www.bircu-journal.com/index.php/birci
Budapest International Research and Critics Institute-Journal (BIRCI-Journal)
Humanities and Social Sciences
ISSN 2615-3076 Online)
ISSN 2615-1715 (Print)
Budapest Institute

Effectiveness of Teleophthalmology As Diabetic Retinopathy Screening Modalities: Literature Review

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Abstract

The high risk of transmission through eye examinations in the COVID-19 pandemic has resulted in teleophthalmology usage in diabetic retinopathy screening programs. This review assesses the effectiveness of teleophthalmology for diabetic retinopathy screening. This literature review uses Pubmed, Proquest, and GoogleScholar as sources. Screening using inclusion and exclusion criteria has been included in 7 articles for review. Results Teleophthalmology increases the number of diabetic retinopathy cases finding on diabetes mellitus, resulting in high patient satisfaction and low cost. Teleophthalmology showed its effectiveness as a screening program for diabetic retinopathy in the era of the COVID-19 pandemic.

Keywords
Teleophthalmology; diabetic retinopathy; COVID-19

I. Introduction

Diabetic retinopathy is the most common microvascular complication in diabetes mellitus which is the most common cause of blindness in the elderly. (1)A person with diabetic retinopathy may not experience visual disturbances, but there is a risk of sudden vision loss. (2) Early detection of diabetic retinopathy is important to prevent blindness through routine (1) screening programs. Routine screening programs can be carried out within one to two years using various instruments, such as direct ophthalmoscopy, indirect ophthalmoscopy, biomicroscopic slit lamp, optical coherence tomography (OCT), or retinal photography. (2)

Meanwhile, the Coronavirus Disease 2019 (COVID-19) pandemic declared by the World Health Organization (WHO) on March 11, 2020, has had an impact on the world's health care sector. Health services, especially eye health services, face challenges to provide safe services. This is because the nature of eye health services requires close contact, both in examination and in providing treatment, in which the patient and ophthalmologist are separated by <20cm in slit-lamp biomicroscopic examination and <5cm in situations requiring direct ophthalmoscopy. (3,4) The outbreak of this virus has an impact of a nation and Globally (Ningrum et al, 2020). The presence of Covid-19 as a pandemic certainly has an economic, social and psychological impact on society (Saleh and Mujahiddin, 2020). Covid 19 pandemic caused all efforts not to be as maximal as expected (Sihombing and Nasib, 2020).

With the high risk of transmission that can occur in daily eye health care practices, problems arise that hinder the screening program for diabetic retinopathy patients which can occur due to a shortage of medical personnel or personal protective equipment (PPE) or an increase in the number of COVID-19 cases. (5) The Centers for Disease Control and Prevention (CDC) and WHO through the American Academy of Ophthalmology recommends the use of telehealth methods in eye health or teleophthalmology in providing eye health services during the COVID-19 pandemic era. (6) Teleophthalmology is

DOI: *https://doi.org/10.33258/birci.v5i2.5251*

considered capable of having potential in developing eye health services, especially for visual threatening diseases (VTD) such as diabetic retinopathy, as well as providing compliance for patients who have difficulty accessing special eye health care facilities. (7–9).

However, the application of teleophthalmology is still not widely applied and obstacles often arise such as limited equipment procurement, lack of imaging protocols, and financial problems. (7)In addition, the use of telehealth, in general, tends to be centered on medical personnel, where the patient plays the role of the patient and focuses only on verbal communication. (10)A further study is needed on teleophthalmology in diabetic retinopathy screening, especially in the effectiveness of diabetic retinopathy screening in patients with diabetes mellitus.

II. Review of Literature

The main goal of the diabetic retinopathy screening program is to reduce the risk of visual impairment and vision loss in patients without visual symptoms through the prompt and appropriate identification and effective management of vision-threatening diabetic retinopathy. Screening is considered positive if a high referral threshold is found; such as the presence of proliferative diabetic retinopathy (PDR) or advanced diabetic macular edema. Patients with positive screening results were given further referrals for confirmation of diagnosis and treatment. (2)

The implementation of the screening program is carried out on patients with diabetes mellitus by inviting these patients to perform eye examinations at regular intervals through invitations and a reminder system. To appear high participation, patients must be given complete information about the screening program that they will undergo so that they can give the choice to participate in the screening program or not. Patients who agree to participate in the screening program will undergo an eye examination by health personnel. (2)

Eye examinations performed on patients have a variety of instruments, and the selection can take into account various factors such as cost and ease of use. In terms of cost and convenience, direct ophthalmoscopy and indirect ophthalmoscopy can be chosen because they are inexpensive and can be performed on a mobile basis, but have shortcomings in ineffectiveness and retrospective review. If cost is not an issue, OCT and retinal photography can be an option because they have advanced technology such as retinal examination and can be reviewed retrospectively. Meanwhile, slit-lamp biomicroscopy is still the gold standard in the retinal examination but still tends to be expensive and not mobile. (2)

2.1 Teleophthalmology in Diabetic Retinopathy

The use of teleophthalmology in the current diabetic retinopathy screening program can be in the form of screening carried out by health workers, both non-doctors (for example, opticians) and general practitioners using fundus cameras (traditional, miniature table tops, integrated adapter-based hand-help ophthalmic cameras, and smartphone-based cameras). (11) One of the instruments that has been used long before the COVID-19 pandemic began is the use of retinal photography or what can be called Diabetic Teleretinal Imaging (DTI). DTI is the most commonly used method because it can be carried out by health workers in primary health facilities with health workers who have basic training. (12,13)

The images obtained from the examination are then sent to an ophthalmologist using the internet or satellite transmission, such as using the Picture Archiving and Communication System (PACS). The next screening program plan can be made by health workers at primary health facilities and given to patients so that patients can save time and money by not visiting special eye health care facilities.

III. Research Method

Writing this *literature review* uses sources from international journal articles taken from online databases such as *Pubmed*, *Proquest*, and *Google Scholar*. Keywords used include *teleophthalmology*, *diabetic retinopathy*, and *screening.*

In the article screening process, researchers used inclusion criteria, namely patients with diabetes mellitus who underwent a *screening program* using *teleophthalmology* with instruments such as fundus or retinal cameras in 2018-2022. Meanwhile, the exclusion criteria used included articles that were abstract, in languages other than English or Indonesian and *full text* was not available.

Search results found 17 articles on Pubmed, 222 articles on Proquest, and 1740 articles on *GoogleScholar.* After filtering articles with inclusion and exclusion criteria, 7 articles were obtained to be studied

IV. Result and Discussion

No	Researcher, Year	Title	Destination	Research design	Number of samples	Results
1	Quiroz et al, 2020	*Diabetic retinopathy screening in an urban primary care setting with a handheld smartphone-based retinal camera*	Evaluating the diabetic retinopathy *screening program using a* portable *smartphone-*based retina camera	Prospective study	627	Clinical decisions were made in 508 patients (81.2%), of which there were 333 without diabetic retinopathy, 40 with diabetic retinopathy who did not need a referral, and 66 with diabetic retinopathy who needed a referral.
2	Leeman et al, 2021	*Criteria Based Assessment of a Teleophthalmology Diabetic*	Comprehensively conduct a clinical and operational evaluation of	*Retrospective analysis*	211	Clinical findings of diabetic retinopathy

		Retinopathy Evaluation Program in a Primary Care Setting	primary care in a 1-year pilot *teleophthalmology program*			increased from 34% to 75% over 14 months
3.	Martin et al, 2020	*Satisfaction of patients and primary care professionals with a teleophthalmology-based screening program for diabetic retinopathy in a rural area in Castilla y Leon, Spain*	Determine the prevalence of diabetic retinopathy in diabetic patients and. Classifying diabetic retinopathy patients based on the type and severity of complications, as well as evaluating the degree of satisfaction of both patients and health workers in conducting a diabetic retinopathy *screening program* with teleophthalmology.		114	As many as 29.4% of patients who underwent a screening program found vision-threatening retinopathy. Patient satisfaction was reported as 93.8% and satisfaction of health professionals as much as 70%.
4	Kuo et al, 2022	*Utilization of Remote Diabetic Retinal Screening in a Suburban Healthcare System*	Provide an assessment of the utilization of the *screening program teleophthalmology* in a low-risk suburban population of patients with diabetes	*Cross-sectional* study	214	Of the 214 patients who had never detected diabetic retinopathy, 6 patients (3%) were found to have diabetic retinopathy with a grade above moderate.
5	Benjamin et al, 2021	*A 15-month experience with a primary care-based telemedicine screening program for diabetic retinopathy*	Improving cost-effective access to appropriate retinal services for areas that require close monitoring and management	Retrospective study	689	In 1377 eyes of 689 patients, 928 photographs could be examined, and as many as 755 (81.4%) had no diabetic retinopathy, 56 patients (6.0%) had non-modifier diabetic retinopathy, 78 patients (8.4%)

						mild, 16 (1.7%) moderate, 19 (2.0%) severe and 4 (0.4%) PDR
6	Alhumud et al, 2020	*Patient Satisfaction Toward a Tele-Retinal Screening Program in Endocrinology Clinics at a Tertiary Hospital in Riyadh, Saudi Arabia*	Measuring patient satisfaction with the tele retinal *screening program* among diabetic patients seeking treatment at an endocrinology clinic at a tertiary hospital in Riyadh	Cross-sectional study	163	The overall satisfaction rate is 80.4% where the highest satisfaction rate is in interpersonal relationships, while the lowest is not being able to see an ophthalmologist when needed
7	Avendano-Veloso et al, 2019	*Teleophthalmology: a strategy for timely diagnosis of sight-threatening diabetic retinopathy in primary care, Concepcion, Chile*	Estimating the prevalence of diabetic retinopathy in the public health system	Cross-sectional, non-experimental and descriptive study	7382	The prevalence of diabetic retinopathy via teleophthalmology was found to be 14.9%.

Based on the results of the analysis of the eight articles obtained as follows:

4.1 Teleophthalmology Process

The *teleophthalmology process* in the eight articles was carried out on patients with diabetes mellitus, both in the scope of primary and tertiary health services, whereas in Alhumud et al's research the study was conducted at the endocrinology clinic of King Abdul-Aziz University Hospital in Riyadh, Saudi Arabia.

The tools used in the *teleophthalmology program* in these eight articles are divided into two, using a table-top and *hand-handling non-mydriatic fundus camera*. In a study conducted by Quireoz et al (2020) using a smartphone-based *hand-handling camera.* This smartphone-based hand handling camera has advantages over *tabletop cameras* because it is cheaper and can be used *portable.*

Some of the service providers who carry out the shooting process are nurses or technicians who have been given training. A study by Leeman et al (2021) described a 14-month training process by a retinal specialist ophthalmologist and a certificate was awarded.

4.2 Results

teleophthalmology screening program, it was found to an increase in the number of diabetic retinopathy examinations through the *teleophthalmology screening program,* both in the Avendano-Veloso et al. (2019) study as many as more than a quarter of the community and diabetes in the study area and affecting the number of clinical diabetic retinopathy examinations in the Leeman et al study. (2021) which is an increase of 34-75%. (14)The number of detectable diabetic retinopathy from the studied studies is quite

diverse, ranging from 3-to 15%. (14–19)Some cases of new diabetic retinopathy can be found with further *follow-up* because the retinal images taken are of limited quality and cannot be assessed. (17)Not only that, poor image quality can result in unnecessary referrals. (18)This demonstrates the importance of assessable retinal imaging and thus training for good quality fundal imaging is important. The use of mydriasis drops is also considered to be able to improve the image quality of the eye fundus. (16)
Mild diabetic retinopathy was the most common finding in each study. There is continuity between referrals based on findings on fundal radiographs and the results of diagnoses made by ophthalmologists. (18)

4.3 Patient Satisfaction

Meanwhile, in studies examining patient satisfaction with the use of teleophthalmology screening programs, it was found that in general, patient satisfaction was quite high. In a study conducted by Alhumud et al, it was found that the level of satisfaction was 80.4% where interpersonal relationships had the highest value. The same thing appears in the study of Martin et al, where patient satisfaction is generally said to be good. The patient's interest in using teleophthalmology also emerged with the possibility of using a *smartphone-based handheld camera* that could be done at the patient's home, given the current state of the COVID-19 pandemic, some patients are afraid to go to the hospital.

4.3 Cost Analysis Teleophthalmology

Teleophthalmology is considered a low-cost diabetic retinopathy screening program, this is seen in the study of Kuo et al where the cost savings that can occur in patients undergoing a diabetic retinopathy *screening program are* $7.58 to $29.20. This (15,17)research is a *teleophthalmology screening program* that uses a *smartphone*-based *handheld camera*. This shows promising potential in the use of *smartphone*-based *handheld cameras in diabetic retinopathy screening* programs, especially in reaching the wider community in areas far from the reach of tertiary health services.

V. Conclusion

Teleophthalmology effectively increases the number of case findings of diabetic retinopathy in patients with diabetes mellitus. Not only that, teleophthalmology offers ease of use for health workers and low costs, and patient satisfaction undergoing the program. This will assist in the implementation of the diabetic retinopathy screening program in the era of the COVID-19 pandemic.

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