AI-assisted Triage and Screening of Head and Neck Cancers in Low-Resourced Settings

Michael Dorosan[1*], Min Hun Lee[8], Samuel Altonji[4], Hiang Khoon Tan[1-3,7,8], Walter Lee[4-6], Sean Lam[1,7-9]

[1]Singapore Health Services Pte Ltd 168582, Singapore
[2]Singapore General Hospital 169608, Singapore
[3]National Cancer Center Singapore 168583, Singapore
[4]Duke University Health System, Durham NC 27710, USA
[5]Duke Global Health Institute, Durham NC 27708, USA
[6]Duke Cancer Institute, Durham NC 27710, USA
[7]Duke NUS Medical School 169857, Singapore
[8]SingHealth Duke NUS Global Health Institute 169857, Singapore
[9]Singapore Management University 188065, Singapore
*michael.ayo.dorosan@singhealth.com.sg

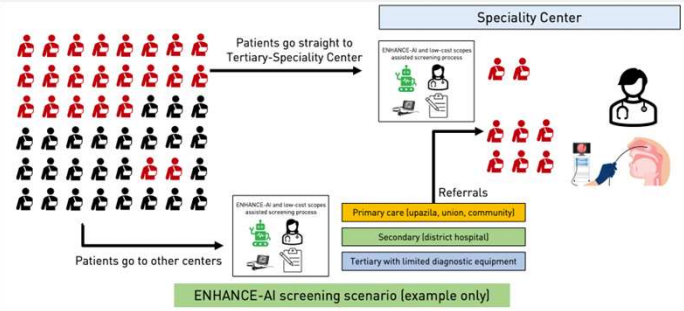
Singapore Healthcare Management 2024

INTRODUCTION

- Early diagnosis of head and neck (H&N) cancers is of primary importance in reducing global health burden and patient morbidity.
- In the developing world, there is a disproportionate growth in the incidence and mortality of H&N Cancers.
- AI-augmented Head and Neck Cancer Screening Support System (AI-HNC-SSS) would enable personnel in low and middle-income countries (LMICs) to effectively screen, triage and refer head and neck diseases for advanced care at specialized centres.

Objectives

- Develop and AI-based screening support system to enable health workers in low-resource settings to triage patients more accurately for laryngeal and other head and neck cancers
- Validate the system in populations targeted for deployment
- Curate data sets that will support continuous validation of such a system in other regions



PRELIMINARY RESULTS

Image Quality Model (IQM) Performance

Model	Accuracy	F1-score	AU_ROC	AU_PRC	GFLOPS
CNN	0.652	0.624	0.595	0.805	50.0
ResNet50	0.739	0.697	0.667	0.850	245
MobileNetV2	0.696	0.629	0.611	0.833	20.3
GhostNet [2]	**0.870**	**0.863**	**0.833**	**0.912**	**8.7**

Disease Classification Model (DCM) Performance

Model	Accuracy	F1-score	AU_ROC	AU_PRC	GFLOPS
CNN	0.699	0.673	0.724	0.729	50.0
ResNet50	**0.833**	**0.832**	0.746	**0.957**	245.0
GhostNet [2]	0.829	0.827	**0.895**	0.878	**8.7**

Confusion Matrix –Patient level (DCM); n = 23 test size

		Actual		
		Grade 1	Grade 2/3	Precision
Predicted	Grade 1	6	0	6 (100%)
	Grade 2/3	3	14	17 (82%)
	Recall	9 (67%)	14 (100%)	

METHODOLOGY

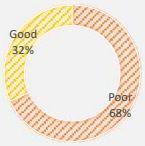
Data Sources

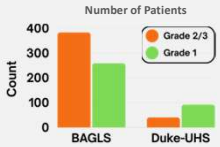
- **BAGLS** – The Benchmark for Automatic Glottis Segmentation Dataset [1] with 640 flexible nasopharyngoscope (FNS) videos with 59,250 extracted image frames labelled with disorder type and a glottal region trace. **[Open-source Dataset]**
- **Duke-UHS** – The Duke University Health System Cohort with 132 FNS videos with 190,978 frames **[Proprietary Dataset]**

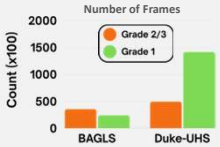
Data Description

Poor Quality Frames:
Glottis is not visible; Blurry images

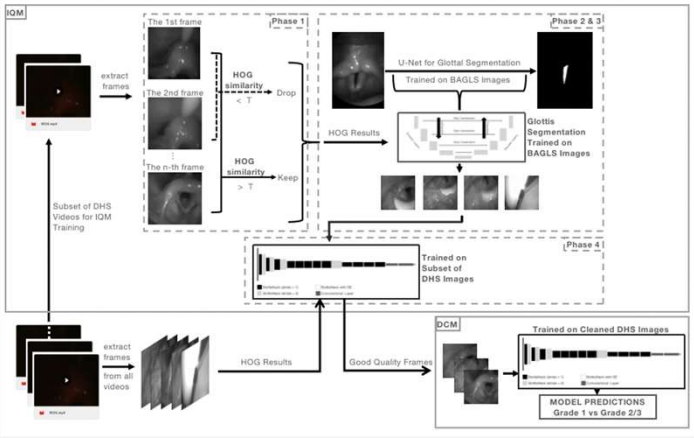
Good Quality Frames:
Glottis is visible for screening of disorders







Model Development Process



ONGOING WORK

International Collaborations

Country	Institutions	Features	Status
Bangladesh	National Institute of Cancer Research & Hospital, Dhaka Labaid Cancer Hospital, Dhaka	• High incidence and mortality of head and neck cancers • High congestion; few specialist care facilities	Ongoing; Data transfer agreements underway
Vietnam	Multiple Institutions	• High incidence and mortality of nasopharyngeal cancers • Early adopters of low-cost portable endoscopes	Pending deployment of low-cost scopes; September 2024

Data Curation

Risk Factor Interview App (On-site)

Data Labelling Platform

AI Model Enhancement

Multimodal (Image and Text) Model Training	Object detection and localization i.e., disorder locations in frame and within video	Uncertainty Quantification and Usefulness Evaluation

CONCLUSION

- An efficient [2] AI-augmented Head and Neck Cancer Screening Support System (AI-HNC-SSS) can screen patient laryngoscopy videos with acceptable performance.
- The AI-HNC-SSS is a tool and a vision of empowerment for health workers in low-resourced regions. It is envisioned to enable them to triage and screen patients more accurately, potentially reducing the burden on limited specialty care centers.
- Our ongoing work attempts to address the following challenges: (i) validation of the AI-HNC-SSS performance on low-resourced populations, (ii) collection of local data from intended deployment sites, and (iii) enhancement of the predictions through well-curated labeled datasets.

References
1. Gómez, P. et al. BAGLS, a multihospital Benchmark for Automatic Glottis Segmentation. Sci. Data 7, 186 (2020) doi:10.1002/bjs.11670
2. Han, K. et al. GhostNet: More Features from Cheap Operations. (2019) doi:10.48550/ARXIV.1911.11907.