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Teleneurology during the COVID-19 pandemic: a step forward in modernizing medical care

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Abstract:

Background: The COVID-19 pandemic mandated rapid transition from face-to-face encounters to teleneurology visits. While teleneurology is regularly used in acute stroke care, its application in other branches of neurology was limited. Here we review how the recent pandemic has created a paradigm shift in caring for patients with chronic
neurological disorders and how academic institutions have responded to the present need.

**Method:** Literature review was performed to examine the recent changes in health policies. Number of outpatient visits and televisits in the Department of Neurology was reviewed from Yale University School of Medicine and Johns Hopkins School of Medicine to examine the road to transition to televisit.

**Results:** The federal government and the insurance providers extended their supports during the COVID-19 pandemic. Several rules and regulations regarding teleneurology were revised and relaxed to address the current need. New technologies for video conferencing were incorporated. The transition to televisits went smoothly in both the institutions and number of face-to-face encounters reduced dramatically along with a rapid rise in televisits within 2 weeks of the declaration of national emergency.

**Conclusion and Relevance:** The need for “social distancing” during the COVID-19 pandemic has created a major surge in the number of teleneurology visits, which will probably continue for the next few months. It may have initiated a more permanent transition to virtual technology incorporated medical care.

**Introduction**

Health care systems throughout the world face unforeseen challenges with the novel COVID-19 pandemic. Apart from providing acute care to the overwhelming number of patients with COVID-19 infection, it is crucial to minimize community spread while continuing necessary patient care.\(^1,^2\) To mitigate exposure of patients and to protect health care providers, reduction of any unnecessary face-to-face interaction was recommended.\(^1\) The majority of neurology clinic visits have been either deferred or transformed into tele-health visits.\(^1,^3-^5\)

Tele-health in neurology was initially studied in the treatment of Parkinson’s disease over 20 years ago and has been widely used in acute stroke care.\(^4,^6,^7\) However, implementation of teleneurology in non-stroke services has been limited.\(^6,^8-^12\) Prior to the COVID-19 pandemic, telemedicine programs were gradually being integrated with medical care throughout the world.\(^13\) It is still a relatively new platform and requires specific infrastructure.

Recognizing the need for a rapid transition to televisits, the federal government granted telemedicine services to seniors regardless of where they live, supporting a cost of $500 million for such expansion.\(^3,^14\) Many Medicare restrictions to telehealth have been
relaxed, including the Health Insurance Portability and Accountability Act (HIPAA) compliance.\textsuperscript{15} Other insurance providers also came forward and agreed to reimburse telehealth visits.\textsuperscript{16, 17}

In this report, we highlight some of the recent changes in telehealth policy, challenges with the recent transition, and review such transformation in the Department of Neurology at two large academic institutions in the USA.

Methods:

Throughout this article, we have used teleneurology as equivalent to the application of telehealth, an umbrella term for remote healthcare not necessarily including clinical services, in neurology.\textsuperscript{13, 18} Apart from providing direct clinical care, use of store-and-forward techniques, in which clinical information (including case history, electroencephalography tracing, imaging studies) can be sent to a clinician for review and consultation were considered as part of teleneurology.\textsuperscript{4, 13}

Electronic searches were conducted of PubMed, Web of Science, EMBASE, and Ovid MEDLINE for any relevant articles on teleneurology. Recent articles and policies published in electronic media were also reviewed.

The number of outpatient visits, including in-person encounters and televisits, were obtained from Yale School of Medicine and Johns Hopkins School of Medicine neurology departments over a two-month period (March-April 2020). Types of visits were also examined when available. Approval by an ethical standards committee on human experimentation (institutional or regional) was not indicated. This was not a human research or clinical study.

Results:

1. Recent changes in healthcare policies

   a. Insurance

   In response to the COVID-19 emergency, rural and site limitations for televisits have been removed by Medicare and Medicaid.\textsuperscript{19} In addition, the following broader coding changes were incorporated:

   1. Virtual check-in codes (G2010, G2012), for established patients, for quick check-ins (5-10 minutes), were available even before COVID-19, and no changes were made in these codes. Similarly, no significant changes were made for interprofessional
telephone/internet/EHR consults (eConsult - 99444, 99447, 99448, 99451, 99452), online digital evaluations (G2061-2063), and online medical evaluations (99421-99423).

2. Modifier 95, which indicates “Telemedicine Service Rendered via Real-Time Interactive Audio and Video Telecommunications System”, can be used for 99201-99205 (Office/outpatient visit new), 99211-99215 (Office/Outpatient visit established), 99231-99233 (Subsequent hospital care) for reporting synchronous (real-time) telemedicine services through an audiovisual media.\(^2\)

Most of the malpractice insurance carrier should cover within the state (within license area) medical care providing activities; it is recommended to ensure that the policy covers those providing care via telemedicine.\(^{16, 19, 21}\)

b. State licensing

During the COVID-19 emergency, to address the lack of physicians, many states allowed licensed providers from other states to practice televisits. It is important to ensure appropriate malpractice coverage.\(^{16, 19, 21, 22}\)

2. Challenges with teleneurology and some general guidelines

a. Setting up teleneurology

Despite rapid expansion of televisit capacity, it became immediately clear that current need far outstripped available standard televisit resources. Recognizing this limitation, the Office of Civil Rights at the Department of Health and Human Services (HHS) has allowed use of commonly available video conferencing applications for televisits with relaxation of HIPAA related regulations during the COVID-19 nationwide public health emergency (Table 1).\(^{15}\) However, access to data generated during the encounter should be limited only to pertinent personnel.\(^{23, 24}\)

Unlike telestroke, the majority of these visits will take place at a patient’s home. A good connection with high bandwidth (preferably more than 100 kbs/s) is necessary for uninterrupted and fair quality video conferencing.\(^9\)

b. The encounter

The telemedicine service should be patient-initiated, and a verbal consent from the patient is required as Medicare coinsurance and deductibles are applicable. It is recommended to use two-factor identifier, such as name and date of birth, before starting the encounter.\(^{20}\)
Given the remote nature of the visit, a consent should be obtained for visit and must be integrated in the electronic health record. A sample consent template from the American Academy of Neurology website:

“This is a telemedicine visit that was performed with the originating site at [INSERT PATIENT LOCATION] and the distant site at [INSERT PROVIDER LOCATION]. Verbal consent to participate in video visit was obtained. This visit occurred during the Coronavirus (COVID-19) Public Health Emergency. I discussed with the patient the nature of our telemedicine visits, that:

• I would evaluate the patient and recommend diagnostics and treatments based on my assessment

• Our sessions are not being recorded and that personal health information is protected

• Our team would provide follow up care in person when the patient needs it.”

c. Presence of a caregiver during the encounter

Having a family member or caretaker with the patient during the visit can be helpful for patients with cognitive deficits and/or significant motor impairment. They can help with adjusting the camera including the angle, zooming, adjust room lighting, adjusting the volume of audio, limit background noise (such as taking care of barking pet dogs, crying children etc.), limit distraction (switching off the television) to optimize ambiance for the televisit. Providing a neurological exam sheet to the caregiver/assistance prior to the televisit can be helpful to ensure a seamless encounter (a sample is provided in appendix 1). Similarly, a sample video instruction for neurological examination can be useful to educate the caregiver/assistance on performing some aspects of the neurological examination, such as gross motor strength testing, and sensory examination.

While presence of a caregiver/assistance during the encounter can be helpful, we should be respectful to patient privacy and ensure that the patient is comfortable with the presence of a second person during the encounter.

d. Neurological assessment

Teleneurology has been studied in a relatively smaller scale in many branches of neurology. The majority of these studies focused on patient and provider satisfaction, diagnostic accuracy, and improved outcomes. Some of the studies on teleneurology have used a telepresenter/junior physician to examine the patient, and some did not
require any neurological examination at all, thus providing only limited guideline on conducting neurological examination over a televisit.\textsuperscript{6, 8, 27}

Cognitive status, speech, some of the cranial nerves, and gait can be assessed in a relatively straightforward way over the video conference. Cerebellar signs such as dysdiadochokinesia, touching nose with finger from extended hand position, and heel-to-shin testing can also be performed with relative ease. However, proper assessment of some of the cranial nerves, muscle strength, and sensory examination would be difficult.\textsuperscript{28, 29}

Gross motor examination can be performed over video to ensure that there is no pronator drift, and both proximal upper and lower extremity strengths are antigravity (as implemented in NIH stroke scale).\textsuperscript{20} Finger tapping, rapid opening and closing of fist, rapid alternative hand movements, and rapid heel tapping can provide some basic idea of fine motor functions and subtle weakness. Without having a trained assistant, confrontational muscle strength testing will not be accurate.\textsuperscript{20} Apart from getting up from the chair with crossed arm, squatting, hopping, heel and toe walking can be used as surrogates of lower extremity strength.

Sensory examination will also be difficult to perform if there is no companion. But, if a companion is present, light touch with a piece of cotton and pinprick with a tooth pick/safety pin (after wiping with alcohol swab) should be possible. Similarly, a Romberg test can be helpful to assess proprioception.

Reflexes can only be examined if there is a companion who can be instructed, and probably the patellar reflex will be the easiest to elicit; however, accuracy of such exam has not been examined.

Study by Bove et al. has shown that sending the patient a kit with a Rosenbaum 14-inch vision card for vision, and 128 Hz tuning fork, safety pin, and alcohol swab (the entire kit cost < $20) was useful to obtain sensory exam with fair accuracy in controlled settings.\textsuperscript{31} Sending a similar kit with cotton ball/gauze, safety pin/tooth pick, tuning fork, vision card, alcohol swab can be considered for selected patients.

\textbf{e. Use of scores to assess severity of disease}

Some subspecialties of neurology, such as neuromuscular medicine, movement disorders, require regular neurological examination.\textsuperscript{4} When detailed neurological examination is not feasible, use of disease severity scores can be helpful and should be encouraged during televisits. Studies have shown the reliability of the Unified
Parkinson’s Disease Rating Scale (rigidity was measured by a nurse clinician), Unified Huntington’s Disease Rating Scale (modified-excluding rigidity and balance assessment), and Abnormal Involuntary Movement Scale over televisit encounters. There are only limited studies on amyotrophic lateral sclerosis (ALS) and one study has validated ALS functional rating scale-revised (ALSFRS-R) score over online assessment. Timed maintenance of a limb position as used in quantitative myasthenia gravis (MG) score can also be helpful to assess muscle strength and fatigability. MG Activities of Daily Living (MG-ADL), a validated patient reported outcome measure, also has the potential to be incorporated into televisit as it does not require a physical examination. Few studies have assessed the Expanded Disability Status Scale (EDSS) in multiple sclerosis over televisits either with the help of a telepresenter or in a controlled environment.

3. Transition to teleneurology at Yale School of Medicine and Johns Hopkins School of Medicine

Both institutions adapted to a rapid transition, as depicted in Figure 1. After the declaration of national emergency in the USA (March 13th), and face-to-face encounters were reduced to minimal numbers by week 2 and more than 98% of outpatient care was provided via teleneurology. However, the total number of outpatient encounters was reduced almost by 40-50% in both health systems. At Yale School of Medicine such reduction in volume was secondary to reduction in the number of new patient evaluations. While a detailed breakdown report was not available from Johns Hopkins, a similar reason can be presumed. As tertiary medical centers, both institutions receive a significant number of referrals from a wide territory. Such referrals often demand detailed physical examinations and thorough scrutiny of previous records, and the former was not possible during the COVID-19 pandemic. Moreover, resources from the outpatient clinic, including support staff, were relocated to more critical needs, which also may have affected the process of streamlining new appointments.

Discussion

The future course of the COVID-19 pandemic cannot be predicted with certainty, but teleneurology will probably be an integral part of neurology outpatient care for at least the next few months, and this change in care may become entrenched for the longer term. Telemedicine not only decreases non-essential (or non-critical) face-to-face encounter and potential spread of disease during this pandemic, but also provides earlier access to specialized care, reduces the burden of patient transport, and is often more comfortable for both patients and caregivers. While there are clear limitations to
this healthcare approach in many aspects of neurology, the benefits are also considerable.

It can address the increasing demand for neurological care and cater to patients from remote areas.\textsuperscript{4, 13} Such application will continue to grow as long as insurance providers recognize such needs and continue to support teleneurology. In the past, the upfront investment of teleneurology was a concern, but advances in video conferencing and smartphone technologies have tremendously improved the accessibility of telehealth.\textsuperscript{13}

Similarly, use of smartphone tools, programs that improve medication adherence, electronic diaries for migraine/seizures, body-worn sensor to monitor falls in Parkinson disease, “smart home” installation with ADL assistance, robotic technologies to enhance remote physical exams, application of smart devices to detect movement, can be useful in selected circumstances.\textsuperscript{13, 24, 35} Many of these applications are still under investigation and are not directly applicable to the current need. However, more integration of such devices is expected in the future.

Given the nature of current technology, it is possible that teleneurology will not provide the same diagnostic accuracy as a face-to-face encounter for the initial evaluation, particularly when the diagnosis is dependent on a detailed and accurate neurological examination. For some subspecialties, such as epilepsy, where seizure control, assessment of medication adherence and medication side effects, medication adjustments, and counseling, teleneurology are the focus of the follow-up visits, teleneurology can be an excellent substitute of face-to-face encounter.\textsuperscript{36, 37} Similarly, diagnostic accuracy, treatment, and outcome of nonacute headache related visits are comparable between teleneurology and face-to-face encounter.\textsuperscript{27} For dementia, studies have suggested similar diagnostic accuracy, outcome measure, and compliance between teleneurology and regular outpatient visit.\textsuperscript{4, 38}

The COVID-19 pandemic will not be the time to optimize the full potential of teleneurology. Basic video conferencing with a reasonable quality or a telephone encounter can be helpful to accommodate the present demand.\textsuperscript{20, 23} Particularly when the connection or data speed is not optimal, telephone encounter can provide information on patient wellbeing and also functional status can be estimated. Moreover, for elderly patients, who are not well oriented with new technologies and videoconferencing, and if there is not a second person around to help them, a telephone encounter is the only alternative and can help to avoid a face-to-face visit. Dialing *67 prior to placing the call, use of Doximity Dialer (which is free), or use of a hospital phone line can be used to make incognito calls.\textsuperscript{20, 39}
Despite the necessity and various benefits, there are several limitations of
teleneurology. Some aspects of the neurological examinations will be limited; it will be
preferable to document the observed findings as clearly as possible, and state clearly the
associated limitations.20 “Guessing” at what the exam probably would show if
completed in person adds little value. Proper telecommunication support and good
data connection are essentials for teleneurology, and lack of either will limit the quality
of the visit.19 Moreover, teleneurology is not well-studied in some neurology
subspecialties, such as neuromuscular medicine, neuro-oncology, neuro-
ophthalmology, etc. Utility and effectiveness of teleneurology for such subspecialties
will become more evident with our daily experiences during the COVID-19 pandemic,
and further dedicated studies, focused on validation and the development of best
practice standards, in these areas should be performed.

Conclusion
Teleneurology cannot replace the need for face-to-face neurological encounters, but it is
playing a pivotal role in protecting many patients with neurological disorders from
potential exposure to COVID-19. It also protects the physicians and puts into full effect
the concept of “social distancing.” 20,23,40 The COVID-19 pandemic will likely expedite
modernization of medical care and bring it into the 21st century. It represents an
opportunity that we all must participate in for the optimization of health care delivery.

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Dr. Rutkove is a founder of the Myolex, Inc, the company which have designed the
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Dr. Roda reports no conflicts of interests.

Dr. Khokhar reports no conflicts of interests.

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References:

1. Interim Guidance for Healthcare Facilities: Preparing for Community Transmission of COVID-19 in the United States. Available from: https://www.cdc.gov/coronavirus/2019-ncov/healthcare-facilities/guidance-hcf.html.
2. CMS Takes Action Nationwide to Aggressively Respond to Coronavirus National Emergency Available from: https://www.cms.gov/newsroom/press-releases/cms-takes-action-nationwide-aggressively-respond-coronavirus-national-emergency.
3. Cohen JK. New telemedicine strategies help hospitals address COVID-19. Available from: https://www.modernhealthcare.com/patients/new-telemedicine-strategies-help-hospitals-address-covid-19.
4. Hatcher-Martin JM, Adams JL, Anderson ER, et al. Telemedicine in neurology: Telemedicine Work Group of the American Academy of Neurology update. Neurology. 2020 Jan 7;94(1):30-8.
5. Guidon AC, Amato AA. COVID-19 and neuromuscular disorders. Neurology. 2020 Apr 13.
6. Awadallah M, Janssen F, Korber B, Breuer L, Scibor M, Handschu R. Telemedicine in General Neurology: Interrater Reliability of Clinical Neurological Examination Via Audio-Visual Telemedicine. Eur Neurol. 2018;80(5-6):289-94.
7. Hubble JP, Pahwa R, Michalek DK, Thomas C, Koller WC. Interactive video conferencing: a means of providing interim care to Parkinson’s disease patients. Mov Disord. 1993 Jul;8(3):380-2.
8. Janssen F, Awadallah M, Alhalabi A, et al. Telemedicine in general neurology: use of audiovisual consultation for on call back-up service in an acute care hospital. J Neurol. 2018 Apr;265(4):880-4.
9. Kissani N, Lengane YTM, Patterson V, et al. Telemedicine in epilepsy: How can we improve care, teaching, and awareness? Epilepsy Behav. 2020 Feb;103(Pt A):106854.
10. Muller KI, Alstadhaug KB, Bekkelund SI. Headache patients’ satisfaction with telemedicine: a 12-month follow-up randomized non-inferiority trial. Eur J Neurol. 2017 Jun;24(6):807-15.
11. Srinivasan R, Ben-Pazi H, Dekker M, et al. Telemedicine for Hyperkinetic Movement Disorders. Tremor Other Hyperkinet Mov (N Y). 2020;10.
12. Wong L, Martin-Khan M, Rowland J, Varghese P, Gray LC. The Rowland Universal Dementia Assessment Scale (RUDAS) as a reliable screening tool for dementia when administered via videoconferencing in elderly post-acute hospital patients. J Telemed Telecare. 2012;18(3):176-9.
13. Dorsey ER, Glidden AM, Holloway MR, Birbeck GL, Schwamm LH. Teleneurology and mobile technologies: the future of neurological care. Nat Rev Neurol. 2018 May;14(5):285-97.
14. Pelosi Statement on Coronavirus Emergency Response Bill. 2020; Available from: https://www.speaker.gov/newsroom/3420.
15. Notification of Enforcement Discretion for Telehealth Remote Communications During the COVID-19 Nationwide Public Health Emergency. Available from: https://www.hhs.gov/hipaa/for-professionals/special-topics/emergency-preparedness/notification-enforcement-discretion-telehealth/index.html.
16. COVID-19 Telehealth Coding and Billing Practice Management Tips. Available from: https://www.acponline.org/practice-resources/business-resources/covid-19-telehealth-coding-and-billing-practice-management-tips.
17. Medicare will now cover telehealth to fight coronavirus. Available from: https://www.healthcaredive.com/news/medicare-will-now-cover-telehealth-to-fight-coronavirus/574312/.
18. Seewon R. Telemedicine: Opportunities and Developments in Member States: Report on the Second Global Survey on eHealth 2009 (Global Observatory for eHealth Series, Volume 2). Healthc Inform Res. 2012;18(2):153-5.
19. TELEHEALTH COVERAGE POLICIES IN THE TIME OF COVID-19 Available from: https://www.cchpca.org/resources/covid-19-telehealth-coverage-policies.
20. TELEMEDICINE AND COVID-19 IMPLEMENTATION GUIDE. Available from: https://www.aan.com/siteassets/home-page/tools-and-resources/practicing-neurologist-administrators/telemedicine-and-remote-care/20-telemedicine-and-covid19-v103.pdf.
21. Is the Doctor In? Medical Malpractice Issues in the Age of Telemedicine. Available from: https://www.natlawreview.com/article/doctor-medical-malpractice-issues-age-telemedicine.
22. COVID-19 | Key Policy Updates. Available from: https://info.americantelemed.org/covid-19-key-policy-updates-1.
23. AMA quick guide to telemedicine in practice. Available from: https://www.ama-assn.org/practice-management/digital/ama-quick-guide-telemedicine-practice.
24. Bloem BR, Dorsey ER, Okun MS. The Coronavirus Disease 2019 Crisis as Catalyst for Telemedicine for Chronic Neurological Disorders. JAMA Neurol. 2020 Apr 24.
25. Geronimo A, Wright C, Morris A, Walsh S, Snyder B, Simmons Z. Incorporation of telehealth into a multidisciplinary ALS Clinic: feasibility and acceptability. Amyotroph Lat Scl Fr. 2017;18(7-8):555-61.
26. Lindauer A, Seelye A, Lyons B, et al. Dementia Care Comes Home: Patient and Caregiver Assessment via Telemedicine. Gerontologist. 2017 Oct;57(5):E85-E93.
27. Muller KI, Alstadhaug KB, Bekkelund SI. A randomized trial of telemedicine efficacy and safety for nonacute headaches. Neurology. 2017 Jul 11;89(2):153-62.
28. Martin-Khan M, Flicker L, Wootton R, et al. The diagnostic accuracy of telegeriatrics for the diagnosis of dementia via video conferencing. J Am Med Dir Assoc. 2012 Jun;13(5):487 e19-24.
29. Russell TG, Jull GA, Wootton R. The diagnostic reliability of Internet-based observational kinematic gait analysis. J Telemed Telecare. 2003;9 Suppl 2:S48-51.
30. NIH stroke scale score. Available from: https://www.stroke.nih.gov/documents/NIH_Stroke_Scale_508C.pdf.
31. Bove R, Bevan C, Crabtree E, et al. Toward a low-cost, in-home, telemedicine-enabled assessment of disability in multiple sclerosis. Mult Scler. 2019 Oct;25(11):1526-34.
32. Bull MT, Darwin K, Venkataraman V, et al. A pilot study of virtual visits in Huntington disease. J Huntington’s Dis. 2014;3(2):189-95.
33. Maier A, Holm T, Wicks P, et al. Online assessment of ALS functional rating scale compares well to in-clinic evaluation: a prospective trial. Amyotroph Lateral Scler. 2012 Feb;13(2):210-6.
34. Bedlack RS, Simel DL, Bosworth H, Samsa G, Tucker-Lipscomb B, Sanders DB. Quantitative myasthenia gravis score: assessment of responsiveness and longitudinal validity. Neurology. 2005 Jun 14;64(11):1968-75.
35. de Lima ALS, Smits T, Darweesh SKL, et al. Home-based monitoring of falls using wearable sensors in Parkinson’s disease. Movement Disord. 2020 Jan;35(1):109-15.
36. Rasmusson KA, Hartshorn JC. A comparison of epilepsy patients in a traditional ambulatory clinic and a telemedicine clinic. Epilepsia. 2005 May;46(5):767-70.
37. Reider-Demer M, Reja P, Martin N, Schwingere M, Babayan D. Prospective and retrospective study of videoconference telemedicine follow-up after elective neurosurgery: results of a pilot program. Neurosurg Rev. 2018 Apr;41(2):497-501.
38. Kim H, Jhoo JH, Jang JW. The effect of telemedicine on cognitive decline in patients with dementia. J Telemed Telecare. 2017 Jan;23(1):149-54.
39. Telehealth: Rapid Implementation For Your Cardiology Clinic (Updated March 24, 2020). Available from: https://www.acc.org/latest-in-cardiology/articles/2020/03/01/08/42/feature-telehealth-rapid-implementation-for-your-cardiology-clinic-coronavirus-disease-2019-covid-19.
40. Manji H, Carr AS, Brownlee WJ, Lunn MP. Neurology in the time of covid-19. J Neurol Neurosurg Psychiatry. 2020 Apr 20.

Table 1. Selected list of video communication platforms
### HIPAA-compliant video communication products

| Products                                                                 |
|-------------------------------------------------------------------------|
| Skype for Business / Microsoft Teams                                    |
| EPIC/Polycom                                                            |
| Updox                                                                   |
| VSee                                                                    |
| Vidyo                                                                   |
| Starleaf                                                                |
| Zoom for Healthcare                                                     |
| Doxy.me                                                                |
| Google G Suite Hangouts Meet                                            |
| Cisco Webex Meetings / Webex Teams                                      |
| Amazon Chime                                                           |
| GoToMeeting                                                            |

### Other popular applications

| Applications                                                                 |
|-----------------------------------------------------------------------------|
| Apple Face Time                                                            |
| Facebook Messenger video chat                                              |
| Google Hangouts Video                                                      |
| Zoom                                                                       |
| Skype (regular)                                                            |

### Applications which are not recommended

| Applications                  |
|-------------------------------|
| Facebook Live                |
| Twitch                        |
| TikTok                        |

### Table 2:

| Initiation of encounter | Salutation |
|-------------------------|------------|
|                         | Two-factor identification |
|                         | Consent |
|                         | It will be easier to perform the examination in the presence of a companion |
|                         | Preferable to have a few feet of space for gait assessment |

| Neurological assessment | Routine bedside/clinic examination applicable |
|-------------------------|-----------------------------------------------|
| Speech                  | Comprehension, naming, repetition (ensure proper audio output and microphone) |
| Cranial Nerves          | Visual fields, and examination of palate raise and |


| Motor Exam | uvula can be limited
| Non-confrontational measures: Pronator drift, Finger tapping, Rapid opening and closing of fist For lower extremity check drift, standing up unassisted (and arms crossed), squat, heel and toe walking |
| Sensory Exam | If there is a companion, then light touch can be examined by cotton, and pin prick can be examined by a toothpick |
| Cerebellar | Rapid alternative movements Nose touch with extended upper extremities Heel to shin Gait |
| Reflexes | Can be difficult If there is a companion, attempts can be made to elicit patellar reflex with a household item such as back of the spoon, wooden spatula. |
| Gait | Be considerate of patient’s capacity If no companion around, there can be fall risk. |
| Validated disease activity scores | Unified Parkinson’s Disease Rating Scale Unified Huntington’s Disease Rating Scale Abnormal Involuntary Movement Scale |
| Partially validated disease activity score | ALS functional rating scale-revised |

**Appendix 1: Teleneurology encounter sheet for patient and caregiver**

| Initiation of encounter | A guideline on how to start the encounter This may vary depending on the institute and the electronic health record being use |
| Ensuring optimal environment for the encounter | -Optimal lighting -Proper positioning of camera (zooming function can also be utilized) -Reduce background noise to minimal -Ensure the audio and microphone is working |
| Expectations of the visit | -State about the audiovisual nature of the encounter. -State that a full neurological examination will not be possible. |
### Preparedness of neurological examination

- State the limitations of the visit.
- Assess whether the caregiver/assistant will be willing to help with the neurological examination.
- The caregiver/assistant can help with the visual field testing, motor strength testing, sensory examination.

**Figure 1: Transition to teleneurology**

![Transition to teleneurology Yale](image1)

![Transition to teleneurology Johns Hopkins](image2)
**Figure 1 legend**: Transition to teleneurology during the COVID-19 pandemic at the Yale School of Medicine and Johns Hopkins School of Medicine. Data were collected for March and April 2020 and reported as number of patient encounters per week. Nationwide emergency in the United States was declared on March 13th.