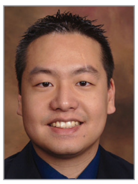
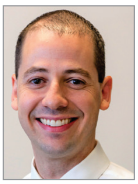
Teleneuro-ophthalmology

Something can almost always be offered virtually for people with neuro-ophthalmologic conditions.

By Kevin E. Lai, MD; Devin D. Mackay, MD; and Melissa W. Ko, MD


The global spread of the SARS-CoV-2 virus has pressured medical providers to examine new models for delivering high-quality medical care while minimizing direct patient face-to-face contact, evidenced by the surge in international telemedicine.[1] For some subspecialties, appropriate telemedicine use remains debated. Physical examination accuracy, billing limitations, and liability are some of the ongoing concerns. However, the COVID-19 pandemic has prompted many countries to address some of these challenges in order to improve access to care while maintaining social distancing recommendations. For example, the Centers for Medicare and Medicaid Services (CMS) in the US have expanded access to reimbursable telehealth services, lifting restrictions on qualifying patients and service locations, and even declaring nonenforcement of Health Insurance Portability and Accountability Act (HIPAA) requirements for video software.[2,3] In turn, neurologists have had to rapidly adopt telemedicine, remotely treat conditions previously managed in person, and innovate solutions to increase access to already scarce subspecialists.[4]

These changes also provide an unprecedented opportunity for telemedicine in neurology. We believe this temporary expansion of services will improve access to and facilitate communication among subspecialists within neurology. A recent report from the Telemedicine Work Group of the American Academy of Neurology noted that teleneurology provides "benefits in expediting care, increasing access, reducing cost, and improving diagnostic accuracy and health outcomes." Teleneurology was found to be noninferior to office-based care in subspecialties with workforce shortages (eg, movement disorders) and was beneficial for multiple sclerosis, neuromuscular disease, and inpatient general neurology.[5] An accompanying editorial declared "…the premise of telemedicine is no longer a research question. The question now is how we best implement the technology."[6] Here, we review the use of teleneuro-ophthalmology and provide 2 recent case examples performed over telemedicine.

Teleneuro-ophthalmology Capabilities

The teleneuro-ophthalmologic exam through the use of validated mobile applications (apps) can assist with remote assessment of visual acuity and other tests of afferent visual function (Table).[7-9] Conceptually, conditions amenable to teleneuro-ophthalmologic examination can be categorized into 3 types:

1. Efferent disorders that are evident through external observations of the eye, lid, and eye movements (eg, anisocoria and other pupillary abnormalities, lid position and ptosis, eye movements, nystagmus, and gaze abnormalities). Commonly diagnosed conditions include Horner syndrome (Case 1), ocular myasthenia

TABLE. VALIDATED APPLICATIONS FOR TESTING VISUAL SYMPTOMS

Test	Applications	Available platforms and devices
Visual acuity	Peek Acuity	Android only
	Vision@home	Validated on Apple iPhone, but can be used on any smartphone web browser
Color vision	Eye Handbook	Apple and Android
Visual fields	Melbourne Rapid Fields	Apple iPad tablet; others in development

gravis (Case 2), and motility disorders secondary to cranial nerve palsies (ie, oculomotor [CN3], trochlear [CN4], and abducens [CN6] nerves).

2. Afferent visual or sensory complaints with previously established normal funduscopic examination and no evidence of intracranial pathology. Commonly diagnosed conditions include symptoms of visual snow, headache or eye pain variants, migraine with visual aura, and other positive visual phenomena.
3. Afferent visual disease that can be evaluated and managed with supplemental information from a referring provider (including fundus imaging, visual fields, optical coherence tomography [OCT] and MRI). Commonly diagnosed conditions include optic neuritis, pituitary tumors, pseudotumor cerebri syndrome, or ischemic optic neuropathy.

Case 1. Horner Syndrome Teleneuro-ophthalmology Visit

Ms. T, who is age 53 with a 6-month history of right Horner syndrome, was seen via teleneuro-ophthalmology for a follow-up video visit that included reviewing results of her recent emergent neuroimaging studies. Head and neck CT angiography (CTA) revealed chronic bilateral focal carotid artery dissections and a mass near the right carotid bifurcation. Ms. T gave consent for the use of and billing for telemedicine services and connected via a HIPAA-compliant third-party web-based application on her smartphone. We obtained a focused history and performed a limited examination that demonstrated right eye miosis and ptosis (Figure). We counseled Ms. T, initiated antiplatelet therapy, and made referrals to a neurovascular specialist and an otolaryngologist.

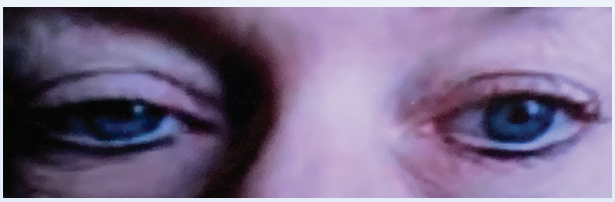


Figure 1. Patient with a right Horner syndrome via telemedicine. Upper and lower eyelid ptosis is present in the right eye. The right pupil is smaller than the left pupil.

Ms. T saw the neurovascular specialist the following day, who determined the carotid dissections could be managed medically. She was diagnosed with fibromuscular dysplasia and prescribed antihypertensives. The otolaryngologist did not recommend surgical biopsy or removal of the carotid body tumor because there was extensive vascular involvement. It is suspected that Ms. T has a benign paraganglioma and she is being followed closely.

Case 2. Ocular Myasthenia Gravis Teleneuro-ophthalmology Visit

Mr. O, age 62, was referred with a history of fluctuating ptosis and diplopia concerning for ocular myasthenia gravis. Test results ordered by the referring physician were positive for antibodies to the acetylcholine receptor (antiAChR). Mr. O gave consent for the use of and billing for telemedicine services and connected via a HIPAA-compliant third-party web-based application on his computer.

We obtained a comprehensive medical history and directed portions of the neuro-ophthalmic examination that demonstrated fluctuating and fatigable bilateral ptosis, Cogan lid twitch, a variable supraduction deficit in the left eye, and resolution of ptosis after a 2-minute ice pack test (Figure). Mr. O had weakness of the orbicularis oculi and left frontalis muscles and flattening of the left nasolabial fold. Neck flexion and extension were intact. We counseled Mr. O about myasthenia gravis, initiated pyridostigmine therapy, ordered a chest CT, made a referral to a neuromuscular specialist, and arranged for a follow-up appointment.

Figure 2. Ice test in a patient with myasthenia gravis via telemedicine. Patient attempting sustained upgaze with bilateral upper eyelid ptosis prior to ice test showing bilateral fatiguability (A). Ice test performed by patient (B). Patient with improved ptosis after ice test (C).

The main limitation of the teleneuro-ophthalmologic examination is the inability to view the fundus, which is critical when evaluating for optic nerve swelling. Although there has been promising work in digital ocular fundus photography through nonmydriatic (ie, without pupillary dilation) funduscopic cameras, which can be used in the emergency department and outpatient settings, limitations include the need for greater portability, affordability, rapid interpretation by experts, and ease of use before there can be broader use in nonophthalmic settings.[10,11] Recent demonstration of using artificial intelligence algorithms to evaluate funduscopic photographs to detect papilledema and differentiate it from other funduscopic abnormalities with high sensitivity (96.4%, [95% CI, 93.9-98.3%]) and specificity (84.7% [95% CI, 82.3-87.1])[12] may allow for rapid screening and interpretation of digital ocular fundus images in the future. When there are exam limitations and signs of an acute neurologic problem or emergency, it is important to refer patients for emergent care.

Teleneuro-ophthalmology Evaluation Tips and Tricks

For any eye finding that can be evaluated with telemedicine, challenges arise when the clinical signs are subtle and technologic challenges (eg, reduced video resolution) make adequate evaluation more difficult. For example, a recent attempt to evaluate a patient with a subtle third nerve palsy who had poor internet connectivity resulted in reduced quality of the video image, limiting a proper exam. To optimize the resolution of video visits, patients are encouraged to check their internet speed before the visit in order to establish whether or not they have download speeds of at least 15 megabits/second (Mbps) and upload speeds of 5 Mbps. This can be easily tested on free websites such as speedtest.net or with their internet provider. If a patient is using wireless internet, it maybe helpful to be sure they are physically close to their router, which may improve download speeds.

Some symptoms can be well-evaluated at home with a little extra assistance. For example, telemedicine is ideal for a patient with ocular myasthenia gravis who started a treatment and has a follow up visit to assess their double vision, eye motility, degree of lid ptosis, and any systemic signs. For patients with visual or mobility impairments, having a family member available to hold a flashlight to assess pupillary reactivity, obtain ice from the freezer for the ice test, or lift the patient's eyelids may also be helpful.

Tools for Teleneuro-ophthalmology

Having clinic staff contact patients at least 1 and preferably several days in advance of a teleneuro-ophthalmology visit is helpful to streamline care. Staff can inform and obtain consent from the patient (although we have clinicians reiterate this at the visit) and help them understand that this is a formal visit to the doctor and should be treated as such. The staff can also reiterate the importance of arriving early and being prepared for the examination. This previsit counseling can also include confirmation that the patient has appropriate video and audio capabilities through their device(s), assistance with downloading any vision apps that might be needed (Table), and a review of the process for the visit. Additionally, patients are encouraged to use a tripod or stand for their mobile device to minimize camera shaking, place their device in landscape mode, and utilize adequate room lighting (ie, patient and physician ideally should avoid bright, harsh lighting directly above or in front of them). A gentle light source about two feet directly opposite the viewer can provide even lighting and reduce glare. Providers can consider using a "selfie light," which is an affordable (~$15) portable ring light, to maximize their own clarity and visibility to patients. Because visual function testing requires utilizing a mobile device with vision apps, ideally, the patient should utilize 2 connected devices (eg, a tablet and a mobile phone), the first for video communication with the physician and the second for the vision testing apps. In our practices, we also find tablets more useful for apps that test visual acuity, color vision, and visual fields (Table). The Peek Acuity app has been validated in adults and children for visual acuity testing, but requires the presence of an assistant due to testing at 2 meters away.[7] Vision@home has been validated on an iPhone, but can be accessed for free for near and distance testing via any smartphone web browser.[8] Although Eye Handbook has various vision tests available, the only validated component is the color vision testing.[9] The Melbourne Rapid Field (MRF Glaucoma) visual field test has been validated and can be useful for longitudinal evaluation of peripheral vision.[13]

Summary and Conclusions

Teleneuro-ophthalmology is useful in the evaluation and management of afferent and efferent disorders that can be adequately viewed on a screen, tested with a vision test app, or evaluated in the context of already existing imaging and laboratory test results. Conditions that require detailed visualization of the optic disc need to be evaluated in person, and clinicians must be sensitive to the possibility of a true neurologic emergency requiring additional emergent care. Even if a telephone or video visit results in an in-person appointment or visit to an emergency department, the initial evaluation remains useful. Preparing patients in advance of an appointment to establish appropriate privacy, adequate lighting, and resources is crucial to success.

Despite the exam limitations, there is always something that can be gained via a phone or video visit and always something that can be offered to the patient. The ability to let people know whether or not they can wait for an

(Continued on page 54)

(Continued from page 49)

in-person visit from a telemedicine visit has provided reassurance and satisfaction amongst our patients. There is a need for increased flexibility in the delivery of healthcare, especially within neurology and its subspecialties where we grapple with limited patient access and a challenging reimbursement landscape.[14] In neuro-ophthalmology, we continue to pursue ways to provide greater access to care and telemedicine may be one way for us to cohesively continue to deliver high-quality neurologic care to our patients. ■

1. The smartphone will see you now: millions of Chinese, cooped up and anxious, turn to online doctors. *The Economist* [online]. March 5, 2020; Accessed March 20, 2020. https://www.theeconomist.com.
2. Centers for Medicare and Medicaid Services. Medicare telemedicine health care provider fact sheet. *CMS.gov*. March 17, 2020. Accessed March 20, 2020. https://www.cms.gov/newsroom/fact-sheets/medicare-telemedicine-health-care-provider-fact-sheet
3. Center for Connect Health Policy. COVID-19 *Telehealth Coverage Policies*. April 30, 2020. Accessed May 5, 2020. https://www.cchpca.org/resources/covid-19-telehealth-coverage-policies
4. Frohman LP. The human resource crisis in neuro-ophthalmology. *J Neuroophthalmol.* 2008;28(3):231-234. https://doi.org/10.1097/WNO.0b013e318185e084
5. Hatcher-Martin JM, Adams JL, Anderson ER, et al. Telemedicine in neurology: Telemedicine Work Group of the American Academy of Neurology update. *Neurology*. 2020;94(1):30-38. https://doi.org/10.1212/WNL.0000000000008708
6. Guzik AK, Switzer JA. Teleneurology is neurology. *Neurology*. 2020;94(1):16-17. https://doi.org/doi:10.1212/WNL.0000000000008693
7. Bastawrous A, Rono HK, Livingstone IA, et al. Development and validation of a smartphone-based visual acuity test (Peek Acuity) for clinical practice and community-based fieldwork [published correction appears in *JAMA Ophthalmol*. 2015 Sep;133(9):1096]. *JAMA Ophthalmol.* 2015;133(8):930-937. https://doi.org/10.1001/jamaophthalmol.2015.1468
8. Han X, Scheetz J, Keel S, et al. Development and validation of a smartphone-based visual acuity test (Vision at home). *Transl Vis Sci Technol*. 2019;8(4):27. https://doi.org/10.1167/tvst.8.4.27
9. Ozgur OK, Emborgo TS. Vieyra MB, Huselid RF, Banik R. Validity and acceptance of color vision testing on smartphones. *J Neuro-Ophthalmology*. 2018;38(1): 13-16. https://doi.org/10.1097/WNO.0000000000000637
10. Irani NK, Bidot S, Peragallo JH, Esper GJ, Newman NJ, Biousse V. Feasibility of a nonmydriatic ocular fundus camera in an outpatient neurology clinic. *Neurologist*. 2020;25(2):19-23. https://doi.org/10.1097/NRL.0000000000000259
11. Vasseneix C, Bruce BB, Bidot S, Newman NJ, Biousse V. Nonmydriatic fundus photography in patients with acute vision loss. *Telemed J E Health*. 2019;25(10):911-916. https://doi.org/10.1089/tmj.2018.0209
12. Milea D, Najjar RP, Zhubo J, et al. Artificial intelligence to detect papilledema from ocular fundus photographs. *N Engl J Med*. 2020;382(18):1687-1695. https://doi.org/10.1056/NEJMoa1917130
13. Prea SM, Kong YXG, Mehta A, et al. Six-month longitudinal comparison of a portable tablet perimeter with the Humphrey Field Analyzer. *Am J Ophthalmol*. 2018;190:9-16. https://doi.org/10.1016/j.ajo.2018.03.009
14. Frohman LP. Neuro-ophthalmology: transitioning from old to new models of health care delivery. *J Neuroophthalmol*. 2017;37(2):206-209. https://doi.org/10.1097/WNO.0000000000000518

Kevin E. Lai, MD
Department of Ophthalmology
Indiana University School of Medicine
Indianapolis, IN

Devin D. Mackay, MD
Departments of Neurology, Ophthalmology, and Neurosurgery
Indiana University School of Medicine
Indianapolis, IN

Melissa W. Ko, MD
Departments of Neurology, Ophthalmology, and Neurosurgery
Indiana University School of Medicine
Indianapolis, IN

Disclosures
The authors report no disclosures.