Radiotracer Generalizability: CNN Automated Detection in PSMA PET/CT - A Multi-Tracer Pilot Study in ^{68}Ga-PSMA-11,^{18}F-DCFPyL and ^{18}F-PSMA-1007

Ojaswita Lokre[1], Bogdan Dzyubak[1], Mikaela Dell'Oro[2], Roslyn J. Francis [2,3], Martin A. Ebert [2,3,4], Timothy G Perk[1]

[1]AIQ Solutions, [2]The University of Western Australia-Perth, [3]Sir Charles Gairdner Hospital-Nedlands, [4]University of Wisconsin- Madison

INTRODUCTION

Prostate-specific membrane antigen (PSMA) PET/CT imaging has provided significant advances in diagnosing and treating patients with prostate cancer. PSMA PET/CT has been used in AI models to evaluate lesions; however, few studies have assessed the transferability of AI models across the commonly used tracer types.

In this analysis, we deployed a CNN-based AI model designed to identify lesions on both ^{68}Ga-PSMA-11 PET/CT and ^{18}F-DCFPyL PET/CT images and evaluated the generalizability and performance on ^{18}F-PSMA-1007 PET/CT images, which has a different biodistribution.

MATERIALS AND METHODS

- A set of N=169 images, comprising ^{68}Ga-PSMA-11 PET/CT images from 89 patients (126 images, 1-2 imaging time-points/patient) and ^{18}F-DCFPyL PET/CT images from 43 patients (43 images, 1 imaging time-point/patient), all diagnosed with metastatic prostate cancer, were used for training a lesion detection CNN employing a retina U-net architecture.

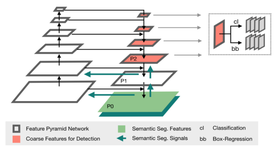

Image from Jaeger et al., 2018

Figure 1: Architecture for the Retina U-net [1]

- The CNN's performance was assessed separately in external validation datasets with ^{68}Ga-PSMA-11 PET/CT images (200 patients, 337 images), ^{18}F-DCFPyL PET/CT images (27 patients, 27 images) and an additional dataset of ^{18}F-PSMA-1007 PET/CT images (13 patients, 18 images).
- Lesions were manually delineated for comparison and reviewed by a clinician with extensive training in reading PSMA PET/CT.
- Detection performance was evaluated using the sensitivity and the number of false positives per image (FPs/image).
- Performance was summarized for all lesions, for lesions with SUV_{max}>2.5 g/ml, and for lesions with SUV_{max}>4 g/ml.

RESULTS

- In the ^{68}Ga-PSMA-11 test images (N= 337), an average of 4 lesions per image (range: 1-100 lesions per image) were delineated. The median detection sensitivity for all lesions was 92% (IQR: 43%-100%) with 1 (IQR: 0-2) FPs/image

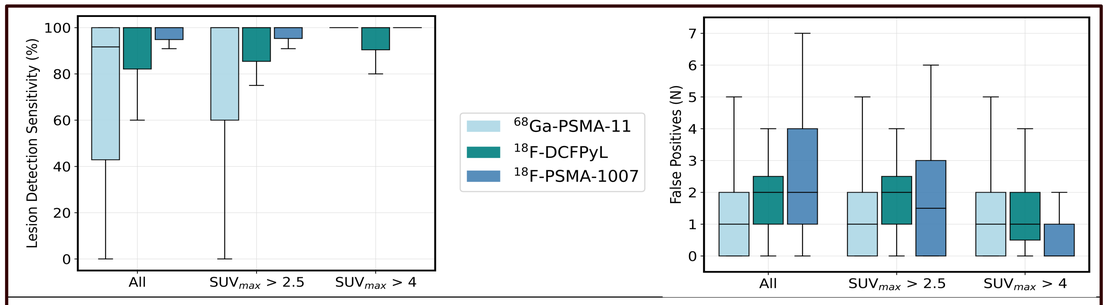

Figure 2: Comparison of the Lesion Detection Sensitivity (%) and False Positives (N) across different tracers

- For the ^{18}F-DCFPyL test images (N= 27), an average of 20 lesions per image (range: 1-157 lesions per image) were delineated. The median detection sensitivity for all lesions was 100% (IQR: 82%-100%) with 2 (IQR: 1-2.5) FPs/image.
- Similarly, for the ^{18}F-PSMA-1007 test images (N=18), an average of 7 lesions per image (range: 1-29 lesions per image) were delineated. The median detection sensitivity for all lesions was 100% (IQR: 95%-100%) with 2 (IQR: 1-4) FPs/image.

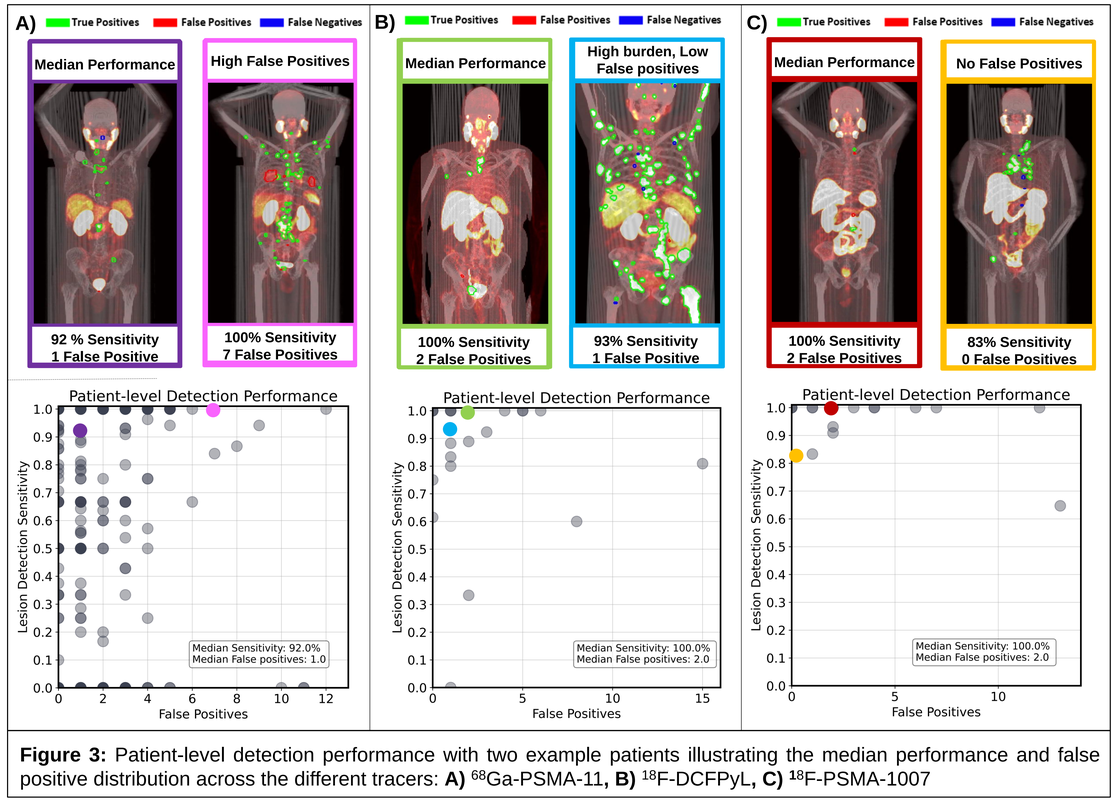

Figure 3: Patient-level detection performance with two example patients illustrating the median performance and false positive distribution across the different tracers: **A)** ^{68}Ga-PSMA-11**, B)** ^{18}F-DCFPyL**, C)** ^{18}F-PSMA-1007

KEY FINDINGS

A CNN detection model, trained on ^{68}Ga-PSMA-11 and ^{18}F-DCFPyL PET/CT images, demonstrated high median sensitivity and minimal false positive rates in the ^{68}Ga-PSMA-11, and ^{18}F-DCFPyL external holdout datasets, and on the ^{18}F-PSMA-1007 images.

Although the ^{18}F-PSMA-1007 dataset was small, this preliminary data shows the potential for generalizability across different PSMA tracers, including those with different biodistributions such as ^{18}F-PSMA-1007.

Investigating generalizability in larger, diverse cohorts is vital to fully understand the implications for model stability and clinical reliability. Analysis is ongoing to include more ^{18}F-PSMA-1007 images in this study.

REFERENCES

[1] Jaeger, P. F. *et al.* Retina U-Net: Embarrassingly Simple Exploitation of Segmentation Supervision for Medical Object Detection. *Proc. Mach. Learn. Res. NeurIPS 2019* 1–12 (2018).

DISCLOSURES

Authors OL, BD and TGP are employed by AIQ Solutions. RF is a scientific advisory board member of AIQ Solutions. MD is an AIQ Research Fellow. Remaining authors have no relevant relationships to disclose.

CONTACT INFORMATION

✉ ojaswita.lokre@aiq-solutions.com