Intelligent Eye Triaging System - Improving referral accuracy from primary health care clinics to specialist eye clinics

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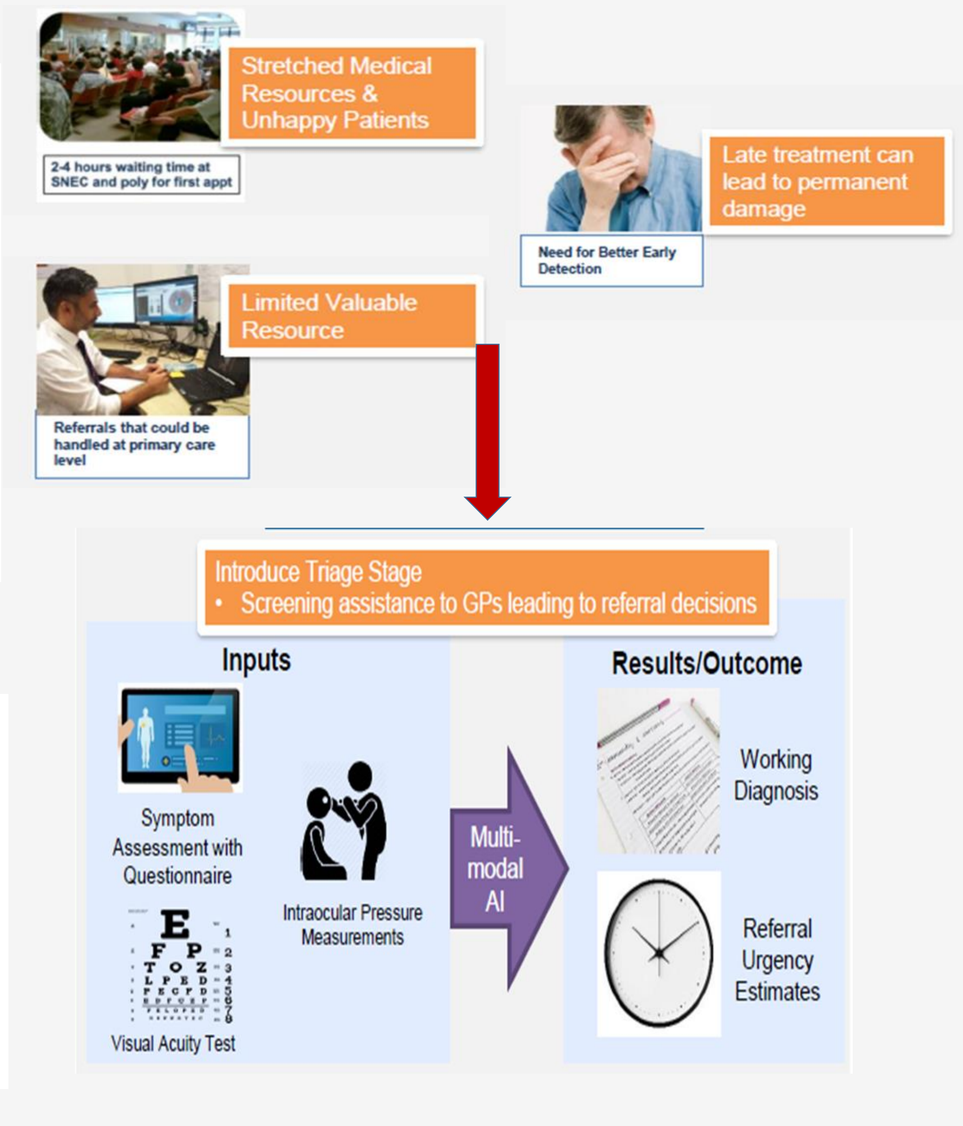
IMPETUS FOR CHANGE

In 2019, SingHealth Polyclinics saw over 35,000 patients with eye symptoms. The standard of care to patients varies depending on the level of training and proficiency of the polyclinic doctors. This may result in:

1. **Unnecessary referrals to specialist care resulting in long waiting times at SNEC**
2. **Timeliness in eye referrals (example normal track referral vs fast track referral)**
3. **Potentially serious eye conditions not getting a timely referral**

Currently, there is a set of simple guidelines for evaluating the severity of eye conditions and the corresponding referral action(s) to be followed by primary care practitioners. However, it is manual and with varying adherence by the doctors.



PROPOSED SOLUTION

To develop a questionnaire-based diagnostic tool, augmented with artificial intelligence (AI) to be used as an eye-care triaging system to:

1. Provide better care to patients by reducing inappropriate referrals that result in unnecessary visits, queues and allowing them to receive care at the right time.
2. Improve the timeliness of right-siting of care with a more accurate diagnosis of eye conditions earlier in the process.
3. Upskill doctors at primary care to better manage eye conditions with clinical decision support tools.

METHODOLOGY

1. **Development of the questionnaire and app**: Questionnaire was based on cross-cluster guidelines that were written to guide the doctors at the polyclinics and are yes/no questions for ease of use. The IHPC team developed the app to give a provisional diagnosis and referral route based on the answers to the questions (input by patients).
2. **Trial at SNEC:** Consenting patients referred to SNEC were asked to trial the app. The provisional diagnosis given by the app and initial diagnosis given by the referring polyclinic doctors were compared against the ground truth (diagnosis from ophthalmologists at SNEC) to determine the accuracy of app vs the polyclinic doctors.
3. **Pilot at Outram Polyclinic**: Developed prototype app was tested on site at SingHealth Polyclinics - Outram. 85 patients were recruited from 10th Jan 2022 to 31st January 2023. Workflow at Outram Polyclinic:
   - Research coordinator obtains consent from patient and guides the patient on completing the questionnaire on the iPad. App gives a working diagnosis as well as the referral urgency.
   - If the app prompts the patient to take VA/IOP tests, the research coordinator will guide the patient to the nurse's station and will input the results into the iPad. She then guides the patient back into the consult room. Polyclinic doctor uses the working diagnosis given by the app as a guide in making his/her own diagnosis and referral urgency.

   The provisional diagnosis given by the app and the diagnosis given by the polyclinic doctors (will be compared against the ground truth (diagnosis from ophthalmologists) to determine the accuracy of app vs the polyclinic doctors.

RESULTS

	Trial at SNEC	Pilot at Outram Poly (interim results based on 38/85 patients)
Accuracy of app trained with machine learning	60.16%	76.3%
Accuracy of app trained with machine learning (blurred vision and floaters)	67.39%	78.57%
Accuracy of polyclinic physicians	41.5%	76.3%
Accuracy of polyclinic physicians (blurred vision and floaters)	42.39%	75%

CONCLUSION

This study has provided insights on developing an alternative model of assessing symptoms which can help to improve diagnostic accuracy and timeliness of referral to manage healthcare resources.

EVALUATION STUDIES

The team has performed the following studies:

1. **User feedback:** Out of 217 patients, 90% of respondents found the questionnaire easy to understand and were willing to use the triaging app if implemented.
2. **Doctors feedback**: When asked if the app facilitated/enhanced their current process in determining diagnosis and referral urgency, 6/9 doctors responded that they felt neutral. 5/9 doctors were unlikely to use the app in its current state as a permanent feature.
   General comments from doctors:
   - Better use of the app as upstream triage prior to consultation (minimizing disruptions mid consult)
   - Workflow should be improved to minimize patient movement around multiple stations and need for more manpower
3. **Time motion study:** Time motion study was conducted to determine time spent by patients with physicians under the current (16- 20mins) and new model of care (25mins) The time taken after implementing the app is longer as additional tests (IOP) is required at the nursing station, and on top of usual history and physical examination done by doctors, the doctors would have to document the app findings too (as the app is not currently integrated to SCM).
4. **Analysis on reduction of workload in SNEC with the SEERS app:** Based on the data from the trial at SNEC, it was found that the impact of the triaging app on the workload at SNEC would not be sustained after 90 days i.e it would eventually be comparable to the current state A sustained reduction in workload can only be seen if:
   - If the app referred more routine patients to CEC instead of SNEC, then a greater impact could be seen (the cost of manpower is greater at SNEC than at CEC)
   - If the app can identify patients who need not be referred and thus referral isn't given (reduction in manpower and workload
5. **Cost-effectiveness study on PVD patients**: In progress