Application of Novel Machine Learning Model in [68Ga] Ga-PSMA-11 PET/CT – Predicting Survival in Oligometastatic Prostate Cancer Patients

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Background

- Biochemical recurrence is estimated to occur in ≥ 25% of patients with prostate cancer following primary curative therapy.
- Machine learning models are being developed for lesion detection and tracking to provide a comprehensive view of disease burden, allowing clinicians to quantify and predict effectiveness of treatment for individual lesions [1].
- This study applied novel AI-assisted technology to automatically extract features from [68Ga]Ga-PSMA-11 (PSMA) PET/CT images that correlate with treatment intervention and survival data to create a scoring system.

Methods

- 185 men with oligometastatic prostate cancer had a baseline (BL) and follow-up (FU) PSMA PET/CT scan (~ 6 months apart) whilst treated per standard clinical care [2].
- Inclusion criteria was low-disease burden defined as negative/oligometastatic disease (> 3 lesions) on bone scintigraphy and abdominal CT staging scans.

Table 1. *Patients treatment.*

Treatment received	%
ADT alone or with chemotherapy/surgery	44%
Observation	30%
Radiation therapy	26%

- PSMA-positive lesions were identified using Nuclear Medicine physician-based delineation at both timepoints.
- Lesions were quantified and matched between timepoints using AIQ Solutions technology. 1,233 lesions were identified at BL, and 1,605 were identified at FU.
- Imaging features were extracted from each patients two scans, including:
  - Change in basic features (SUV_{max}, SUV_{mean}, and number of lesions at baseline)
  - Heterogeneity features (intrapatient heterogeneity of disease and response).
- Univariate predictive power of overall survival (OS) of each measure was determined using Cox regression models.
- Imaging features were input into the TRAQinform Profile (AIQ Solutions), which used 5-fold cross-validation of a random survival forest to predict OS.
- Model performance was evaluated using the c-index as the measure of predictive power of OS.

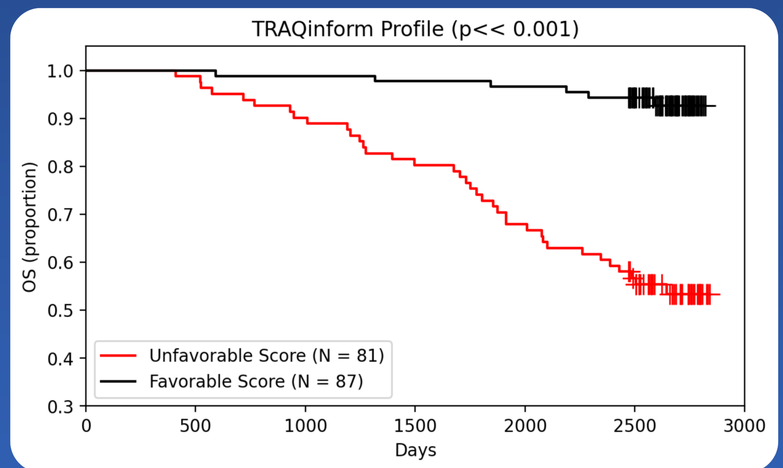

Figure 1. *Kaplan Meier curve plot of patients responders vs suboptimal responders based on whether they had a treatment intervention or observation alone.*

In an individual scan, the proportion of increasing lesions >29% (based on SUV_{total}) correlated with poorer progression (Figure 1).

The top univariate predictors of survival were all heterogeneity features:

1. Proportion of lesions increasing (c-index=0.62)
2. Number of stable lesions (c-index= 0.62)
3. Number of decreasing lesions (c-index= 0.60)
4. Number of new lesions (c-index= 0.59).

The AI model was able to predict responders vs suboptimal responders based on whether they had a treatment intervention or observation alone (35%) (c-index= 0.83 in both cases). See Figure 2 for examples of individual scores.

CONFLICT OF INTEREST: AIQ Australia Pty Ltd in collaboration with UWA have established AIQ Research Fellows - full time research fellowships in medical imaging. Dr Dell'Oro holds one of these Fellowships.

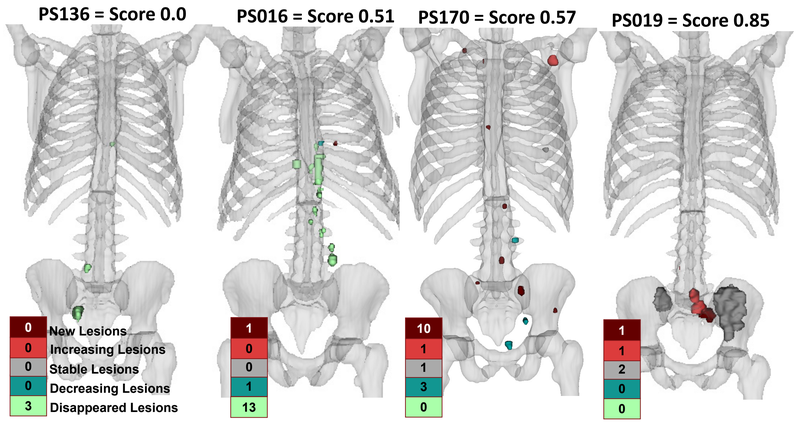

Figure 2. *Response assessment map of patients demonstrating a higher TRAQinform Profile score for patients (PS136 and PS16) who were predicted to do favourably compared to patients (PS170 and PS019) who did not.*

Conclusion

This study demonstrates that an AI-assisted lesional response analysis can help predict response and prognosis of oligometastatic prostate cancer patients using [68Ga]Ga-PSMA-11 imaging. These results support further studies to validate these findings in a prospective cohort.

References

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2. McCarthy M, Francis R, Tang C, Watts J, Campbell A. A Multicenter Prospective Clinical Trial of 68Gallium PSMA HBED-CC PET-CT Restaging in Biochemically Relapsed Prostate Carcinoma: Oligometastatic Rate and Distribution Compared With Standard Imaging. Int J Radiat Oncol Biol Phys. 2019 Jul 15;104(4):801-808. doi: 10.1016/j.ijrobp.2019.03.014. Epub 2019 Mar 16. PMID: 30890448.