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# Telestroke Across the Continuum of Care: Lessons from the COVID-19 Pandemic

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While use of telemedicine to guide emergent treatment of ischemic stroke is well established, the COVID-19 pandemic motivated the rapid expansion of care via telemedicine to provide consistent care while reducing patient and provider exposure and preserving personal protective equipment. Temporary changes in reimbursement, inclusion of home office and patient home environments, and increased access to telehealth technologies by patients, health care staff and health care facilities were key to provide an environment for creative and consistent high-quality stroke care. The continuum of care via telestroke has broadened to include prehospital, inter-facility and intra-facility hospital-based services, stroke telerehabilitation, and ambulatory telestroke. However, disparities in technology access remain a challenge. Preservation of reimbursement and the reduction of regulatory burden that was initiated during the public health emergency will be necessary to maintain expanded patient access to the full complement of telestroke services. Here we outline many of these initiatives and discuss potential opportunities for optimal use of technology in stroke care through and beyond the pandemic.

**Key Words:** Telestroke (1)—Telemedicine (2)—Teleneurology (3)—COVID-19 (4), Pandemic (5)—SARS CoV-2 (6)—Coronavirus (7)—Stroke (8)—Stroke care (9)—Stroke delivery (10)

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## Introduction

As disruptive and devastating as the COVID-19 pandemic has been for patients and providers, it has also created an environment ripe for innovation, particularly in the wide acceptance and usage of telemedicine across medical and surgical specialties.<sup>1,2</sup> While telemedicine is

reliable and effective for medical decision-making in acute stroke,<sup>3,4</sup> the pandemic has accelerated the application and integration of telemedicine across the continuum of stroke care.<sup>5–8</sup> To maintain patient care while avoiding unnecessary exposure, conserving personal protective equipment (PPE), and optimizing the ability for multiple

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participants to examine patients in this pandemic setting, alternative stroke care models have been developed including protected stroke codes and streamlined triage for endovascular therapy.<sup>7,9,10</sup> Concomitantly, in the early months of the pandemic, U.S. stroke centers and telestroke networks experienced an alarming decline in the number of stroke patients seeking emergency care, likely driven by patients' and families' fear of exposure.<sup>11–13</sup>

From wider acceptance of the technology and procedures of telemedicine by stroke patients and practitioners, to the benefits seen with the availability of remote care, we anticipate the widened continuum of telestroke care to persist long after this crisis, with advantages of continuing these expanded services seen by patients, providers and health care systems.<sup>14–16</sup> Preserving access to telestroke services will largely depend on supporting the mechanisms that facilitated rapid implementation during this pandemic including maintaining infrastructure, prioritizing favorable reimbursement pathways, and simplifying regulatory requirements.<sup>14</sup> For long term maintenance of these programs, legislators, Centers for Medicare and Medicaid Services (CMS), state and federal regulatory agencies, and physician credentialing will face the challenge of revising current laws and procedures to preserve the gain achieved by innovative telehealth solutions.

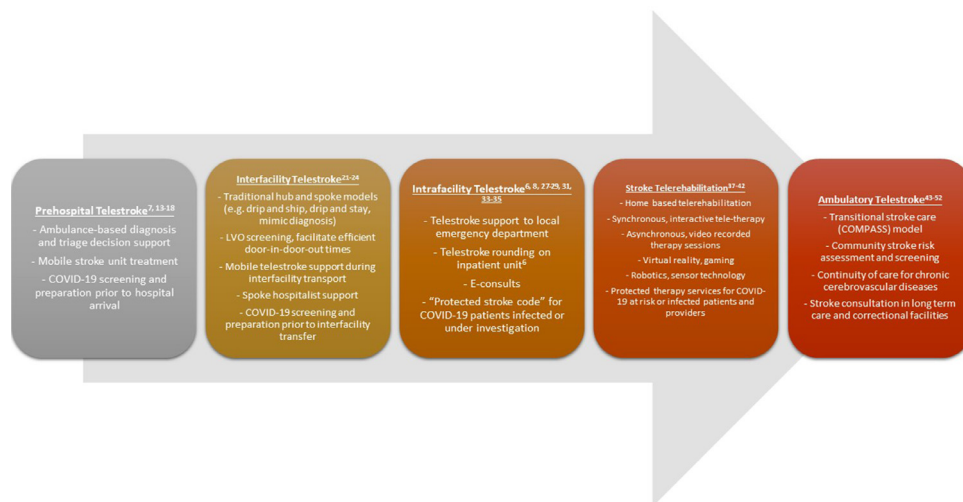
With experience in leading telestroke networks through the U.S., and expansion in services delivered via telemedicine during this pandemic, we offer our perspective and experience with best practices for telestroke across the continuum of care, defining how expansion of remote stroke care is or can be utilized beyond the studied and established use of acute telestroke (Fig. 1, Supplemental Table 1). We describe our experience in the deployment of telemedicine across the spectrum of stroke care and highlight areas of future research to definitively establish

equivalence of quality and efficiency of care. Finally, we will discuss major regulatory and reimbursement changes needed to support continuation of clinically important and cost-effective use of telestroke in the “new normal” post pandemic.

### Prehospital Telestroke

Ambulance-based telestroke systems are reliable and cost-effective in a range of environments, with successful evaluation of presumptive stroke patients including completion of NIHSS via telemedicine in the prehospital setting.<sup>17–21</sup> Ambulance-based telestroke is also an essential component of mobile stroke unit deployment, and remote evaluation of stroke patients in transit has been shown to decrease mean door to needle time.<sup>20,22,23</sup>

As mobile stroke units are not widely deployed due to limitations in cost and resource allocation, this modality has not been frequently utilized,<sup>24</sup> and use has not increased significantly during the pandemic. Major changes in emergency service resource allocation would be needed to cover the high cost of mobile units and skilled staff needed for operation.<sup>24</sup> Traditionally, there has been no physician/provider re-imbursement for this service provided by stroke specialists. However, in the Bipartisan Budget Act of 2018, CMS expanded the definition of the originating site for telehealth services to include a “mobile stroke unit,” defined as “a mobile unit that furnishes services to diagnose, evaluate, and/or treat symptoms of an acute stroke” (Table 1).<sup>25</sup> Ambulance-based telestroke care can also facilitate selective hospital triage from the field, potentially prioritizing endovascular capable facility triage for patients who screen positive for large vessel occlusion (LVO) and reducing the time to life saving treatment.<sup>7</sup>



**Fig. 1.** Telestroke Applied Across the Continuum of Care The COVID-19 pandemic has motivated an expansion in the utility and access to telehealth services across the continuum of stroke care. Fig. 1 lists examples of how telestroke can be applied across the continuum including aspects of prehospital, interfacility, intrafacility, telerehabilitation, and ambulatory stroke care.

**Table 1.** Reimbursement Pathways Along the Continuum of Telestroke Care, Including Expanded Coverage during the COVID-19 Pandemic.<sup>22, 28, 43</sup>

Setting	Procedural Codes for Telehealth Services <sup>^,±</sup>
Prehospital Telestroke	G0 modifier may be applied to acute stroke telehealth services performed on mobile stroke units, defined as “a mobile unit that furnishes services to diagnose, evaluate, and/or treat symptoms of an acute stroke” <sup>*</sup>
Hospital-Based Telestroke	G0425-G0427 (Emergency Department or Initial Inpatient) G0406-G0408, 99221-99223 (Follow-up Inpatient Consultation) G0508 (Critical Care) 99231-99233 (Subsequent Hospital Care) <sup>**</sup> 99446-99452 (Electronic Consultation, Interprofessional) <sup>**</sup>
Telerehabilitation	97161-97164 (Physical Therapy) <sup>**</sup> 97165-97168 (Occupational Therapy) <sup>**</sup> 92507, 92521-92524 (Speech and Language Pathology) <sup>**</sup> G2061-G2063 (E-visits using online patient portals; can be used by licensed clinical social workers, clinical psychologists, physical and occupational therapists, and speech language pathologists)
Ambulatory Telestroke	99201-99205 (New Patient) <sup>**</sup> 99211-99215 (Established Patient) <sup>**</sup> G2012 (Virtual Check-In) G2010 (Remote Evaluation of Recorded Video and/or Images) 99421-99423 (Online Digital E/M, Established Patient) <sup>***</sup> 99441-99443 (Telephone Consultation)

<sup>^</sup>Common Procedural Terminology (CPT)<sup>®</sup> codes, descriptions, and other data are copyright of the American Medical Association (AMA).

<sup>±</sup>G-codes are Medicare-specific codes created by Centers for Medicare and Medicaid Services (CMS) serving the same purpose as CPT codes. Some commercial carriers accept G-codes instead of corresponding CPT codes, but this varies by payer.

<sup>\*</sup>G0 codes were added as part of the Bipartisan Budget Act of 2018 providing new rules for acute stroke telehealth services performed on or after January 1, 2019.

<sup>\*\*</sup>GT Modifier and Modifier 95 can be appended to E/M codes indicating a telemedicine service using synchronous, interactive audio/video telecommunication. Modifier requirements may vary between payers.

<sup>\*\*\*</sup>May only be reported once in a seven-day period, and cannot be used if patient had another E/M service within the past seven days.

In the setting of a public health emergency, prehospital telestroke offers several advantages for hyperacute stroke care. Mobile telestroke systems may limit person-to-person contact in the prehospital stroke assessment, and ambulance-based telestroke allows for parallel care. Emergency medical services (EMS) providers can focus on heightened attention to COVID-19 concerns, such as PPE and respiratory management, while a remote emergency provider or stroke specialist can assist with necessary stroke screening during ambulance transport.<sup>26</sup> Community paramedic partnerships can facilitate telestroke initiation in the field as well. The prehospital evaluation by the remote practitioner has the potential to reduce PPE usage upon arrival to the hospital by limiting the need for multiple re-evaluations prior to acute treatment decisions, and allow adequate precautions for obtaining advanced imaging and thrombectomy preparations by pre-screening patients prior to arrival. Utilization of prehospital triage with telestroke could further limit unnecessary exposures and PPE usage by identifying the appropriate hospital for the patient’s needs, obviating the need for a secondary transfer to a tertiary care center. However, additional research is necessary to identify the ideal scenarios for

tele-triage protocols. As the pandemic continues, this may become further utilized during additional surges or in times of limited bed capacity, requiring creative decision making for who needs evaluation and where.

#### *Interfacility Hospital Telestroke*

Telestroke contributes to the identification and assessment of patients with syndromes or imaging concerning for LVO, via remote imaging review and planning for transfer to endovascular-capable centers.<sup>27</sup> Rapid interfacility transfer programs have been developed to optimize transfer times in stroke emergencies.<sup>28</sup> Traditional hub and spoke models of telestroke support the retention of patients with mild stroke syndromes or stroke mimics in their local hospitals by providing guidance for initial stroke management and hospitalization. Following acute assessment, interfacility telestroke can provide continued consultation to non-neurologist hospitalist teams at the spoke hospital to support high quality subacute stroke care, similar in concept and structure to the evolving field of tele-critical care.<sup>29</sup>

Retaining patients with mild stroke syndromes or stroke mimics in their local facilities is essential during a public health emergency, both limiting unnecessary transfers and reducing potential exposures to the patient and transfer and treating teams. This is especially important in this patient population given the vulnerability of stroke patients to infection.<sup>30</sup> With optimal use, this model can prevent unnecessary transfers and provider exposures, and preserve bed availability at the hub for those needing higher level of care, triage that is essential during pandemic surge planning. For those needing transfer, ambulance-based mobile telestroke systems can be incorporated to support long transports, particularly for “drip-and-ship” post-thrombolysis care, and for critically ill stroke patients with or without comorbid illness from COVID-19 as above.<sup>31</sup>

#### *Intrafacility Telestroke*

In addition to providing specialist care at distant facilities, telestroke allows stroke specialists to deploy virtually to assess acute stroke patients in their own emergency departments and inpatient units remotely, and work with tele-presenter nurses and/or non-neurology providers at the bedside to assess the patient and make initial diagnostic and treatment recommendations. Though there is limited data, this model can support specialist coverage off-hours, or support trainees from a remote location. Though some models suggest that remote supervision is not as time efficient as on-site supervision, Emergency Medicine residents at one center felt adequately supported with remote supervision.<sup>32</sup> Re-evaluation of this strategy in specific interactions is appropriate in a pandemic, with implementation of emergency protocols and PPE needs supporting prioritization of remote supervision.

During the public health emergency, many hospitals and stroke centers have deployed in-house telestroke to help reduce provider and patient exposures, PPE usage, and fill workforce shortages due to COVID-19 related illness and quarantining of staff.<sup>33,34</sup> Deploying telestroke locally expands on the concept of the pandemic-derived “protected stroke code”, which provides a framework for COVID-19 screening and proper usage of PPE incorporated with acute stroke assessment.<sup>9</sup> In this setting, the addition of telestroke would allow additional team members to participate in the patient evaluation remotely, while preserving PPE and limiting staff-patient interactions. Given the importance of social distancing to further protect our patients and healthcare providers, some academic centers have switched to virtual rounds using a teleconferencing platform.<sup>6</sup> In this model, table rounds are first completed via teleconferencing, with one in-house team member wearing appropriate PPE moving the workstation to each patient room to perform the exam, functioning as tele-presenter for the remainder of the remote rounding team. Which team member functions

as the tele-presenter varies by institution. Whether the in-house team member is a resident or attending physician, in addition to limiting exposure and reducing need for PPE for the whole team, this model allows stroke neurologists and trainees to continue to provide care to patients even when under therapeutic or prophylactic quarantine. In addition, this allows a rotating schedule which can be used to address staff shortages by avoiding the need for direct patient exposure and increasing the number of team members that could provide telestroke evaluations virtually, from anywhere at any time.

#### *Interprofessional Electronic Consultations (E-Consults) for Stroke*

E-consults enable patients and their primary physicians to benefit from stroke specialist expertise remotely and asynchronously via chart review, and can be utilized in both the inpatient and outpatient settings.<sup>35</sup> Referring practitioners submit a question about their patient with stroke within the shared electronic healthcare record. The stroke specialist responds within a predetermined time frame after reviewing relevant data. Focused questions related to stroke care are often handled sufficiently by e-consult and obviate the need for an in-person visit (e.g. choice of antithrombotic therapy, request for neurovascular imaging review). If the review does lead to a need for face-to-face assessment via video or in-person visit, pre-visit workup can still be optimized beforehand via this mechanism to best utilize the patient-provider interaction. While there is limited reimbursement for these services through Medicare, this model traditionally lacks significant reimbursement from the majority of payers, leading many to favor in person or tele-visits for the bulk of consultative services.

During the pandemic, addressing focused questions via electronic medical record is essential to reducing in-person contact. In addition, pre-visit planning via initial review could be utilized to limit time of exposure when hands-on examination is required. CMS recognizes several new service codes related to non-face-to-face, interprofessional consultation (Table 1).<sup>36</sup> However, for widespread use, expansion of reimbursement would be necessary to fully utilize this option.

#### *Stroke Telerehabilitation*

There has been great interest in utilizing telemedicine to broaden the scope, access, and cost-effectiveness of telerehabilitation (TR) for stroke patients. Transportation and mobility limitations, as well as reliance on caregivers, make TR an attractive option for post-acute stroke patients. A multisite, randomized trial of home based TR versus in-clinic therapy of 124 stroke patients with arm motor deficits found that TR was non-inferior in improving motor function and stroke knowledge compared to traditional methods.<sup>37</sup> In patients with hemiplegia, motor

training via TR was accompanied by MRI changes including increased functional connectivity of the primary motor cortex.<sup>38</sup> At a broader level, a recent Cochrane review of randomized clinical trials of TR services for stroke patients (encompassing 22 trials and 1937 participants) found at least moderate quality evidence that patients had similar gains in activities of daily living following post-hospital discharge TR versus usual care therapies.<sup>39</sup> However, the high degree of variability across stroke TR trials prevents definitive conclusions about specific services and methods of delivery.<sup>39</sup> Available stroke TR delivery models are dynamic and may incorporate synchronous or asynchronous therapy sessions as well as novel technologies such as sensors, robotics, gaming and virtual reality.<sup>40</sup> Importantly, the quality of stroke TR services requires verifying a consistent home environment for performing TR services, maintaining patient safety in the home through the help of family members or in-person facilitators, and ensuring adequate audiovisual equipment and quality through access to broadband for both therapy services providers and stroke patients in their homes or post acute care facilities.

The COVID-19 pandemic has required reassessment of the necessity of in-person stroke rehabilitation, including physical, occupational, and speech and language therapies. For COVID-19 patients with ischemic stroke, TR could dramatically lower the risk of infection without compromising post-stroke recovery. Even for non-infected patients, delivering these essential therapy services via TR reduces PPE consumption, limits the exposure of therapists and providers, and helps maintain patient safety for a vulnerable at-risk population.<sup>41</sup> Converting from in-person therapy to TR is equally important for patients in densely populated urban areas where exposure risk is higher, and for rural-based patients for whom geographic barriers and shelter-at-home orders limit access to therapy services. With the experience of the current pandemic, a blueprint for developing stroke TR programs should be developed for rapid deployment now and for future disruptive crises.<sup>42</sup>

#### *Ambulatory Telestroke Care*

Telemedicine has been utilized for outpatient care in multiple neurologic conditions with both equivalent diagnostic accuracy and patient and caregiver satisfaction demonstrated when compared to in person encounters across multiple subspecialties.<sup>43</sup> With patient-level mobility and transportation barriers to care in the stroke population, as well as variable access to vascular subspecialists, in-home telemedicine follow-up has the potential to improve long term stroke care. Pre-pandemic barriers to widespread acceptance have been due in large part to reimbursement challenges and lack of infrastructure.<sup>44</sup>

Telemedicine has the potential to address unique challenges in the transition between hospital and home.

Transitional care models have shown potential to improve subacute stroke care and decrease length of stay. However, a comprehensive post-acute stroke services model integrating early supported discharge with individualized stroke prevention care plans was not consistently incorporated into real world practice due in part to patient-level barriers to in-person care.<sup>45,46</sup> Delivery of these models remotely via telemedicine, and integration with in-home rehabilitation services, has the potential to expand and enhance transitional care following acute stroke.

With the pandemic, social distancing requirements and restrictions on non-essential ambulatory clinic visits created an urgent need for outpatient telemedicine, particularly in the stroke population, with multiple comorbidities increasing risk of serious symptomatic infection with COVID-19. Expansion of CMS reimbursement in March 2020 lifted the final barrier to implementation (Table 1). The rapid integration of telemedicine into outpatient practice has required an overhaul of the typical clinic workflow.<sup>47</sup> Institutional support is required for enhancement of technology including hardware, audiovisual platforms, EHR integration, and server support. Staffing changes to consider include scheduling and billing and coding integration. Training for providers and staff, patient education, and on-call technology assistance for both patients and providers is also necessary to ensure comparable delivery of care. Resource utilization of support staff to mitigate issues with connectivity and device settings may challenge efficient telemedicine clinic sessions. Many elderly stroke patients, in isolation from children with more experience using technology, may be fearful and resistant to timely sessions using telemedicine.

Preliminary experience suggests good uptake of telemedicine during the crisis, both via video and phone, with a call for continued development post pandemic. But disparities in health care delivery can be exacerbated by inequalities in technology access in socially or economically disadvantaged populations.<sup>48,49</sup> Lack of consistent access to technology, high-speed internet services and increased need for technology support will need to be addressed for widespread improvements in access to care. Additional expansion in other sectors of telehealth including integration of applications for remote monitoring via e-diaries, sensors, vital sign monitoring, or even cardiac monitoring via smart watches may be utilized for a more robust telehealth program to improve management of chronic diseases.<sup>45</sup>

#### *Long Term Care and Correctional Facilities*

Patients in long term care facilities have limited access to specialty care that can be addressed by enhanced telemedicine support.<sup>50</sup> A major concern during the COVID-19 pandemic is the heightened risk and exposure for vulnerable patients and staff in long term care facilities and correctional facilities due to close living quarters and need for

frequent in-person assessments of healthcare needs. An advantage with the use of telemedicine for post-acute care in long term care settings is staff support, with the potential for reduced technological burden on patients, and on-site assistance with the physical exam. Telemedicine systems can also be deployed in order to assess patients with stroke symptoms in these environments and help guide necessary triage decisions.<sup>51,52</sup> Telestroke facilitated screening in these environments could inform appropriate hospital destination choices for both thrombolytics and thrombectomy. Remote assessment within the facility could guide appropriate triage and treatment, minimizing activation of EMS services and exposures of EMS providers, and avoiding unnecessary emergency room visits for high-risk patients who can remain in place.

### *Challenges to Broadened Access to Telestroke Services in the United States*

As of March 6, 2020, CMS expanded access to telehealth services under the waiver authority of a public health emergency and issuance of the Coronavirus Preparedness and Response Supplemental Appropriations Act.<sup>53</sup> Under the new waiver, Medicare has dramatically expanded the reimbursement for telehealth services across the stroke care continuum, regardless of the patient's location including in private residences and long-term care facilities. Many commercial payers have followed suit in expanding coverage for telehealth services during the pandemic, although specific policies pertaining to commercial coverage and Medicaid continue to vary state by state. The Department of Health and Human Services renewed the current public health emergency for an additional 90 days on January 21, 2021 and indicated in a letter to state Governors that it will likely remain in place for the entirety of 2021.<sup>54</sup>

Even before the pandemic, CMS rendered several new changes to expand coverage for telehealth services. In 2019, Medicare initiated reimbursement for new telehealth encounters including "virtual check-ins", which are short patient-initiated encounters via telemedicine. Additionally, "E-Visits" allow patients to initiate non-face-to-face communications with providers through online patient portals. Although virtual check-ins and e-visits are fairly limited in scope and billability, they have provided an additional opportunity for providers to continue ambulatory stroke care and follow-up during the pandemic.<sup>53</sup>

Current Procedural Terminology (CPT) codes which describe the type of care provided are developed and copyrighted by the American Medical Association (AMA). Payers, including CMS, use these codes to decide whether and how much to reimburse for various services. While the COVID-19 pandemic has not led to the creation of any new CPT codes, expanded coverage for telehealth services has allowed providers to take more advantage of

billing for remote care with currently available codes, many of which are applicable to essential services along the stroke care continuum, using a remote care modifier (eg 95 of GT) (Table 1). During the public health emergency, these codes are billed and reimbursed at the same level as in person care. However, it remains to be seen what future coverage allows. Examining the expanded scope of telehealth services in the post-pandemic world could guide development of new CPT codes, or preserve the coverage of existing CPT codes for care delivered via telemedicine, to reflect the current and future state of telestroke care.

In addition to expanded reimbursement, policy modifications that adapt to telehealth practice need to be considered in the post-pandemic environment to allow widespread adoption and sustainability of these new systems of care (Table 2). Regulatory restrictions such as origination site limitations and lack of coverage for home visits limit the ability of telehealth to address access to care issues for our sickest stroke patients. During the national emergency of the COVID-19 Pandemic, the Office for Civil Rights announced discretionary enforcement of HIPAA for good faith provision of telehealth.<sup>55</sup> To sustain telehealth delivery, secure videoconferencing platforms and procedures which are fully HIPAA compliant should be used. However, current HIPAA policies that were created for in person interactions need to be appropriately adjusted to virtual care to ensure continued health information privacy.

State-specific licensure and malpractice insurance limit the ability to care for patients who live across state lines, motivating the majority of U.S. state medical boards to waive state-specific licensure requirements during the COVID-19 pandemic, though variably.<sup>56</sup>

Loosening of regulatory and billing limitations during the pandemic has propelled a dramatic increase in utilization of telestroke services and helped expand stroke care to patients at all levels along the continuum. Yet, we must continue to advocate for adequate resources and infrastructure to meet this demand.<sup>57</sup> It remains to be seen whether the expanded access policies stemming from CMS's public health emergency waiver will be continued following the pandemic. Whatever the future holds, the pandemic has motivated payers and policymakers to take a closer look at the integration of telemedicine into healthcare, which could have lasting positive impact for patients with stroke.

With further expansion and solidification of telehealth as a standard route of healthcare delivery, we must also consider the shortcomings of telemedicine. Further studies are needed to address where telemedicine can replace in person care, and where it is best utilized as a complement to traditional healthcare delivery. The expansion of virtual care brings a broadened definition of the "doctor patient relationship" that needs to be further considered. Current HIPAA, licensing, ethical, and liability standards

**Table 2.** *Proposed Policies To Sustain Improved Access to Telestroke Services*

Recommendation	COVID-19 Response and Goals for Continued Access
1. Expand licensure to perform telestroke services across state lines.	<ul style="list-style-type: none"> <li>• CMS allows providers licensed in any state to perform telehealth services in other states.</li> <li>• U.S. state medical boards waive state-specific licensure requirements.</li> </ul>
2. Allow parity between stroke care performed via telemedicine and in-person.	<ul style="list-style-type: none"> <li>• CMS and many commercial payers expand reimbursement for billing codes allowing parity with the same services performed via interactive audio/video communication.</li> </ul>
3. Eliminate the originating site restriction for telestroke services.	<ul style="list-style-type: none"> <li>• CMS waives originating site restriction to include telemedicine encounters at the patient's home or community dwelling.</li> <li>• Future goal: eliminate originating site restriction for all forms of telestroke service to enhance access, cost utility, and timeliness of care.</li> </ul>
4. Allow any health care professional eligible to bill for professional services to render care via telemedicine.	<ul style="list-style-type: none"> <li>• CMS expands the range of practitioners who can perform and supervise telehealth services to include advanced practice providers, physical therapists, occupational therapists, and speech and language pathologists.</li> </ul>
5. Allow certain stroke services to be provided by telephone only communication, such as telephone-only patient encounters and check-ins, and remote imaging review and discussion.	<ul style="list-style-type: none"> <li>• CMS allows certain services to be performed via telephone, audio-only communication.</li> </ul>

were developed for in person care and need to be modified to address both synchronous and asynchronous telehealth modalities. Finally, the shift to remote delivery of care will have a lasting impact on the stroke workforce both in training needs for Neurology residents and fellows, and in staffing considerations.

## Summary

Telemedicine has been instrumental to the delivery of acute stroke care for over 20 years, and there is great potential for the use of telestroke across the continuum of stroke care. While the COVID-19 pandemic has devastated lives and gravely disrupted healthcare delivery, it has accelerated the deployment of telemedicine services across medical specialties including stroke care. As the current pandemic plateaus and hopefully recedes, it is essential to build on the knowledge gained and experience of best practices for telestroke across the continuum to broaden access for patients. Strong telemedicine infrastructure will allow us to prepare for future pandemics or crises that may challenge traditional healthcare delivery, as well as address existing challenges to healthcare including access to care, a rapidly aging population, and staffing shortages by thinking outside the hospital for solutions. This requires patient and provider buy in, institutional acceptance by hospitals and practice plans, universal access to technology and high-quality broadband in both rural and urban areas, and legislation and policies facilitating long term sustainability. Outcome data from comprehensive research studies designed to investigate the multitude of telemedicine applications proposed are needed to identify the ideal use of telemedicine as a complement to in person care within the

field of stroke. With the broader scope of telestroke care as viewed through our experience across the continuum of care, and particularly through the lens of the pandemic, we hope and anticipate that expanded utilization, access, and reimbursement pathways will remain in place through the remainder of the public health crisis and in the future.

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Dr. Guzik provides legal expert consultation in cases related to stroke and vascular neurology. Dr. Chapman reports intellectual property (U.S. Patent Application No. 14/910,890 B2). Dr. Southerland reports research support (Diffusion Pharmaceuticals, AHA/ASA, NIH, National Science Foundation), intellectual property (U.S. Patent Application No. 14/910,890 B2, U.S. Provisional Patent Application No. 62/620,096- automated video-based stroke detection) and provides legal expert consultation in cases related to stroke and vascular neurology. Drs. Tadi, Al Kasab, Martini, Martin-Schild, Meyer, Demaerschalk, and Wozniak report no disclosures.

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## Supplementary materials

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