Project Title

Development of web based application for self-assessment of functions of the eye (Eye Doctor in pocket – Poc Doc)

Project Lead and Members

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Organisation(s) Involved

Tan Tock Seng Hospital

Healthcare Family Group(s) Involved in this Project

Medical, Allied Health

Applicable Specialty or Discipline

Ophthalmology

Project Period

Start date: 01 Sep 2020

Completed date: 24 Apr 2024

Aims

The primary aim of this project is to develop an affordable, comprehensive, and engaging application for functional assessment and home monitoring of common causes of preventable vision loss or blindness.

This app can address the unmet need for comprehensive out-of-hospital monitoring of eye disease progression and treatment response. The proposed project will be a proof-of-concept study for this technology, which is targeted to be eventually made available in participants' homes. Hence it will help to relieve the current strain on

hospital manpower and improve the comprehensiveness of monitoring these conditions.

In addition, the project also aims to evaluate the efficacy of the VA- Visual Acuity) assessment tool on our app (PocDoc) versus conventional VA testing in participants in a comparative study.

Background

Participants with these chronic conditions can develop acute exacerbations in visual impairment due to poor treatment response or a myriad of possible complications such as advance peripheral visual field loss in glaucoma and central vision loss in AMD. Despite education by clinicians during follow-up visits, the elderly often does not recognise visual deterioration as a progression of their chronic disease that requires early medical assessment. Commonly reported reasons include their own ageism and attributing of visual deterioration to ageing or the underlying disease. Elderly who wait until their next appointment to seek evaluation by an ophthalmologist, can easily have medical intervention be delayed by 3-6 months. This could result in a missed opportunity to intervene in a reversible cause of vision loss/ blindness if it progresses to an irreversible state. For children, visual tests such as visual acuity testing, colour visual test, stereoacuity test etc are very relevant in terms of assessing their visual function. This can allow us to monitor for the presence of amblyopia as well as significant refractive errors such as myopia progression. This is particularly pertinent in conditions such as DR, glaucoma or AMD, whereby participants may not perceive any visual deterioration during early stages.

Methods

The study uses application installed on PC, phones or tables to obtain user responses for participants presenting themselves to the eye clinic.

Suitable patient will be referred by their attending physicians. Volunteer such as patients' attendants and staff will be referred by other healthcare worker or colleague through word of mouth. The physician will explain an overview of the study and

potential interested participants will be further briefed by a study team member prior to being recruited into the study.

PocDoc will be developed for multiple screens with responsive user interface such as handheld devices like smart phone, tablet and computer/ laptop. This increases the coverage of the application across different phones and computers. Screening application will be developed to provide an engaging experience.

In the future when PocDoc is launched officially, a common user interface will be employed for various tests to reduce the learning curve of the user. If user is familiar with one test it is easy for him/her to try the other tests. User and doctor will have access to his/her reports for the tests taken remotely which will show the progress of the user overtime. Analysis of these reports helps doctor in decision making.

In the VA study that we have conducted, participants assessed VA using both PocDoc and conventional VA tests consecutively on the same day. Different test types/ VA charts in PocDoc were compared against conventional Snellen charts. Statistical data in the form of Bland-Altman plots were used to compare the outcomes of both tests. Fisher's Exact tests assessed categorical parameters, and the Kruskal-Wallis test explored associations between categorical and numerical parameters. VA results were the converted into LogMAR scores for analysis.

Results

Based on the data that we have collected, there was a moderately positive correlation between the conventional and PocDoc logMAR results. PocDoc VA scores were also worse than conventional VA scores and poorer VA is associated with more inaccurate PocDoc VA scores. By comparing PocDoc with conventional VA tests, PocDoc had a relatively high accuracy and sensitivity as well as a high specificity. Based on the different test types that were administered in PocDoc, PocDoc Snellen and Landolt C tests produced worse scores while Tail the Dog had better VA scores when compared to the conventional Snellen scores. Based on the analysis of different age groups, there were no significant differences between the various age ranges.

Lessons Learnt

We have not managed to recruit a group of patients with certain conditions to validate some tests in the app as there are a lack of Co-Investigators who are actively assisting in the recruitment. There are also discrepancies in the data obtained in the app and the one obtained from the tests done conventionally. As such, there is a need to further validate this app by including more study sites and to redesign the study.

To proceed with the recruitment efficiently, the research assistant would be on stand-by in the clinics to ensure a smooth workflow for both the patients and the personnel who are involved in the recruitment. Additionally, the research assistant would be recruiting from the different Co-Investigators in their respective clinic sessions to maximise the number of potential patients to recruit for that day. There are also frequent meetings with the developer to have discussions on the app.

Conclusion

Based on our findings in this study, PocDoc is a promising tool for assessing VA within clinical settings and it can be a potentially versatile screening tool. However, Further research to ascertain the functionality of PocDoc especially within the community is required.

Recruitment and data analysis are still ongoing. More participants with certain conditions/diseases have to be recruited to validate some tests in the app. With discrepancies in some of the data obtained, there is clearly a need to validate this app in other settings or populations and to address the various challenges and flaws in the project. There are also room for improvement of some features in the app. Overall, there has been a huge progress in the project in recent months.

Additional Information

Scientific validation of the prototype will be done and with new grants coming up, will be applied to support the project. Also, PocDoc will be licensed to external vendor to further commercialise it.

We have also validated the use of the app in rural settings and we have published a manuscript based on use of the app in rural settings. We are now submitting other manuscripts based on our current results.

Appended link to this project on published on PubMed:

https://pubmed.ncbi.nlm.nih.gov/37707995/

Project Category

Technology

Product Development, Commercialisation, Proof of Concept, Prototyping Resources

Keywords

Visual Acuity, Home Monitoring

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Figures:

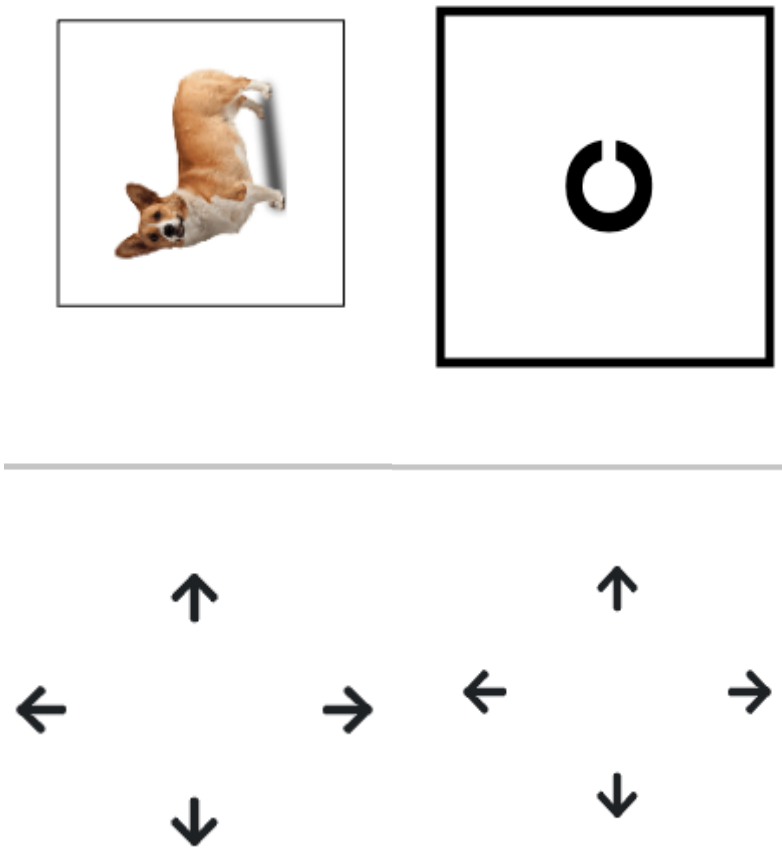

Figure 1: Tail the Dog (left) and Landolt C (right) tests as shown on PocDoc. Users are to select the arrow which represents where the dog's tail should go based on its orientation for Tail the Dog. Similarly, users are to select where the gap in the letter C is for the Landolt C test.

1. Please kindly adjust your screen brightness to the maximum level
2. Position the phone / table / PC screen at 75cm away from you.
3. If you are using phone or table, please use it in landscape mode.
4. You are required to wear your distance glasses or as instructed.
5. Use your palm to completely occlude your eye that is NOT being tested.
6. Read out what you can see on the screen. Your examiner will key in your responses.
7. For Snellen or LogMAR chart, patient will have to identify the letters displayed.
8. For Landolt C or Tumbling E chart, patient will be required to indicate direction of gap seen in the letter.
9. Tail the dog is a fun and highly interactive test designed especially for children. Try to spot the direction of where the dog's tail is pointing towards.
10. Continue to try even when mistakes are made.

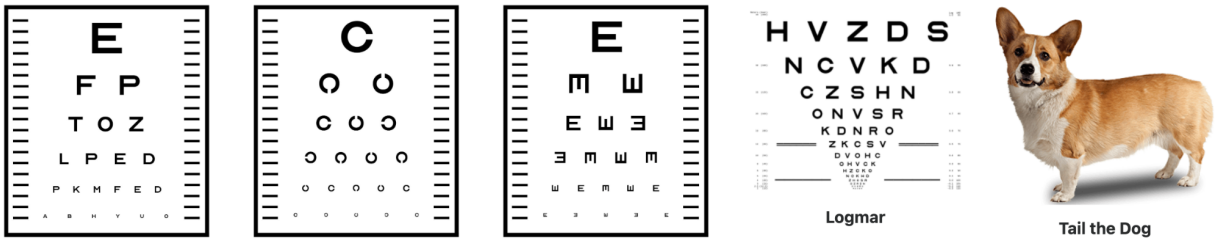

Figure 2: Instruction manual on how to carry out PocDoc VA test. Specific instructions for Snellen or LogMAR charts are under step 7; steps for Landolt C or Tumbling E are under step 8, steps for Tail the Dog are under step 9. VA test options are shown below.

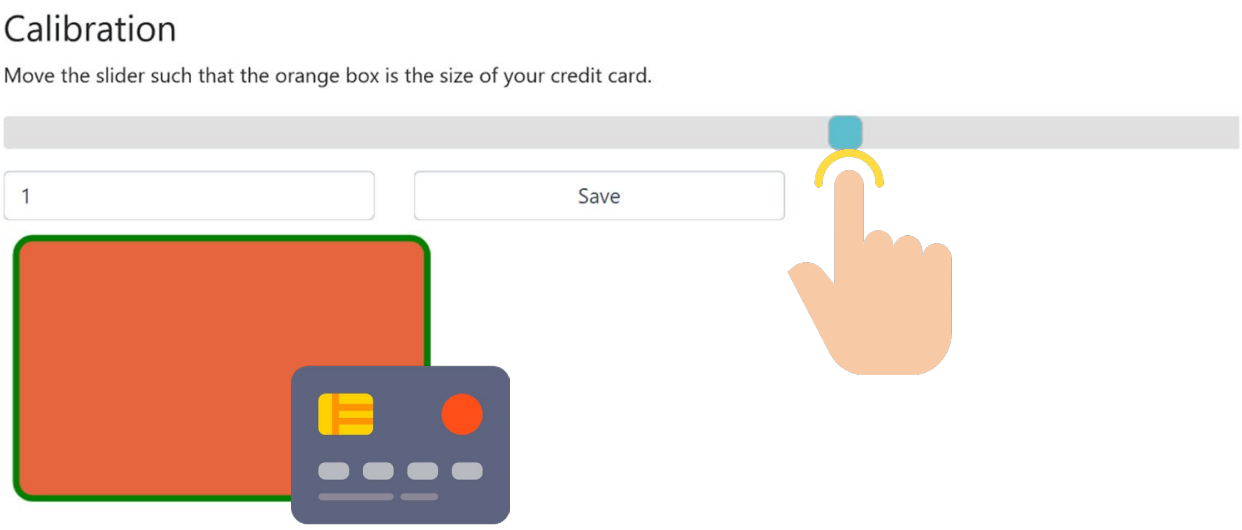

Figure 3: Image showing calibration using a credit card on PocDoc. Users would overlay their credit card on the screen and move the blue toggle to adjust the size of the orange box. Icons credits to Flaticon.

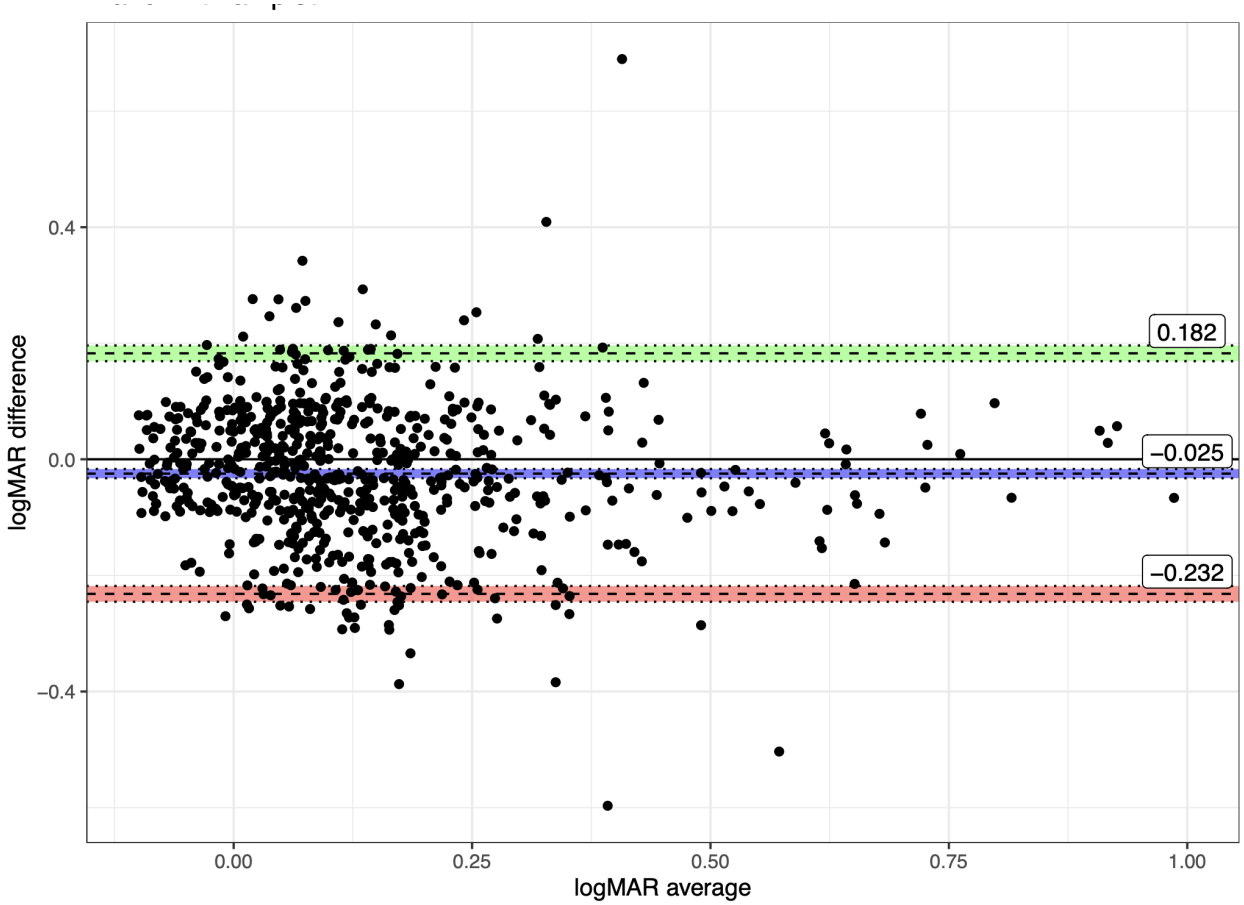

Figure 4: Bland-Altman plot of logMAR difference (y-axis) against logMAR average (x-axis). Mean logMAR difference = -0.0247 as shown by the blue bar in the middle, which differs from 0.00 logMAR, the straight black line. 95% limits of agreement (LOA) of ±0.270 are shown by the green and red bars (LOA = ± 1.96 x SD logMAR differences).

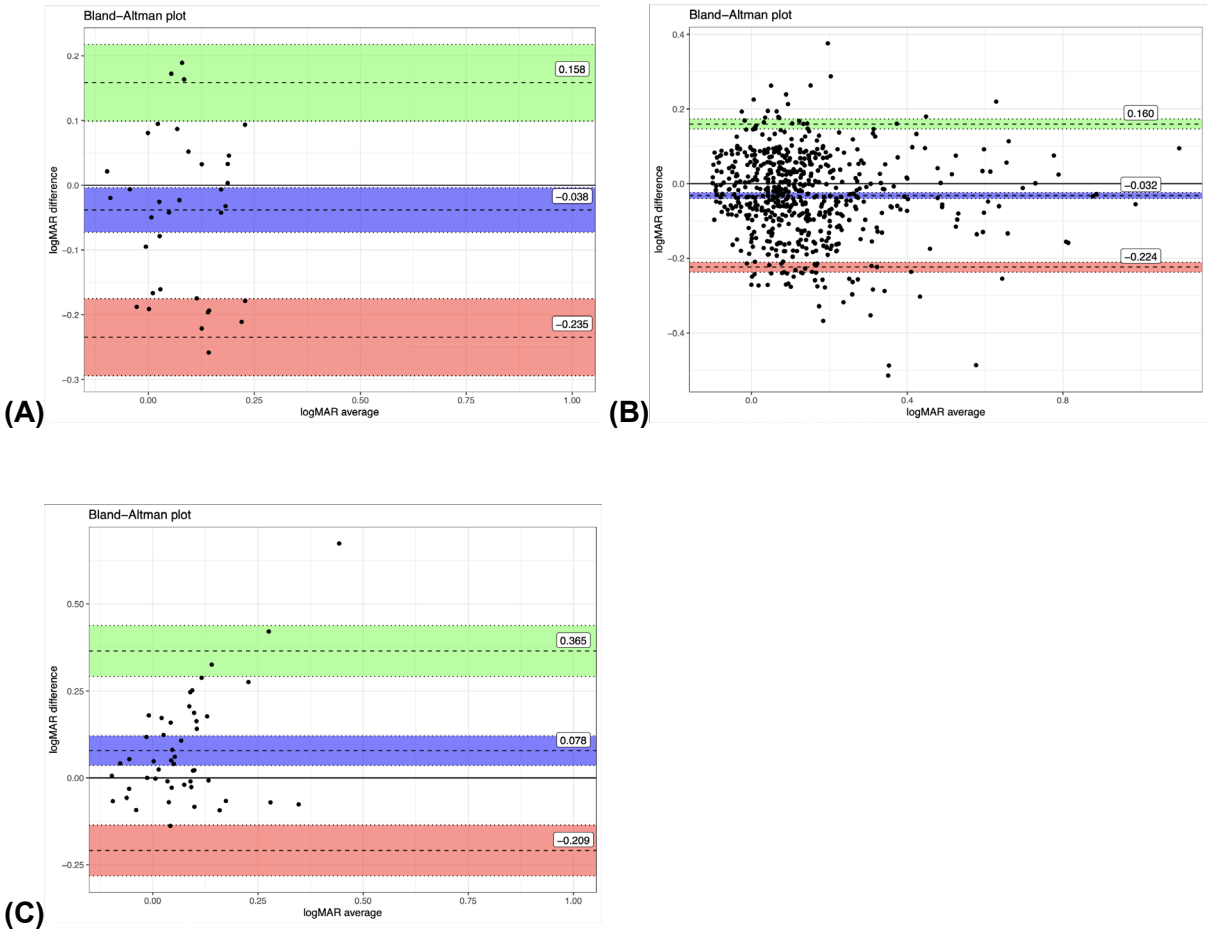

Figure 5: Bland-Altman plots of logMAR difference against logMAR average of Snellen charts (A), Landolt C charts (B), Tail the Dog charts (C). Mean logMAR differences are represented by the blue bars, 0.00 logMAR is shown by the straight black line, and upper and lower limits of agreement are shown by the green and red bars respectively.

Visual acuity range	PocDoc	Conventional
6/6 to 6/12	619 (90.2%)	634 (92.4%)
>6/12 to 6/18	36 (5.25%)	25 (3.64%)
>6/18 to 6/60	31 (4.59%)	27 (3.94%)
Total, n eyes	686 (100%)	686 (100%)

Table 1: Frequencies of visual acuity between PocDoc and conventional tests. Categories were determined based on World Health Organisation guidelines of visual impairment.

	Conventional VA tests			
PocDoc	**No visual impairment**	**Visual impairment (any grade)**	**Total n eyes**	
No visual impairment	610	9	619	**NPV = 98.55%**
Visual impairment (any grade)	24	43	67	**PPV = 64.18%**
Total n eyes	634	52	686	
	specificity = 96.21%	**sensitivity = 82.69%**		

Table 2: PocDoc VA assessment - Contingency Matrix for Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV). Visual Impairment is considered VA worse than 6/12.