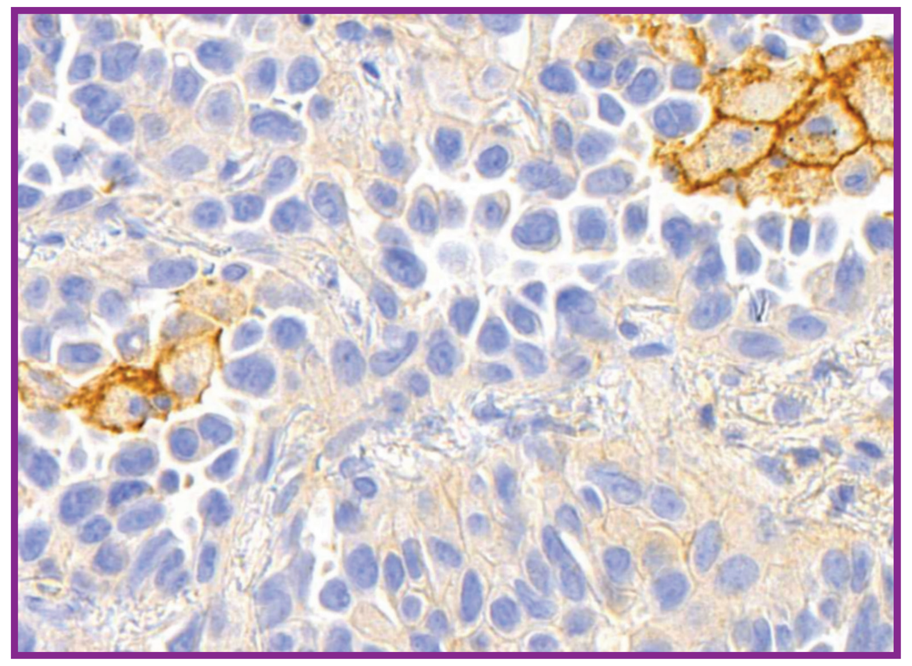
Artificial Intelligence-Aided Diagnostics Saves Time and Improves Reliability of PD-L1 Scoring in Non-Small Cell Lung Cancer

Nelli Sjöblom, Anna Laury, Marja Kovala, Anna Knuuttila, Anniina Manninen, Sami Blom, Marika Karjalainen, and Juuso Juhila

Disclosures: AK, AM, SB, MKa, and JJ are employed by, and NS, AL, and MKo are consultants for, Aiforia Technologies, Plc

NON-SMALL CELL LUNG CANCER

- The most common cause of cancer death in the world is lung cancer (1).
- Non-small cell lung cancer (NSCLC), of which adeno- and squamous cell carcinoma are the most common histological subtypes, represents at least 80% of all newly diagnosed lung cancers (1).
- Treatment with PD-L1 blockers in these diseases improves prognosis, even in advanced stage disease (2).



PD-L1 AND IMMUNOHISTOCHEMICAL STAINING

PD-L1 immunohistochemical staining is the most commonly used method of evaluating the potential for response prior to treatment with immune checkpoint inhibitors in non-small cell lung cancer .

Evaluation of PD-L1 staining is performed by pathologists, but interpretation is burdensome and slow due to variations in staining, interpretation protocols, and pathologist experience.

STUDY DESIGN

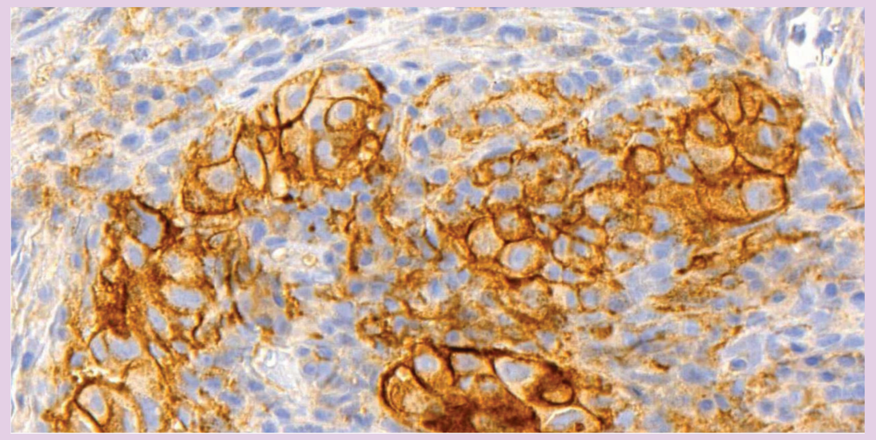
80 whole slide images (WSI) of NSCLC
Stained with PD-L1 (clone SP142)

ROUND 1
Visual evaluation: TPS assessed for each WSI
Score reported in 5% increments

Two week washout

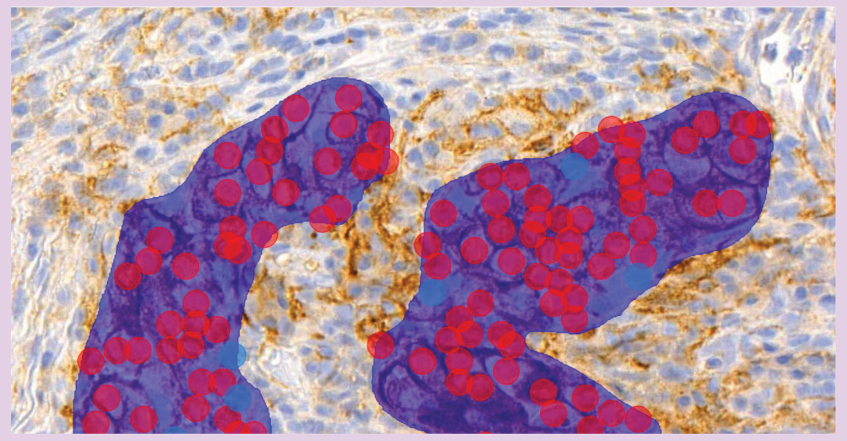
ROUND 2
AI-assisted evaluation: TPS assessed for each WSI
Score reported in 5% increments

ROUND 1



Standard visual scoring of PD-L1 staining.

ROUND 2



Blue regions represent regions the AI model has identified as invasive carcinoma.

Red circles within the invasive areas identify PD-L1 positive tumor cells.

RESULTS

The model predicted PD-L1 positivity with a 90.2% recall ratio with 97.4% precision.

The F1-score for accuracy was 93.7%. The reliability of agreement (Fleiss' kappa) between rounds was 0.873.

Reliability between analyses increased from 0.87 (95% CI 0.82-0.92) to 0.96 (95% CI 0.95-0.97) for individual pathologists.

Inter-rater reliability improved from 0.71 (95% CI 0.69-0.83) to 0.88 (95% CI 0.89-0.97) in AI-assisted analysis.

The average time per WSI analysis decreased from 196.9 seconds to 154.1 ($p<0.05$).

SCORING AND PATIENT COHORT

Slide evaluation was performed independently by three pathologists (NS, MKo, AL). The tumor proportion score (TPS) is defined as the percentage of PD-L1 positive tumor cells out of all tumor cells that are demonstrating membranous staining at any intensity.

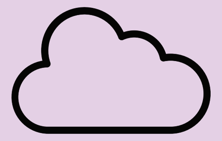
Specific consensus scoring guidelines were not reviewed, and the pathologists were instructed to score as they would in routine clinical practice.

The AI model was designed to detect membranous staining in cancer cells of any staining intensity.

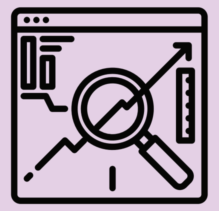
The study population consisted of 80 adult patients (18 - 85 yrs.) with a diagnosis of non-small cell lung cancer (C34), and who had been treated in the Uusimaa district, Finland. Slides were obtained from Helsinki Biobank. Information about treatment response was not available.

All patients provided written consent for their archival samples to be used for research purposes. This study was approved by the Ethical Committee of Helsinki University Hospital (statement number HUS/430/2021).

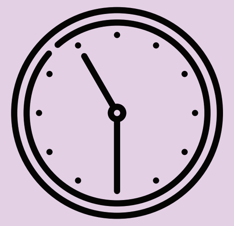
BENEFITS OF AI-ASSISTED ANALYSIS



Cloud based tools mean low entry point and support for remote access.



Consistent output with reduction of bias and inter-observer variation.



Significant time savings.

CONCLUSIONS

- AI-assistance improved the PD-L1 score concordance between pathologists.
- AI-assisted WSI analysis was more rapid and produced more reproducible data.
- Novel tools provide valuable diagnostic assistance by both reducing the pathologist's workload, and improving interobserver variation in scoring.

1) Herbst RS, Morgensztern D, Boshoff C. The biology and management of non-small cell lung cancer. Nature. 2018 Jan 24;553(7689):446-454. doi: 10.1038/nature25183. PMID: 29364287.

(2) Reck M, Remon J, Hellmann MD. First-Line Immunotherapy for Non-Small-Cell Lung Cancer. J Clin Oncol. 2022 Feb 20;40(6):586-597. doi: 10.1200/JCO.21.01497. Epub 2022 Jan 5. Erratum in: J Clin Oncol. 2022 Apr 10;40(11):1265. PMID: 34985920.