Summer Internship Report

Narrative report based on literature review

Submitted by Simran Mehrotra

Title – Effective use of teleopthalmology in diabetic retinopathy.

Introduction

Telemedicine is exchange of medical data by electronic telecommunications technology that allows a patient's medical problems evaluated and monitored by a remotely located physician. Over the past decade, there have been rapid strides in progress in the fields of telecommunication and medical imaging. There is growing evidence regarding use of teleophthalmology for screening of diabetic retinopathy. Teleophthalmology is the integration of electronic information and medical technology through digital medical equipment and telecommunications technology. It provides access to specialized expert health care to people living in remote and underserved areas. Visual impairment due to diabetic retinopathy (DR) is a significant health problem in the working age group. The disease has a recognizable pre-symptomatic stage and is readily detected by clinical examination and retinal imaging. The value of screening is well established, since DR has few visual or ocular symptoms until vision loss develops. With early detection, DR can be treated with modalities that can decrease the risk of severe vision loss.

In India 80% of the population resides in the rural area whereas more than 70% of the healthcare resources are in the urban area. There is a ration of one opthalmologist per 100,000 population of which 70% practice in the urban areas. Teleopthalmology holds a great potential for quality, access and affordability in healthcare. For patients in the rural arfea it can reduce the need to travel and open the access to super- specialists.

The rapid progress achieved in the field of telecommunications has made teleopthalmology easily feasible some of the pioneers of opthalmic care in India are Sankara Nethralya, Chennai, Arvind Eye Hospital, Madurai, Agarwal Eye Hospital, Chennai etc. just to name a few.

The imaging techniques and telecommunication services have evolved exponentially over the past decade. Newer techniques like stereoscopic imaging and nonmydriatic camera have comparable sensitivity and specificity in diagnosing DR. Telemedicine is an emerging strategy for improving evaluation for DR through retinal imaging with remote interpretation by an expert. Introducing this technology at the point of care from the PCP could reduce many of the aforementioned barriers and improve early detection of DR.

Methodology

Research design- Narrative report based on literature review

Search strategy- a search of PubMed, Scopus and Google Scholar for relevant articles published was conducted. Studies were included if they met the following criteria: - recruited subjects with either type 1, type 2 diabetes, evaluated telemedicine technology, patients underwent primary screening for DR, compared a telemedicine-based intervention with standard care, performed an economic evaluation or provided sufficient data for evaluating the cost-effectiveness of the technology used, evaluated the effectiveness of telemedicine for DR

Keywords- Teleophthalmology, telescreening, nonmydriatic, diabetic retinopathy, cost-effective, patient satisfaction, efficacy, telemedicine, screening programs. eye images, screening.

Literature Review

S.No	First author, Year, Country	Purpose	Population size	Method	Outcome
1	Rachapelle, 2013, India	To assess the cost-utility of telemedicine to screen for DR in India.	1000	Cohort study Mobile van with built-in ophthalmic unit where optometrist took retinal images that were transferred to base hospital by satellite for review and grading by ophthalmologist.	By using WHO threshold of cost-effectiveness, the rural teleopthalmology program was cost-effective.
2	Stanimirovic, 2019, Canada	To assess the cost-effectiveness of tele-retina screening program in comparison with existing standard of care (SOC) diabetic retinopathy (DR) screening for patients with DM	566	Cohort study Fundus examination of the retinal images by opthalmologist	The teleretinal screening program correctly diagnosed more patients (496 v/s 247) and was cost saving
3	C Schulze-Dobold, 2012, France	5 Year Experience of a Telemedical Screening Programme (Ophdiat(®)) for Diabetic Retinopathy in Paris and the Surrounding Area	38,596	Pilot Study 17 hospitals, 11 primary healthcare centres and 2 prisons in the Paris area were gradually equipped with a non-mydriatic funduscopic camera between June 2004 and December 2009. Photos were taken	38,596 patients were screened during 51,741 examinations. Of these patients, 26.55% were referred because of unreadable photographs (9.94%), advanced stages of retinopathy (14.71%) or concomitant eye

				by trained orthoptists and nurses, and interpreted by an average of seven certified ophthalmologists.	diseases (1.90%). Patients screened in hospitals and prisons exhibited a greater prevalence of retinopathy and at more advanced stages. In view of the increasing number of such patients and the decreasing number of ophthalmologists, expansion of the Ophdiat(®) screening network is desirable.
4	ManCho Ng, 2009, Canada	To assess the improving Access to Eye Care using Teleophthalmology in Alberta, Canada	9016	Patients underwent stereoscopic digital retinal photographs following pupillary dilation. Digital images were then encrypted in password-protected compressed file for uploading on a secure server. Images were digitally unpackaged for review as a stereoscopic digital slide show and graded with a modified Early Treatment DR Study algorithm. Reports generated automatically and sent back to referring physician.	Approx 2% of teleophthalmology assessments have required referral for in-person examination due to ungradable image sets, due to cataract or corneal drying. In Canada, many patients with diabetes do not receive an annual dilated eye examination. Teleophthalmology is beneficial because patients can be assessed within their own communities. This decreases the time to treatment, allows treated patients to be followed remotely, and prevents unnecessary referrals.

5	Jorge Cuadros, 2009, California	EyePACS: An Adaptable Telemedicine System for Diabetic Retinopathy Screening	3562	Primary clinic personnel are trained and certified by the EyePACS program to acquire retinal images from standard digital retinal cameras. Relevant clinical data and eight high-resolution images per patient are encrypted and transmitted to a secure Internet server, using a web browser. Images are then interpreted by certified EyePACS reviewers or local eye care providers Reports indicating retinopathy level and referral recommendations are transmitted back to primary care providers through the EyePACS web site.	Since 2006, EyePACS has been expanded to over 120 primary care sites throughout California and elsewhere recording over 34,000 DRSs. The overall rate of referral is 8.21% for sight-threatening retinopathy and 7.83% for other conditions (e.g., cataract and glaucoma). The use of license-free Web-based software, standard interfaces, and flexible protocols has allowed primary care providers to adopt retinopathy screening with minimal effort and resources.
6	Pooja D. Jani, 2017, North Carolina	To assess how well does telemedicine retinal screening affect retinal screening for patients with type 1 or 2 diabetes in rural settings of North Carolina	1787	evaluation was conducted from January 6, 2014, to November 1, 2015, at 5 primary care clinics serving rural and underserved populations in North Carolina among 1787 adult patients with type 1 or 2 diabetes who received primary care at the clinics and obtained retinal telescreening to determine the presence and	study found that the burden of advanced DR requiring referral to an ophthalmologist was high among minorities; factors associated with the need for referral included minority race/ethnicity, older age, and history of kidney disease and stroke. A total of 60% of referred patients completed an ophthalmology

				severity of DR. A total of 1661 patients with complete data were included in the statistical analysis.	referral visit within the study period. When implemented in the primary care setting, retinal telescreening increased the rate of evaluation for DR for patients in rural and underserved settings. This strategy may also increase access to care for minorities and patients with DR requiring treatment.
7	Gopal Datt Joshi, 2011, India	DrishtiCare: A Telescreening Platform for Diabetic Retinopathy Powered with Fundus Image Analysis	450	A Web-based platform on the software as a service (SaaS) delivery model is chosen to make the service cost-effective, easy to use, and scalable. A server-based prescreening system is employed to scrutinize the fundus images of patients and to refer them to the experts. An automatic quality assessment module ensures transfer of fundus images that meet grading standards	3 local primary eye hospitals have participated and used DrishtiCare's telescreening service. A preliminary evaluation of the proposed platform is performed on a set of 119 patients, of which 23% are identified with the sight-threatening retinopathy. The approach integrates automated fundus image analysis in the telescreening It offers a low-cost, effective, and easy screening solution to primary care providers.
8	Robb R. Wilson, 2008, United States	To evaluate Telemedicine Process Used to Implement an Effective and	706	project created software to support effective retinal screening process for people with diabetes. The	76% of the sample was instructed to follow-up with their eye doctor in 1 year (had no retinopathy). Only

		Functional Screening Program for Diabetic Retinopathy		system included four separate software components: registration, imaging, grading, and tracking/reporting. The imaging component consisted of customized software running on a computer attached to a camera that drives retinal image acquisition.	six patients (0.8 %) were asked to see their eye doctor within 6 weeks (proliferative retinopathy or diabetic maculopathy). Project demonstrated that the retinal screening software and workflow process can be used to overcome challenges of providing adequate screening and diagnostic services for people at risk for diabetic retinopathy.
9	Cynthia Owsley, 2016, United States	To examine the rate and types of DR identified through a telemedicine screening program using a non-mydriatic camera, as well as the rate of other ocular findings.	1894	A cross-sectional study Four urban clinic or pharmacy settings in the United States serving predominantly minority and uninsured persons with diabetes. Persons age ≥ 18 years old who have type 1 or 2 diabetes and present to the community-based settings.	1 in 5 persons with diabetes screened positive for DR. The vast majority of DR was background indicating high public health potential for intervention in DR's earliest phases when treatment can prevent vision loss. Other ocular conditions were detected at a high rate, a collateral benefit of DR screening programs that may be under appreciated.

10	Khalid Al Sabti, 2003, Kuwait	To examine the Efficacy and Reliability of Fundus Digital Camera as a Screening Tool for Diabetic Retinopathy in Kuwait	51	Patients who were not treated for DR earlier were enrolled in the study. All patients underwent digital fundus photography. The photographs were evaluated and compared with the clinical findings as recorded by retinal specialists. DR and macular edema were analyzed separately, and the correlation was statistically measured. The kappa statistic was used to estimate the extent of the agreement between the two procedures.	Comparison of the digital image of the fundus and the examination by an ophthalmologist showed a good correlation. The kappa score for retinopathy was estimated to be 93% with 95.6% concordance. Digital images provide an efficient method for diagnosing and classifying sight-threatening DR, particularly proliferative diabetic retinopathy (PDR). It was also felt that the digital photographs can be used as a tool for teleophthalmology and can be integrated as a screening system in Kuwait.

Findings

After reviewing the literature of the above articles being published around different time frame, it has been seen that the use of telemedicine for screening DR had turn out to be fruitful and promising. It was observed that not only is teleopthalmology for DR an efficient strategy but is also very cost effective as compared to the conventional methods. The teleretinal screening process can be used to overcome challenges of providing adequate screening and diagnostic services for people at risk for diabetic retinopathy. It offers a low-cost, effective, and easy screening solution to primary care providers and has also has allowed primary care providers to adopt retinopathy screening with minimal effort and resources. This strategy may also increase access to care for minorities and patients with DR requiring treatment. Teleophthalmology is beneficial because patients can be assessed within their own communities. This decreases the time to treatment, allows treated patients to be followed remotely, and prevents unnecessary referrals.

Discussion

The studies done in India by using WHO threshold of cost effectiveness found that the teleopthalmology program was cost effective and the drishti care platform of telesreening for DR showed that it offers a low cost effective and easy screening solution to healthcare providers. Telemedicine is a screening method that is well adapted for diabetic patients. In view of the increasing number of such patients and the decreasing number of ophthalmologists, expansion of the telescreening for DR is desirable. In studies done in Alberta, as in other provinces across Canada, patients with diabetes face many barriers to an annual dilated eye examination. As a result, many Albertans with diabetes do not undergo an annual eye examination In order to increase the percentage of patients with diabetes who undergo annual eye examinations, improved delivery paradigms must be developed. Teleophthalmology offers one solution by which patients can be assessed within their own communities in an accurate, efficient fashion, without the need for travel. EyePACS was designed to reduce barriers to access to retinal exams for diabetes patients. The use of license-free Web-based software, standard interfaces, and flexible protocols has allowed primary care providers to adopt retinopathy screening with minimal effort and resources. By implementing a retinal telescreening program for evaluation of DR in primary care clinics across North Carolina, it was suggested that telemedicine can increase the rate of evaluation of DR for a diverse group of underserved patients with type 1 or 2 diabetes. The implementation of ocular telemedicine programs provides an opportunity to redefine the paradigm of diabetic eye care so that primary care physicians can aid the ophthalmologist in the prevention, screening, and monitoring of this blinding disease. The ocular telemedicine approach increases rates of detection and surveillance for individuals with DR, thereby allowing identification of patients who can be managed and monitored by their primary care physicians. Because of the success of recruitment using the electronic devices in clinical settings, it may be useful to have automatic alerts go off in the electronic health record that prompt clinicians to schedule eye examinations yearly for their patients. This may increase patient treatment compliance greatly. Prevalence of DR in rural India (or the world) is not too different than the urban people. However, the rural population is disadvantaged for not having a similar access to skilled personnel, particularly a specialist ophthalmologist similar to their urban counterpart. The modern technology of digital nonmydriatic photography, particularly the smartphones, fast expanding broadband transmission of these fundus pictures, and smarter auto detection of the retinal lesions will make the rural diabetic patients no more remain disadvantaged. The success of these new developments partly rests on similar improvement in the knowledge, aptitude and practice of the rural folk.

References

Rachapelle, S., Legood, R., Alavi, Y., Lindfield, R., Sharma, T., Kuper, H., & Polack, S. (2013). The cost-utility of telemedicine to screen for diabetic retinopathy in India. *Ophthalmology*, *120*(3), 566–573. https://doi.org/10.1016/j.ophtha.2012.09.002

Tele-retina Screening of Diabetic Retinopathy Among At-Risk Populations: An Economic Analysis—PubMed. (n.d.). Retrieved May 23, 2020, from https://pubmed.ncbi.nlm.nih.gov/31712029/

Schulze-Döbold, C., Erginay, A., Robert, N., Chabouis, A., & Massin, P. (2012). Ophdiat(®): Five-year experience of a telemedical screening programme for diabetic retinopathy in Paris and the surrounding area. *Diabetes & Metabolism*, *38*(5), 450–457. https://doi.org/10.1016/j.diabet.2012.05.003

Improving Access to Eye Care: Teleophthalmology in Alberta, Canada. (n.d.). Retrieved May 23, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2771508/

Cuadros, J., & Bresnick, G. (2009). EyePACS: An Adaptable Telemedicine System for Diabetic Retinopathy Screening. *Journal of Diabetes Science and Technology (Online)*, *3*(3), 509–516.

Evaluation of Diabetic Retinal Screening and Factors for Ophthalmology Referral in a Telemedicine Network | Cerebrovascular Disease | JAMA Ophthalmology | JAMA Network. (n.d.). Retrieved May 23, 2020, from https://jamanetwork.com/journals/jamaophthalmology/fullarticle/2627936?guestAccessKey=13f8a064-c5e6-4ba5-97df-5600ddf119aa

Joshi, G. D., & Sivaswamy, J. (2011). DrishtiCare: A Telescreening Platform for Diabetic Retinopathy Powered with Fundus Image Analysis. *Journal of Diabetes Science and Technology*, *5*(1), 23–31.

Wilson, R. R., Silowash, R., Anthony, L., Cecil, R. A., & Eller, A. (2008). Telemedicine Process Used to Implement an Effective and Functional Screening Program for Diabetic Retinopathy. *Journal of Diabetes Science and Technology (Online)*, *2*(5), 785–791.

Owsley, C., McGwin, G., Lee, D. J., Lam, B. L., Friedman, D. S., Gower, E. W., Haller, J. A., Hark, L. A., & Saaddine, J. (2015). Diabetes Eye Screening in Urban Settings Serving Minority Populations: Detection of Diabetic Retinopathy and Other Ocular Findings Using Telemedicine. *JAMA Ophthalmology*, *133*(2), 174–181. https://doi.org/10.1001/jamaophthalmol.2014.4652

Al Sabti, K., Raizada, S., Wani, V. B., Al Ajmi, M., Gayed, I., & Sugathan, T. N. (2003). Efficacy and reliability of fundus digital camera as a screening tool for diabetic retinopathy in Kuwait. *Journal of Diabetes and Its Complications*, *17*(4), 229–233. https://doi.org/10.1016/s1056-8727(03)00007-2

Telemedicine in diabetic retinopathy: Access to rural India. (n.d.). Retrieved May 23, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4821127/