

The Teleneurology Revolution

The application of telemedicine to remotely connect patients with providers dates back decades.¹ Prior to the COVID-19 pandemic, telestroke and teleneurology were already delivering much needed care to regions of the country without neurological expertise.^{2,3} Large hospital systems such as Kaiser recently reported more than half of all patient interactions were through telehealth.⁴ However, until now many barriers for even greater acceptance of telemedicine prevented growth.⁵ The Centers for Medicare and Medicaid Services restricted payment to rural areas, specific originating sites (the location of the patient), and certain Current Procedural Terminology codes. Reimbursement from private insurers varied from some to no coverage of telemedicine. There was widespread skepticism among physicians in many areas regarding the effectiveness of telemedicine visits, which were often considered substandard and antithetical to the proper practice of medicine.⁵ Due to challenges to health care during the COVID-19 crisis, telemedicine has moved from a technology with limited use to mainstream medicine.

Many reimbursement and licensing obstacles that previously constrained telemedicine adoption were suspended in the setting of the COVID-19 public health emergency. To continue to care for urgent non-COVID-19 neurological disorders, almost all health systems, departments, and practices turned to telemedicine.⁶ Hospital consults in many cases were converted to telemedicine using iPads, carts, cameras, tablets, or cell phones in patient rooms. New applications of telemedicine emerged to minimize exposure during the pandemic.^{7,8} At NYU Langone Health at the epicenter of the pandemic, virtual visits grew from a typical 50 visits per day to >7,000 daily visits within 10 days.⁹ Between March 16 and June 7 at the University of Pennsylvania Health System (UPHS), there were nearly 400,000 telemedicine encounters across thousands of providers, requiring expansion of videoconferencing availability, rapid training, and development of new workflows for outpatient and inpatient practices. The UPHS Department of Neurology increased from 36 telemedicine encounters on March 16 to >200 daily visits in early June. All of these changes occurred in days or weeks rather than months or years. If widespread use of teleneurology is to continue after the pandemic, the major impediments might be the lack of

evidence for the efficacy of teleneurology and understanding the proper place of teleneurology when in-person care is also available. Randomized trials are challenging in telemedicine,¹⁰ but given the high volume of virtual visits during the COVID-19 crisis, it should be possible to compare outcomes in patients with similar characteristics across modalities. Further evaluation of the physical examination, provider–patient interaction, and workflow changes using telemedicine will be necessary to determine its place in our medical armamentarium.

In some ways, teleneurology may allow us to improve on in-person visits. Telemedicine supports a team approach by virtually bringing together providers from various disciplines without traveling to a single location and devoting a dedicated block of time. Similarly, family members can be incorporated into telemedicine visits to obtain relevant history and counseling and to participate in shared decisions even if those family members are remote from the patient and provider. For neurological patients in rural areas and those with limited mobility making it difficult to reach medical offices, telemedicine might be favored when an in-person visit is not practical or the alternative is reduced or no care at all. Teleneurology consultations in such situations streamline evaluation and testing, potentially improving outcomes and reducing costs while increasing time efficiency for busy clinicians.

Teleneurology in its current form is in its infancy. As evidenced by digital transformation in other industries, the possibilities for change and improvement are considerable.⁴ The experience in large networks with analytics and big data should allow exploration of new and useful applications. The addition of artificial intelligence may automate some of the processes now requiring training and proficiency, expediting teleneurology visits and improving diagnosis and outcomes. Integration into the electronic medical record and interoperability will be essential to improving the teleneurology experience. Wearable devices add important new information to augment teleneurology capabilities. The physical examination is limited in teleneurology, but elements of the examination may be enhanced through observational aids or in some cases the assistance of family members on site.^{11,12} The addition of activity monitors and sensors should increase the yield of

virtual neurological examinations and possibly provide a view of patient characteristics not available during an in-person visit. Along with greater availability and a likely flood of data from home monitoring and wearable devices, it will become necessary for providers to find ways to sort, monitor, and respond to patient-generated information. Health systems must explore new approaches to informatics to manage inflow, establish reliability, and ensure incorporation into the health record.

The promise of telemedicine to reach rural and underserved areas, increase efficiencies, and focus on patient priorities has been clearly evident during this crisis. Health systems that include community and tertiary care facilities along with widespread outpatient offices strive to distribute services rationally, keeping patients in their environment and optimizing utilization of high-technology resources. For many neurological subspecialties such as epilepsy, stroke, or movement disorders, complex procedures and acute illnesses requiring a high level of expertise and advanced technology could be concentrated in hub hospitals and lower-acuity problems preferentially directed to community hospitals with appropriate specialist support by telemedicine. The goal should be for every patient within a system to receive the same level of excellent care regardless of the hospital to which they are admitted. With the expanding reach of telemedicine and removal of restrictions on licensing and credentialing, the local and regional emphasis on market share becomes a national competition, particularly for highly specialized areas of medicine. This might result in consolidation of subspecialty centers, reducing costs and avoiding duplication of valuable resources.

Until now, the medical system has largely been provider-oriented. We ask patients to leave their homes, travel to our offices, and wait patiently until the provider is ready. Although the provider time is relatively brief, patients may spend several hours for each visit. In contrast, the focus with telemedicine is on the patient, saving time, increasing convenience, and improving access. Video visits help providers learn about the home environment, offering new insights into features that contribute to health outcomes and enhance overall care.

Teleneurology expands access and availability across a wide spectrum of clinical venues from outpatient to acute care and rehabilitation.¹³ Given the acceptance of telemedicine during the pandemic by both providers and patients, the temporary enabling policies that expire with the public health emergency will hopefully translate into lasting changes. Congress is considering legislation to give the Health and Human Services secretary flexibility to waive geographic and originating site restrictions, private payers are increasing coverage, and states are considering

new approaches to interstate telemedicine licensing. These advances could dramatically improve the landscape for telemedicine and teleneurology. Telemedicine is here to stay, and we should not return to the restrictive policies limiting its use. Hopefully, national, regional, private, and public entities will join forces to keep this revolution moving forward.

Potential Conflicts of Interest

Nothing to report.

Lawrence R. Wechsler, MD

Perelman School of Medicine
University of Pennsylvania
Philadelphia, PAUSA

References

1. Levine SR, Gorman M. "Telestroke": the application of telemedicine for stroke. *Stroke* 1999;30:464–469.
2. Amorim E, Shih MM, Koehler SA, et al. Impact of telemedicine implementation in thrombolytic use for acute ischemic stroke: the University of Pittsburgh Medical Center telestroke network experience. *J Stroke Cerebrovasc Dis* 2013;22:527–531.
3. Hatcher-Martin JM, Adams JL, Anderson ER, et al. Telemedicine in neurology: Telemedicine Work Group of the American Academy of Neurology update. *Neurology* 2020;94:30–38.
4. Duffy S, Lee TH. In-person health care as option B. *N Engl J Med* 2018;378:104–106.
5. Dorsey ER, Topol EJ. State of telehealth. *N Engl J Med* 2016;375:154–161.
6. Al Kasab S, Almallouhi E, Holmstedt CA. Optimizing the use of tele-neurology during the COVID-19 pandemic. *Telemed J E Health* 2020. <https://doi.org/10.1089/tmj.2020.0109>. Epub ahead of print.
7. Hollander JE, Carr BG. Virtually perfect? Telemedicine for Covid-19. *N Engl J Med* 2020;382:1679–1681.
8. Langabeer JR Jr, Gonzalez M, Alqusairi D, et al. Telehealth-enabled emergency medical services program reduces ambulance transport to urban emergency departments. *West J Emerg Med* 2016;17:713–720.
9. Mann DM, Chen J, Chunara R, et al. COVID-19 transforms health care through telemedicine: evidence from the field. *J Am Med Inform Assoc* 2020;27:1132–1135.
10. Robb JF, Hyland MH, Goodman AD. Comparison of telemedicine versus in-person visits for persons with multiple sclerosis: a randomized crossover study of feasibility, cost, and satisfaction. *Mult Scler Relat Disord* 2019;36:101258.
11. Ansary AM, Martinez JN, Scott JD. The virtual physical exam in the 21st century. *J Telemed Telecare* 2019. <https://doi.org/10.1177/1357633X19878330>. Epub ahead of print.
12. Grossman SN, Han SC, Balcer LJ, et al. Rapid implementation of virtual neurology in response to the COVID-19 pandemic. *Neurology* 2020;94:1077–1087.
13. Wechsler LR. Advantages and limitations of teleneurology. *JAMA Neurol* 2015;72:349–354.

DOI: 10.1002/ana.25849