential conflict of interest relevant to this article was reported.

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### KEY POINTS

**QUESTION:** What are the experiences of NMTs working in PET/CT facilities in Gauteng Province?

**PERTINENT FINDINGS:** The study had a qualitative, exploratory, descriptive design and used a phenomenologic research approach. The findings suggest that NMTs experience joy and fulfilment from working in PET/CT facilities but perceive a training gap and are concerned about high radiation exposure and lack of psychologic support.

**IMPLICATIONS FOR PATIENT CARE:** The results highlight factors that may need to be addressed to improve the quality of services in PET/CT departments, which in turn will improve the overall quality of patient care.

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