AI-assisted mitosis counting in breast cancer. A large-scale validation study.

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Introduction

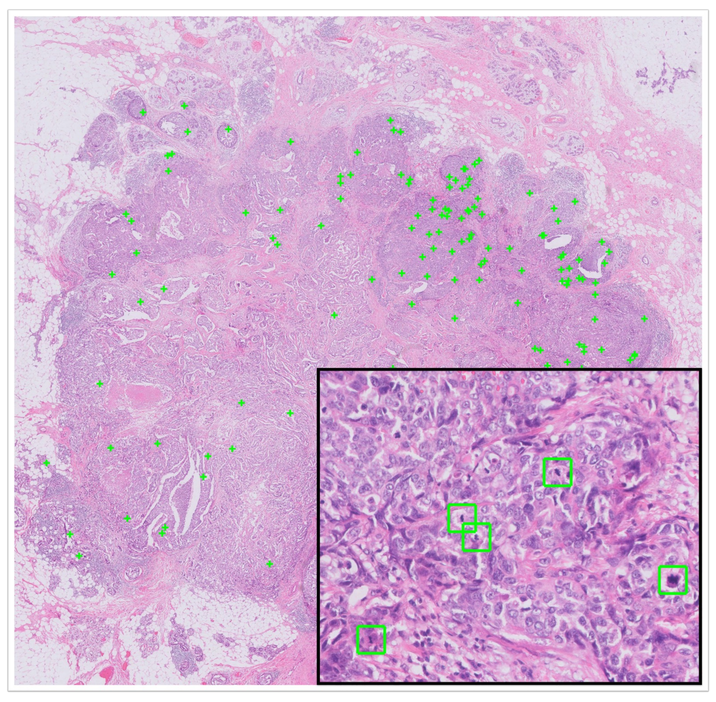


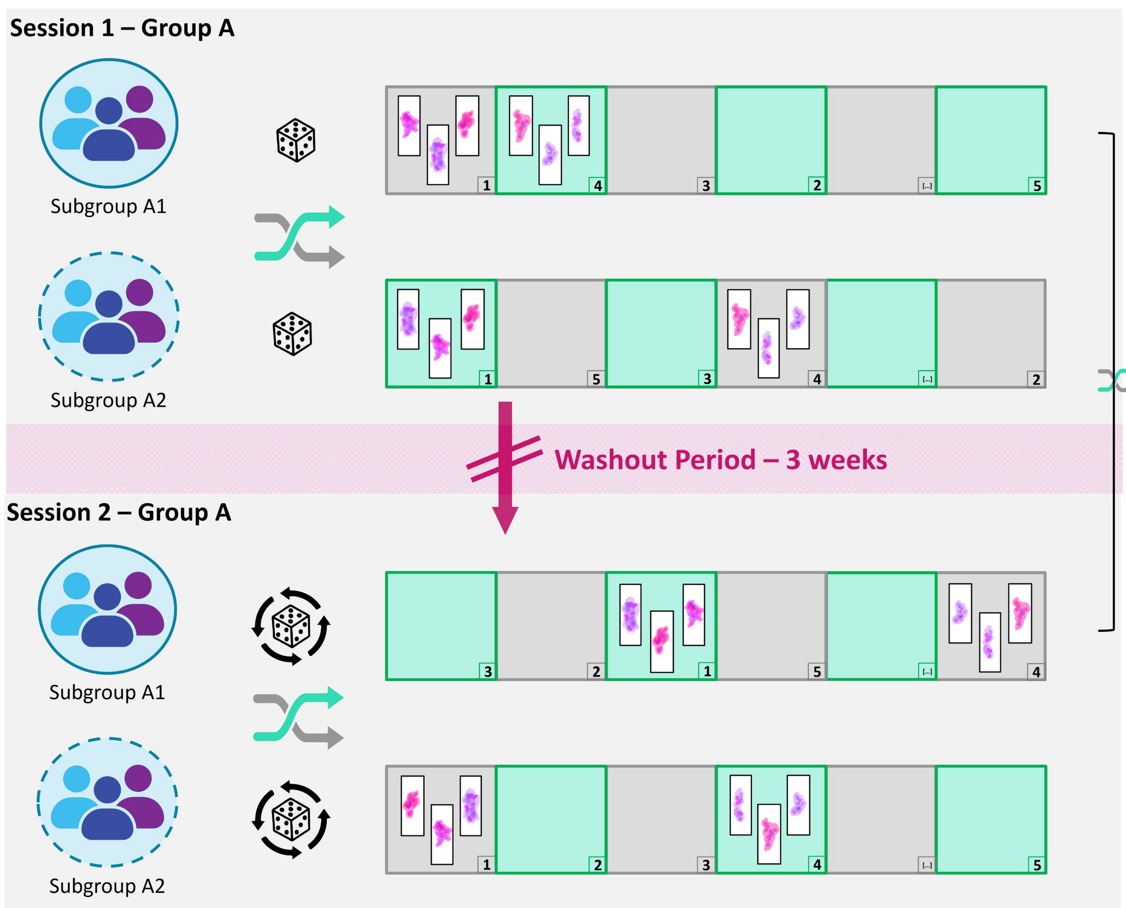
Figure 1: **Aiosyn Mitosis Breast**, output as seen by participants in the study

Expectations for artificial intelligence (AI) in pathology are very high, yet only a few studies attempted to quantify its impact in clinical practice.

Mitosis counting in breast cancer is a tedious, time-consuming and error-prone task.

We designed a large-scale, international study to quantify the impact of an AI device (Aiosyn Mitosis Breast) aiming at detecting mitoses in breast cancer slides in pathology practice (Fig. 1)

Material and Methods



28 participants

9 countries

Various degrees of experience in breast pathology

Split-plot design

- 2 groups
- **210 slides**
- 105 per group
- read without and with AI-assistance

Figure 2: **Study workflow.**
Data shown for group A only (likewise for group B, on a different set of 105 slides).
Crossover on reading modality in each phase for subgroups A1 and A2. Reading modality alternates every 10 slides for each reader (green : AI-assisted, grey : unassisted). Randomization (⊛) of slide order for each participant and in each phase.

Results

Primary endpoints:

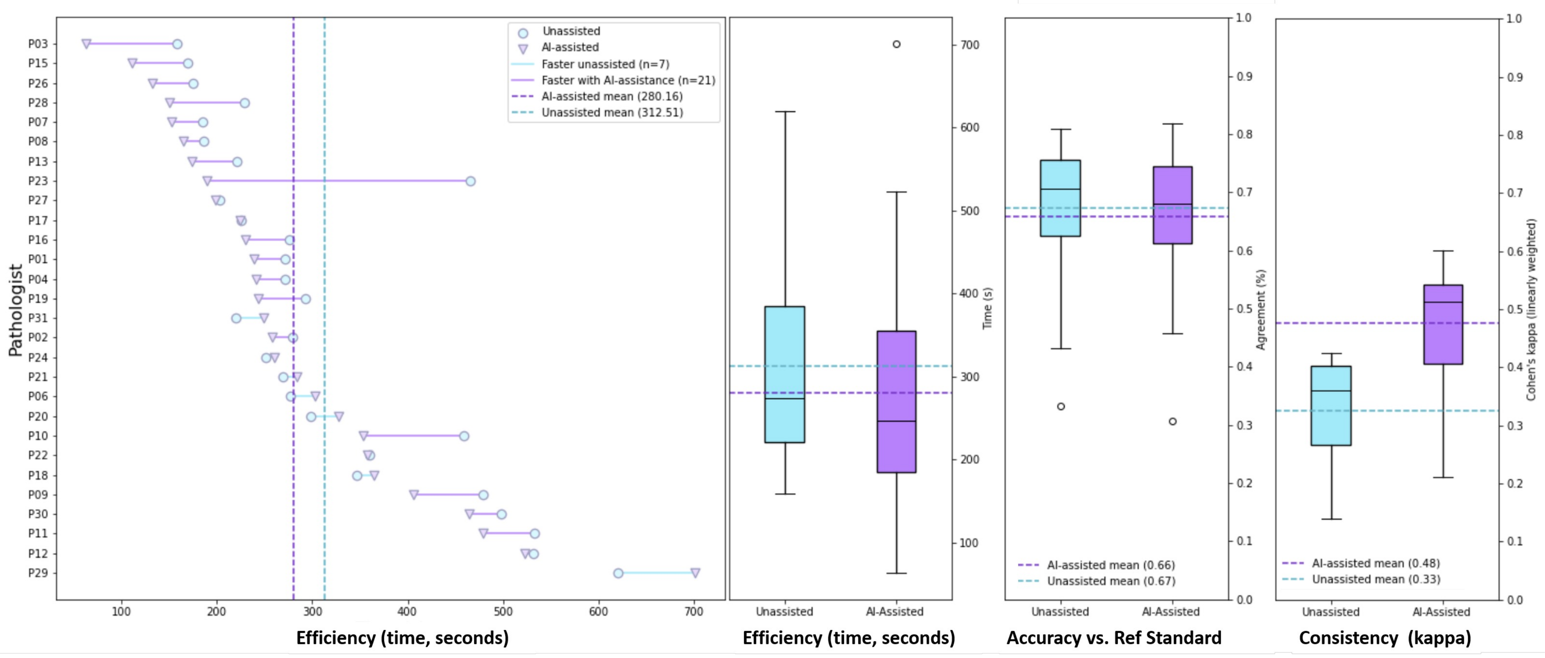


Figure 3: **Graphical representation of the main results on efficiency, accuracy, and consistency.**

	Unassisted	AI-assisted	p-value
Accuracy (score, %)	67.37 [63.26, 72.07]	65.87 [61.64, 70.64]	<0.01*1
Efficiency (time, seconds)	312.5 [264.1, 357.4]	280.2 [226.9, 328.6]	<0.01*2
Consistency (score, avg. linear kappa)	0.33 [0.3, 0.35]	0.48 [0.46, 0.50]	<0.01*3

Table 1: **Main results summary**

1. Generalized mixed-model (agreement~modality+(1/Cases/User)), non inferiority testing (delta: 10%).
2. Linear mixed-model (time~modality+(1/Cases/User)), superiority testing.
3. Wilcoxon signed-rank test (interobserver variability per case, per modality), superiority testing.

Homogeneity in hotspot selection:

- Overlap analysis: Normalized ratio of the union of areas of all users divided by the sum of all areas (per case) - **More overlap in the AI-assisted modality** (p<0.01)

User experience survey:

- Users would like to use this AI device in practice: 90%

- AI helped them locate the highest mitotic density area: 90%

- AI made them feel:
  - **Faster: 86%**
  - More accurate: 62%
  - More confident: 67%

Figure 4: **Homogeneity in hotspot selection.**
Counting areas of the pathologist. Overlap is presented as a heatmap from green (no overlap) to red (max overlap observed across the two reading modalities).

Discussion and Conclusion

Results of our study show that the use of the AI induces:

- **A significant time gain of 10.35% overall (~32 sec/case)**, and a 15.54% productivity increase in resections.
- **A significant decrease in interobserver variability (in scores and area selection)**
- **No significant decrease in the score accuracy** compared to reference standard.

Pathologists welcomed the AI algorithm, with 90% declaring they would use it in clinical practice.

Strengths of the study:
Large scale and robust study setup designed to limit biases and interactions.

Limitations:
Platform-agnostic tools might have lowered overall efficiency in both modalities.

Readily-available AI can play a significant role in pathology practice across countries, not only by decreasing time consumption for tedious tasks, but also by improving interobserver reproducibility and, therefore, patient care.

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