Abstract #613

Systematic Review and Meta-Analysis of Artificial Intelligence-Assisted Cystoscopic Diagnosis in Bladder Cancer and IC/BPS:

Clinical Performance and Challenges in CIS vs. Hunner Lesion Differentiation

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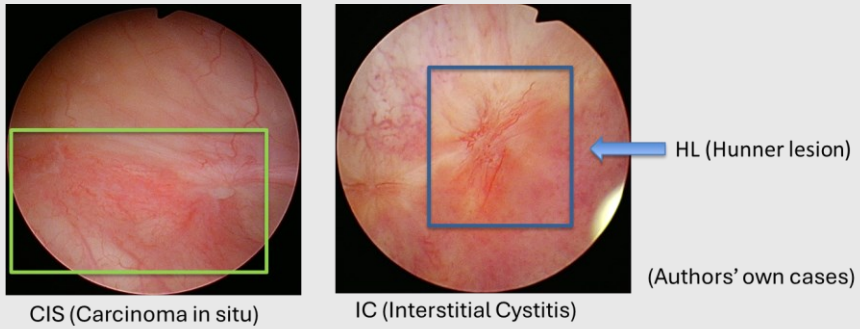
Background

- Cystoscopy is essential for diagnosing Carcinoma in situ (CIS) and interstitial cystitis/bladder pain syndrome (IC/BPS).
- Both CIS and Hunner lesions (HL) appear as flat erythematous lesions, making differentiation difficult. HL is pathognomonic for IC, whereas CIS requires oncological treatment.
- Therefore, accurate distinction is critical, and AI-assisted cystoscopy may improve diagnostic reproducibility.

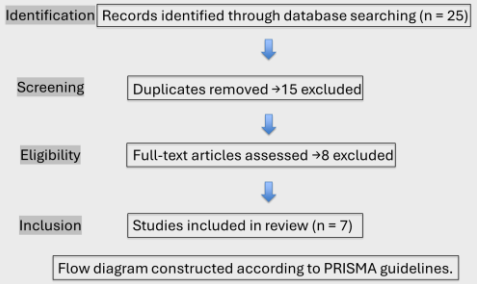
Figure 1. Cystoscopic images of CIS and HL



Methods

- PRISMA-based systematic review (2015–2024)
- AI-assisted cystoscopy in BC and IC/BPS
- Included validated AI models reporting diagnostic metrics (accuracy, sensitivity, specificity, AUC, DSC)
- Pooled via random-effects model

Figure 2. PRISMA Flow Diagram



Results

- **Studies included**: 7 (BC: 5, IC/BPS: 2)
- **Pooled performance**:

Sensitivity: 91.8%, Specificity: 93.5%, Accuracy: 92.6%

- **Limitation:** Differentiation between CIS and HL remains challenging

Figure 3. Forest plot of pooled diagnostic metrics

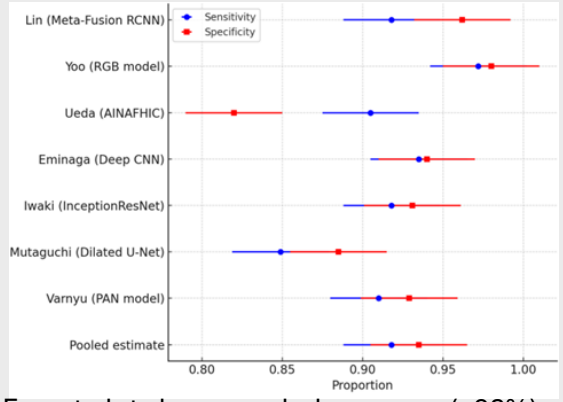


Figure 3. Forest plot shows pooled accuracy (~92%) across studies, highlighting robust but variable performance.

Table 1. Summary of included studies

Author (Year)	Target	Imaging	AI Model	Performance
Eminaga et al. (2018)	CIS vs Inflammatory	WLI	Deep CNN	Se 93.5%, Sp 94.0%
Lin et al. (2022)	Bladder Cancer	WLI + NBI	Meta-Fusion RCNN	Acc 94.5%, Se 91.8%, Sp 96.2%
Yoo et al. (2022)	Bladder Cancer (CIS)	RGB images	Mask R-CNN	Acc 92.3%, Se 89.5%, Sp 94.7%
Mutaguchi et al. (2022)	Bladder Cancer	WLI	Dilated U-Net	DSC 83%, PWSe 84.9%, PWSp 88.5%
Varnyú et al. (2022)	Bladder Cancer	WLI	PAN / DeepLabv3+	F-score 91%, Prec 92.9%
Ueda et al. (2022)	IC/BPS (HL)	WLI + NBI	AINAFHIC (Cascade Mask R-CNN)	WLI Acc 91.3%, NBI Acc 67.8%
Iwaki et al. (2023)	IC/BPS (HL)	WLI	InceptionResNetv2	Acc 92.5%, Se 91.8%, Sp 93.1%

Abbreviations:
WLI = White Light Imaging; NBI = Narrow Band Imaging; CIS = Carcinoma in situ; HL = Hunner lesion; IC/BPS = Interstitial Cystitis/Bladder Pain Syndrome; DSC = Dice Similarity Coefficient; CNN = Convolutional Neural Network; Acc = Accuracy; Se = Sensitivity; Sp = Specificity; Prec = Precision; PWSe = Pixel-wise Sensitivity; PWSp = Pixel-wise Specificity.

Discussion

- Overall, AI demonstrates robust diagnostic performance.
- Key barrier: Differentiation between CIS and HL remains insufficient due to overlapping morphology. This remains the major clinical barrier.
- Narrow-band imaging (NBI) alone is inadequate; multimodal approaches (WLI, NBI, PDD) are needed.
- Broader training datasets and federated learning may improve model generalizability.
- Clinical adoption requires real-time integration and explainable AI (XAI) for usability and trust.

Conclusions

- AI-assisted cystoscopy achieves high accuracy (~92%).
- **Key limitation:** CIS vs HL differentiation.
- **Future focus:** multimodal imaging, federated learning, and explainable AI.