Economic Evaluation of AI-Powered Digital Colposcopy in Women Referred for Colposcopic Assessment Following Abnormal HPV Screening in India

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BACKGROUND:

- Cervical cancer is a significant public health issue in India, with 127,526 new cases and 79,906 deaths in 2023 (17.7 per 100,000 women).
- Conventional colposcopy has a sensitivity of 0.71 for CIN2+ and is primarily available in urban areas.
- AI-powered digital colposcopy (AI-DC) enhances sensitivity to 0.90 and shortens diagnosis time by combining high-resolution imaging with real-time AI-assisted CIN classification.

OBJECTIVE:

To evaluate the cost-effectiveness of AI-DC versus conventional colposcopy for confirmatory diagnosis among HPV screen-positive women in India, from a healthcare payer's perspective.

METHODS:

- A hybrid decision tree-Markov model was created for 10,000 women aged 30-35 after a positive HPV screen.
- The decision tree outlined the diagnostic pathway, where 75% of test-positive women underwent biopsy, leading to classifications of no CIN, CIN1, CIN2/3, or invasive cancer. Women then transitioned through a nine-state annual-cycle Markov model over their lifetime, including states like Healthy, HPV+, CIN1, CIN2/3, Cervical Cancer Stages I-IV, and Death.
- Diagnostic accuracy was based on a meta-analysis of 18 studies, with costs calculated using micro-costing and utilities from Indian EQ-5D-5L data, discounted at 3% annually, at a WTP threshold of ₹2,30,000/QALY.
- Robustness was tested via one-way sensitivity analysis (key parameters varied ±10-20% from base case)
- Probabilistic sensitivity analysis (1,000 Monte Carlo simulations), summarised using a tornado diagram, a cost-effectiveness plane, and a cost-effectiveness acceptability curve (CEAC).

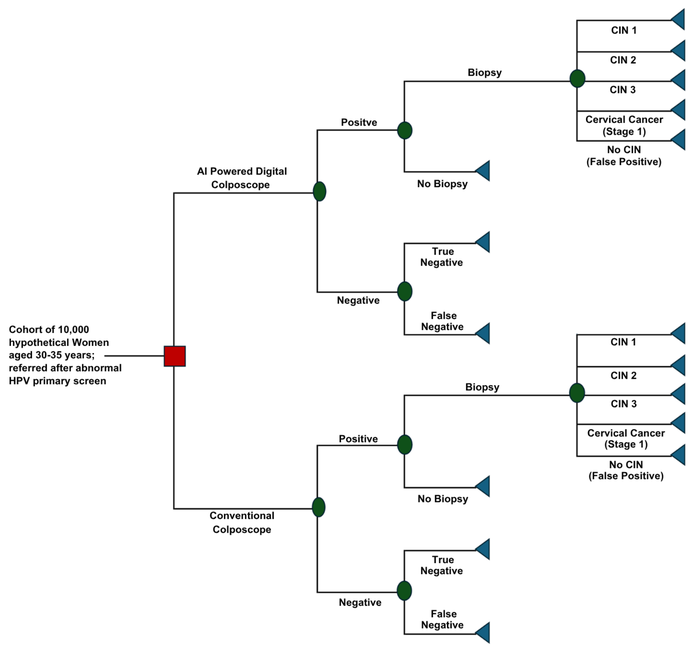

Figure 1. Decision tree for the diagnostic pathway following colposcopic evaluation.

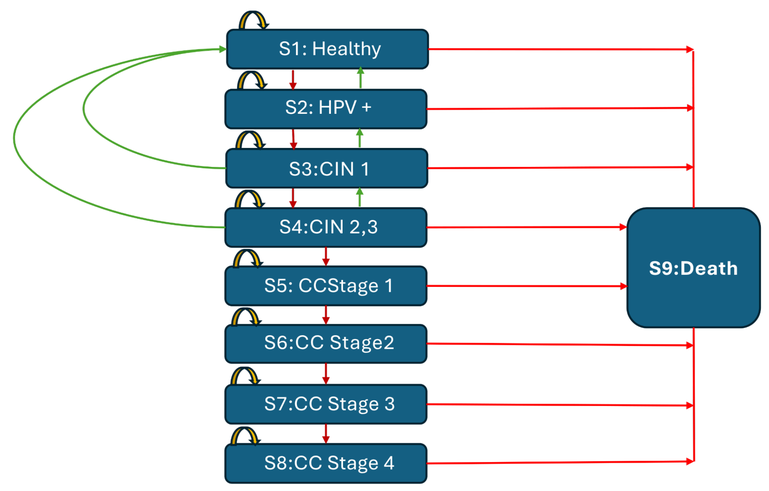

Figure 2. Nine-state Markov model of cervical disease progression (annual cycles, lifetime horizon).

RESULTS:

- Over the lifetime horizon, AI-DC generated 225,380 QALYs versus 225,208 for conventional colposcopy (incremental gain: 172.36 QALYs), at a total discounted cost of ₹70.56 crore versus ₹71.58 crore (incremental saving: ₹1.02 crore).
- AI-DC was therefore dominant more effective and less costly with a positive Net Monetary Benefit at the ₹2,30,000/QALY threshold, and averted 12 cervical cancer deaths per 10,000 women screened (1,237 vs 1,249 deaths).

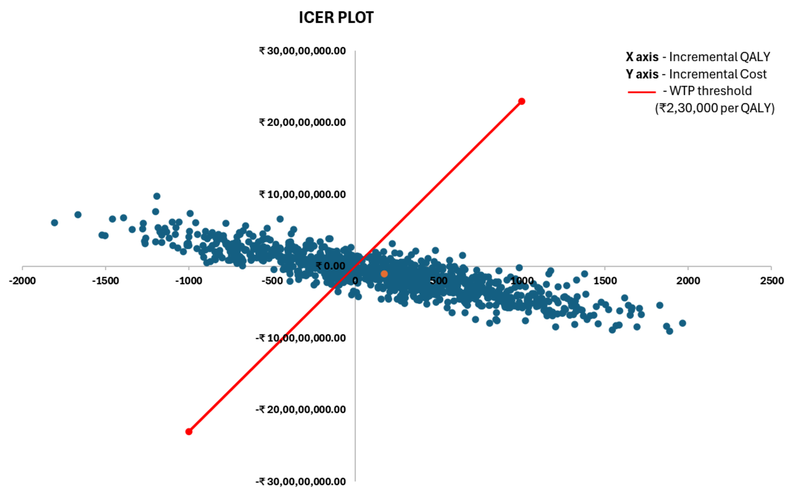

Figure 3. Cost-effectiveness plane 1,000 Monte Carlo simulations. 55% of iterations fell in the SE quadrant (AI-DC more effective & less costly); dominance was robust across simulations.

Outcome	AI-DC	Conv. Colposcopy
Total Cost (INR)	₹70,56,03,766	₹71,57,82,771
Total QALYs	2,25,380.36	2,25,208.00
Total Deaths	1,237	1,249
Incremental Cost	−₹1,01,79,005	—
Incremental QALY	172.36	—
ICER / QALY	−₹59,056.51 (Dominant)	—
Net Monetary Benefit	₹4,98,21,903	—

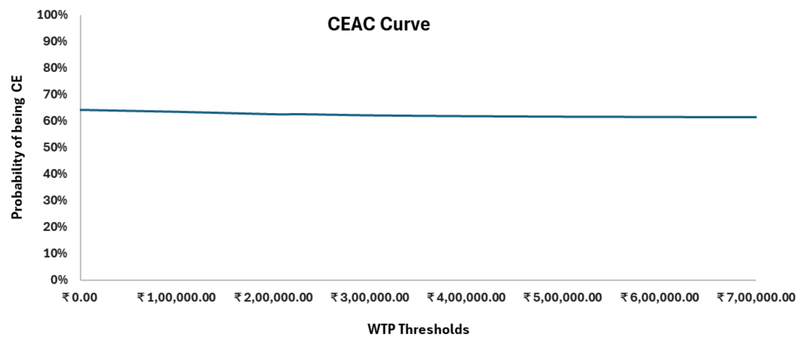

Figure 4. Cost-effectiveness acceptability curve probability AI-DC is cost-effective remains ~62–64% across WTP thresholds from ₹0 to ₹6,90,000/QALY.

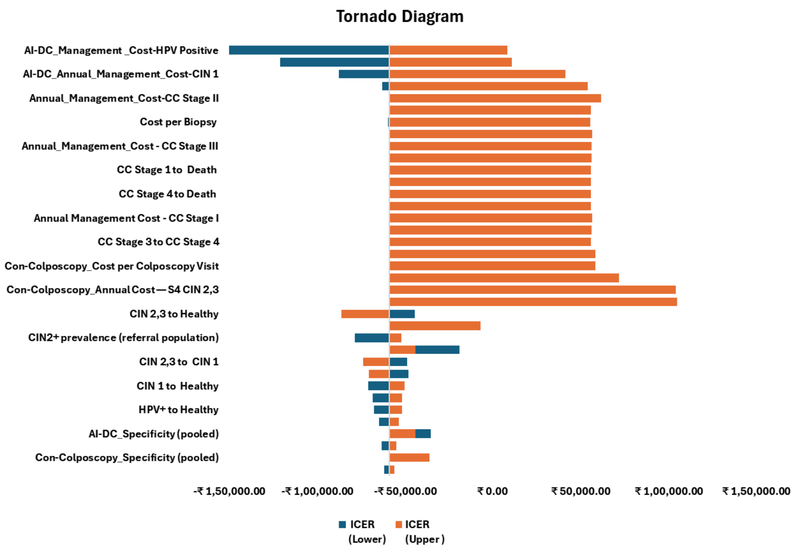

Figure 5. One-way sensitivity analysis the ICER is most sensitive to the annual management costs of HPV+, CIN1, and CIN2/3 health states.

POLICY IMPLICATIONS:

AI-DC improves early detection, reduces per-examination and advanced-disease costs, and could support India's cervical cancer screening goals through integration into national colposcopy pathways.

LIMITATIONS:

Limitations included reliance on international transition probabilities, cohort-level modelling, and an assumed 75% biopsy compliance, while AI-DC's decision support may improve real-world adherence and potentially yield benefits.

CONCLUSION:

AI-powered digital colposcopy is economically dominant, offering greater health benefits at lower cost ano supporting its integration into India's national cervical cancer screening programme, especially in specialist limited setting

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