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Surfing the COVID-19 Tsunami with Teleophthalmology: the Advent of New Models of Eye Care

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Abstract

Purpose of Review In this article, we reviewed the impact resulting from the COVID-19 pandemic on the traditional model of care in ophthalmology.

Recent Findings Though virtual eye care has been present for more than 20 years, the COVID-19 pandemic has established a precedent to seriously consider its role in the evolving paradigm of vision and eye care. New hybrid models of care have enhanced or replaced traditional synchronous and asynchronous visits. The increased use of smart phoneography and mobile applications enhanced the remote examination of patients. Use of e-learning became a mainstream tool to continue accessing education and training.

Summary Teleophthalmology has demonstrated its value for screening, examining, diagnosing, monitoring treatment, and increasing access to education. However, much of the progress made following the COVID-19 pandemic is at risk of being lost as society pushes to reestablish normalcy. Further studies during the new norm are required to prove a more permanent role for virtual eye care.

Keywords Ophthalmology · Telemedicine · Teleophthalmology · Vision and eye care · COVID-19 · Pandemic

Introduction

As the SARS-CoV-2 pandemic swept across the world starting in 2019, it caused major changes in society overall and in health care in particular. However, just as the full effects of a tsunami appear only after the storm surge recedes, the pandemic's impact on the future landscape of healthcare remains uncertain. During this critical period, as the pandemic wanes and we work to establish the future paradigm of healthcare delivery, we have an opportunity to leverage the difficult lessons learned during these past 2 and a half years.

The use of information and communication technologies (ICT) to support healthcare processes grew exponentially worldwide during the pandemic, and vision and eye care were no exception [1]. Nonetheless, our specialty presents unique challenges that require innovation to overcome. Traditional synchronous and asynchronous models of care were blended into new hybrid versions, where drive-through exams and visit splitting minimized the risk of exposure [2]. Mobile applications enhanced the possibility of examining patients remotely, and the use of smartphone photography, coined as smart phoneography, enabled physicians to capture and transmit videography and still images of the eye [3•, 4]. Finally, e-learning became a mainstream tool to continue accessing education and training [5].

The purpose of this review is to explore the different teleophthalmology initiatives that took place during the pandemic and highlight those changes that should carry over to the new norm. There has been a staggering amount of work accomplished over the past few years, which needs to be critically appraised. We need to harness the best practices for the use of ICTs and emerging technologies established during the pandemic and increase access to education in ophthalmology.

Paradigm Shift in Healthcare

In 1970, Thomas Kuhn described "paradigms" as representations of a set of theories or practices that define a scientific discipline and that are universally accepted [6].

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They provide solutions or models that guide a practice until technological innovations or revolutions arise, and they are challenged or replaced, resulting in a paradigm shift.

In healthcare, telemedicine challenges the traditional delivery model. The arrival of emerging technologies led to significant disruptions in how we communicate [7]. For the first time in contemporary history, the physical presence and contact of the health professional with the patient were truly challenged by the presence of a global pandemic. As stated by Saleem et al., "during this pandemic, everyone became remote and underserved, making telehealth mainstream."[8••] This concept is perhaps the most disruptive of all paradigms in modern medicine. In 2011, Rashid Bashshur described telemedicine as a "care modality that challenged the traditional sine qua non dependence on physical presence and contact between providers and patients for the provision of medical assistance/health services." He cautioned us all to understand the urgent need to determine its true effects on providers, patients, and society [9].

Other paradigm shifts relate to patient-physician relationships and the models of healthcare. From a paternalistic to a patient-centric model, from a disease-focused to a health and wellness model, and from reactive medicine to a predictive, preventative, participatory, and personalized model. These four components form the basis of the new paradigm called "4P medicine."[10]

Finally, health, medicine, and their educational processes have witnessed new technological revolutions such as those caused by collaborative networking solutions, artificial intelligence (AI), nanotechnology, 3D printing, the internet of medical things, blockchain, and extended reality just to name a few [11]. In 2016, the founder and CEO of the World Economic Forum, Klaus Schwab, stated, "the new technologies and approaches are merging the physical, digital, and biological worlds in ways that will fundamentally transform humanity. How positive this transformation is will depend on how we navigate the risks and opportunities that will arise along the way."[12]

Paradigms Shifts in Ophthalmology

The rise of ophthalmic digital imaging occurred during the early 1990s, allowing image capture and storage on computers for time-deferred evaluation [13, 14]. Furthermore, the advent of the internet enabled digital transfer of these images and increased the portfolio of portable and digitally enabled medical devices [15•]. Traditional eye care in clinics or hospitals partnered with diverse community settings such as schools, retail spaces, health fairs, and religious organizations in alignment with new public health strategies [16]. Home care became a true paradigmatic concept that has been growing steadily in recent years, enhancing the opportunity for timely and convenient management of chronic eye diseases [17].

But it was not until the COVID-19 pandemic that teleophthalmology gained unprecedented attention. Lockdown orders, changes in national policies, regulations, and licensing privileges, as well as enhanced reimbursement incentives for telehealth services, drove its adoption on a larger scale [18–20]. In many countries, both governments and professional organizations recommended canceling non-urgent patient visits and procedures, closing retail optical shops, and leaving open only those services, such as eye emergency departments or centers, that were treating urgent or emergency vision-threatening diseases [1, 20]. In this context, synchronous or real-time initiatives began to surge and prevail over the preexisting traditional asynchronous screening programs designed for diabetic retinopathy (DR) in the early 2000s [19]. However, barriers such as digital literacy and access to appropriate and affordable technology and connectivity disproportionately affected people of color, low-income individuals, and those living in geographically isolated regions, impairing their access to these new models of care [11, 21, 22].

As stated previously, teleophthalmology has many unique challenges in replicating the physical exam in a virtual setting. This challenge is not felt equally among the various subspecialties in ophthalmology. Before the pandemic, Caffrey et al. showed that general eye care had the highest utilization of virtual screening and triage visits, followed by emergency and trauma consultations.[23•] In 2021, the Weill Cornell report analyzed 2330 video visits and found that oculoplastics, pediatrics, and neuro-ophthalmology had the largest utilization rate.[24••] This agrees with the findings by Saleem et al. in 2020.[8••]

Models of Virtual Care in Ophthalmology

Store and Forward

For over 20 years, store-and-forward was the most common model of care used in teleophthalmology, specifically targeting screening of retinal diseases such as DR, age-related macular degeneration (AMD), and retinopathy of prematurity (ROP) [25•]. Available technology only accommodated 30 to 45° images of the retina, and dilation was required to clearly assess the peripheral retina. The evolution of portable non-mydriatic cameras has improved resolution, costs, and increased accessibility, making them a reasonable option for asynchronous programs [26]. Additionally, fundus ultrawide field imaging has become more reliable [27]. Nonetheless, this equipment is still too space-consuming and highly priced to propose as mainstream for screening purposes in public-health settings.

Another limiting factor has been the availability of certified or trained readers to report the imaging and refer the patients accordingly. A network of reviewers and technological innovation, such as AI, needs to be established to facilitate the turnaround times for evaluating, reporting, and building the proper referral pathway so patients can complete their diagnostic and therapeutic processes in a due manner.[28, 29•]

Smart phoneography was used not only as an imaging solution but also as a means of distributing medical data to groups of experts who read the images and replied to senders. This occurred because, in many countries, personal data protection regulations and cyber security norms were relaxed as the need to communicate soared during the first wave of the pandemic. In Israel, a cross-sectional study using a self-administered survey was performed during the onset of the outbreak to estimate the extent of WhatsApp utilization among ophthalmologists in various clinical settings. They concluded that many already used WhatsApp as a tool for professional consultations with other providers, due to its simplicity and wide availability and urged policymakers, healthcare organizations, and insurers to address the concerns not only of data protection but coverage and reimbursement for these types of encounters.[30]

Real-time

Before the pandemic, the use of real-time video was underutilized compared to telephone communications between providers and patients. It is puzzling why the added value of video in medical communications has not always been well understood. Pervasive video allows for communicating verbally and non-verbally, adding more information to a simple conversation. Direct eye contact, bodily expressions, and the surrounding environment and family/caretakers that are lost over a phone call, come into full bloom on the screen [31].

The use of videoconferencing to enhance face-to-face experience grew exponentially during the pandemic as the use of new mobile and desktop platforms was marketed overnight. Some subspecialties were swifter than others in adopting telemedicine.[20, 24••, 32] At the Lion's Children Hospital in Minneapolis, MN, USA, the pediatric ophthalmology service adapted quickly to the pandemic restrictions, revamping their original synchronous patient-to-provider virtual visit (SPPVV) protocol that allowed for new, established, and postoperative patient care.[33••]

Lastly, the advent of synchronous smart phoneography with digital slit lamps (SLs), adapters for smartphones and tablets, and good examining techniques allowed trained personnel to share live images with remote colleagues, bridging the gap in underserved areas while addressing the concerns of social distancing. It also allowed for avoiding unnecessary referrals to specialty care. In Scotland, video and iPad-adapted SLs were used by community optometrists to perform real-time teleophthalmology consultations with secondary care specialists during lockdown [34].

Hybrid

During the pandemic, the hybrid model grew the most. Typically, a hybrid care model refers to the combination of synchronous and asynchronous models. In many places, the need to minimize the risk of exposure to infection transformed the usual clinical practices. Eye visits were split into two encounters: patients had pre-ordered tests performed onsite followed by an online encounter with specialists, giving rise to the name "hybrid visit" or "split visit" [35]. This new visit type allowed fewer touch points for the patient and provider and had additional benefits in educating the patient through easy sharing of test results and informational resources in the virtual wrap-up as depicted in Fig. 1.[36, 37]

Multiple facilities offered "curbside" monitoring of intraocular pressure, as an example, to minimize contact between the patient and health personnel. One such experience was published by the Kellogg Glaucoma Clinic in Chicago, USA, where a total of 241 patients were seen with a drive-through model of IOP checks for glaucoma patients. They reported efficiency and minimized the risk of exposure to COVID-19 for patients and staff.[38]

Hybrid visits were ideal for stable patients who required regular monitoring of their medical problems, such as chronic open-angle glaucoma, AMD, uveitis, or diabetes [1, 39]. A community collaborative care approach in India revealed the value of the hybrid model during the pandemic. By "coupling" teleophthalmology with community centers staffed with trained ophthalmic technicians, ophthalmologists were able to follow up patients with stable conditions as well as non-complicated postoperative cataract patients [40]. Nonetheless, the current trends show that the patient population and providers have started to abandon the hybrid modality, navigating back to the care they were used to the traditional ophthalmic setting.[21]

Home Monitoring (RPM)

Home monitoring has only recently seen an increase in its uptake. Patients are increasingly connected to devices collectively referred to as the Internet of Medical Things (IoMT), which can monitor and report their health data to a centralized location such as an EMR (electronic medical record) or cloud

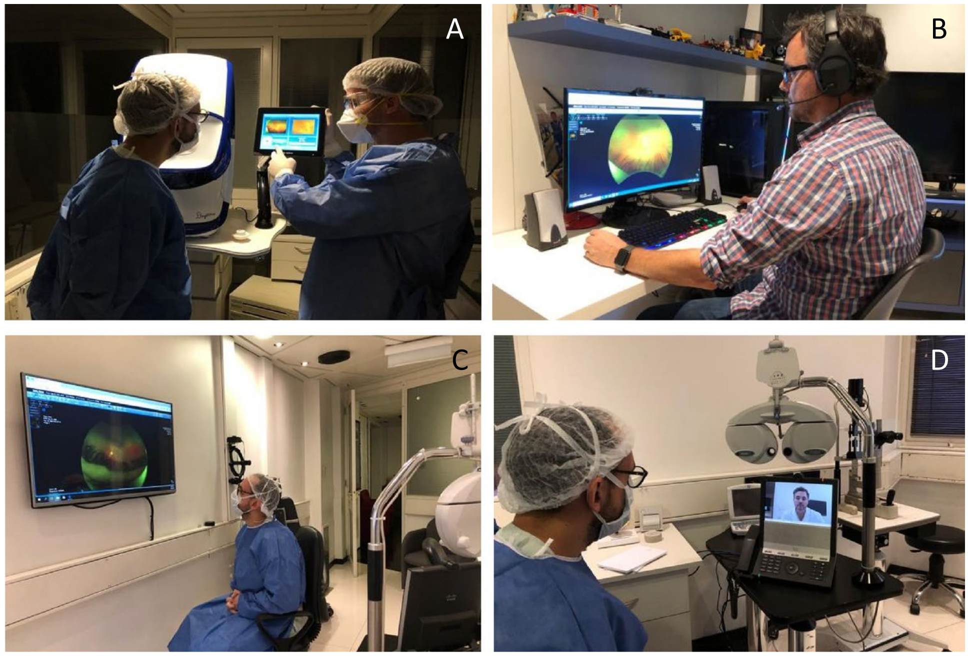


Fig. 1 Instituto Zaldivar's hybrid visit model during 1st wave of the COVID-19 pandemic. **A** Technician (right) performs ultra-wide fundus photography on patient (left). **B** Eyecare provider evaluates images from home setting asynchronously. **C** and **D** Patient and provider review images and discuss management during a synchronous wrap-up. Photographs courtesy of Dr. Lucio L. Arias, Service chief retina and vitreous diseases, Instituto Zaldivar, Mendoza, Argentina

service. Empowering patients to take control of their eye and vision health and actively participate in the monitoring and management of their diseases should be one of the goals of healthcare reform.

In the eye and vision care, the advancement in biosensor development and self-assessment ophthalmic apps and equipment has enabled patients to monitor themselves at home [4, 41]. The limited access to clinical visits during the pandemic yielded an important push for such technologies to be not only developed but also integrated into accessible and user-friendly systems. Building upon the widespread network of smartphone and tablet devices, all-in-one integrated applications were developed, allowing patients to monitor and report data such as visual acuity, Amsler grid changes, intraocular pressure, visual fields, and optical coherence tomography (OCT) [42, 43]. The next frontier will be the regular adoption of extended reality devices to perform comprehensive eye tests as well as self-managed remote SL and fundus imaging.

Enhancing Virtual Eye Care with Technology

As seen, the ability to perform a robust teleophthalmology visit has grown in tandem with the advancements in ophthalmic devices and apps, as well as patient and provider acceptance of the technology. Novel approaches to the ophthalmic exam which have seen increased adoption during the pandemic include smartphone-adapted and robotic-controlled SLs, smartphone-adapted indirect ophthalmoscopes, ultrawide-field retinal cameras, portable OCTs, and virtual reality (VR) visual field devices. Emerging technologies have made remote ophthalmic examination more reliable and user-friendly than ever before [44].

The ocular surface and adnexa are ripe with potential for use of teleophthalmology given these structures' location [45–47]. On the other hand, cataract evaluation, as well as posterior segment analysis, still requires significant work to approach the gold standard ophthalmic assessment which utilizes a SL exam in the first case and dilated fundus exams with lens or an indirect ophthalmoscope in the second.[48••].

Regarding cataract screening, corneal evaluations, and other anterior segment conditions, several reports demonstrate the importance of imaging resolution as a limiting factor [45, 48••]. Identification of flare and cells in the aqueous is a crucial observation in uveitis patients that may be overlooked during synchronous SL examinations.[49]. As for retinal diseases, ROP screening is an excellent example of how the adoption of new retinal cameras and the use of video catalyzed the growth of these programs.[50, 51].

Mobile (mHealth) solutions provide access to isolated patients, either in hostile or underserved areas, during the pandemic. In Afghanistan, the mobile eye care app *FOXTROT* was used by the US Army to assess eye trauma, showing eternal segment and corneal trauma as the most frequent teleconsultations [52]. These mobile solutions saw increased uptake in certain subspecialties, such as neuro-ophthalmology [53]. Pediatric eye and vision care also benefited from the development of mHealth solutions, like the *TreC Oculistica* project in Trento, Italy. Using a hybrid model, a patient-centered app coupled with the provider's EMR allowed for time management during the pandemic. [35]. In India, multiple video communication platforms were used to reach patients and transfer clinical data from their *eyeSmart* EMR to their phones. Apps like *9 Gaze* produced ocular photographs of the child's eye and transferred the data to the provider for their analysis. [54]

Finally, technology has also played an important role in expanding the scope of public health and vision care. Preventable blindness is still a major concern globally, and many studies are targeting the use of telemedicine as a means to facilitate data interpretation and documentation across a broad spectrum of ocular diseases [55–57]. DR screening evolved, and more importantly, AMD and glaucoma screening expanded their outreach noticeably with the development of remote monitoring devices described earlier.

The need to offload the burden of ophthalmic care from specialty services has been approached in multiple studies by pairing a visit to the primary care provider's office with a teleophthalmology visit, whether this is to allow peer-to-peer discussion or to allow different specialties to collaborate. In Brazil, *TeleOftalmo* is one such project that utilized telemedicine in primary care to manage patient eye care with the collaboration of a remote ophthalmologist [58]. Using a system specifically designed to meet their needs, the *TeleOftalmo* system incorporates a secure online platform, synchronous videoconferencing and remotely operated robotic cameras, integration with a DICOM (digital imaging and communication in medicine) server, and remotely operated medical equipment [58]. The authors report the first use of telemedicine to perform synchronous subjective refraction, which allowed them to fully manage 70% of the patient's eye care needs and remove such patients from the need for specialty eye and vision care referral [59••].

Leveraging of ICTs also allows for decreasing the waiting times for first available appointments in overloaded eye centers [60]. Many institutions turned to virtual care as a strategy to provide timely consultations and examinations. The rapid virtual eye care (RVEC) program at Bascom Palmer Eye Institute, in Miami, started in April 2020. Since its inception, the RVEC has served over 3300 patients. As of the time of this review, the first available appointment is in 1.3 days, compared to 69 days for an in-person new patient visit. Patient satisfaction is high, with over 93% willing to recommend the service to others. Providers surveyed expressed their comfort and satisfaction with the model, and a new revenue stream was secured without investing in additional retail space. See Fig. 2.[61]

Smart Phoneography

Harnessing the video capability of increasingly powerful smartphones has opened a promising avenue for teleophthalmology due to the devices' widespread availability, integrated connectivity, and post-processing capabilities. Smart phoneography for anterior segment imaging markedly increased during the pandemic.[48••]

Smartphone-adapted SLs can now capture images that are of similar quality to traditional SL photography. The modality pairs well with both synchronous and asynchronous teleophthalmology [62]. When combined with robotic controls, a smartphone-adapted SL enables an ophthalmologist to perform a remote examination that is comparable to a traditional examination [48••]. The use of stereoscopic cameras and displays allows for 3D viewing that is even closer to a traditional in-person examination and does not require a highly trained technician or ophthalmologist to be present with the patient [39].

Smartphone-based fundus imaging (SBFI) is a disruptive technology for fundus examination and screening and may be particularly well suited for low and middle-income settings where direct ophthalmoscopy is not readily available [63]. While the image quality produced by a SBFI is dependent on multiple factors, including the smartphone employed and the operator's skill with the device, the benefits of the smartphone may make it an ideal alternative to traditional fundus imaging.

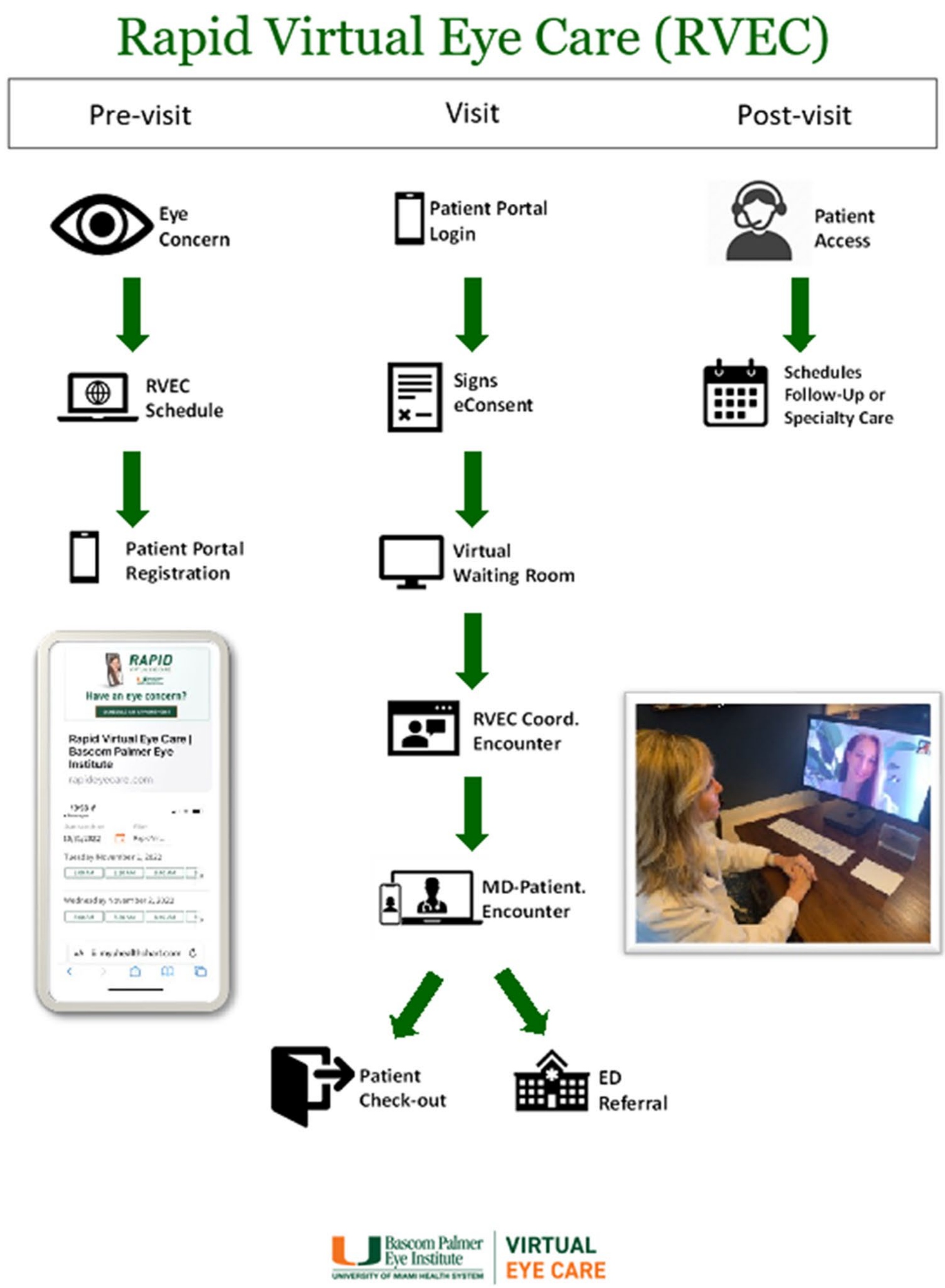
As SBFI devices become increasingly user-friendly, the ability to train allied health professionals and even lay persons to capture images will enable task shifting away from more skilled team members and will expand geographic access to care. Limitations in the degree field of view, when considering nonmydriatic options, make these devices more suited to particular disease processes where the view of the macula and optic disc is most important [63]. By utilizing the post-processing capabilities of the smartphone, multiple images may be spliced together, providing a high-quality 100° image [64]. The development of wide-field imaging is a potential solution to this limitation, which has received great attention during the past several years. Smart phoneography and SBFI use in the emergency room and pediatric clinic has been reported, and the devices have been employed to screen for DR, glaucoma, and ROP with overall promising results, although mixed reports are noted in the literature [63]. The technology is studied as a tool to teach fundoscopy to students and non-eye and vision care providers because of the ability for the instructor and the student to share the same view, and early results have been promising.

Artificial Intelligence

Amongst the myriad technological advancements in eye and vision care, one of the most promising is the advent of AI.[11] With the ever-expanding promise of personalized healthcare, AI may deliver unique results to each patient by utilizing the vast amount of data generated in each clinical encounter [65].

AI presents a valuable opportunity for enhancing current technology while simultaneously shifting workload away from

Fig. 2 RVEC workflow initiates with patient's pre-visit registration, followed by an encounter with the RVEC coordinators and providers (same day or within 24–36 h), and finalizes with a post-visit, where patient access schedules necessary follow-up



clinical bottlenecks, including ophthalmologists and trained image graders [65]. AI has already gained traction within the eye and vision care for its use in screening vision-threatening diseases as well as predicting prognosis for established eye diseases [66]. In the USA, AI has been operationalized for the interpretation of DR screening photos with funding from government-sponsored healthcare [67]. As with other developing technologies, AI applications will require both validations compared to current practice and cost–benefit analyses [68]. Further development of AI requires large data sets with accurate classification and high quality for training the AI system [69].

Educating in the New Norm

Virtual training and education of providers and allied healthcare personnel expanded rapidly during the COVID-19 pandemic [70].

Remote learning is certainly not a new model of education. Previous analyses have weighed the benefits of virtual learning, including reduced travel time and expense, increased geographic access, scalability, and decreased operational expenses in conducting classes, to the negative consequences such as loss of in-person interaction, increased time to prepare new teaching material, and the need for trainers and trainees to own and learn to use new technologies. The pandemic temporarily halted such debate when the possibility of in-person encounters was removed from the discussion [71].

With the many advancements in technology and increased uptake of digital education, there are many opportunities to improve our education architecture. Utilizing widely accessible web-based platforms to conduct problem-based learning and gain clinical experience has been found to improve the diagnostic competency of students compared to traditional educational resources [71]. It is critical to design interactive and engaging material through implementation of innovative learning solutions such as virtual reality.

While many have noted a serious limitation of virtual education is the lack of hands-on training and experience, this is changing. Virtual reality, augmented reality, and haptic feedback simulations are being developed that allow students to practice repeatably in a low-stakes environment [72, 73].

The pandemic severely restricted the ability to work in a clinical setting and gain direct feedback [74]. Students had limited access to mentorship, which is critical for finding opportunities for research and earning robust letters of recommendation [5]. These limitations disproportionately affected students who lacked a home program at their university, given the limitations in travel and externships during the pandemic. As we move back to a state of normalcy, it is imperative not to forget the difficulty many students have faced and will continue to face. Harnessing the lessons learned will allow utilization of the resources we have established to create a more equitable landscape.

Another exciting prospect enabled by the advancements in technology is telementoring. Systems such as the remote surgeon virtual presence allow expert surgeons to remotely guide trainees in surgical wet laboratory environments across the globe [75]. Such systems have incredible potential to allow knowledge and skill transfer that transcends borders which may be particularly beneficial in rural settings and in the developing world where resources are scarce. It may also be implemented in acute care settings where time does not permit the transfer of a patient to an expert provider.

Metaverse and Healthcare

Though the COVID-19 pandemic largely normalized the use of remote technology to connect people in a safe manner, it remains challenging to overcome the feeling of separation that may induce strain on the patient-physician relationship as well as between the student and the mentor. This problem is being addressed through immersive experiences utilizing technology such as virtual reality, augmented reality, and mixed reality. The combination of such immersive experiences is revolutionizing many sectors of business and daily life with the concepts of the metaverse and digital twins (virtual representations of a physical object or person), which represents a potential evolution of the medical landscape [76].

While virtual environments are often designed with the intention of delivering new and unique experiences, such as visiting distant worlds, their power to transport users anywhere can also be realized by developing digital twins. The ability to bring physical objects into a digital world is not limited to buildings and environments alone but conceivably can be done with any object, such as a human body, medical instrument, or individual organ [36]. Allowing patients to visit facilities and environments they are already familiar with and comfortable with may be valuable when introducing them to the new digital frontier. [36]

Lessons Learned

The tsunami caused by the pandemic highlighted many variables that needed to be addressed to provide timely and safe virtual care services across the medical field, in both rural and urban areas. Guidelines were drafted and regulations adapted, as the world embraced the first waves and led “ophthalmologists to consider virtualizing their services” as so nicely stated by Sharma et al.[77••]

Ophthalmology, like other specialties, rapidly converted its processes to accommodate remote eye assessments. Subspecialty-specific guidelines were published to address the lack of experience in how to design and manage the workflows incorporating virtual encounters as mainstream during the first wave of the outbreak [11, 78–81]. There was also an absence of videoconferencing software or telephone platform integration into the EMR ecosystem, producing data silos. Although some EMR companies quickly partnered with vendors and adopted web-based real-time communication solutions (WebRTC) embedded in the EMR, the vast majority used each platform independently, losing the ability to track and document the data related to virtual encounters. The advantage of open-source technologies such as WebRTC is that it enables real-time voice, text, and video communications capabilities between web browsers and devices very intuitively, and it is available for all modern browsers and major platforms.

Another limiting factor is that eye and vision care relies heavily on diagnostic examinations and tests, which in some cases are not amenable to virtual care. As described in the studies reviewed, the developments of new models of care expanded during the pandemic and can still be of use in the new norm. Nonetheless, there are some models, such as home care, where progress still needs to be made. While many apps have become available for providing diagnostic tools from home, assessment of a patient’s anterior or posterior segment is still not accessible.

Widespread adoption of telemedicine requires further technological innovation, increased awareness, and digital health literacy, as well as universal connectivity to be fully realized [2, 82]. Universal connectivity is becoming an equity debate and is now considered by many as a social determinant of health [83]. The level of future adoption will be defined by intuitive and more user-friendly applications and platforms, as well as access to seamless and affordable internet services [24••, 84]. Globally, the increase in number of cell phones and the presence of high-bandwidth telecom networks such as 4G or 5G enhances patient access regardless of their location [11].

Worth mentioning is the level of investment that a successful teleophthalmology program requires, based on the wide range of equipment and ICT infrastructure eye and vision care requires in comparison to other fields like psychiatry or primary care [85]. In addition, partnership with a skilled allied workforce such as certified ophthalmic technicians and assistants, which is currently in severe shortage, is critical to a successful operation. In some countries, collaborative care with optometry proves its value by streamlining the continuum of care with community-based optometric teleophthalmology programs, as well as improving outcomes and decreasing costs [86•].

The exponential growth witnessed during these past 2 years was mainly fostered by allowing the use of communication solutions like WhatsApp, Facetime, or Doxymity [41, 87, 88], the possibility of seeing both new and established patients regardless of their location, and the relaxing of regulations for licensing and reimbursement due to changes in reimbursement policies by Medicare and private insurers due to the public health emergency [18]. However, as we see the water surge of the tsunami recede, so will the rate of utilization as the restrictions come back into place and the reimbursement policies change.

Regardless of where we are, we should all advocate for the opportunity of providing our patients with a continuum of care, whether it be face to face or virtual. Major health organizations and national governments need to endorse virtual care strategically, on an ongoing basis [89]. Teleophthalmology is not meant to replace all non-virtual eye and vision care; it is a healthcare strategy that can complement, enhance, and in some cases be the only means of accessing an eye specialist for timely, appropriate care. Ethics and the patient-physician relationship must remain unchanged in the realm of the new models of virtual care [90]. And as we strive to implement and advance technology to provide innovative solutions and care modalities, we must not forget the importance of the patient-physician relationship. Utilizing real-time, dynamic, and immersive 3D experiences may allow telemedicine to be more fully realized for the many advantages and benefits it offers [91].

During the COVID-19 pandemic, our response to lockdowns, shelter in place, and the use of telemedicine was reactionary. Millions of patients who had never previously utilized or experienced telehealth now had access to and need its services, and this resulted in overburdened healthcare administration and the use of third-party company solutions without time to fully train, test, or integrate these systems into place [92].

This resulted in both physicians and patients who had negative first encounters with telemedicine, who will carry away from their experience negative bias, which will need to be overcome. By promoting, studying, training, and correctly implementing telemedicine into our expanding tool belt as physicians while not under the limitations of a health crisis, we can advance the medical field responsibly for the betterment of patients and healthcare providers alike.

Conclusion

Teleophthalmology has shown its value with its different models of care in screening, examining, diagnosing, and monitoring treatment, as well as increasing our access to continuing education in eye and vision care. However, much of the progress made following the COVID-19 pandemic is at risk of being lost as society pushes to reestablish normalcy.

We have a responsibility, as physicians, to harness the lessons learned during these past years and carry over the experiences into the next norm as the healthcare delivery models continue to evolve through the digital transformation that technological innovations create. Cultural appropriateness is crucial to successfully adopt these paradigm shifts.

Nonetheless, we still need to determine its true effects on providers, patients, and society. Further studies during the new norm are required to prove a more permanent role for virtual eye care as the tsunami waves continue to recede.

Declarations

Conflict of Interest The authors declare no competing interests.

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Papers of particular interest, published recently, have been highlighted as:
• Of importance
•• Of major importance

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