Feasibility and accuracy of artificial intelligence–assisted sponge cytology for screening of esophageal squamous cell carcinoma and adenocarcinoma of the esophagogastric junction in China

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Background
Esophageal squamous cell carcinoma (ESCC) and adenocarcinoma of the esophagogastric junction (AEJ) remain major health burdens and co-occur geographically worldwide. Screening is the pivotal strategy to relieve the burden of ESCC and AEJ in high-risk areas. However, early detection depends on upper gastrointestinal endoscopy, which is not feasible to implement at a population level.

Aim
We aim to evaluate the feasibility and accuracy of artificial intelligence (AI)-assisted sponge cytology tests using a novel cell collection device for ESCC and AEJ screening in Chinese high-risk regions.

Methods
Participants aged 50 years or older were recruited in five high-risk regions of ESCC and AEJ. Cells from esophagus and esophagogastric junction were collected using a novel and minimally invasive capsule sponge, and cytology slides were scanned by a trained AI system. The qualitative outcomes (indicating the location of abnormal cells) and quantitative outcomes (counts of total scanned cells and potentially abnormal cells) were reported. A cytological diagnosis was made by consensus. Participants scored acceptability immediately following the procedure on a scale of 0 (least) to 10 (most acceptable). Upper gastrointestinal endoscopy was performed subsequently with biopsy as needed. We trained and validated logistic regression model to predict a composite outcome of high-grade lesions (ESCC, AEJ and high-grade intraepithelial neoplasia), with cytological diagnosis and 10 epidemiological features as the predictive features. Model performance was primarily measured with the area under the receiver operating characteristic curve (AUC). Internal validation of the prediction models was performed using the 1000-bootstrap resample.

Results
A total of 1289 participants were enrolled and completed study procedure. No serious adverse events were documented during the cell collection process, and acceptability scores were 10 (74.9%), 9 (13.2%), 8 (5.7%), 7 (2.2%) and 6 (1.2%). 19 (1.5%) participants were diagnosed with high-grade lesions confirmed by endoscopic biopsy. The AUC of the logistic regression model was 0.81 (95% confidence interval [CI], 0.73-0.90), with a sensitivity of 73.7% and specificity of 72.4% for detecting high-grade lesions. Internal validation by bootstrapping analysis demonstrated an optimism-corrected AUC of 0.72 for the model.

Conclusion
We demonstrate the safety, acceptability and feasibility of AI-assisted sponge cytology in high-risk regions, with high accuracy for detecting high-grade lesions. Our results pave the way for innovative etiology and early-detection research.

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