Diagnosis 2.0: AI-Assisted Gleason Group Grading in Prostate Cancer

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Disclosures: MKa, AW, AM, VK, SB and JJ are employed by, and NN, HP and MKo are consultants for Aiforia Technologies, Plc

PROSTATE CANCER

- According to WHO, there were more than 1.4 million new cases of prostate cancer in 2020. (1)
- Prostate cancer is the second most common cancer in men, and it caused globally more than 375 000 deaths in 2020. (1)
- Early intervention based on correct characterization of the tumor is a key element of treatment planning and survival. (2)
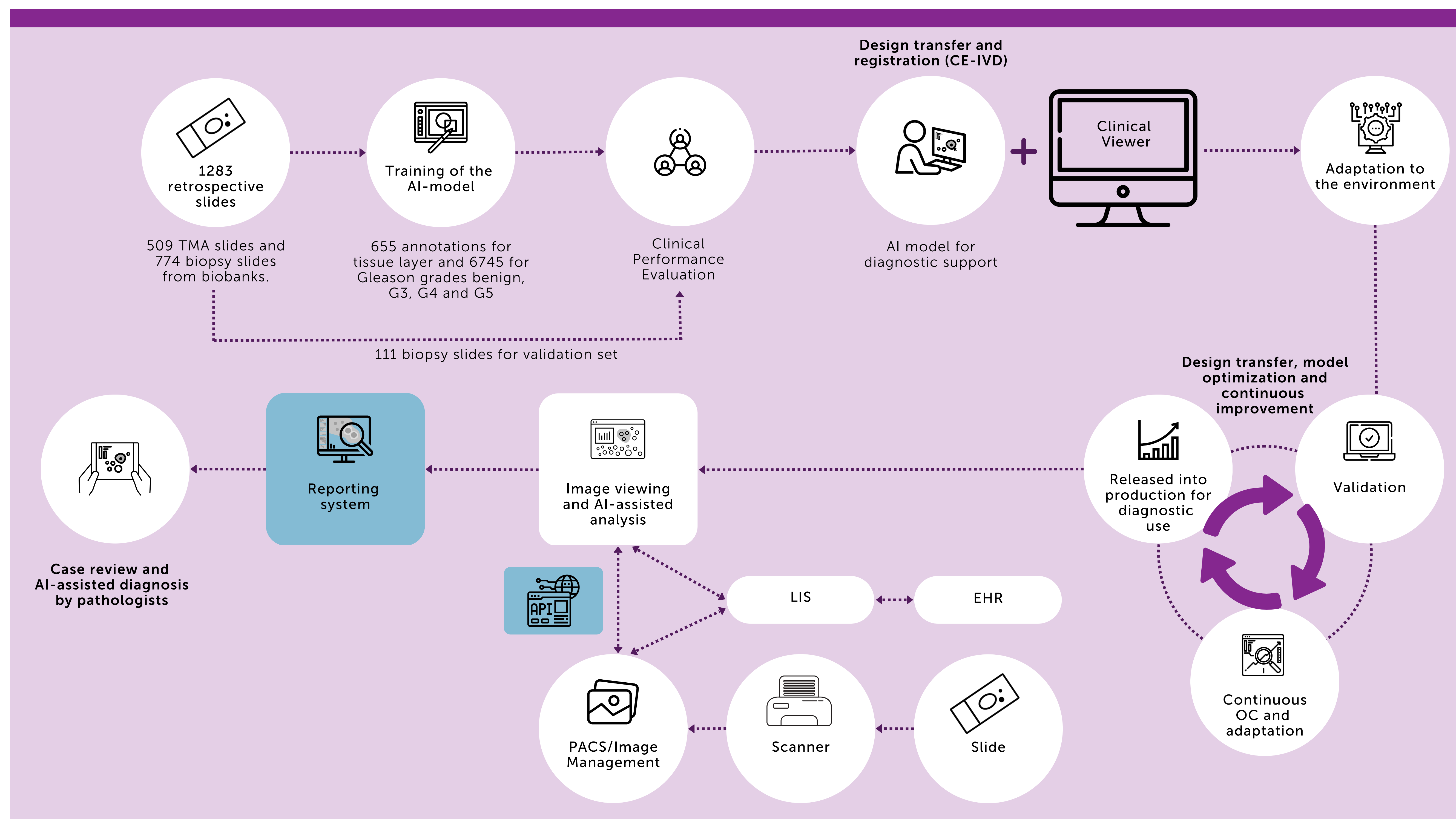
TECHNOLOGY

Computational pathology and artificial intelligence (AI)-based tools have enabled the objective diagnosis of whole slide images (WSIs) along with the access to necessary clinical information and case-related images. The current gold standard for prostate cancer management, Gleason grading, is under constant development, and its limitations underline the need for more standardized and objective analysis tools. AI-assisted approaches offer the possibility to augment pathologists' capabilities and support their diagnostic workflow.
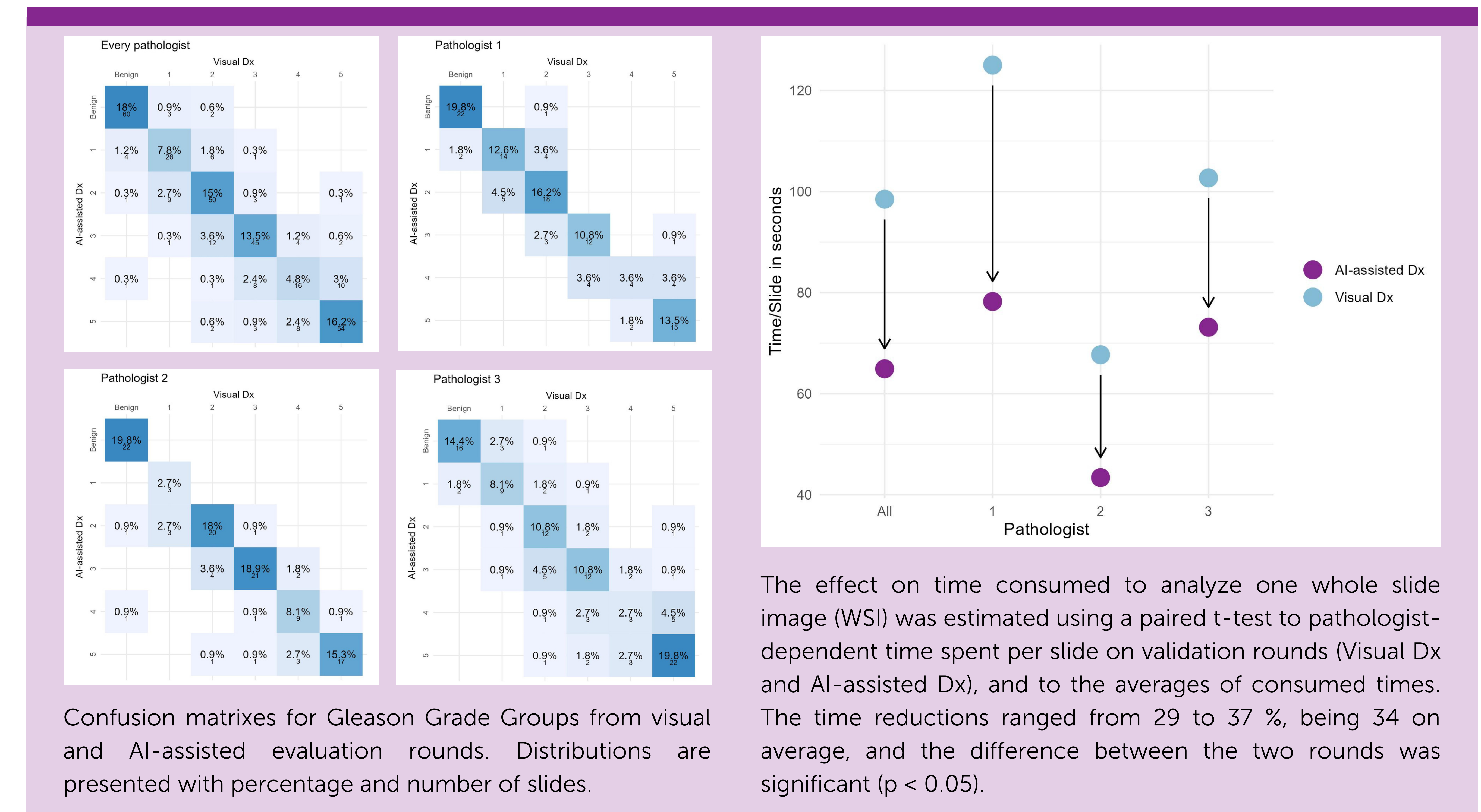
CLINICAL PERFORMANCE EVALUATION

- 509 TMA slides and 774 biopsy slides from EU (3) and US (4) used for training an AI model consisting of two separate convolutional neural networks (CNNs) for semantic segmentation of
  - Tissue layer (655 annotations)
  - Gleason grades benign, G3, G4 and G5 (6745 annotations)
- Validation set of 111 prostate tissue WSIs analyzed by 3 pathologists
  - Without the assistance of the AI model (Visual Dx, reference)
  - With the assistance of the AI model (AI-assisted Dx)

CLINICAL WORKFLOW

CLINICAL PERFORMANCE EVALUATION RESULTS

Confusion matrixes for Gleason Grade Groups from visual and AI-assisted evaluation rounds. Distributions are presented with percentage and number of slides.

The effect on time consumed to analyze one whole slide image (WSI) was estimated using a paired t-test to pathologist-dependent time spent per slide on validation rounds (Visual Dx and AI-assisted Dx), and to the averages of consumed times. The time reductions ranged from 29 to 37 %, being 34 on average, and the difference between the two rounds was significant (p < 0.05).

MORE RESULTS

- The model can predict positive observations with 96.8 % recall ratio for the combined dataset, ranging from 93 to 100 % for individual pathologists. Precision ranged from 86.9 to 93.9 % per pathologists, being 89.8 for the combined dataset. Overall accuracy (F1) ranged from 89.8 to 96.6 % per pathologist, being 93.2 % on average.
- The reliability of agreement between Visual Dx and AI-assisted Dx was 0.846 (Cohen's weighed kappa) for the combined dataset, and the range for pathologists was 0.788-0.878.
- Time spent for Gleason pattern analysis per slide was significantly reduced during AI-assisted Dx; on average each slide took 34% less time (p < 0.05).

BENEFITS OF AI-ASSISTED ANALYSIS

- Improved treatment efficacy with more precise diagnosis
- Faster time to diagnosis and less waiting time for patients
- Samples are reviewed consistently and efficiently ensuring everyone treated the same
- Time savings and reduction in error while improving treatment accuracy results in faster work and lower costs

CONCLUSIONS

- AI-assisted Gleason grading is very well in concordance with the analysis performed without its assistance.
- The AI methodology reduced the needed time for grading by 34 % versus eyeballing method.
- With digital tools and automated workflow the increasing burden of prostate diagnostics may be reduced significantly.
- Performance will be further investigated with third-party clinical performance evaluations at real-world settings.

1) Cancer Today - IARC. (2023, February 2nd). Online analysis table. WHO. https://gco.iarc.fr/today/
2) Mohler, J. L. et al. Prostate cancer, version 2.2019, NCCN clinical practice guidelines in oncology. J. Natl Compr. Canc. Netw. 17, 479–505 (2019).
3) Approved by the ethical board of Helsinki University Hospital (statement number HUS/415/2021.
4) Commercial slides.