Telemedicine in Ophthalmology The Art & Science

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Telemedicine, or health care in the home-based setting as it was known before, has a long history.[1] In 1897, there was a Lancet report on how the telephone was used to reduce the number of unnecessary office visits.[1] With the inception of the telecommunications infrastructure, such as the telegraph, telephone, and radio, ordering of medical supplies and consultations were done by telegraph during the Civil War in America. In the space age in the 1950s and 1960s, home monitoring by NASA started with physiologic monitoring. After World War II and with the advent of the television, radiologic images were sent between hospitals and universities for teaching and for areas without the appropriate specialties.[1]

Such need was borne out of the necessity of treating chronic diseases. Traditionally, they have been managed through an episode office-based model, rather than a care-management model, that require frequent patient contact and regular physiologic measurement.[1] Other models included personalized education, monitoring, and feedback at home from a remote disease management team to deal with the rising health care costs and shortage of doctors, especially in rural areas.[1] These led to reductions in hospitalization, shorter hospital stay, and better adherence to medications. In remote areas where specialists were scarce, expert management of more complicated diseases suffered and unnecessary morbidities and mortalities occurred. Referrals to tertiary institutions with more sophisticated equipment were made but transportation was difficult and the lengthy stay in an urban area was prohibitive for those with limited funds.

Advances in information technology over the last few decades have grown tremendously. Nowadays, many people carry around a smartphone or a tablet with internet connection. The advent of the digital age before the turn of the century, starting with the "world wide web" and the ability to transfer data faster with the 4G and 5G, has made information more easily available with the touch of a button. Whenever anyone needs clarification on any subject matter, he can look it up through Google in an instant. Health information and other data stored in cloud services can now be accessed anywhere in the world.

What is telemedicine?

In the modern age, telemedicine refers to the practice of caring for patients remotely when the provider and the patient are not physically in contact with each other to share medical information.[1-3] Simply put, it is the "remote delivery of healthcare services". There are 3 common types of telemedicine,[2] which include but is not limited to: 1) Interactive medicine - which allows patients and doctors to communicate in real-time, largely through video platforms; 2) Store and forward - which permits providers to share patient information with a physician in another location; 3) Remote patient monitoring - which allows remote caregivers to monitor patients at home by using mobile medical devices to collect data (i.e. blood sugar and blood pressure).[2]

What is the difference between telemedicine and telehealth?

Although the two terminologies are used interchangeably, there is a difference. The World Health Organization (WHO) refers to **telemedicine** as "healing from a distance".[2] It is the use of telecommunications and information technologies to provide remote clinical services to patients where there are transmission of digital images, video consultations, remote medical diagnoses, and where treatments are provided. This is especially useful to those living in remote areas and frequently utilized during the COVID-19 pandemic. **Telehealth**, on the other hand, refers to the utilization of electronic information and telecommunications technologies to support and promote long distance clinical health care, patient and professional health education, public health, and health administration.[2] It is broader and includes continuing medical education for physicians and allied health personnel, improvement of health care systems and deliveries, all with the aim of improving patient care and education. Thus, telemedicine is under the umbrella of telehealth.

What are the benefits of telemedicine?

The digital age has brought significant changes in the health care infrastructure, and telemedicine is here to stay. It provides benefits to providers and patients with more efficient health care delivery. This is coincident with the rising popularity of using electronic medical records, AI diagnosis, and medical streaming devices, all with the aim of assisting providers with diagnosis and treatment, monitoring patients in real-time, and adjusting treatment plans as needed, allowing for better patients' outcomes.[2-3] Physicians can see more patients without increasing office staff or space, leading to increased revenue. Patients do not have to miss work or spend on transportation, childcare or healthcare services, especially for seniors who may need to be accompanied. There is less risk of acquiring contagious diseases in the hospital or clinics. For those who previously have limited access to specialists, they can now see the appropriate experts through telemedicine.

What are the disadvantages of telemedicine?

With the rapid rise of technology, policies regarding privacy and confidentiality of personal information, particularly health information, have not kept up.[2-3] There are still many uncertainties regarding privacy protection, healthcare laws, and reimbursements. With fewer face-to-face consultations, physicians are concerned about inaccuracies of medical data collected that can result in mismanagement, especially when dealing with older patients. There is the potential that technology may not fully capture what the human touch can.

Technology used in telemedicine can be expensive if not used appropriately. Setting up the capabilities of telemedicine requires some infrastructure changes and heath care systems management.[2-3] Training of staff by a system manager is required. Laboratory results and video images must be digitized and interconnected with the ability to be stored in the cloud server and must be integrated for each patient and easily retrievable. This is easily accomplished in large institutions with IT management team but more difficult for smaller clinics. Still, there are different ways and degrees of applying telemedicine in today's health care environment.

Telemedicine in Ophthalmology

The practice of ophthalmology is equipment-intensive. Ophthalmologists depend on instruments to look inside the eye and for visualization of the posterior pole to make a diagnosis for the cause of the problem and give the appropriate management. They are used to visualizing the different structures of the eye many times magnified and used sophisticated equipment to discern structures not visible to the human eye, using technologies such as optical coherent tomography (OCT), swept source fourier domain, Scheimflug principle, and so forth.

The COVID-19 pandemic has affected many ophthalmology clinics and eye centers, disallowing too close face-to-face contacts and encouraging social distancing for safety reasons. In the 2020 lockdown, during the months of March to May, ophthalmology was one of the most affected specialties with decreased patients' visits of more than 70%.[4] Since ophthalmology deals largely with the elderly, many seniors were afraid to visit hospitals being in the high-risk category to contracting severe COVID requiring hospitalization, particularly for those with co-morbidities. When clinics re-opened few months later, safety measures were instituted, such as adding breath shields to the slit lamp biomicroscope, disallowing direct ophthalmoscopy, mandatory wearing of face masks and shield, temperature monitoring and history taking for specific signs and

symptoms of COVID, wearing of proper personal protective equipment (PPE) by the staff, installation of filters and purifiers, and proper ventilation among others. For ophthalmologic procedures that are aerosol generating, such as phacoemulsification, and the induction of general anesthesia, additional precautions were instituted.

In a recent informal survey of local ophthalmologists, about 50% were against telemedicine for fear of not adequately managing the eye problems of patients. Most of the teleophthalmology consults through video platforms such as, Viber or Zoom, dealt with anterior segment problems; commonly, sore eyes, ocular allergy, tear dysfunction, chronic meibomitis, and chalazion. Management could easily be instructed to patients with copies of prescriptions sent through those platforms or email. For more serious complaints, such as blurry vision that can be caused by a multitude of conditions, some more serious than others signaling pathologies and requiring further evaluation, most ophthalmologists and patients are not ready to do teleconsults without face-to-face visits. Such conditions will require special instruments to look into the eye.

Telemedicine in ophthalmology, or teleophthalmology, is not new. The emergence and availability of powerful technologies and specialized equipment allow ophthalmologists to diagnose and treat a variety of urgent and chronic eye conditions, ranging from screening for eye diseases, consultative services, remote supervision, education, and emergency services.[5-7] Most teleophthalmology services rely on digital images captured by trained technicians who utilize various in-clinic devices for anterior segment and fundus photography. These images are digitally transmitted to an ophthalmologist for real-time or later assessment. In rural areas where experts are not available, these images may be taken by local staff or by visiting healthcare workers and they are sent to tertiary institutions for evaluation. This type of teleophthalmology has been used for diabetic retinopathy, age-related macular degeneration, and glaucoma screening.[5-7]

Over 20 years, the Moorfields Hospital, the National Health Service (NHS) in Great Britain, has employed teleophthalmology for screening of diabetic eye diseases utilizing retinal photography.[8] In 2016, the Royal College of Ophthalmologists published a guidance for "Standards for Virtual Clinic in Glaucoma Care in the NHS Hospital Eye Service".[9] The none face-to-face clinics are divided into synchronous and asynchronous. In the synchronous model, the patient and clinician interact in real time, such as through webcam or phone call. In the asynchronous model, patient-clinician interaction occurs at a later time during the decision-making and treatment plans after all the health information has been gathered. Many of the screening and stable monitoring services are relegated to trained technicians to improve efficiency with better use of resources and better patient flow, to improve effectiveness so doctors can spend time to more complex patients, and to improve patients' experience of the service with reduced time spent in the clinic.[10] Puertas, *et al.* showed that there was low rate of adverse misclassification (<2%), coupled with the slowly progressive nature of most glaucoma and the regular re-assessment.[10]

Apps or software are now available for virtual visual acuity measurements and refraction, as well as rebound tonometer (home tonometry) that glaucoma patients can acquire or lease, including continuous intraocular pressure measurements (IOL or contact lens) connected to a remote site.[11-13] Cameras and/or adaptors attached to smartphones to obtain fundus pictures are available, including those obtained on-line and are getting better with advanced technology. In the future, much improved blockchain enabled artificial intelligence (AI) medical platforms can assist in the diagnosis and management of chronic conditions with better accuracy.[14] Visual field testing using virtual reality visual field goggles are in the works for sale or rental that can be utilized during periods requiring more intensive monitoring. The possibilities are endless!

As the COVID-19 pandemic persists and the realization that it may be with us for sometime, the use of telemedicine continues to rise and becomes more acceptable to doctors and patients. Different variations of telemedicine have been implemented.[15-18] At the Bascom Palmer,[15] virtual visit types are classified into several categories: (1) virtual urgent care; (2) outpatient visits: new, follow-up, post-op; (3) virtual counseling; (4) doctor-doctor consults; (5) second opinion consults; (6) hybrid tele-visits; (7) resident/ER telestaffing; (8) e-visits/online communication; (9) remote monitoring, and; (10) executive health/autonomous screening. In implementing telemedicine, the office staff is engaged for telehealth, with designated telehealth-only clinics that are not mixed with in-person clinics. Messaging is crucial, and staff training is necessary. Group chats with the team in-charge of a particular patient on virtual visit days are

frequently utilized. Electronic check-in streamlines the technical work-up and engages patients further. The standard examination procedure is followed, including the technical and scribing workflows.[15] The whole process must be simple to be adaptable.

The future holds so much promise and the COVID-19 pandemic is just a stimulus that hastens the acceptance of modern technology and AI in the practice of eye care. Teleophthalmology is an added tool and ophthalmologists need to be updated on the availability and usage of these new innovative devices to be able to practice telemedicine confidently. In the meantime, to make telemedicine work in physician's practice, the following are needed: (1) electronic medical records in cloud services; (2) digital images integrated to patient information and health records; (3) easy-to-use software and adaptable that is geared toward continuous care for trend evaluation, and; (4) provisions for privacy and confidentiality. For continuous learning in the practice of medicine, a digital library is also needed. Thus, the development of a workflow system for integrating AI models, imaging, and electronic health records is vital to the success of telemedicine with the highest priority of protecting privacy and confidentiality of these data. It requires restructuring and smooth integration of IT related activities and application of cybersecurity.[19]

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