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A Pilot Study to Improve Access to Eye Care Services for Patients in Rural India by Implementing Community Ophthalmology through Innovative Telehealth Technology

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Abstract. Objective: To inform about a very unique and first of its kind telehealth pilot study in India that has provided virtual telehealth consultation to eye care patients in low resource at remote villages. **Background:** Provision of Access to eye care services in remote population is always challenging due to pragmatic reasons. Advances in Telehealth technologies have provided an opportunity to improve access to remote population. However, current Telehealth technologies are limited to face-to-face video consultation only. We inform about a pilot study that illustrates real-time imaging access to ophthalmologists. Our innovative software led technology solution allowed screening of patients with varying ocular conditions. **Methods:** Eye camps were conducted in 2 districts in South India over a 12-month period in 2014. Total of 196 eye camps were conducted. Total of 19,634 patients attended the eye camps. Innovative software was used to conduct consultation with the ophthalmologist located in the city hospital. The software enabled virtual visit and allowed instant sharing of fundus camera images for assessment and diagnosis. **Results:** About 71% of the patients were found to have Refractive Error problems, 15% of them were found to have cataract, 7% of the patients were diagnosed to have Retina problems and 7% of the patients were found to have other ocular diseases. The patients requiring cataract surgery were immediately transferred to city hospital for treatment. Software led assessment of fundus camera images assisted in identifying retinal eye diseases. **Conclusion:** Our real-time virtual visit software assisted in specialist care provision and illustrated a novel tele health solution for low resource population.

Keywords. Telehealth, Ophthalmology, Mobile Eye care services, remote population, low resource settings

Introduction

Approximately 285 million people worldwide live with visual impairment [1]. Of these, 39 million people are blind (defined as best corrected vision of less than 3/60 in the

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better eye), and low vision in approximately 117 million people is due to uncorrected refractive errors [2]. 80% of global blindness is avoidable. One in every three treatable blind people in the world is an Indian. The number of blind persons in India is currently over 18 million and this estimate is 50% more than the figure of 12 million from a decade ago. It amounts to approximately one-fourth of all the blind people worldwide making the Indian blind population account for 20% of blindness [3]. Cataract is still the major cause of avoidable blindness in India. Taking the existing prevalence rate into account, it may be difficult to achieve total elimination of blindness in India by 2020. The recent epidemiological surveys have shown that Cataract, diabetic retinopathy, glaucoma, and childhood blindness have started to cause increased number of blind people in India. Hence, ophthalmology in India needs to be more holistic and medical initiatives towards all eye diseases should be taken. The high magnitude of avoidable blindness in India is concentrated in the rural areas mainly due to the lack of trained ophthalmologists being present in villages, underutilisation of public health services for the eye due to lack of awareness, lack of capital (from both government and public sector) for introducing facilities in the rural areas that can provide primary and secondary care for the eye and lack of adequately trained manpower. These problems can be addressed effectively by mobile, comprehensive and sustainable eye care systems easily accessible to the rural people in villages. Sankara Nethralaya (SN), a unit of Medical Research Foundation, is a tertiary eye care center in South India and is committed to patient care, ophthalmic research, and training at all levels for over three decades. With the aim of providing comprehensive and quality eye care to the rural population, a unique program implementing a mobile tele-ophthalmology unit was designed at SN and launched in 2003 [4]. SN conducts eye care camps in villages of South India. These remote outreach camps must ensure quality, especially in terms of screening vision threatening diseases, referral services, and affordable, rapid rehabilitation. However, subsequent interventions and follow up visits require the same medical records at multiple camp locations. To facilitate this, SN has implemented recording clinical data on electronic medical records (EMR). Teleophthalmology and EMR thus have unleashed a new frontier in ophthalmology for screening and recording of common ophthalmic diseases [5].

Teleophthalmology can reduce the need for travel for both the patient and ophthalmologist. The advances in internet technology and growth of internet across India's population have provided a tremendous opportunity to develop innovative Telehealth solutions [6, 7]. The trend of using video conferencing software solutions for tele-consultation is commonly observed [8]. However, these solutions require higher bandwidth and they also cannot provide real-time image sharing for point-of-care clinical diagnosis and treatment decision making. Therefore, the quality of Telehealth experience does not meet requirements for a clinical-grade consultation. We have addressed this very major limitation in the current state-of-the-art facility by developing an innovative Telehealth consultation service.

Our innovative software enabled service provides real-time fundus image sharing and annotation which allows a specialist ophthalmologist in the city hospital to examine and assess eye anomalies of patients in remote villages that have inadequate internet bandwidth. In this paper, we inform the results of our unique pilot study involving virtual visits during eye camps in low resource settings in villages in South India. Our pilot study suggests that improving access to eye care may facilitate in reducing the incidence of blindness in underserved as well as urban communities.

1. Methods

1.1. Identification of Remote Villages for Eye Camps

Remote Villages in Kanchipuram and Thiruvallur districts with a population of one million from the state of Tamil Nadu were chosen to provide comprehensive eye examination under the directives of the head of the department of Teleophthalmology at SN. The inclusion criteria for the villages considered factors such as distance from the base hospital being an important one (within150km to 200km) of the base hospital in Chennai, Prevalence of district-wise blindness as published by the District Blindness Control Society (DBCS) of India and Economic feasibility of the camp site. After the districts and villages were identified, the permission of the head of the DBCS was obtained in all states. The geographic locations of the villages are shown in Figure 1.

Figure 1. Eye camp locations and eye camp bus.

1.2. Conduct of Eye Screening Camps

This pilot study was conducted in eye screening camps in rural villages near Chennai, Tamilnadu from January 2014 until December 2014. The participating patients were from villages without adequate access to eye care services. The eye screening camps were conducted by a team composed of optometrists, social workers, administrative staff, ophthalmologists as well as information technology experts. This team travelled to the eye camp sites in a bus equipped with fundus camera, slit lamps and other instruments required for conducting eye screening examination. The patients underwent comprehensive eye examination by the team members to determine the prevalence of any ocular conditions. A hospital-based ophthalmologist advised patients through Tele consultations for further treatment. The specialist ophthalmologist consultation was carried out over video conferencing using data card and web-based

communication tools. A detailed ocular assessment was recorded using Electronic Medical Records. The work flow at the eye screening camps is shown in Figure 2.

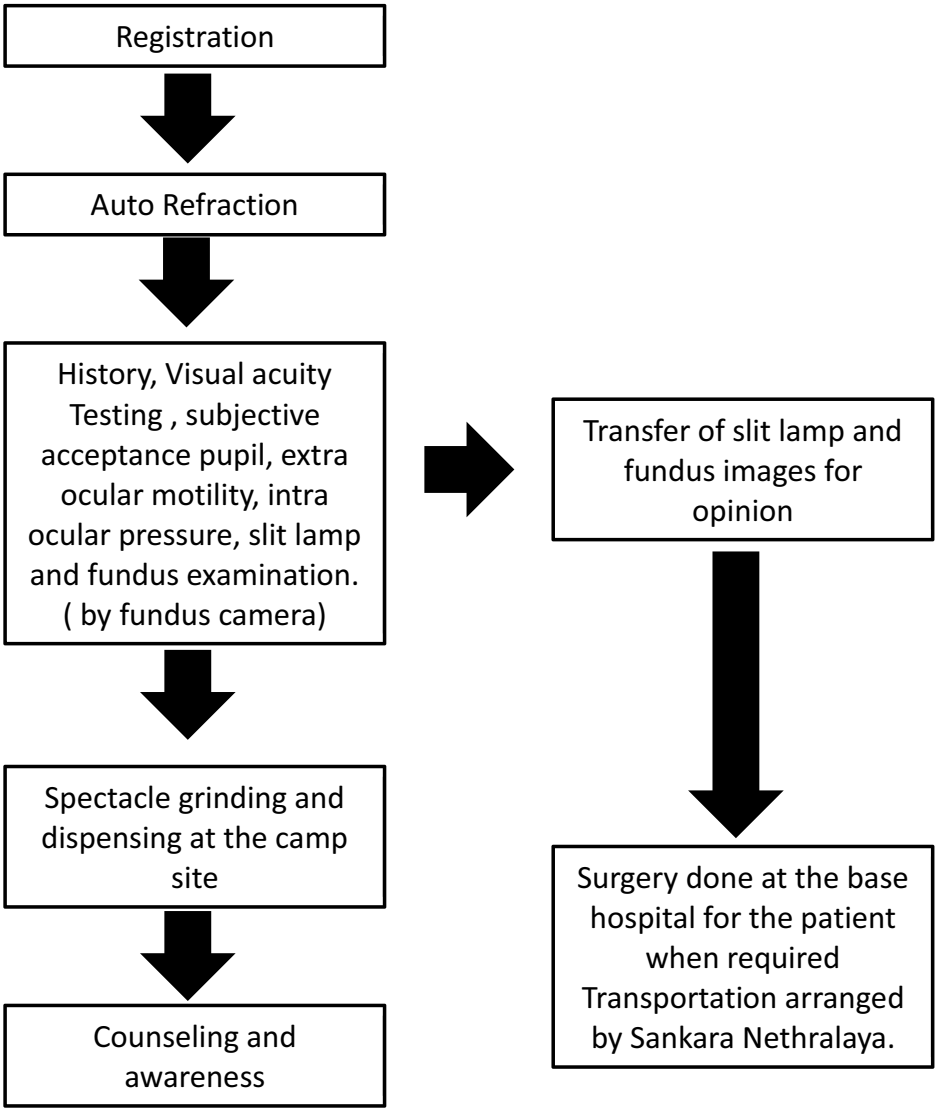

Figure 2. Tele Consultation flow chart.

1.3. Virtual Visit

An innovative software was used to share the fundus camera images in real-time. Since the software used accurate application-level sharing, there was no necessity to transfer images. A schematic representation and implementation of our solution used to conduct virtual visits is shown in Figure 3.

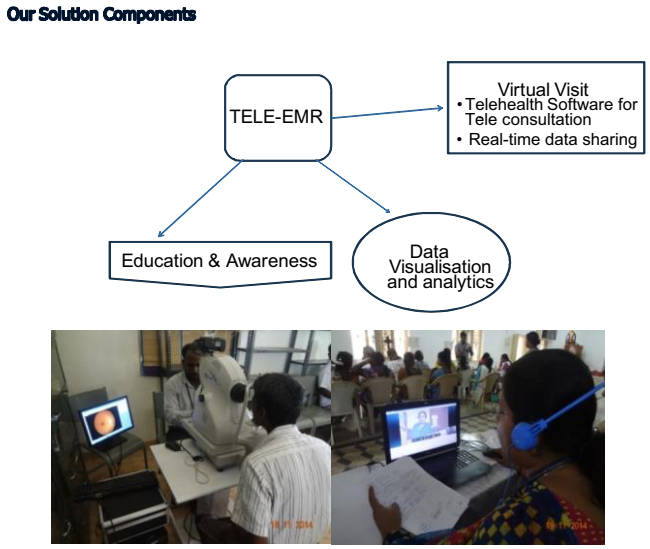

Figure 3. Schematic representation and implementation of our real-time virtual visit solution.

The ophthalmologist based at the city hospital could provide an immediate advice in real-time through the virtual consultation visit. All the patient records in the Tele-EMR were updated with the fundus camera images. The diagnosis of eye diseases is mainly based on eye images generated by the fundus camera. Therefore, automatic integration of the eye images with clinical notes at every visit and storing them into EMR will be very useful, especially in chronic diseases such as glaucoma, diabetic retinopathy and macular degeneration. Our solution enables seamless storing the eye images in the EMR and hence these images can be analysed for management of chronic eye diseases. The virtual visit component of our solution enabled sharing of fundus images with the ophthalmologist in the city hospital. The image sharing was implemented with a simple “click and share” feature. An exact replica of the fundus camera image appeared on the ophthalmologist’s computer screen. The software’s unique capability enabled real-time sharing of images in low bandwidth setting with weaker internet connectivity. Our solution thus addressed the limitations of technology infrastructure in rural regions of India where only allows satellite-based tele-connectivity is available with its implementation challenges. Our solution also simplified the work flow for telehealth consultation. The solution also required very little training to the eye camp site operators. The commercial-grade software was implemented without any development cost. Thus our model offers a cost-effective and efficient telehealth solution.

2. Results and Discussion

From January 2014 to December 2014 we have conducted 196 camps and a total number of 19,634 patients were examined. In our study 10073 males and 9561 females underwent comprehensive eye examination. The study shows a slightly higher percentage presence of male patients. About 51.3% of the patients in this study were males and 48.7% of them were females. The analysis of the results is shown in Figure 4.

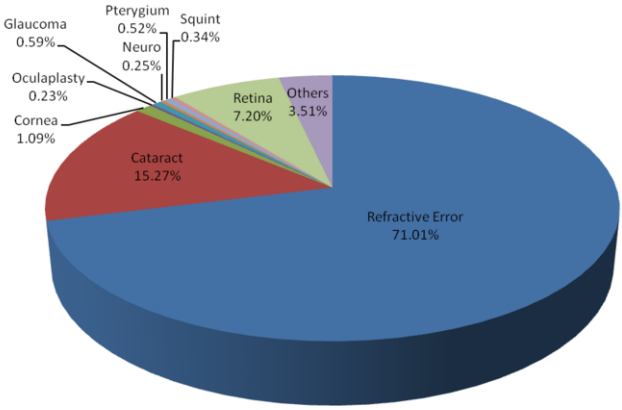

Figure 4. Analysis of patient diagnosis.

About 71% of the patients were having Refractive Error problems, 15% of them were found to have cataract, and 7% of the patients were detected with Retina problems [9] of which about 4% had diabetic retinopathy [10]. Seven (7) % of the patients had other ocular diseases and some of them were referred to the base hospital to undergo specific tests to confirm the diagnosis. Refractive errors included myopia, hyperopia and presbyopia for which glasses were dispensed at the eye camp location, as a corrective measure, with the help of mobile refraction van. All patients with significant cataract and other disorders requiring surgical intervention or other investigations as deemed fit after tele-consultation [11] were issued registration slips and advised to attend the appropriate subspecialty clinics at the base hospital at no cost. The software led diagnosis assisted in proactive assessment of patient's eye condition and resulted into immediate intervention to avoid any further deterioration of their eye health. About 1950 patients were referred to main hospital for cataract surgery during the study period and those patients underwent cost free state of art cataract surgery successfully at the SN community hospital. Our solution thus illustrates promising results for further development into a regular health service that can assist specialist clinicians with the ultimate benefit to the underserved population.

3. Conclusion

We conducted a pilot study that illustrated application of software led telehealth implementation to screen patients in low resource settings. Our pilot study showed that Virtual visit based eye care services can assist in identifying causes of blindness and avoidable blindness can be treated. A large scale commercial rollout of our solution can be considered for future implementation.

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