Improving the quality of PET radiopharmaceutical injections: Our lessons learned

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Objectives

Quality improvement efforts in nuclear medicine seek to reduce errors and variations in care due to our human nature. In our clinic, we embarked on a quality improvement project to analyze and implement change to reduce the extravasation rate of PET injections. This is important to ensure the proper dose is administered, obtain the best quality images, reduce artifacts, and to allow for the most optimal quantitative analysis.

Methods

A plan-do-study-act (PDSA) cycle process was conducted as follows:

1) **Plan**: The number of extravasated PET doses seemed unacceptably high during clinical readouts. The objective of this study was to gain an understanding of the actual number of extravasations and the parameters associated with successful and unsuccessful injections.

2) **Do**: Data was recorded regarding extravasation (yes/no), patient characteristics, injecting technologist, venous access method (IV, butterfly, direct syringe injection), needle gauge, injection site and side, and flush volume.

3) **Study**: Statistical analysis of data with critical evaluation.

4) **Act**: Implement educational program and changes to PET injection methods based on study data. After that, the overall infiltration rate was reassessed.

Results

Our data analysis showed high levels of variation among technologists in extravasation rates, venous access methods, needle gauge, injection side and site, and flush volume among technologists. It also showed that some technologists used a predetermined injection site despite patient characteristics (i.e., "preferred vein" vs. "best vein"). After an educational intervention including an in-service on injection best practice, analysis was repeated and showed improvement in extravasation rates.

Patient-Specific	Procedure-Specific
Height	Injecting Technologist
Weight	Venous Access Method
BMI	Radiotracer dose
Glucose	Flush volume
Age group	Needle gauge
	Injection site location
	Orientation (right/left)

Table 1. Data collected on each PET dose administration.

QI Action Plan	Ability to Measure	Estimated Adherence
[illegible]	Y	100%
[illegible]	N	Low
[illegible]	L	Moderate
[illegible]	L	Moderate
[illegible]	L	Moderate
[illegible]	Y	100%
[illegible]	Y	100%
[illegible]		Moderate

Table 2. Educational interventions to reduce PET dose extravasations.

Conclusion

In our study, the plan-do-study-act cycle resulted in an initial decrease in PET dose extravasation rates. Ongoing analysis could help determine if this QI initiative continues to have positive results, the optimal time for in-service training repetition, and to assist technologists in maintaining optimal injection techniques.

Introduction

In our institution's PET/CT department, we embarked on a quality improvement project to decrease the number of PET radiotracer extravasations. Dose extravasation compromises the final PET images in several ways: SUV values will be abnormally low, reconstruction artifacts create photopenia around the injection site (which may or may not be in the field of view), 3D image reconstructions are often unreadable, and extravasated tracer can travel through the lymphatic system, causing uptake in lymph nodes, which can be confused with cancer.

Quality Improvement Project:

PET dose extravasation analysis

PLAN: The number of extravasated PET doses seemed unacceptably high during clinical readouts. The objective of this study was to gain an understanding of the actual number of extravasations and the parameters associated with successful and unsuccessful injections. Our department decided to study extravasation rates and injection parameters in attempt to better understand this problem.

DO: PET injections were monitored during 11 weeks in 2017. Data was recorded regarding extravasation (yes/no), patient characteristics, injecting technologist, venous access method (IV, butterfly, direct syringe injection), needle gauge, injection site and side, and flush volume. An extravasation-detection device (LARA System, Lucerno Dynamics, LLC, Cary, NC) was used to determine if extravasation occurred. This quality improvement project did not require institutional review board approval.

STUDY: 469 injections were monitored during the 11-week study period. This was 84% of all PET injections during this time. Model-based analysis (SAS v. 9.4) and technologist input were used to identify potential contributing factors.

The infiltration rate was 12.8% (SE 1.6%, 95% CI 9.94, 16.24). Analysis revealed a significantly higher predicted probability of infiltrations for right-side injections (13.5%) compared to left-side injections (5.5%).

Predicted probability of infiltration was not significantly different among the technologists; however, technologist-specific differences in injection practices were observed. For example, one technologist had a 16% infiltration rate and was using butterflies to administer the radiopharmaceutical. This infiltration rate decreased to 0% once IV access was utilized, evidenced in a follow-up study and analysis. However, this improvement and use of IV access was not sustained. (See Analysis After Educational Intervention, next column.)

ACT: An educational intervention was implemented. Approved injection guidelines in the PET protocol book were updated. An educational session was attended by the technologists, with the following guidelines:

1. Use best available vein after evaluating patient rather than predefined target vein per technologist preference.
2. Remind patient to be still while the dose is being readied.
3. Use IV access. No butterflies or straight sticks.
4. Recheck status of IV just prior to radiopharmaceutical administration.
5. Use a moderate saline flush rate.

Analysis After Educational Intervention

An additional 469 PET injections were monitored in a similar fashion to the initial study and data and were analyzed in a similar fashion. Adherence to quality improvement measures was assessed. Technologist data were evaluated. After this, 2322 injections were monitored in a similar fashion to see if results were sustainable.

Analysis of three technologist infiltration rates over time (See Graph, below.)

Technologist A

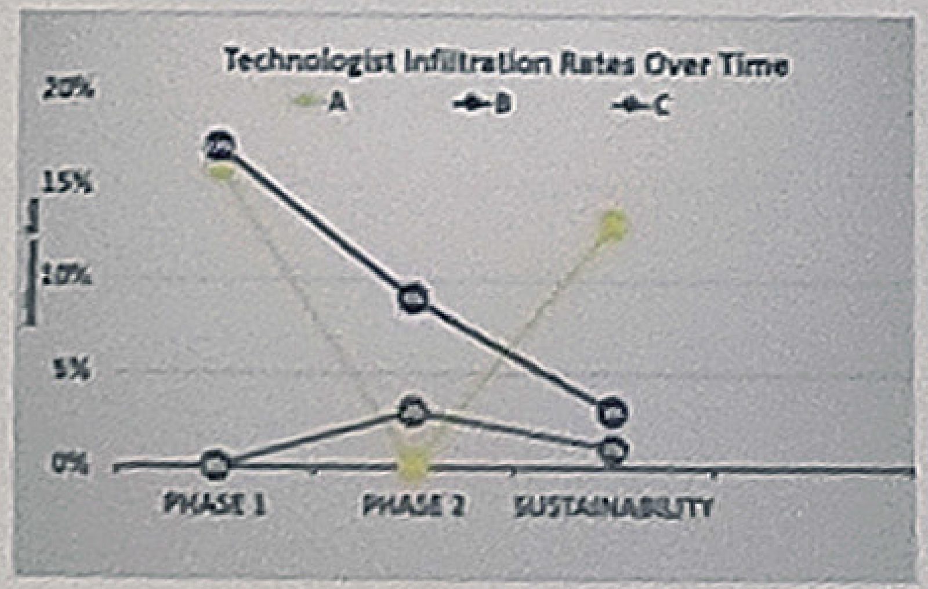
Technologist A had a 16% infiltration rate and was using butterflies to administer the radiopharmaceutical. This infiltration rate decreased to 0% once IV access was utilized, evidenced in the follow-up study and analysis. After this improvement was seen, however, Technologist A had an increase in extravasation rate to 13%, which was similar to the initial infiltration rate. Upon review of the data, Technologist A had returned to using butterflies for radiopharmaceutical injection.

Technologist B

Technologist B began with a 17% infiltration rate, decreased to 9% after the initial educational intervention, and continued to decrease to 3% in the long-term analysis to assess if improvement in infiltration rate was sustainable.

Technologist C

Technologist C had the lowest infiltration rates throughout the study (0%, 3%, 1%). Technologist C adhered to best injection protocol practices in the course of personal professional practice, and continued to practice these throughout the study.



Conclusion

Our PET/CT center reduced infiltration rates through our plan-do-study-act quality improvement project. We found that PET dose extravasation rates decreased after active monitoring and educational practices were implemented. Our study shows, however, that ongoing monitoring may be useful as technologist practice patterns and infiltration rates can fluctuate over time.