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The Effects on Technologist Occupational Exposure in PET/CT Departments When Working With Students and the Levels of Supervision Imposed

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Abstract

PURPOSE: The purpose of this study was to evaluate the effect of having a student present in the PET/CT department on the technologists' occupational radiation exposure; furthermore, to investigate if this effect is influenced by the type of supervision performed.

METHODS: This was a retrospective, IRB approved study that collected data from two PET/CT departments. Dosimetry reports, correlated with the clinical schedules of the students, were normalized for workflow (amount of radioactivity), the number of technologists, and the number of monitored days in the department. A two sample t-test assuming unequal variances with an alpha of 0.05 was used to compare doses between student and no student groups, and between direct supervision and indirect supervision groups.

RESULTS: The study consisted of a data set of 42 dosimetry reports, 19 with students and 23 without students. When comparing student and no student groups, the total (N=42) extremity dose had a p-value of 0.012 with a mean of 0.0011665 uSv/MBq/Tech/day; all other dose comparisons between groups were greater than 0.05 (P>0.05). For Indirect supervision (n=21), the extremity dose p-value was 0.298. The other dose p-values were all less than 0.05. For Direct supervision (n=21), the dose p-values were all greater than 0.05. There was a trend of decreasing exposure to technologists with students in the department.

CONCLUSION: Extremity dose decreases when students were present. There was a trend of decreasing dose with indirect supervision.

Introduction

Nuclear medicine technologists are continuously monitored for radiation exposure throughout their careers. The Nuclear Regulatory Commission has occupational exposure limits set to ensure the technologists are below levels of observed effects. Radiation monitoring badges should be worn in the correct locations, otherwise readings may be skewed (*1*). Though these limits are rarely reached, the radiation exposure in the workplace itself may raise concerns for nuclear medicine technologists.

In the PET/CT department, technologists tend to alternate patient preparation in order to reduce their exposures. For example, if the department has three technologists, one technologist would inject every third patient. When a student is present in the PET/CT department, his or her presence can either be used for benefit or seen as a potential risk of more exposure.

Radiopharmaceuticals used in PET require specialized personnel, facilities, and equipment, primarily because of the relatively short physical half-lives of the radionuclides and the relatively high radiation exposure to the technologist (*2*). The three main principles to be mindful of when dealing with radiation exposure are time, distance, and shielding. By having a student complete marginal tasks, the technologist may be able to maximize their usage of these principles.

Having a student inject the radioactive tracer may significantly reduce the technologist's radiation exposure. A 2005 study regarding radiation exposure reduction for technologists showed that the bulk of a technologist exposure in the PET/CT department comes from injecting the dose (*3*). This is largely due to the radioactive material no longer being shielded once put into the body (*4*). Other normal student duties include getting patients from the injection rooms, positioning patients on the table, getting patients off the table, and walking patients out of the clinic. This helps the technologist increase distance from and reduce time spent with the radioactive patient.

There are two main teaching strategies in the clinical setting, indirect supervision and direct supervision. According to the Joint Review Committee on Educational Programs in Nuclear Medicine Technology (JRCNMT) Standards, “Direct supervision of students is required at clinical affiliates until competence is demonstrated, after which time supervision may be indirect. Direct supervision requires the clinical instructor to be physically present with the student. Indirect supervision requires the clinical instructor to be within the facility and immediately available to provide direct supervision,”(*5*). Students should be supervised by the technologists they are working with, but the level of supervision is not prescribed. Direct supervision fulfills this requirement but does not allow the technologist to utilize the radiation protection principles. (*5*).

The purpose of this study was to evaluate the effect of having a student present in the PET/CT department on the technologists’ occupational radiation exposure; furthermore, to investigate if this effect is influenced by the type of supervision performed.

Methods

Institutional Review Board approval was received, and HIPAA guidelines were followed. This was a retrospective study using data collected from two PET/CT departments. The two departments were selected because they both had full-time PET/CT technologists who worked only in the PET/CT department and did so consistently over the 21 month study period (June 2017/April 2019). The data collected included monthly occupational dosimetry reports as well as the total monthly prescribed radioactivity. The dosimetry reports contained data regarding the lens dose equivalent (LDE), deep dose equivalent (DDE), shallow dose equivalent (SDE), and extremity dose. The number of technologists in each department were recorded, as well as the number of days monitored for each monthly exposure report. Each monthly data point was separated into two categories: with a student (W, student days in department ≥ 1) and without a student (WO, student days in department = 0). They were further divided into supervision strategies: direct supervision and indirect supervision . Departments were categorized as indirect supervision if they allowed students to be alone with the patient during injection, patient education and history, dose administration, scanning and processing. Departments were categorized as direct supervision if the technologist was physically present during these tasks.

The occupational exposures (uSv) were then normalized for patient workload (MBq prescribed), number of technologists working in the department (technologist), and the days monitored (day). The normalized data was presented in the base units of uSv/MBq/technologist/day. The data sets for exposures with and without students were analyzed through a two-sample t-test assuming unequal variances with an alpha of 0.05. The data subsets of direct supervision and indirect supervision were analyzed in the same way.

Results

A total of 42 dosimetry reports were collected and divided into two categories: with students (N=19) and without students (N=23). When comparing the student and without student groups, the extremity dose had a p-value of 0.012 with a mean of 0.0011665 uSv/MBq/tech/day.

The DDE, LDE, and SDE p-values were all greater than 0.05; though not significantly different, all three had lower means with students (Figure 1).

For Direct supervision (n=21), the extremity dose, DDE, LDE, and SDE p-values were all greater than 0.05, but with means that were lower with students (Table 1). For Indirect supervision, extremity dose p-value was greater than 0.05. The DDE, LDE, and SDE p-values were all less than 0.05. All categories showed lower mean exposures with a student than without a student (Table 2, Figures 2 and 3).

Discussion

Though the p-values did not show a statistically significant difference in most cases, the overall trend of the means shows a reduced exposure when having a student present in the PET/CT department. In departments using direct supervision, the technologists did not show a significant difference in exposure compared to departments using indirect supervision that did show a significant dose reduction to the technologists. The means within the supervision subsets themselves still show a reduction in dose with a student in the department. These results could be related to the amount of work the student does for the technologist.

The radionuclide energies in PET/CT are considerably higher and result in a higher whole-body dose than the radionuclides used in the general nuclear medicine department (*6*). For this reason, students may not be introduced to PET/CT in their early stages of training. In some nuclear medicine technology programs, students rotate through general nuclear medicine first, to obtain skills such as injection techniques and to practice radiation protection around lower energy radionuclides, before going into the PET/CT department.

The JRCNMT suggests that clinical sites should operate under competency-based clinical education guidelines (5). It is important that technologists follow these guidelines of supervision because, as our results indicate, the level of supervision may affect the amount of radiation the technologist receives. If a technologist works at an educational facility, they should be trained on how to effectively train students and use these guidelines in order to reduce their radiation exposure.

Due to the higher radiation risks, students may develop their injection techniques and radiation protection skills in the general department before continuing in PET/CT. When the student becomes introduced to the PET department, he or she should have a substantial number of competent skills established. In order to take full advantage of a student's presence in the department, a technologist should take time to learn what skills the student has and use indirect supervision on those skills .

There were limitations to this study. The number of days the student was in the department were not gathered. That information could lead to a further understanding of how much a student can reduce a technologist's exposure. It was assumed that technologists wore their badges each day and wore them correctly. It was also assumed that the PET/CT technologists did not have any other technologist working part time during the 21-month study period. A further limitation was that technologists may alter their injection techniques when students are present, perhaps opting for a more conventional technique. A non-conventional technique may lead to higher or lower radiation exposure. Since the study was retrospective, the injection techniques could not be regulated. A further evaluation of the exposures should be expanded to general nuclear medicine departments as well, along with departments with more than one student present.

Conclusion

Extremity dose decreases when students were present. There was a trend of decreasing dose with indirect supervision.

References

1. Salesses F, Perez P, Maillard AE, Blanchard J, Mallard S, Bordenave L. Effect of dosimeter's position on occupational radiation extremity dose measurement for nuclear medicine workers during (18)F-FDG preparation for PET/CT. *EJNMMI Phys.* 2016;3:16.

2. Callahan RJ, Chilton HM, Ponto JA, Swanson DP, Royal HD, Bruce AD. Procedure Guideline for the Use of Radiopharmaceuticals 4.0. *J Nucl Med Technol.* 2007;35:272-275.

3. Roberts FO, Gunawardana DH, Pathmaraj K, et al. Radiation dose to PET technologists and strategies to lower occupational exposure. *J Nucl Med Technol.* 2005;33:44-47.

4. Peet DJ, Morton R, Hussein M, Alsafi K, Spyrou N. Radiation protection in fixed PET/CT facilities--design and operation. *Br J Radiol.* 2012;85:643-646.

5. Joint Review Committee for Education Programs in Nuclear Medicine Technology. Accreditation Standards for Nuclear Medicine Technologist Education. 2019:15. https://www.jrcnmt.org/sites/jrcnmt2/uploads/documents/Accred__Policy_Documents/Standards_Nov2019rev.pdf Accessed December 2019

6. Guillet B, Quentin P, Waultier S, Bourrelly M, Pisano P, Mundler O. Technologist radiation exposure in routine clinical practice with 18F-FDG PET. *J Nucl Med Technol.* 2005;33:175-179.

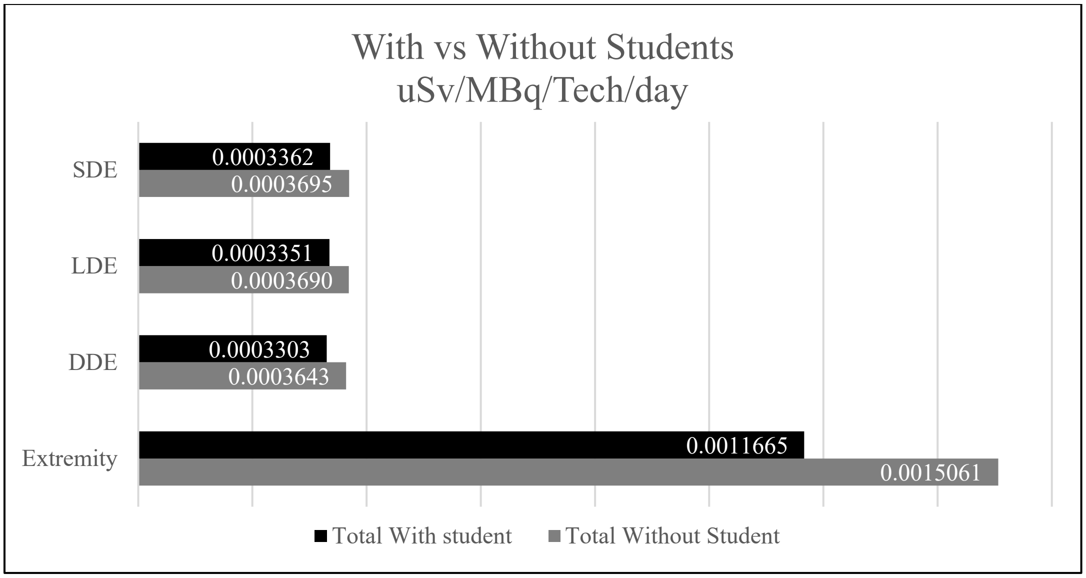

FIGURE 1 All Departments: With vs. Without Students

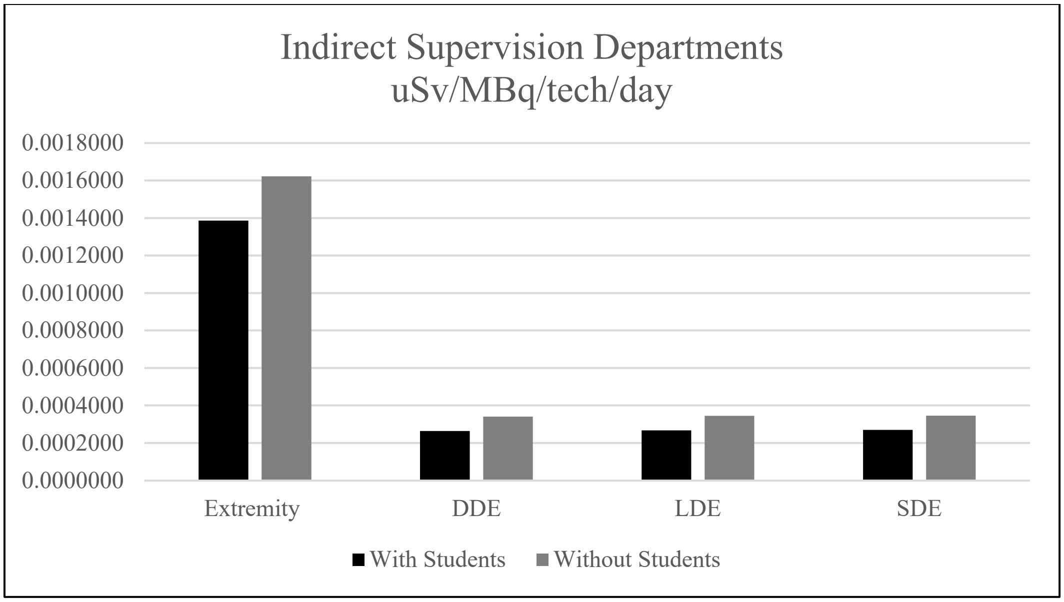

Figure 2: Indirect Supervision Departments only: With vs Without Students

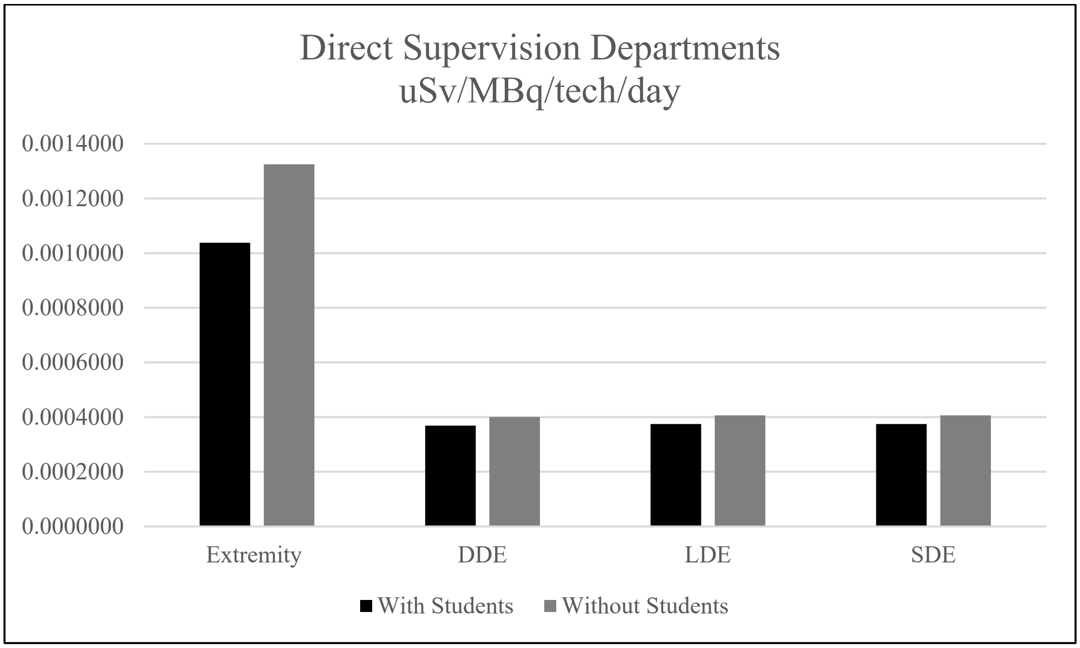

Figure 3 Direct Supervision Departments only: With vs. Without Students

Indirect Supervision Departments	Extremity	DDE	LDE	SDE
With Students	0.0013867	0.0002642	0.0002672	0.0002700
Without Students	0.0016225	0.0003408	0.0003452	0.0003459
Percent Reduction in Exposure	**14.5%**	**22.5%**	**22.6%**	**22.0%**
Direct Supervision Departments	Extremity	DDE	LDE	SDE
With Students	0.0010380	0.0003689	0.0003748	0.0003748
Without Students	0.0013251	0.0004007	0.0004061	0.0004061
Percent Reduction in Exposure	**21.7%**	**7.9%**	**7.7%**	**7.7%**

TABLE 1 Percent Reduction in Exposure for Indirect Supervision Departments and Direct Supervision Departments depending on whether or not students were present.

	Extremity	DDE	LDE	SDE
All Departments	**0.01206**	0.14676	0.15299	0.15722
Direct Supervision Departments	0.09177	0.20746	0.21274	0.21274
Indirect Supervision Departments	0.29835	**0.03316**	**0.03536**	**0.04091**

TABLE 2 P-values comparing when students are present and when they are not present, by department type. In bold are those with a statistically significant difference ($p<0.05$).