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Original Article

Ophthalmology Section

Functional Evaluation of an EMR Teleglaucoma System in a Malaysian Urban Setting

XIAO HUI WEE[1], JEMAIMA CHE HAMZAH[2], AFZAN ADAM[3], SHARANJEET SHARANJEET-KAUR[4], MOHD IZZUDDIN HAIROL[5], MOHD HARIMI ABD RAHMAN[6], RONA ASNIDA NASARUDDIN[7], ZALEHA MD ISA[8]

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ABSTRACT

Introduction: Teleophthalmology has become much more popular after the Coronavirus Disease 2019 (COVID-19) pandemic because it can be implemented at a distance without contact with the patients. However, teleophthalmology for glaucoma has not been implemented in Malaysia. The present study project adapted an in-house Electronic Medical Record (EMR) system for teleophthalmology in glaucoma (teleglaucoma).

Aim: To evaluate the functionality of a teleglaucoma system in Malaysia.

Materials and Methods: The present cross-sectional research was conducted in July 2023, which involved eye healthcare professionals working at a primary health clinic and an eye clinic affiliated with a tertiary university hospital in Malaysia. The participants were recruited using a purposive sampling method. A google form questionnaire, consisting of three sections -demographic information, evaluation of functionality (yes/no), and an open-ended question for system improvement were given to participants after they had completed using the teleglaucoma system. Descriptive analysis was used to analyse the data.

Results: Ten eye healthcare professionals were recruited for the study. The findings of the study revealed that most eye healthcare professionals were able to use the functions in the system. Most ophthalmic personnel (71.4%, n=5) could use 90% of the system functions, while the rest (28.6%, n=2) could use 80% of the functions. All ophthalmologists were able to use the function in the system. Some participants suggested several system enhancements, including the ability to upload multiple images, an improved interface with a standardised template for patient history, and a side-by-side image display. They also suggested an 'edit' button to modify clinical sheets after they have been submitted.

Conclusion: The adapted EMR-based teleglaucoma system was found to be functional by eye healthcare professionals. The EMR enables ophthalmologists to review patient information, diagnose, and manage glaucoma remotely. Therefore, this system can be used for glaucoma screening in healthcare clinics that are virtually connected to a hospital with ophthalmology services. Future studies comparing the teleglaucoma system with opportunistic case finding should be conducted to determine the effectiveness of the system.

Keywords: Health information system, Glaucoma, Screening, Telemedicine, User-computer interface

INTRODUCTION

Telemedicine has gained popularity, especially during the COVID-19 pandemic, because it allows patients to consult healthcare providers remotely [1], thereby reducing infection risk [2,3] and improving access to healthcare services especially for patients living in rural areas [4,5]. These systems can be synchronous (real-time) [6,7], asynchronous (store and forward) [6,7], and hybrid [7] to provide the assessment, diagnosis, monitoring, and treatment of the patients [8]. In ophthalmology, telemedicine has been adopted as teleophthalmology [8]. Teleophthalmology has effectively screened eye diseases such as glaucoma, age-related macular degeneration, and diabetic retinopathy [9].

Glaucoma is a chronic disease which can cause irreversible vision loss if undetected [10]. As glaucoma is asymptomatic at early stages, screening high-risk individuals through teleophthalmology will enable early detection of glaucoma, especially in developing countries [11]. Teleglaucoma is a branch of teleophthalmology and allows procedures such as measurement of Intraocular Pressure (IOP), optic nerve imaging, and visual field assessments to be performed by healthcare providers at nearby health centres, and all data will be sent electronically to glaucoma specialists for analysis [12]. This approach saves patients time by reducing the need for in-person clinic visits [13] as diagnosis can also be obtained effectively by teleglaucoma compared to in-person examinations [14].

Glaucoma was the third leading cause of blindness in Malaysia, with a prevalence of blindness of 6.6% [15]. In Singapore, most primary glaucoma cases were undiagnosed (72.1%), with Malays having the highest rates (2.1%) [16]. The higher rate among Malays may be due to cultural beliefs favouring traditional treatments [16]. A similar trend of undiagnosed glaucoma could be present in Malaysia, as most of Malaysia's population is Malay. Moreover, there was a severe shortage of ophthalmologists in Malaysia, especially in rural areas, which may reduce the efficiency of glaucoma services. In 2024, only 860 ophthalmologists [17] served 34.2 million people [18], or a ratio of 1 to 39,767. There is currently no national teleglaucoma programme in Malaysia.

This was the first study of a web-based EMR teleglaucoma system in Malaysia. Evaluation of this system can help to overcome the weakness of the system before implementing the teleglaucoma programme nationwide. The aim of the study was to assess the functionality of this system, which is a module in the EMR of a tertiary teaching hospital named Caring Hospital Enterprise System (C-HetS).

MATERIALS AND METHODS

The present study was a cross-sectional study conducted in July 2023. Participants recruited were eye healthcare professionals (ophthalmologists, optometrists, ophthalmic technicians, assistant medical officers) who were working in a primary health clinic (Primer Health Clinic, Hospital Canselor Tuanku Muhriz (HCTM)) or eye clinic

at HCTM in Kuala Lumpur, Malaysia. This study was approved by the Medical Research and Ethics Committee of the university hospital (PP1/111/8/JEP-2020-127). The present study was conducted according to the Declaration of Helsinki.

Sample size calculation: The sample size was determined using the 10±2 rule of thumb from usability testing, which is considered sufficient to identify the most common problems in a system evaluation [19]. Purposive sampling was used to recruit the participants. A list of eye healthcare professionals at both centres was obtained. Those on the list who met the inclusion criteria were invited to participate in the study.

Inclusion and Exclusion criteria: Inclusion criteria included registered healthcare professionals, able to understand English and the purpose of the study. Participants were excluded if they were not interested in joining the study. All participants signed the informed consent after agreeing to join the study.

Study Procedure

Participants were introduced to the teleglaucoma system, followed instructions to perform the tasks according to their job description and evaluated the system using an online questionnaire. Teleglaucoma system was developed by the Information Technology Centre. It can only be accessed through a link using the Wi-Fi at the hospital. The web-based system was built using JDeveloper 10 g. Oracle Database was used to store and organises the data. For security, all data transmissions were restricted to the working location. In addition, a username and an encrypted password were required to log in. Private and confidential records were accessible to selected personnel.

The participants were given different tasks to perform in the system depending on their job descriptions, as shown in [Table/Fig-1]. Ophthalmic personnel (optometrists, ophthalmic technicians, and assistant medical officers) will be able to register the patients, upload clinical results and JPEG images from the fundus examination, and PNG images of the visual field test, as well as view the list of patients. Whereas ophthalmologists were able to view the list of patients, clinical results, and JPEG fundus images and PNG images of the visual field test. Additionally, they can record the findings, diagnosis, and management in the clinical sheet and refer the patient in the system.

Type of user	Task performed before system evaluation
Ophthalmic personnel	• Registration • Recording of visual acuity • View patient's list • Upload images • Upload nurse sheet
Ophthalmologist	• View patient's list • View file images and nurse sheet • Submit clinical sheet • Submit referral letter

[Table/Fig-1]: Tasks performed before system evaluation.

There were three sections in the questionnaire. The first section contained demographic data such as gender, age, race, occupation, current working place, working experience (years), and education level. The second section contained the evaluation of the system's functionality. This section was adapted from a functionality questionnaire by A'bas NN et al., [20]. Finally, an open-ended question for improvement of the system was asked at the end of the questionnaire.

In the functionality testing section, ophthalmologists responded to questions different from the ophthalmic personnel as both were assigned different tasks as illustrated in [Table/Fig-1]. [Table/Fig-2] shows that a different set of questions was presented to each group: Ophthalmologists answered six questions, and ophthalmic personnel answered ten questions. Each question required a yes or no response from the participants. The content validity of the functionality section was assessed by six experts, who were not the study participants in the functionality evaluation. The experts consisted of two ophthalmologists, three optometrists, and an assistant medical officer. The Content Validity Index (CVI) was 0.95, which shows good content validity [21]. The Kuder-Richardson Formula 21 was used to assess the reliability of the questionnaire, which was 0.82. The Kuder-Richardson formula (KR-21) is used to measure the reliability of a questionnaire with dichotomous items [22]. It has the same coefficient as Cronbach's alpha when applied to dichotomous data [22].

Type of eyecare professionals	Questions
Ophthalmologist	I was able to view the patient list for the day.
	I was able to view details of a new patient.
	I was able to view the uploaded file images.
	I was able to make comments, diagnoses, and management in the patient's clinical sheet.
	I was able to successfully submitted the patient's clinical sheet.
	I was able to issue a referral letter to a patient if necessary.
Ophthalmic personnel	I was able to register a new case.
	I was able to view the patient list for the current day.
	I was able to view details of a new patient.
	I was able to edit the details of a new patient.
	I was able to delete patient details if necessary.
	I was able to make comments in the nurse sheet.
	I was able to upload file images.
	I was able to change or re-upload another file image
	I was able to delete the file images uploaded.
	I was able to view uploaded file images.

[Table/Fig-2]: Questions in the functionality testing section.

STATISTICAL ANALYSIS

The data was entered into Statistical Package for Social Sciences (SPSS) version 27 (IBM Corp, New York, USA). Descriptive analysis was performed, utilizing frequencies and percentages for categorical data and mean scores for each item for continuous data.

RESULTS

Ten eye healthcare professionals participated in this study. [Table/Fig-3] shows the demographic data of the participants.

Variables	Frequency (%)
Age (years)	
Mean±SD	36.4±6.96
Range	24-52
Gender	
Male	7 (70%)
Female	3 (30%)
Race	
Malay	8 (80%)
Chinese	1 (10%)
Indian	1 (10%)
Occupation	
Assistant Medical Officer	4 (40%)
Ophthalmologist	3 (30%)
Optometrist	2 (20%)
Ophthalmic technician	1 (10%)
Current workplace	
Hospital	6 (60%)

Primary health clinic	4 (40%)
Working years	
Less than 3 years	1 (10%)
3-5 years	1 (10%)
6-8 years	1 (10%)
8-10 years	2 (20%)
More than 10 years	5 (50%)
Level of education	
Diploma	4 (40%)
Degree	2 (20%)
Masters	3 (30%)
PhD	1 (10%)

[Table/Fig-3]: Demographic data of the participants.

[Table/Fig-4] shows the result from the functionality section of the questionnaire for ophthalmic personnel. Most participants were able to use all functions except the functions to delete patient details and delete uploaded file images. [Table/Fig-5] shows the result from the functionality section of the questionnaire for ophthalmologists. All ophthalmologists were able to use the functions in the system.

Questions	No. of participants responding Yes (%)	No. of participants responding No (%)
I was able to register a new case.	7 (100%)	0 (%)
I was able to view the patient list for the current day.	7 (100%)	0 (%)
I was able to view details of a new patient.	7(100%)	0 (%)
I was able to edit the details of a new patient.	7 (100%)	0 (%)
I was able to delete patient details if necessary.	5 (71.43%)	2 (28.57%)
I was able to make comments in the nurse sheet.	7 (100%)	0 (%)
I was able to upload file images.	7 (100%)	0 (%)
I was able to change or re-upload another file image	7 (100%)	0 (%)
I was able to delete the file images uploaded.	0 (%)	7 (100%)
I was able to view uploaded file images.	7 (100%)	0 (%)

[Table/Fig-4]: Frequency and percentage of ophthalmic personnel who responded to the functionality questionnaire.

Questions	No. of participants responding Yes (%)	No. of participants responding No (%)
I was able to view the patient list for the day.	3 (100%)	0 (%)
I was able to view details of a new patient.	3 (100%)	0 (%)
I was able to view the uploaded file images.	3 (100%)	0 (%)
I was able to make comments, diagnoses, and management in the patient's clinical sheet.	3 (100%)	0 (%)
I was able to successfully submit the patient's clinical sheet.	3 (100%)	0 (%)
I was able to issue a referral letter to a patient if necessary.	3 (100%)	0 (%)

[Table/Fig-5]: Frequency and percentage of ophthalmologists who responded to the functionality questionnaire. Ophthalmologists responded "yes" if they successfully completed the task and "no" if they were unable to.

Participants also shared suggestions for improving the system from the open-ended question in the qualitative section. Several participants noted that the system was "easy to navigate", which they felt would save them time in clinical practice. Others emphasised that the side-by-side image display would "help in making comparison and interpretation between two eyes." At the same time, some participants described frustration with the current data entry process, which they found to be "time-consuming". Therefore, they suggested a more user-friendly interface for clinical data entry, such as a standardised template for patient history and examination. Other suggestions included the function to upload multiple images and an 'edit' button that would allow users to modify entries after a clinical sheet had been submitted.

DISCUSSION

User involvement is crucial for developing and enhancing the performance of health information systems [23]. Evaluation of the system is crucial for identifying strengths and weaknesses as well as developing solutions to enhance system performance [24]. Functionality testing evaluates the system's function to ensure it works as expected [25]. To our knowledge, this is the first teleglaucoma system in Malaysia. The functionality evaluation revealed that most eyecare professionals were able to use the system's functions effectively. These results were similar to a functionality study of a telediabetic retinopathy system, which reported that most participants were able to use the system's functionalities, except for some who were unable to delete case details [26]. The present study system does not have a function to delete images, which may cause incorrectly uploaded images to remain in the system. This finding was in contrast to another telemedicine system for diabetic retinopathy, which reported that participants were able to delete uploaded fundus images due to the presence of a deletion button in their system [20]. Further improvement of the system will be to add a deletion button for uploaded images.

Most existing teleophthalmology systems are web-based systems integrated with EMR [27-31], delivered as a standalone application [32], or developed as mobile applications [33,34]. Web-based systems integrated with EMR allow access to a patient's complete medical history [35]. The present study system is built on an existing EMR infrastructure, making incorporating it into clinical workflows easier. In contrast, a standalone application such as EyePACS offers greater flexibility in connecting with ophthalmologists outside an organisation [32]. However, this standalone application may cause problems with the clinic workflow [36]. A study reported that EyePACS was found to create workflow issues due to incomplete patient information [36]. This problem prevented ophthalmologists from accurately interpreting cases, which could delay the review process [36]. Mobile applications, such as the Yun Bao app in China, allow users to conduct screenings anywhere and at any time [34]. This convenience can greatly facilitate early glaucoma detection [34]. However, mobile applications are prone to hacking compared to other systems [37].

Training for a telemedicine store and forward platform may be important in increasing healthcare professionals' confidence and trust in using the platform [38,39]. Lack of familiarity with teleophthalmology among healthcare providers could hinder the effective implementation of the system [40].

The system allows a single image to be displayed on the screen while reviewing the case. Therefore, allowing images of both eyes to be displayed side-by-side may help clinicians quickly identify differences in relevant clinical parameters such as cup-to-disc ratio. Other participant suggestions include standardized clinical data entry fields, an "edit" function after submission of the clinical information and allowing the simultaneous upload of multiple images. These suggestions would significantly improve workflow efficiency, especially since the current process of uploading one image at a time is time-consuming and inefficient. These comments by some participants were similar to previous research, which emphasises that an efficient user interface such as displaying all patient

information on multiple screens, is crucial for reducing teleglaucoma consultation times [12]. An integrated artificial intelligence with the teleglaucoma system will be helpful to aid in the interpretation of clinical data, especially fundus images.

Implementation of teleglaucoma in the Malaysian healthcare system has its challenges. Poor and unreliable internet connectivity, especially in rural areas is a major challenge, as a stable internet connection is needed to transfer clinical data and images. A survey of 331 residents in a remote Sarawak village revealed that only 36% used the internet [41]. Implementing teleglaucoma requires a large financial investment as the required infrastructure, specialised equipment such as non-mydriatic fundus cameras, a tonometer, and trained personnel are needed for teleglaucoma screening [42]. A systematic review reported that the cost for establishing a teleglaucoma programme was between $89,703.53 and $123,164.55 [43]. Other challenges include the lack of enforcement of the Telemedicine Act 1997, which led to the introduction of the Malaysian Medical Council Telemedicine Guidelines 2024, which restrict virtual consultations to only existing patients who need follow-up care [44]. Furthermore, the Medical Act 1971 only allows registered doctors with a valid practicing certificate to practice telemedicine [45]. This will hinder the broader implementation of teleglaucoma. A survey in Malaysia reported about 25.2% of participants was unaware of glaucoma, making them less likely to participate in a screening programme [46]. Many patients prefer in-person consultations, which limits the adoption of teleglaucoma. A study in Iran found that 71% of 1,226 participants preferred in-person consultation over telemedicine [47].

Limitation(s)

A limitation of this study was that it used simulated tasks, in which real-world scenarios may be different from the findings of the study. Another limitation is that the number of participants was small. Future research should include a larger-scale evaluation using a more diverse sample of healthcare professionals to prepare the system for wider implementation. Patient perspectives will also need to be included in future studies to gain a more comprehensive understanding of the effectiveness of the teleglaucoma system.

CONCLUSION(S)

In conclusion, eyecare professionals were satisfied with the system's functionality making it a potential teleglaucoma platform to be used locally. Implementing a teleglaucoma system can contribute to the early detection of glaucoma and facilitate remote access of eye care services, especially in rural areas. Future research is necessary to assess the effectiveness of the teleglaucoma programme in the primary care setting.

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Conflicts of Interest: The authors have no conflicts of interest to declare. This is a part of PhD work.

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PARTICULARS OF CONTRIBUTORS:
1. Postgraduate Student, Department of Ophthalmology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Cheras, Wilayah Persekutuan Kuala Lumpur, Malaysia.
2. Senior Lecturer, Department of Ophthalmology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Cheras, Wilayah Persekutuan Kuala Lumpur, Malaysia.
3. Senior Lecturer, Center for Artificial Intelligence Technology, Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia, Bangi, Selangor, Malaysia.
4. Senior Lecturer, Centre for Rehabilitation and Special Needs Studies (iCaReRehab), Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Wilayah Persekutuan Kuala Lumpur, Malaysia.
5. Senior Lecturer, Centre for Community Health Studies (ReaCH), Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Wilayah Persekutuan Kuala Lumpur, Malaysia.
6. Senior Lecturer, Centre for Rehabilitation and Special Needs Studies (iCaReRehab), Faculty of Health Sciences, Universiti Kebangsaan Malaysia, Wilayah Persekutuan Kuala Lumpur, Malaysia.
7. Senior Lecturer, Department of Ophthalmology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Cheras, Wilayah Persekutuan Kuala Lumpur, Malaysia.
8. Senior Lecturer, Department of Public Health Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, Cheras, Wilayah Persekutuan Kuala Lumpur, Malaysia.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Jemaima Che Hamzah,
Senior Lecturer, Department of Ophthalmology, Faculty of Medicine, Universiti Kebangsaan Malaysia, Jalan Yaacob Latif, Bandar Tun Razak, 56000, Cheras, Wilayah Persekutuan Kuala Lumpur, Malaysia.
E-mail: jemaima@ppukm.ukm.edu.my

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: May 02, 2025
- Manual Googling: Oct 25, 2025
- iThenticate Software: Oct 28, 2025 (1%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

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