BAINES IMAGING

Non-Invasive Prediction of ^{177}Lu-DOTATATE Treatment Response Using ^{68}Ga-DOTATATE PET/CT and Deep Learning

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Introduction

- **Neuroendocrine tumors (NETs)** are the **fastest growing class of cancer**, accounting for approximately 2% of all cancers [1]
- NET cells overexpress somatostatin receptors, allowing for combined **medical imaging of tumors** and **targeted radiation therapy**, known as theranostics
- There are **no reliable prognostic markers** to guide patient selection for 177Lu-DOTATATE theranostic treatment
- Somatostatin receptors can be visualized prior to treatment with ^{68}Ga-DOTATATE PET/CT scans
- Deep learning **convolutional neural networks** provides the opportunity to **better characterize NETs**, by predicting therapeutic response and determining treatment eligibility

Objective

To develop and evaluate a custom deep learning convolutional neural network (CNN) using pre-treatment ^{68}Ga-Dotatate PET/CT scans to predict disease control following ^{177}Lu-DOTATATE therapy in patients with NETs.

Methods

191 patients with NETs treated at 4 Canadian centres with ^{177}Lu-DOTATATE as part of the **Ozmosis trial**

Diagnostic PET/CT, 16 clinical parameters and time to progression was collected **(Figure 1-1)**

31 excluded (< 3 treatment cycles complete)

Eligible Patients **n = 160**
- 59% male (n=95)
- Mean age of 61 [range 24-87]
- 64% (n=103) with prolonged disease control

- The torso volumes were automatically segmented on the CT scan using TotalSegmentator [2] **(Figure 1-2)**
- Images were pre-processed, normalized and cropped based on the torso segmentation to 128x128x256 voxels **(Figure 2a)**
- **70%** (n=112) of the dataset was used for **training**, **15%** (n=25) for **validation** and **15%** (n=23) for **testing** a CNN model
- Data augmentation was generated through rotations, zoom and elastic deformation of the training dataset **(Figure 2b-c)**
- A custom CNN deep learning model was developed and trained **(Figure 1-4)** [4]
- Model performance was evaluated based on accuracy and area under the receiver operator curve (AUC) **(Table 1)**

Study Design Overview

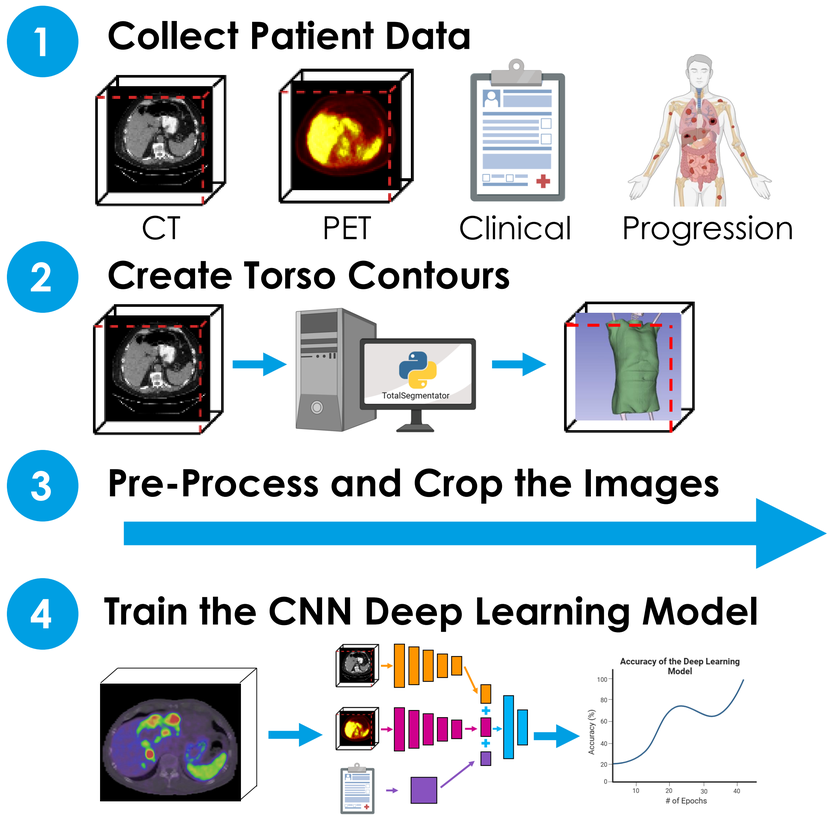


Figure 1: The overall methodology of the study.

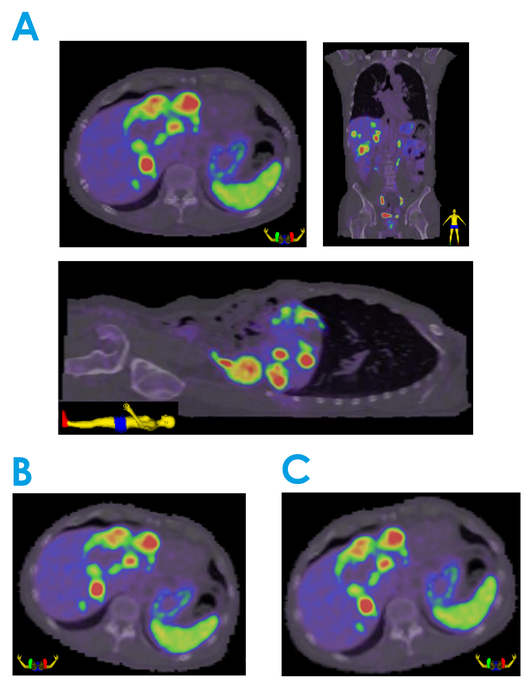
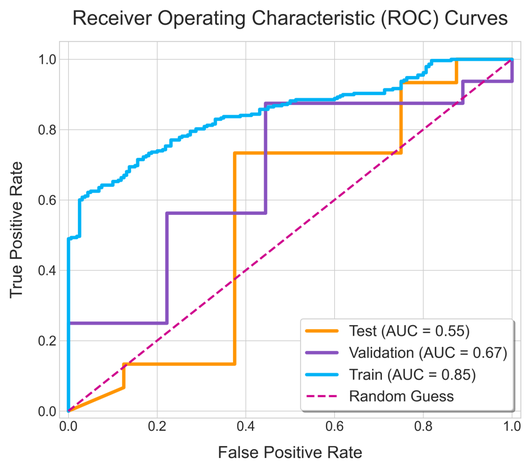


Figure 2: The pre-processed and cropped PET/CT images used as the input for the model in (A) the original image, (B) right rotation and elastic deformation and (C) left rotation and zoom.

Results



Metric	Value
Accuracy	75
	76
	61
Sensitivity	85
	88
	60
Specificity	57
	56
	62
Precision	78
	78
	75

Figure 3: The Receiver Operating Characteristic Curve and performance metrics for the model in the **training**, **validation**, and **testing** datasets.

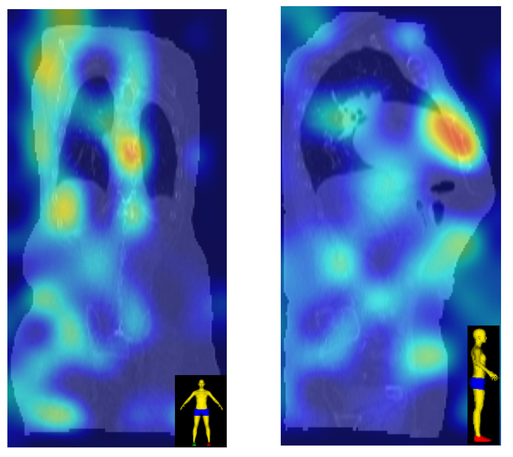


Figure 4: Example grad-CAM map highlighting the regions of the PET/CT images the CNN used to make its predictions in the coronal and sagittal planes.

Discussion & Conclusion

- A custom CNN model can successfully extract prognostic markers from pre-treatment ^{68}Ga-DOTATATE PET/CT scans
- The high precision suggests this model may be useful in identifying patients for clinical trial selection
- Future work includes integrating more clinical information and anatomical contours to create a more comprehensive CNN model

References

[1] Dasari, A. *10.1001/jamaoncol.2017.0589*
[2] Wasserthal, J. *10.1148/ryai.230024*
[3] He, K. et al. *arXiv:2510.24036v1, 2015*

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