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Tele–Neuro-Ophthalmology: Vision for 20/20 and Beyond

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Background: Telehealth provides health care to a patient from a provider at a distant location. Before the COVID-19 pandemic, adoption of telehealth modalities was increasing slowly but steadily. During the public health emergency, rapid widespread telehealth implementation has been encouraged to promote patient and provider safety and preserve access to health care.

Evidence Acquisition: Evidence was acquired from English language Internet searches of the medical and business literature and following breaking news on the COVID-19 pandemic and responses from health care stakeholders, including policymakers, payers, physicians, health care organizations, and patients. We also had extensive discussions with colleagues who are developing telehealth techniques relevant to neuro-ophthalmology.

Results: Regulatory, legal, reimbursement, and cultural barriers impeded the widespread adoption of telehealth before the COVID-19 pandemic. With the increased use of telehealth in response to the public health emergency, we are rapidly accumulating experience and an evidence base identifying opportunities and challenges related to the widespread adoption of tele–neuro-ophthalmology. One of the major challenges is the current inability to adequately perform funduscopy remotely.

Conclusions: Telehealth is an increasingly recognized means of health care delivery. Tele–Neuro-Ophthalmology adoption is necessary for the sake of our patients, the survival of our subspecialty, and the education of our trainees and students. Telehealth does not supplant but supplements and complements in-person neuro-ophthalmologic care. Innovations in digital optical fundus photography, mobile vision testing applications, artificial intelligence, and principles of channel management will facilitate further adoption of tele–neuro-ophthalmology and bring the specialty to the leading edge of health care delivery.

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INTRODUCTION TO TELEHEALTH

Telehealth is the use of technologies for long-distance clinical care, health-related education, public health, and health administration (1,2). Telemedicine is the subset of telehealth that delivers remote patient care through 2-way live interactive communication between the patient and the provider using telecommunication technology (3). Real-time patient and provider interactions are synchronous encounters. Data transmitted to a provider for later review are asynchronous or "store and forward." Remote data monitoring includes synchronous or asynchronous care for inpatients or outpatients. Interprofessional electronic consultations enable physicians to consult with remote specialists.

During the global COVID-19 pandemic, telehealth use grew rapidly to reduce face-to-face interactions. This review addresses telehealth in neuro-ophthalmology, including current challenges and opportunities. Although we highlight activities in the United States, the basic principles have global relevance. Ongoing dialog with international colleagues will help develop standards for best practice.

THE STATE OF TELENEUROLOGY BEFORE THE PANDEMIC

The first telephone call in 1876 was a telehealth encounter. Alexander Graham Bell requested assistance after spilling sulfuric acid on his clothes by saying, "Mr. Watson, come here, I want you." (4). Telehealth evolved with technologic advances. By the 1920s, scientists envisioned medical care by radio and video connections. Remote physiological monitoring developed alongside manned space programs (5). Before powerful mobile computing devices and broadband wireless network connectivity were widely available, telehealth services were provided at health care facilities through dedicated telemedicine carts staffed by telepresenters. Recently, telehealth migrated away from hospitals and clinics toward homes and personal devices (6,7).

Before COVID, the value proposition for telehealth was improving access to care. Telemedicine can overcome geographical, physical, and biological barriers to health care (6–8). Telehealth adoption was slowly increasing (9,10). In neurology, the primary use of telehealth has been acute stroke evaluation (6). In ophthalmology, uses include screening for diabetic retinopathy and retinopathy of prematurity (11,12).

Impediments to widespread implementation included technological, political, regulatory, reimbursement, clinical, and social barriers (7,8). A major hurdle was cultural. Telehealth has not been considered the true practice of medicine by many health care stakeholders (12).

In 2016, the American Medical Association asked physicians what attracted them to digital health (13). Respondents believed telehealth improves work efficiency, increases patient safety, improves diagnostic ability, helps reduce stress and burn-out, improves the patient–physician relationship, and increases patient adherence and convenience. Their main concerns were the evidence base regarding effectiveness, reimbursement, medical liability, and integration into existing practices.

The site of a telehealth encounter is defined as the patient's location at the time of service. There are negligible technological barriers in providing telehealth services across state lines. However, states have the ultimate licensing authority regarding who can practice medicine within their borders, with great variability in regulations regarding practicing telehealth across state lines. A provider's medical liability insurance must explicitly include interstate telehealth.

Coverage parity laws require payers to cover telehealth services if they cover comparable in-person services. Payment parity laws determine whether payments for telehealth and in-person services are the same. Before the public health emergency, not all states had coverage parity laws, and even fewer had payment parity laws.

Despite these barriers, physicians and patients were attracted to telehealth. In 2019, 17.6% (61–70-year-old) to 28.4% (31–40-year-old) of physicians, 52% of women and 49% of men, expressed interest (14). In a 2019 survey, 66% of consumers stated that they were willing to use telemedicine services, citing convenience, faster service, cost savings, and better access to professionals (15). Before the pandemic, global telehealth trends indicated a projected growth from USD $38.5 billion in 2018 to USD $130.5 billion by 2025, and in the United States, the telehealth market had an anticipated value of $36.2 billion by 2020, doubling its value from $14.3 billion in 2014 (16,17).

CHANGES IN TELEHEALTH SINCE THE PANDEMIC

The COVID-19 pandemic dramatically changed the practice of telehealth. Mandates for social distancing transitioned US health care providers toward non–face-to-face patient care (18–25). Telehealth adoption has been encouraged by sweeping regulatory changes from the Centers for Medicare and Medicaid Services (CMS) (3) and private insurers, which lower barriers to telehealth adoption and establish reimbursement parity for virtual and in-person visits (26). Within the first week of the new CMS rules, telehealth use increased by 400% (27). Telehealth services comprised only 1% of all claims before the pandemic and increased to 25% in the United States within the first 2 weeks after the new CMS policies (27).

Many academic and private practice groups converted most in-person outpatient visits into telehealth encounters (28,29). JD Health, one of China's telehealth platforms, reported monthly consultations grew 10-fold since the outbreak to 2 million people/month (30). US consumers are now accepting telehealth at increasing rates as demonstrated in a survey from mid-March 2020, the week that the CMS loosened telehealth restrictions. Nineteen percent of respondents had used telehealth, and two-thirds of respondents indicated that the pandemic increased their willingness to try it (31).

Regulatory Concerns

Despite CMS's guidance to streamline interstate telehealth, there remains great variability in state laws regarding out-of-state providers performing telehealth encounters within their borders. Medical liability insurance policies regarding interstate telehealth and coverage and payment parity laws remain variable. Early in the pandemic, rules and regulations changed so rapidly it was difficult for practices to comply with the latest information.

Billing/Reimbursement

Currently, to preserve patient access to health care regardless of economic and health status, telephone visits, remote audio and video visits, and in-person visits are reimbursed at the same rate by Medicare and some other payers. Payment policies still vary, however. Procedures and certain detailed physical examinations must be performed in-person because of the inability to provide these types of services virtually. Reimbursement parity for virtual and in-person visits aligns payment policies with patient access needs and practice/provider economic viability.

Technologic Advances

Some countries used instant messaging to release newly developed applications for virtual health care services, including public messaging about behavioral modification, epidemiological tracing, and access to virtual health care providers (32). Virtual check-ins were deployed including chatbots powered by artificial intelligence (AI).

Security/Patient Privacy Concerns

The CMS waived patient privacy rules during the pandemic to encourage telehealth delivery through a wide variety of existing technologies. Telehealth applications need not be

Health Insurance Portability and Accountability Act (HIPAA)-compliant for now, greatly expanding the types of software that can be used for virtual visits (23).

Issues of Disparities in Access and Cultural Acceptance

The digital divide impedes access to telehealth services. It has narrowed with 96% of US adults possessing a cell phone and 81% having a smartphone (33). Greater disparity and variability exist regarding home broadband access. In the United States, nearly 80% of white adults have home broadband, compared with 66% of black and 61% of Hispanic adults. Home broadband access is more limited in older adults, rural residents, and those of lower socioeconomic levels (34).

There are still some patients and providers who do not wish to participate in virtual visits despite the advantages. The ubiquity of telehealth during the global pandemic and its high visibility in the public sphere is changing this perception (35).

Workflow Challenges

Workflows for optimal health care delivery must be established for telehealth services (24,25). Telehealth providers, local providers, and patients need to understand their respective responsibilities including how patients are referred, visits scheduled, providers notified, orders entered, and follow-up arranged.

Virtual visits and in-person visits are not mutually exclusive. Telehealth visits can triage patients, determining which patients need in-person visits, procedures, or tests (36). If the patient is faced with the alternative of telehealth vs no care, focusing on actionable information obtainable within the confines of a virtual encounter still serves the patient.

Aspects Specific to Neuro-Ophthalmology Workforce

A 2019 North American Neuro-Ophthalmology Society (NANOS) US membership survey found that there are 1.63 million people per 1.0 clinical full-time equivalent (CFTE) neuro-ophthalmologist, with only 386 individuals in active practice (187 CFTE) in the nation, concentrated in metropolitan areas (37). Before COVID, the median wait time for a new patient appointment was 6 weeks, and over 20% of survey respondents reported over 3-month wait times (37). With projections indicating that an additional 180 physicians (working 0.5 CFTE) are required to meet the goal of 1 neuro-ophthalmologist for every 1.2 million individuals, there is a sizable workforce shortage with low numbers of trainees entering the field coupled with physician retirements (37–39).

Before the outbreak, fewer than 15% of US physicians identified telemedicine as part of their skillset (14) and fewer than 4% of NANOS members used video tele–neuro-ophthalmology (40). A survey of pre–COVID-19 and peri–COVID-19 telemedicine utilization in neuro-ophthalmology found that an additional 64% of neuro-ophthalmologists adopted video telehealth visits. Respondents cited benefits including ensuring continuity of care, improving patient access to care, and patient convenience (41). Respondents also increased adoption of asynchronous telehealth models, including remote interpretation of tests, second opinion record review, and interprofessional consultations. Peri-COVID, telehealth has been an important alternative not only for the underserved but also for the elderly, immunocompromised, mobility-restricted, and visually impaired patients. The main barriers to implementation cited by telehealth adopters and nonadopters include concerns about data/physical examination quality, reimbursement, medical liability, and sufficient infrastructure support for implementation (41).

Challenges and Opportunities of the Tele-Neuro-Ophthalmic Examination

Obtaining a high-quality neuro-ophthalmology examination is critical to telehealth adoption. Presently, validated mobile applications for components of the neuro-ophthalmic examination are available for visual acuity (PEEK Acuity and Vision@home) (42,43), color vision (EyeHandbook) (44), and visual fields (45). Mobile applications can measure torsion (46) and are in development for measuring esotropia (EyePhoneDevices.com) and heterophorias (L. Sun and J. Odell, personal communication, April 4, 2020).

Funduscopy is the major barrier to a complete tele–neuro-ophthalmology evaluation. A solution would require the development of a portable nonmydriatic fundus camera of diagnostic quality easily accessible to patients, with ability to perform mass screenings, that is adopted by providers (47). Nonclinical personnel must be easily trained to perform remote funduscopy. This should be readily scalable to be done by anyone successfully and quickly.

The 3 phases of the Fundus Photography vs Ophthalmoscopy Trial Outcomes in the Emergency Department (FOTO-ED) study demonstrated the feasibility of nonmydriatic ocular fundus photography in the emergency department (ED) and its utility in improving diagnosis and patient disposition compared with direct ophthalmoscopy (48–50). The FOTO-ED study modeled the elements needed for successful tele–neuro-ophthalmology adoption:

1. The ease of capturing quality nonmydriatic fundus photography by nonphysicians who were trained within minutes;
2. Performed when needed for medical decision making at the patient's location;
3. Leading to the correct diagnosis;
4. Noninferior to ophthalmoscopy.

Modern table-top cameras, particularly with the development of nonmydriatic fundus photography, capture high-quality images with a 45° field of view without pharmacological dilation and with remote interpretation by eye specialists, have been advantageous in settings where neuro-ophthalmologists or ophthalmologists are unavailable. Limitations of table-top cameras include lack of portability, cost, technical training requirements, and office-based set-up. Patients must also sit upright. Commercially available portable systems for digital ocular fundus photography include hand-held ophthalmic cameras and smartphone-based ophthalmic cameras. Limitations of hand-held ophthalmic cameras include the time and technical expertise required to obtain high-quality images (51,52). Image capture on smartphone-based ophthalmic cameras can be challenging because of the high-intensity built-in flash, which constricts pupils requiring pharmacologic dilation or utilization of applications to adjust intensity and exposure time (47). When easy-to-use, portable, affordable digital ocular fundus photography is widely available, the rapid interpretation of those images by ophthalmologists/neuro-ophthalmologists potentially assisted by AI/deep learning will reduce a major barrier to a complete tele-neuro-ophthalmologic examination (53).

Optical coherence tomography through telehealth faces similar challenges. Although portable optical coherence tomography scans have been commercially available for over a decade, limitations include high cost, large size, and extensive technical training. Optical coherence tomography integration into tele–neuro-ophthalmology requires development of affordable, easy-to-use, lightweight optical engines with fast acquisition speeds. Such devices are under development (54).

Educational Mission

ACGME program requirements for neurology and ophthalmology training programs state that "at each training program there must be sufficient faculty members with competence to instruct and supervise residents at that location and that faculty members must have subspecialty expertise" including neuro-ophthalmology (55,56). Before COVID, neuro-ophthalmology workforce shortages required some US training programs to secure outside neuro-ophthalmology faculty. Projections suggest this arrangement may increase in the future. In one example, a faculty member travels over 200 miles per month to train residents lacking an on-site neuro-ophthalmologist. This physician provides remote synchronous (through telecommunications) and asynchronous teaching (through their online neuro-ophthalmology curriculum) that has also been used by global learners (K. Golnik, personal communication, April 2, 2020). Additional tele-educational opportunities include the Neuro-Ophthalmology Virtual Education Library (NOVEL) and the Eccles Health Sciences Library at the University of Utah with more than 14,000 users and 77,000 page views from 144 countries (56, N. Lombardo, personal communication, April 24, 2020). The NOVEL and NANOS developed the Illustrated Curriculum with content for basic, intermediate, and advanced learners to support residencies and fellowships, fill curriculum gaps, and increase the availability of neuro-ophthalmology resources (57).

A comprehensive telemedicine neurology residency curriculum is implemented at the University of Rochester (58). This consists of a multifaceted, longitudinal educational program for neurology residents including observational outpatient teleneurology experiences in various subspecialties, completion of a web-based didactic curriculum (highlighting technical, clinical, and medicolegal aspects of teleneurology), and direct observation and evaluation during mock teleneurology visits using both standardized and actual patients (C. Tomcik, personal communication, April 29, 2020).

During the COVID-19 pandemic, many academic neuro-ophthalmologists rapidly implemented remote trainee education. The resident or fellow sees a telehealth patient, leaves the virtual examination room to present to the attending who is located elsewhere, and then learner and attending virtually evaluate the patient together. Given workforce shortages, synchronous and asynchronous tele–neuro-ophthalmology curricula will benefit from continued development and expansion to introduce medical students to the subspecialty and then recruit, train, and retain residents.

FUTURE CONSIDERATIONS

After COVID, the role of telehealth is unclear. Questions include: Will coverage and payment parity continue? What is the right way to provide care for a particular patient: in-person, or through synchronous or asynchronous telehealth services? These and many other questions will be determined by policymakers, regulators, providers, patients, and payers. Stakeholders need to strike a balance between ensuring access to care, the quality of care, and supporting physical practices. Careful consideration of multiple interacting factors includes the evidence base, work processes, reimbursement, state parity laws, licensure and credentialing, infrastructure and the digital divide, and patient and provider acceptance. Evidence of telehealth's clinical utility should rapidly grow because of the growing number of patients receiving virtual care. Although coverage and payment parity may well continue after the public health emergency, it is unlikely that relaxation of HIPAA policies will outlast the pandemic (21,22).

The next steps for advancing adoption of tele-neuro-ophthalmology include research demonstrating tele-neuro-ophthalmology as noninferior to an in-person evaluation, further validation of vision applications, and development of affordable, portable, easy-to-use quality digital ocular fundus imaging methods. These are all in progress (59).

Channel management will be useful for developing a long-range plan for telehealth. This is a strategy in which a business segments its channels to best meet its customers' needs. Consider modern banking. Traditional customers enter the bank to make deposits and withdrawals and interact with the teller. Others bypass that process and enter the bank drive-through or ATM. Customers who wish to stay home simply bank online. New channels are not replicas of the traditional banking experience, and multiple channels are available to reach every possible consumer. Most of these alternative channels were groundbreaking just a few years ago but are now commonplace. Channel management techniques can be applied to neuro-ophthalmology (60). Existing channels include traditional in-office visits, synchronous audio/video visits, and asynchronous communication with patients through the electronic health record. Another channel is direct-to-consumer digital health. The growing US $700 billion digital health industry includes fitness trackers, wearable heart and sleep monitors, home genetic tests, and neurostimulation devices, which are sold directly to consumers (61). Should neuro-ophthalmology develop consumer-facing applications or devices for visual testing? Software is already available that enables consumers to have their refraction measured using their personal computer. A prescription is generated, and glasses can be ordered without an in-person eye provider visit (L. Sun, personal communication, May 22, 2020). Benefits of such products must be weighed against potential harm when traditional safeguards, regulatory and ethical oversight, and clinical studies are bypassed. Some have suggested the digital health product market should guide consumers through labeling with health facts, not claims, similar to the role of the Food and Drug Administration in overseeing food safety and labeling (61).

Other potential channels include the use of AI applications such as chatbots. Already deployed by the retail and service industries, chatbots have entered the health care sector addressing some straightforward patient questions (e.g., medication refills, appointment scheduling and reminders, and basic symptom triage). A virtual or in-person appointment can be scheduled if the concern was not sufficiently resolved by the chatbot (62,63). Although this may be easiest to implement in primary care where clear algorithms for routine health concerns exist, there are examples of AI triaging patients through specialist-created queries (64). In one of the author's organizations, patients requesting an appointment will soon use an automated system where patient responses to queries direct them to self-schedule with the correct provider. What will the role of AI be in neuro-ophthalmologic referrals? Privacy, ethical, and safety issues are ongoing concerns as the health care industry increases adoption of AI and will require appropriate regulations, policies, and payments to enable proper implementation.

Telehealth is an increasingly recognized and used method of health care delivery. Telehealth does not supplant but supplements and complements in-person neuro-ophthalmic care. We need to determine how it can best serve our patients. It does not treat the patient any more than an ophthalmoscope treats vision loss. Diagnosis and treatment remain the domain of clinicians. Our goal is to craft telehealth's integration into high-quality individualized neuro-ophthalmologic patient care. Tele-neuro-ophthalmology adoption is necessary for the sake of our patients, the survival of our subspecialty, and the education of our trainees and students. Innovations in digital optical fundus photography, mobile vision testing applications, AI, and principles of channel management will facilitate further adoption of tele–neuro-ophthalmology and bring the specialty to the leading edge of health care delivery.

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