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Telemedicine for Neuro-Ophthalmology: challenges and opportunities

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Abstract

Purpose of review: Telemedicine for neuro-ophthalmology (tele-neuro-ophthalmology) has the potential to increase access to neuro-ophthalmic care by improving efficiency and decreasing the need for long-distance travel for patients. Requirements for decreased person-to-person contacts during the COVID-19 pandemic accelerated adoption of tele-neuro-ophthalmology. This review highlights the challenges and opportunities with tele-neuro-ophthalmology.

Recent findings: Tele-neuro-ophthalmology programs can be used for triage, diagnostic consultation, and long-term treatment monitoring. Formats include telephone appointments, interprofessional collaborations, remote data interpretation, online asynchronous patient communication, and video visits. Barriers to long term implementation of tele-neuro-ophthalmology arise from data quality, patient engagement, workflow integration, state and federal regulations, and reimbursement. General neurologists may collaborate with local eye care providers for ophthalmic examination, imaging, and testing to facilitate efficient and effective tele-neuro-ophthalmology consultation.

Summary: Tele-neuro-ophthalmology has tremendous potential to improve patient access to high-quality cost-effective neuro-ophthalmic care. However, many factors may impact its long-term sustainability.

Keywords

tele-neuro-ophthalmology; telemedicine; telehealth; neuro-ophthalmology; COVID-19 pandemic

INTRODUCTION

Shortage of neuro-ophthalmologists, which limits access to care, has been a long-standing issue and it is highlighted by the growing demand (1–3).Based on data from the North

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American Neuro-Ophthalmology Society (NANOS), there is an approximate 20% shortage in the neuro-ophthalmology clinical work force and over 20% of neuro-ophthalmologists report wait times >3 months (personal communication of internal NANOS survey, M. Moster) (4). This shortage of neuro-ophthalmologists may be addressed in part by new care delivery models that expand outreach and improve triage yields (5). Tele-neuro-ophthalmology is one such opportunity with great promise for enhancing patient access to high-quality cost-effective neuro-ophthalmic care by utilizing new telecommunication and diagnostic technologies.

The novel SARS-CoV-2 virus 2019 (COVID-19) pandemic has rapidly transformed neurologic (including neuro-ophthalmology) care delivery. The estimated number of neurology telemedicine visits increased from 100- to 1000-fold in some medical centers across the United States and accounted for the majority of the outpatient visits during the first few months of the pandemic (6). As a result of the growth of tele-neuro-ophthalmology during the COVID-19 pandemic, challenges related to dependence on physical examination and ancillary ophthalmic testing have been brought into sharper focus. Concurrently, the challenges highlighted opportunities for innovation to improve current neuro-ophthalmic clinical practice. In this article, we review research and practice recommendations that address implementation and utilization of tele-neuro-ophthalmologic care.

TELE-NEURO-OPHTHALMOLOGY AND CORONAVIRUS DISEASE 2019 (COVID-19) PANDEMIC

Despite the potential benefits for improving access to and increasing efficiency of neuro-ophthalmic care, before the COVID-19 pandemic, only a minority of neuro-ophthalmologists utilized telehealth services. In our own experience, video visits were mainly offered to follow-up patients with mobility or travel limitations for treating efferent conditions such as ocular myasthenia gravis and nystagmus with oscillopsia, triaging new symptoms in established patients, or assessing in post-procedure follow up. This pattern was partially driven by reimbursement requirements.

During the pandemic, most neuro-ophthalmologists, similar to other neurologic and ophthalmic specialists, limited in-person office consultations to emergent or urgent visits only. Many adopted tele-neuro-ophthalmology strategies to maintain access to care for patients while eliminating the risk of travel and in person contact for patient and provider. A survey of 208 practicing neuro-ophthalmologists (81.3% US, 50.2% female, age range < 35 to >65, mode 35–44 years, 63% with ophthalmology certification and 34% with neurology certification) found that during the COVID-19 pandemic, the adoption of video visits increased by 17-fold (from 4% of providers offering pre-pandemic to 70% offering post-pandemic), providing patients with continued access to care and providers with partial recovery of lost revenue (4, 7, 8). Video visits were felt to be most helpful for conditions relying on history, external exam, and previously collected ancillary testing (e.g. migraine with aura, pituitary tumor with prior visual fields, and magnetic resonance imaging (MRI) results), though there was broad heterogeneity in opinions between individual providers (4). Video visits were deemed not helpful for conditions that require detailed visualization of the

optic disc, such as non-arteritic or arteritic anterior ischemic optic neuropathy, and optic atrophy (4). Further study is needed to define which diagnoses are most suitable for tele-neuro-ophthalmology, define accuracy and reliability of remote diagnosis and determine equivalency of outcomes following remote management (9, 10).

As outpatient practices have re-opened for in person care, tele-neuro-ophthalmology, as with telemedicine in other specialties, has remained an important alternative to in-person outpatient visits for the elderly, immunocompromised, and mobility-challenged patients (11). According to a report by Phreesia, a healthcare technology company that helps ambulatory practices with patient intake, outcome and payment evaluation, as of late July 2020, in person ophthalmology visits have returned to baseline rate, whereas neurology in person visits remained substantially below baseline by 17% (12). As the number of telemedicine visits per weeks has now plateaued at approximately 7% of the baseline number of weekly visits vs less than 2% when compared to pre-pandemic, video visit continues to play a role in access to care for geographically underserved populations, such as those 17% of patients who could not be seen in neurology clinic. In COVID times and beyond, it may be a ‘virtually’ perfect solution (13).

CHALLENGES FOR TELENEURO-OPHTHALMOLOGY

As telemedicine has moved to the frontline of neuro-ophthalmology practices, the challenges to health care delivery in this fashion, both general and specific to neuro-ophthalmology have been highlighted. These specific challenges are also relevant to non-neuro-ophthalmic specialists who may care for patients with neuro-ophthalmic disease.

Telemedicine is fraught with risk in quality of care and patient safety (14–16). Remotely capturing the relevant physical examination has been a major challenge, disproportionately impacting neuro-ophthalmology among neurologic subspecialties (8). In the survey of neuro-ophthalmologists, data quality including exam limitations (e.g., internal assessment of the eyes) was selected as a barrier to telemedicine over 90% of respondents. Variable access to technology, especially broadband internet, has the potential to worsen data quality, further impacting data gathered during telemedicine and potentially increasing health disparities for rural patients who tend to live further way from the nearest neuro-ophthalmologist (8, 17, 18).

Assuming continued telehealth reimbursement, more than 70% of neuro-ophthalmologists who practice video visits plan to continue this in their practice post public health emergency (4). While increased institutional supports and federal/state mandates have facilitated tele-neuro-ophthalmology and telehealth, the sustainability is unknown. Reversals of these institutional and government policies may disincentivize long-term telehealth programs.

OPPORTUNITIES FOR TELE-NEURO-OPHTHALMOLOGY

Even prior to COVID-19, telemedicine had been proven effective in neurology and ophthalmology, which supports the use of tele-neuro-ophthalmology. A one-year randomized clinical trial of telemedicine for migraine management found no difference of clinical outcome between the in-office group and telemedicine group. Patients reported

higher convenience and had shorter visit times in the telemedicine group (19). Telemedicine has been proven to be a cost-effective, accurate, and reliable method for screening and monitoring in patients with retinopathy of prematurity (ROP) and diabetic retinopathy (20–22). In addition, there is an emerging body of literature regarding teleglaucoma programs using a “store-and-forward” approach whereby digital images and data are acquired at one site and transferred electronically to an offsite reviewer. The success of this model is based on the usage of ophthalmic devices that are “telemedicine-friendly”, such as automated perimetry, tonometry, corneal pachymetry, and optical coherence tomography (23–26). Teleglaucoma programs benefited both patients and the healthcare system for early detection of glaucoma (sensitivity of 83.2% and specificity of 79%) (24), reduction in wait and travel times, improvement in specialist referral rates, and cost effectiveness (25). Therefore, teleglaucoma was deemed as an effective screening tool for glaucoma service, specifically for remote and underserved communities (27).

Teleglaucoma and ROP programs illustrate how the challenge of an adequate remote physical exam can be turned into an opportunity through the use of digital imaging and telemedicine in a hybrid format (20, 28–31). Ophthalmic imaging and visual fields remain the main types of tests that are obtained in the neuro-ophthalmologist’s office (4). Given that in-home testing is still in its early stages of deployment and technology has not reached implementation despite promising advancement (32, 33), hybrid visits with ancillary testing in the community and televisits with neuro ophthalmologists may become an emerging solution to improve access to neuro-ophthalmologic care (8). During a video visit, the neuro-ophthalmologist will be able to use the screen share function to review these test results with the patient. Moving part of the visit outside the office can minimize unnecessary direct contact with patients, reduce in-office time, and thereby decongest waiting rooms. A reverse hybrid model, wherein a video visit between the patient and the neuro-ophthalmologist occurs prior to collection of ancillary data, can be useful to establish a sooner and safer patient-physician connection, determine the urgency of an in-person visit, and strategize necessary ancillary testing prior to the visit.

Stand-alone video visits also have a role in neuro-ophthalmic care. Similar to what has been demonstrated for migraine care, in some cases the data available via video may be sufficient to provide effective diagnosis and management. In other cases, previously obtained ophthalmic testing by another provider can be used as supplemental information. There is always something providers can offer to the patient via a phone or video visit. It is to the patient’s advantage to receive timely care by any method rather than delayed or to receive no care, and the role of tele-neuro-ophthalmology for timely triage in times of limited in person availability is critical.

Video visits in any form also enhance a patient encounter by allowing family members to participate in pertinent history taking and treatment decision making while adhering to social distancing.

Clinical data collection for Tele-Neuro-Ophthalmology Encounters

Obtaining a high-quality neuro-ophthalmic examination is critical to telehealth adoption (11). With some creativity, a lot of useful information can be gleaned over video. A full

neurologic examination, including a detailed neuro-ophthalmic examination, adapted to a direct-to-patient audio/video encounter can be found in a recent publication.(34) It includes use of several home-based objects that can be helpful during a virtual appointment, such a blood pressure cuff and a scale for vital sign measurements, and internet sourced Amsler grid for visual field evaluation, a penlight/flashlight for pupillary assessment, and a cotton swab (Q-tip) for the sensory exam. (34) A video demonstrating a visual system examination during video visits is useful for both provider and patient education (35).

Objective data collection can be challenging. There are several technological outlets that can be used for home testing in tele-neuro-ophthalmology. Multiple smartphone and tablet applications have been validated for remote visual acuity and color vision testing (7). However, some of them do not have clear instructions, which makes them unideal. In person ancillary testing either in an appointment preceding or following a video visit or with another provider can offset data shortages. Non-mydriatic cameras can be used to perform neuro-ophthalmic screening without needing to dilate the eyes. Optical coherence tomography and formal perimetry can be performed at a referring eye care provider's office. Tests for intraocular pressure, stereo perception, pupillary reaction, and refractive error may also be helpful if done by prior providers or by technicians. These are all dependent on community resources. Applications for tele-neuro-ophthalmology in different video visit types are listed in Table 1.

TELE-NEURO-OPHTHALMOLOGY CASE EXAMPLES

Case 1: Replacement of in office visit for an established patient

A 61-year-old man presented with fatigable ptosis and diplopia. His blood acetylcholine antibodies were positive, and he was diagnosed with ocular myasthenia gravis. He was instructed to start oral prednisone and pyridostigmine with a plan for dose escalation. Two weeks later, he felt that his symptoms have improved and would like to stop advancing both medications. He requested a video visit with his neuro-ophthalmologist for follow-up. His diplopia had resolved. The neuro-ophthalmologist evaluated his extraocular movement and eyelid position on video with normal ocular mobility without fatigable ptosis. The neuro-ophthalmologist agreed with the patient and provided reassurance. This case demonstrated the advantage of in-home visual diagnosis in tele-neuro-ophthalmology.

Case 2: Patient triage

A 54-year-old man with uncontrolled hypertension presented to the neurologist's office for new onset persistent left-sided headaches and binocular diplopia. His neurologic exam was normal except for mild adduction deficit of the left eye. He was given a ketorolac subcutaneous injection and referred to a local ophthalmologist for evaluation of diplopia. On exam, he had mild left upper lid ptosis and a slightly larger left pupil that was minimally reactive to light and a mild adduction deficit. His dilated fundus exam was normal. When his headaches worsened, the ophthalmologist requested an urgent video visit with a neuro-ophthalmologist who was located 2 hours away. At that time, the patient presented with complete left ptosis and a fixed and dilated left pupil. He had left supraduction, infraduction and adduction deficits. He was directed to the emergency room for large vessel imaging. CT

angiogram revealed a left posterior communicating artery aneurysm. He underwent neuro-interventional procedure for aneurysm coiling and recovered well. This case demonstrated the advantage of tele-neuro-ophthalmology in triaging an urgent and life-threatening situation.

Case 3: Hybrid visit

A 32-year-old woman presented with history of pseudotumor cerebri syndrome (PTCS) that was diagnosed 4 years ago. At that time, she had a rapid weight gain of 50 lbs over 6 months of time due to excessive calorie intake. She initially presented with new onset daily positional headaches, transient visual obscuration, intermittent binocular horizontal diplopia, and persistent tinnitus. Her brain MRI was normal and MR venogram did not reveal cerebral venous obstruction or stenosis. She underwent lumbar puncture with an opening pressure of 43 cmH_2O with normal CSF composition. She was started on acetazolamide 1g twice daily. She subsequently lost 10% of body weight and acetazolamide was weaned off within 18 months of diagnosis under the guidance of a local neurologist. She has been followed by a local ophthalmologist with quarterly eye exam and imaging, which were all within normal limits.

Since last year, she started having frequent right-sided headaches with severe photophobia and nausea that lasted for several hours at a time. Although this was a different type of headache from her initial presentation of PTCS, her local neurologist and ophthalmologist were both concerned about recurrence of PTCS. Her neurologic and ophthalmic exam were both normal. Her ophthalmologist obtained and transmitted fundus photos, OCT, and Humphrey visual field 24–2 to a neuro-ophthalmologist who was located 4 hours away. The neuro-ophthalmologist determined the patient's symptoms were most consistent with migraine headaches, which is common in 2/3 of patients with PTCS (36). Her neurologist started her on topiramate, and her headaches resolved over the following month. This case demonstrated the benefits of tele-neuro-ophthalmology in management decisions which avoided unnecessary repeated neuroimaging, lumbar puncture, or reinitiating acetazolamide as considered by patient's local neurologist.

TIPS FOR GENERAL NEUROLOGISTS WHEN PREPARING PATIENTS FOR TELE-NEURO-OPHTHALMOLOGY CONSULTATION

Advances in telecommunications and diagnostic technologies have allowed for the development of tele-neuro-ophthalmology programs. Regardless of the reason for the tele-neuro-ophthalmology visit (COVID pandemic, provider discretion, patient preference), the referring provider can enhance the value of the consultation by collecting and documenting history, examination, and testing that is available to the consulting neuro-ophthalmologist. We suggest a brief vision specific neurologic exam to be performed and documented prior to neuro-ophthalmology referral, which should include: 1) best corrected visual acuity with pinhole at near or at distance; 2) confrontation visual fields; 3) pupillary exam with swinging flash light for relative afferent pupillary defect; and 4) color perception. It is very important that these examinations are performed for each eye respectively. General neurologists may collaborate with local eye care providers, including ophthalmologists and optometrists to

perform a detailed fundus exam and obtain neuro-ophthalmic imaging and testing as listed above to facilitate a hybrid visit. These elements can be forwarded to the neuro-ophthalmologist for review and care delivery via e-consult or video visit.

CONCLUSION

During the COVID-19 pandemic, telemedicine rapidly rose to the frontline of clinical practice as a prevention and mitigation method for community transmission of the disease (34). As a result, a wide spectrum of tele-neuro-ophthalmology strategies is currently used around the world, resulting in a growing body of experience and literature from active tele-neuro-ophthalmology programs. As we amend our practice to the new era of coexistence with the SARS-CoV-2 virus, tele-neuro-ophthalmology has demonstrated tremendous potential to improve patient access to high-quality neuro-ophthalmic care, both in the United States and worldwide. The future of tele-neuro-ophthalmology is unknown. Future efforts need to be focused in the areas of operational excellence, population health, clinical partnerships, advocacy at the state and federal level, and alignment with payors.

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Key Points:

1. Tele-neuro-ophthalmology is a growing field with great promise for increasing patient access to neuro-ophthalmic care by leveraging new telecommunications and diagnostic technologies.
2. The COVID-19 pandemic has demonstrated the feasibility of delivering neuro-ophthalmic care via telemedicine, highlighted challenges and opportunities.
3. Formal studies of telemedicine in other ophthalmic and neurological subspecialties support implementation of telemedicine as an effective care delivery tool.
4. Stand along tele-neuro-ophthalmology had application for triage and evaluation of patients where sufficient data has been collected or can be collected over video. Hybrid tele-neuro-ophthalmology uses video visits to supplement in office data collection.
5. The coronavirus pandemic led to an expansion in telemedicine that may last long after the relevant surge in healthcare needs has passed. Now that the infrastructure is in place to facilitate telemedicine services, stakeholders in healthcare should therefore consider how they can best utilize telemedicine to improve healthcare delivery and outcomes.

Table 1.

Applications of tele-neuro-ophthalmology in different video visit types

1. Replacement of in office visits
a. Established patients where management based on symptoms, video-compatible exam or completed ancillary testing (Case 1)
b. New patient second opinions with records available and suitable ancillary testing completed by other eye care providers
2. Triage (Case 2)
a. Collection of history and video exam combine with review of records and ancillary testing to plan testing, follow up (in person or video) and determine urgency of future visits
3. Hybrid
a. Combined with in person visit for visual acuity, IOP, ancillary testing
b. Combined visit with ophthalmic testing performed by eye care providers at a remote location and telemedicine visit with neuro-ophthalmologist (Case 3)