ACCESS Telemedicine: An Alternative Healthcare Delivery Model for Rural Cerebral Emergencies Physician-Focused Payment Model Environmental Scan

Updated 03/25/2019

I. Overview

The purpose of this environmental scan is to provide members of the Physician-Focused Payment Model Technical Advisory Committee (PTAC) with background information on the context for the physician-focused payment model (PFPM) ACCESS Telemedicine: An Alternative Healthcare Delivery Model for Cerebral Rural Emergencies, which was proposed by the University of New Mexico Health Sciences Center (UNMHSC) on February 13, 2019.

The scan focuses on: the epidemiology of emergency cerebral conditions; issues in telemedicine and neurology payment policy; problems in care delivery; and results of the proposed and other similar models. Section II presents an annotated bibliography of the sources cited in this scan. Section III includes the questions, search terms, and sources used to identify the research summarized below.

Epidemiology of Emergency Cerebral Conditions

ACCESS aims to expand neuro-emergent telemedicine use in rural hospitals through a bundled payment for Medicare patients with neuro-emergent conditions. The New Mexico Medicaid program implemented the ACCESS bundled payment system as of January 1, 2019, with modifiers for neurology versus neurosurgery consultations. UNMHSC seeks to have a comparable Medicare payment model approved to further sustain the model. This section outlines the epidemiology of emergency cerebral conditions.

Cerebral emergencies includes conditions such as stroke, traumatic brain injury (TBI), spinal cord injury, and brain aneurisms. Incidence differs in cerebral emergent conditions based on various factors, including age and place of residence. Between 2000 and 2015, 86 percent of all estimated strokes in the United States occurred in people age 65 years or older (Yang et al., 2017). As of 2017, roughly 17 percent of Medicare beneficiaries lived in rural areas, where prevalence of cerebral conditions is higher than in urban areas (CMS Rural-Urban Disparities, 2018). For instance, strokes and stroke-related deaths are 30 percent higher among rural residents than urban, potentially a result of an older population, increased use of tobacco and smoking products, and decreased access to preventive and emergency care (Howard et al., 2017; Garcia et al., 2017). TBIs are 23 percent higher in rural than urban areas, where research has found lower rates of adherence to published TBI care guidelines (Brown et al., 2019).

Outcomes of emergency cerebral conditions vary by type, age, location of residence, and treatment. Cerebrovascular diseases including stroke were the fifth-leading cause of death in the United States in 2016 (Xu et al., 2018). There are two main types of strokes: ischemic (including transient ischemic) and hemorrhagic. Hemorrhagic strokes only account for 15 percent of all strokes but account for 40 percent of all stroke deaths in the United States (National Stroke Association). An estimated 14 percent of Medicare patients who present with ischemic stroke die within 30 days (Schwartz et al., 2017). Furthermore, research suggests that stroke mortality is 30 percent higher in rural areas than in urban areas (Howard et al., 2017). The most common treatment for strokes, tissue plasminogen activator

(tPA), increases discharges to home and reduces one-year mortality when provided in time (Sauser-Zachrison et al., 2016). However, tPA must be delivered within 4.5 hours of the onset of stroke symptoms in order to decrease morbidity and mortality (Mayo Clinic, 2019; Lees et al., 2010).

There are significant long-term care needs for survivors of cerebral emergent conditions. Stroke patients often experience depression (35 percent), nursing home placement (26 percent), activities of daily living support (26 percent), and aphasia (19 percent). Post-TBI patients often experience other serious health consequences, such as the onset of Alzheimer's or Parkinson's disease (Ma, Chan, & Carruthers, 2014).

Issues in Payment Policy

Overview of Telehealth. Telehealth[1] is defined as "the use of technology to deliver health care, health information or health education at a distance." Common telehealth services include live video conferencing, store-and-forward electronic transmission, and remote patient monitoring, as well as health care education, wearable devices, and mobile health applications. Common applications of telehealth include addressing primary care physician and specialist shortages, increasing access to care, medical education and training, patient engagement, and communication among providers.

Costs associated with operating a telehealth program include the equipment (e.g., communications equipment, medical devices), personnel and communications costs (e.g., internet connectivity, staff time, including training), and ongoing support and maintenance costs, including information technology (IT) support (National Institute of Justice, 1999; AMD Global Telemedicine, 2015). Telehealth program startup costs vary depending on the type of program. For a hub-and-spoke telestroke program, setup and maintenance costs may include personnel, the videoconferencing system, and wireless fees; spoke hospital costs may include the telehealth system (including the camera, start-up fee, shipping, and training) and maintenance fees (Switzer et al., 2013). A 2017 review on telestroke determined that the major barriers to telestroke implementation are medicolegal ambiguity, financial sustainability, technological infrastructure, and practice-based agreements (Akbik et al., Part 2).

Medicare Fee-for-Service Telehealth Coverage. Under current law, Medicare fee-for-service (FFS) pays for telehealth services when the beneficiary receiving the services presents at an originating site that is either: 1) located in a rural health professional shortage area (HPSA) or a county outside of a Metropolitan Statistical Area (MSA); or 2) participating in a federal telemedicine demonstration project. Eight types of health care settings can serve as originating sites (CMS Report to Congress, 2018).[2] Telehealth may be delivered using an interactive telecommunications system (i.e., two-way communication between the patient and provider using an audiovisual system) or through asynchronous store-and-forward technology.

Medicare-covered telehealth services include office visits, consultations, office psychiatry services, health risk assessment, care planning for chronic care management, and psychotherapy for crisis (CMS Report to Congress, 2018). The 2019 Medicare physician fee schedule (MPFS) expanded telehealth

[1] Definitions and use of the terms "telehealth" and "telemedicine" vary. In this section, we use "telehealth" to be consistent with use in CMS regulations.

[2] Qualifying originating sites include offices of physicians or practitioners, hospitals, critical access hospitals, rural health clinics, federally qualified health centers, hospital-based critical access hospital-based renal dialysis centers (including satellites), skilled nursing facilities, and community mental health centers.

access for substance use disorder treatment or co-occurring mental health disorder beginning July 1, 2019 (CMS PFS, 2019). The MPFS also allows providers to be reimbursed for new communication technology-based services, such as check-ins between patients and providers, and for evaluation of remote prerecorded images or video or store-and-forward technology (American Academy of Neurology, 2018). Previously, use of store-and-forward technology was only permitted in federal telemedicine demonstrations in Alaska and Hawaii.

Between 2014 and 2016, there was a 113 percent increase in the use of telehealth among Medicare beneficiaries with stroke diagnoses, resulting in approximately 2,000 stroke telehealth services billed to Medicare in 2016 (CMS Report to Congress, 2018; MedPAC, 2018). In 2017, CMS added a new critical care service code intended for the use of telestroke services (MedPAC, 2018). The Furthering Access to Stroke Telemedicine (FAST) Act of the Bipartisan Budget Act of 2018 expanded telehealth coverage to remove geographic location and originating site restrictions and include treatment of strokes in urban areas (MedPAC, 2018; American Academy of Neurology press release, n.d.). In addition, mobile stroke units, or ambulances equipped with portable computerized tomography (CT) scanners, point-of-care laboratory testing, access to a vascular neurologist, and select medications (Nguyen & Jia, 2018), can be used as originating sites for purposes of diagnosis, evaluation, or treatment of symptoms of an acute stroke (CMS Newsroom, 2018; 42 CFR § 410.78).

Medicare FFS Neurology Reimbursement. According to the American Academy of Neurology, over 30 percent of the average neurologist's practice revenue is derived from Medicare Part B payments (Donofrio et al., 2015). In 2010, Medicare eliminated reimbursement for consultation codes, which negatively affected neurologist reimbursement, particularly for initial outpatient and inpatient encounters, approximately 90 percent of which were coded as consultations. There are discrepancies in payment for office visits (e.g., evaluation and management [E&M] visits for cognitive services) and procedures, and many neurologists in settings such as private or university practice depend on income from procedural care to supplement the E&M services they provide (Donofrio et al., 2015). However, under the 2019 MPFS, neurologists will be able to add a complexity code to E&M visits; there will also be extended services code for longer visits (American Academy of Neurology, 2018).

Medicare Advantage Telehealth Coverage. Medicare Advantage (MA) plans are required to cover the telehealth benefits that are covered under FFS Medicare. MA plans may also include telehealth services such as remote access technologies in the supplemental benefits they offer to beneficiaries (CMS Report to Congress, 2018). MA plans can include some of the costs of telehealth services in their annual plan bid amounts (MedPAC, 2018). In CY2020, the Center for Medicare & Medicaid Innovation's (CMMI's) MA Value-Based Insurance Design Model will include telehealth networks as one of its four components: "CMS is testing how different service delivery innovations in telehealth can be used to both augment and complement an MA plan's current network of providers, as well as how access to telehealth services may appropriately allow MA plans to expand their service area to currently underserved counties where current MA network adequacy requirements could not be met without the use of telehealth" (CMMI CY2020 RFA).

Medicaid Telehealth Coverage. According to the Center for Connected Health Policy (CCHP), the federally designated National Telehealth Policy Resource Center, as of October 2018, 49 states[3] and

[3] Massachusetts is the only state that does not provide this reimbursement.

Washington, D.C., provide Medicaid FFS reimbursement for some form of live video; 11 states provide reimbursement for store-and-forward;[4] and 20 states provide reimbursement for remote patient monitoring (CCHP, 2018). CCHP identified seven states that cover stroke-related telehealth services, including remote patient monitoring and stroke system-of-care task forces charged with making telestroke service recommendations.[5] Exhibit 1 summarizes this Medicaid telestroke-related coverage. As of January 1, 2019, New Mexico's FFS Medicaid and Centennial Care managed care programs cover the neurological and neurosurgical consultations provided under ACCESS (UNMHSC Proposal to PTAC, Attachment A, 2019).

In addition to state Medicaid policies, 34 states and Washington, D.C., have laws that govern private payer telehealth reimbursement policy (CCHP, 2018). State regulations vary relating to requirements such as where the patient receiving services is located. Many states have enacted telehealth parity laws that require comparable coverage and reimbursement for in-person and telehealth services (Yang, 2016).

Exhibit 1: Medicaid Telestroke-Related Coverage[6]

State	Medicaid Telestroke-Related Coverage
Arizona	When a patient in a rural area presents within three hours of onset of stroke symptoms, Arizona Health Care Cost Containment System (AHCCCS) will reimburse the consulting neurologist if the consult is placed for assistance in determining appropriateness of thrombolytic therapy, even when the patient's condition is such that real-time video interaction cannot be achieved.
Missouri	Remote patient monitoring is covered for eligible conditions, including stroke. Beneficiaries must have two or more risk factors to be eligible.
Nebraska	A stroke system-of-care task force established in 2018 shall recommend eligible essential health care services for acute stroke care provided through telehealth.
North Dakota	A stroke system-of-care task force shall recommend eligible essential health care services for acute stroke care provided through telemedicine services, or use of interactive audio, video, and other electronic media used for the purpose of diagnosis, consultation, or treatment of acute stroke.
Oklahoma	Oklahoma SoonerCare reimburses for telemedicine activities related to the treatment and prevention of strokes.
Texas	Home telemonitoring is available to patients with stroke when the Texas Health and Human Services Commission determines it to be cost effective and feasible.
Utah	With prior authorization, home telemetry for outpatient long-term cardiac monitoring is covered for patients who had a stroke or TIA with no identifiable cause and who meet other criteria.

Problems in Care Delivery

Consequences of Inadequate Care and Need for Telehealth for Neurology Services

Rapid response to neuro-emergent conditions is critical to properly diagnosing patients, identifying the appropriate treatment plan, and minimizing unnecessary costs. While strokes are the most common neuro-emergent condition, other neurological conditions also require rapid response. Ruptured brain

[4] Teleradiology is not counted.

[5] This list is not exhaustive and may not have identified every state's Medicaid telehealth coverage of stroke-related services. Notably, New Mexico was not identified in this search.

[6] Table sources: Center for Connected Health Policy, 2018; Nebraska Legislature, 2018; North Dakota Century Code; VisuWell, 2019.

aneurysms lead to death in 40 percent of cases, but only 15 percent of those afflicted pass away before reaching a hospital (Brain Aneurysm Foundation, 2019).

Clinical evaluations by skilled neurological specialists are imperative to meeting the need for a rapid response to neuro-emergent conditions (e.g., tPA administration for ischemic stroke cases). Rural and medically underserved populations often lack sufficient access to neurological specialists compared to urban areas (American Academy of Neurology, 2012). Compounding access challenges, 47 rural hospitals closed between January 2010 and December 2014, and rural residents are on average 13 aerial miles farther from emergency care than their more urban peers (Kaufman et al., 2016). In addition, the demand for neurologists is expected to further outpace the supply through at least 2020 (HRSA, 2017). Rural and underserved emergency departments (EDs) tend to transfer high-risk patients to larger hospital systems, due to either a lack of expertise or supplies required (Leira et al. 2008).

Current and Proposed Quality Metrics and Outcome Measures

In the proposal, UNMHSC highlights five metrics it is currently using to measure quality and outcomes of the ACCESS model; and the proposal also outlines a combination of six different measures and surveys it proposes for use under the proposed PFPM. It is unclear whether these measures will be in addition to, or instead of, those UNMHSC is currently implementing. The measures discussed in the UNMHSC proposal are outlined in Exhibit 2.

Exhibit 2: Measures for Evaluating ACCESS Model

Measure	Rationale for Use
CAHPS for ACO Survey	Eight patient experience survey measures to report on model performance targets (CMS CAHPS Survey, 2019)
Total cost of care population-based PMPM index	Cost of care measure revised for only neuro-emergent condition transport to report on cost (NQF, 2017)
Number of imaging results for acute stroke patients within 45 minutes	Quality measure for stroke patients
Timeliness of emergency medical care	Quality of care measure to evaluate whether telehealth services are effective at improving timely patient care
Hospital-wide all-cause unplanned readmissions	Widely accepted readmission measure to track quality and outcomes of care[7] (CMS Measures Inventory Tool, 2019)
Proportion of patients with neuro-emergent conditions transported	Quality of care measure to assess if program achieves goal of reducing transports from spoke to hub hospital to less than 25%
Rate of tPA administration for stroke patients	Rapid tPA administration is one quality of care indicator for stroke patients; program has set a goal of 15% of patients receiving tPA
The patient experience questionnaire (PEQ)	Measure patient experience; developed for primary care use but has reported high validity and reliability rates in ED setting (Steine, Finset, & Laerum, 2001)

[7] The proposed ACCESS model places an emphasis on measuring quality and outcomes of stroke patients specifically, although only 28 percent of the ACCESS model's consultations were true stroke incidents. Stroke-specific unplanned readmission measures do exist. Though UNMHSC doesn't specify in the proposal its rationale for using the all-cause readmission metric, using a stroke-specific measure in place of the all-cause unplanned readmission measure would exclude the other 75 percent of consultations the ACCESS model encapsulates (Yale New Haven Health Services Corporation, 2016; Hospital Compare).

Telemedicine Satisfaction Questionnaire (TSQ)	Measure patient satisfaction with author-reported validity (Yip et al., 2003)
Confidence of hub and spoke health care providers[8]	Measure provider experience/confidence in making treatment decisions and providing care for neuro-emergent patients; uses a pre-established, internally created survey

UNMHSC also highlights two standard review procedures currently used to measure quality and outcomes of the ACCESS model and to address technical issues with the telehealth software. It notes an additional two proposed regularly scheduled reviews to implement procedural changes, when needed.

Results of Similar Models

Background on the proposal submitter. The University of New Mexico Health Sciences Center encompasses the University of New Mexico Health System, School of Medicine and other academic centers, and research centers. University of New Mexico School of Medicine is committed to programs serving rural communities in New Mexico, and its Rural Medicine Program is nationally ranked. Project ECHO (Project Extension for Community Healthcare Outcomes), a collaborative model of medical education and care management briefly described below, was founded at the University of New Mexico in 2003.

To deliver the ACCESS program, UNMHSC currently partners with Net Medical Xpress Solutions (NMXS), a telemedicine company that provides remote clinical consultations and a telemedicine platform that includes videoconferencing carts and software. NMXS, which has been a publicly traded company since 1999, began offering teleradiology services in 2008. NMXS now offers a range of diagnostic and clinical services and operates in all 50 states. NMXS also offers support in areas such as contract management and specialty credentialing.

Results of the ACCESS Program

HCIA Evaluation. The HCIA evaluation of the ACCESS model found that the telehealth technology worked as intended and staff generally reported positive impressions of the ACCESS program. University of New Mexico nurses reported that 18 to 20 percent of ACCESS patients with a stroke received tPA within the recommended timeframe. The program experienced challenges enrolling hospitals, and as a result there were too few Medicare and Medicaid treatment beneficiaries to conduct a rigorous impact analysis (Mathematica, 2018).

Other ACCESS Evaluation. A 2018 study of the cost-effectiveness of the ACCESS program estimated that ACCESS has the potential to save $4,241 ($3,952–$4,438) per patient on costs of care and to increase quality adjusted life years (QALYs) by 0.20 (0.14–0.22), or about 73 more days of life at full health. The greatest cost savings were attributable to the decrease in unneeded patient transport (Whetten et al., 2018).

ACCESS Precursor Evaluations. In a 2010 UNMHSC study, a secure, HIPAA-compliant web-based neurological consult system was developed to allow rural hospitals to send digital neurological images to

[8] The results attached to the proposal note high confidence in using the ACCESS equipment (73 percent agree/strongly agree), caring for stroke-admitted patients (87 percent), and in providing care to a patient when consulting with another physician through telemedicine (92 percent).

a neurosurgeon for consult or patient transfer. The study assessed the effect of this telehealth program on transport and management decisions and found that 44 percent of potential transfers were avoided and 44 percent of consult cases resulted in changes in management recommendations, independent of the transfer decision (Moya et al., 2010).

A May 2011 study on the partnership between University of New Mexico Hospital (UNMH) and Indian Health Service (IHS) found that the use of teleradiology in rural areas to triage acute mild head trauma is feasible (Holguin et al., 2011).

CMMI Models. Several ongoing CMMI models have a stroke component, including the Bundled Payments for Care Improvement (BPCI) Initiative and BPCI Advanced (stroke is an eligible clinical episode of care), as well as Million Hearts, a heart attack and stroke prevention program. In addition, three HCIA models were substantially similar to ACCESS and included both stroke and telehealth components; these are described below:

- The Upper San Juan Health Service District Southwest's program is a multifaceted cardiovascular health program that includes a telehealth acute stroke care program and use of telehealth for cardiologist consultations (CMS Innovation Center, 2019). Key findings from the stroke telehealth component include a significant decrease in specialty care transports (SCTs) via air ambulance and a significant decrease in cost per SCT, although overall there was a significant increase in SCT costs due to higher number of ground transports (NORC, 2016).
- The Ochsner Clinic Foundation in Louisiana developed "Stroke Central," providing telemedicine for acute stroke management using an in-hospital team of trained Advanced Practice Nurses to enable care providers to monitor patients, evaluate outcomes, and check on medication and treatment adherence on a real-time basis. This program was associated with nonsignificant overall reductions in 90- and 180-day readmissions but had significant reductions for the high-risk subgroup. There were no clear trends for cost outcomes (NORC, 2016).
- The University of Kansas Hospital Authority's model involved forming a collaborative governance structure to oversee and be accountable for the continuum of care for patients who have suffered from or are at risk for heart attack or stroke (CMS Innovation Center Round 2, 2019). The program includes one acute care arm and two ambulatory care arms. In the acute care arm, patients that present to a rural hospital ED with a suspected stroke receive standardized care according to acute care protocols, and clinicians are supported in their treatment by remote emergency or critical care specialists (Mathematica, 2018). The impact evaluation is still in progress, but the most recent evaluation report indicated that the awardee and the collaborative are successful in implementing the program.

There are also several other CMMI models with a telehealth component, although these programs do not focus on stroke or neurology care. Several CMMI demonstrations include a telehealth waiver in which certain Medicare requirements for the provision of telehealth services are waived, including geographic site requirements. Demonstrations with a telehealth waiver include Next Generation ACO (NGACO), Comprehensive Care for Joint Replacement (CJR), BPCI, and Frontier Community Health Integration Project (FCHIP). ACOs participating in NGACO also have the option to bill for asynchronous store-and-forward teledermatology and teleophthalmology services as of 2018 (CMS Report to Congress, 2018). Evaluations to date indicate that uptake of the telehealth waiver in the BPCI, NGACO, and CJR models is low, with cited barriers including the waiver requirements, lack of necessary IT

infrastructure, burdensome documentation requirements, and perceived beneficiary reluctance to participate in a telehealth visit (Lewin Group, October 2018 [BPCI]; NORC, 2018; Lewin Group, August 2018 [CJR]). In FCHIP, 8 of 10 participating critical access hospitals are participating in the telehealth intervention (USDHHS, 2018).

Several State Innovation Model (SIM) programs include a telehealth component, which includes telehealth services such as remote patient monitoring that differ from the use of telehealth proposed under ACCESS. In SIM, 18 of the Round 2 Model Design states proposed an expansion of telehealth, including eight states that propose connecting patients and primary care providers in rural and frontier areas with specialists using telehealth (RTI, 2017).

Other Telestroke Programs. A 2017 review of telestroke identified at least 56 networks in 27 states linking a stroke center with local hospitals and determined that telestroke programs improve stroke outcomes, including death, institutionalization, and disability (Akbik et al., Part 1).

Major telestroke programs and studies in the US include:

- *Stroke Team Remote Evaluation Using a Digital Observation Camera (STRokE DOC)*. This randomized trial involved 222 patients with acute stroke and compared telephone consults and telemedicine consults. Telestroke decision-making was superior to consultation by telephone for administration of tPA (e.g., correct treatment decisions) (Bladin & Cadilhac, 2014). Clinical outcomes did not vary between groups, but the study was underpowered to detect differences in functional outcomes. A Mayo Clinic Arizona trial established a hub-and-spoke telestroke network in Arizona, demonstrating that it was feasible to extend the STRokE DOC trial to a new state. In Arizona, the team reported high rates of thrombolysis use and appropriate treatment decisions, improved data collection, and low rates of intracerebral hemorrhage (Demaerschalk et al., 2010).
- *Cleveland Clinic*. The Cleveland Clinic Telestroke Network was launched in 2011 and provides remote consultation services to patients in Ohio, Pennsylvania, and Florida. The network includes two-way video conferencing and linked imaging systems to facilitate patient assessment and treatment decision support. Stroke neurologists are on call 24 hours a day. In 2015, more than 1,000 consults were provided, and the tPA utilization rate was 16 percent, compared to the national average of 3 to 5 percent (Hussain & Collins, 2016). Cleveland Clinic also operates a mobile stroke treatment unit (Itrat et al., 2016).
- *Partners Telestroke Program.* The telestroke program at Massachusetts General Hospital uses a hub-and-spoke model to deliver consultations to hospitals in the region. In 2009, an estimated 55 percent of consult patients were provided life-saving treatments in the community hospital setting and remained there, while 45 percent of patients were appropriately transferred to a tertiary center for more advanced care, such as advanced neurosurgical or interventional neuroradiology procedures and/or high-acuity inpatient observation. A study on consults provided between 2006 and 2015 found that the frequency of hub and spoke hospital contact is associated with improved spoke hospital performance in time to tPA administration (Moreno et al., 2017).

- *Medical University of South Carolina (MUSC)*. MUSC Telestroke is a hub-and-spoke program launched in 2008. A 2017 study found reduced average door-to-needle time, reduced transfer rate to MUSC, and increased rtPA[9] administration over the study period (Al Kasab et al., 2017).
- *Remote Evaluation of Acute IsCHemic Stroke (REACH) telestroke system*. The REACH system was developed in Georgia to address obstacles to tPA use in rural settings and sought to determine whether National Institutes of Health Stroke Scale (NIHSS) evaluation values of bedside and remote evaluators would correspond. The study determined that the NIHSS could be reliably performed over the REACH system (Sam et al., 2003). Several major institutions in Georgia are part of the REACH network.

A widely cited 10-year evaluation of the *TeleMedical Project for integrative Stroke Care (TEMPiS)* in Germany found that intravenous thrombolysis was applied in 3,331 stroke cases, with proportions increasing from 2.6 percent to 15.5 percent of all patients with ischemic stroke. Median onset-to-treatment times decreased from 150 to 120 minutes and door-to-needle times went from 80 to 40 minutes (Müller-Barna, 2014).

Project ECHO. Project ECHO (Project Extension for Community Healthcare Outcomes) was founded at the University of New Mexico in 2003 and established a technology-enabled collaborative learning and capacity-building model. The 2016 Expanding Capacity for Health Outcomes (ECHO) Act defines a "technology-enabled collaborative learning and capacity building model" as a "distance health education model that connects specialists with multiple other health care professionals through simultaneous interactive videoconferencing for the purpose of facilitating case-based learning, disseminating best practices, and evaluating outcomes." Project ECHO has been replicated in the United States and internationally to address provider education for a range of health conditions, including neurology. As of 2018, Project ECHO had 101 affiliated hubs in the United States (ASPE, 2019).

[9] Recombinant tissue plasminogen activator (rtPA) is tPA manufactured using recombinant biotechnology techniques.

II. Annotated Bibliography

Akbik F, Hirsch JA, Chandra RV, et al. Telestroke: the promise and the challenge. Part one: growth and current practice. J Neurointerv Surg. 2017;9(4):357-+. doi:10.1136/neurintsurg-2016-012340.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: To describe the growth and current practice of telestroke, which aims to surmount barriers, including the mismatch between the distribution and incidence of stroke presentations and the availability of specialist care, by distributing stroke expertise more effectively.
Main Findings: The safety, efficacy, and improved long term outcomes demonstrated by telestroke have firmly established it as a durable healthcare delivery model.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Literature review of the current practice and patient outcomes of telestroke.

Akbik F, Hirsch JA, Chandra RV, et al. Telestroke: the promise and the challenge. Part two: expansion and horizons. J Neurointerv Surg. 2017;9(4):361. doi:10.1136/neurintsurg-2016-012340.

Subtopic(s): Issues in Payment Policy
Type of Source: Journal article/Review article
Objective: To determine the challenges and future of telestroke care.
Main Findings: Medicare currently pays for telestroke services in health professional shortage areas, but not in urban or suburban areas. Legal, regulatory, and financial barriers stand in the way of expanding coverage. Many telestroke services cross state boundaries, and each state has different regulations for telemedicine practice. Financially, there is a high upfront and maintenance cost. Current implementations of telemedicine are promising, however, and have shown to be cost effective.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Literature review of telestroke programs in the United States.

Al Kasab S, Adams RJ, Debenham E, Jones DJ, Holmstedt CA. Medical University of South Carolina Telestroke: A telemedicine facilitated network for stroke treatment in South Carolina—a progress report. Telemed J E Health. 2017;23(8):674-677. doi:10.1089/tmj.2016.0229.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: To provide an update on how Medical University of South Carolina's (MUSC) telestroke program had developed and the rate and safety of intravenous (IV) alteplase administration through telestroke.
Main Findings: The study shows that the telestroke program evolved over time to involve more sites throughout the state of South Carolina. Post-IV alteplase sICH was low and within the expected range. Over the study period, the number of participating sites increased from 6 to 19 sites. The percentage of transfers to MUSC decreased from 36 percent to 14 percent.
Strengths/Limitations: None described.
Generalizability to Medicare Population: N/A (sample demographics not described)

Methods: Data were collected on all patients evaluated through the MUSC Telestroke program from May 2008 through April 2014. Collected data included National Institutes of Health Stroke Scale (NIHSS) on presentation, number of IV alteplase administrations, number of patients transferred to MUSC, number of mechanical thrombectomies performed on transferred patients, rate of symptomatic intracerebral hemorrhages (sICHs), and discharge location.

AMD Global Telemedicine. I want to "do telemedicine": What is involved and how much does it cost? AMD. https://www.amdtelemedicine.com/blog/article/i-want-do-telemedicine-what-involved-and-how-much-does-it-cost. Published July 2015. Accessed March 12, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Blog post
Objective: To determine costs of telemedicine.
Main Findings: There are key elements and associated costs with telemedicine, including specialty medical devices, video conferencing and communication platforms, packaging design and mobility, bandwidth and internet connection, training, and industry and technical support. The costs vary depending on the existing facility.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

American Academy of Neurology. Neurologists see wins in final Medicare Fee Schedule. American Academy of Neurology. https://www.aan.com/siteassets/home-page/tools-and-resources/practicing-neurologist--administrators/billing-and-coding/medicare-fee-for-service/2019-final-rule-summary.pdf. Published November 2, 2018. Accessed March 1, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Report
Objective: To update neurologists on CMS regulations that affect physician reimbursement as of January 1, 2019.
Main Findings: The regulatory advocacy efforts of the American Academy of Neurology have allowed for code changes, higher reimbursement for telehealth and telemedicine, access to clinical registries, drug costs, and updates to quality payment programs.
Strengths/Limitations: N/A
Generalizability to Medicare Population: Yes
Methods: N/A

American Academy of Neurology. Neurology workforce data. doi:10.1056/NEJMhpr1107519.

Subtopic(s): Problems in Care Delivery
Type of Source: Fact sheet
Objective: To develop a report on shortages in the neurology workforce in the United States.
Main Findings: Neurology shortages in rural areas are well documented, as are the difficulties attracting U.S. medical graduates to neurology residency spots. Physician shortages can manifest in a number of different ways—for example, in longer waiting times for appointments or shorter visit times with physicians.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A

Methods: Literature review and data analysis of the neurology workforce.

American Academy of Neurology. Press release: Telemedicine for stroke expanded with passage of FAST Act. https://www.aan.com/PressRoom/Home/PressRelease/1618. Accessed March 11, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Press release
Objective: To provide the latest information on payment for Medicare beneficiaries who use telestroke services.
Main Findings: As of 2021, Medicare will cover various telestroke services for urban and rural hospital patients.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Bladin CF, Cadilhac DA. Effect of telestroke on emergent stroke care and stroke outcomes. Stroke. 2014;45(6):1876-+. doi:10.1161/STROKEAHA.114.003825.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: To provide an outcome overview of telestroke care and outline new shifts in care delivery, research, and education.
Main Findings: While telestroke applications vary widely, they are reproducible and financially sustainable. Telemedicine is applicable to almost every part of stroke care, from initial emergency room visits to stroke rehabilitation.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Literature review of existing telestroke applications

Brain Aneurysm Foundation. Statistics and Facts. Brain Aneurysm Foundation. https://bafound.org/about-brain-aneurysms/brain-aneurysm-basics/brain-aneurysm-statistics-and-facts/. Accessed March 8, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: Fact sheet
Objective: To provide statistics on brain aneurysms.
Main Findings: An estimated 6 million people in the United States have an unruptured brain aneurysm, or 1 in 50 people. Ruptured brain aneurysms are fatal in about 40 percent of cases. Of those who survive, about 66 percent suffer some permanent neurological deficit. Approximately 15 percent of people with a ruptured aneurysm die before reaching the hospital. Most of the deaths are due to rapid and massive brain injury from the initial bleeding. Ruptured brain aneurysms account for 3 to 5 percent of all new strokes.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Brown JB, Kheng M, Carney NA, Rubiano AM, Puyana JC. Geographical disparity and traumatic brain injury in America: Rural areas suffer poorer outcomes. J Neurosci Rural Pract. 2019;10(1):10. doi:10.4103/jnrp.jnrp_310_18

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Journal article
Objective: To determine the rural-urban disparity in traumatic brain injury (TBI) outcomes.
Main Findings: For all TBI, there were 13 more deaths per 100,000 people in the most rural urban influence code (UIC) compared to the most urban UIC. Rural Midwestern and Southern counties observed higher fatality rates.
Strengths/Limitations: While there are minimum guidelines for management of severe TBI, many rural areas have limited or no access to high-quality resources to exceed these standards.
Generalizability to Medicare Population: N/A
Methods: Geospatial and statistical analysis of age-adjusted TBI-specific fatality from the CDC Injury Statistics Query and Reporting System based on certain ICD-10 codes. County-level UICs were assigned to counties according to the U.S. Department of Agriculture scale.

Center for Connected Health Policy. State telehealth laws and reimbursement policies report. Center for Connected Health Policy—The National Telehealth Policy Resource Center. https://www.cchpca.org/telehealth-policy/state-telehealth-laws-and-reimbursement-policies-report. Accessed March 12, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Report
Objective: To review nationwide state telehealth laws.
Main Findings: Each state differs in telehealth definitions and regulations. There are variations in payments for live video and store-and-forward sessions, remote patient monitoring, originating sites, facility fees, and private payer telehealth reimbursement.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Centers for Medicare & Medicaid Services. Hospital-wide all-cause unplanned readmission measure. CMS Measures Inventory Tool. https://cmit.cms.gov/CMIT_public/ViewMeasure?MeasureId=2593. Accessed March 12, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: CMS measure description
Objective: To provide—for each measure—properties, steward, characteristics, groups, programs, links, and similar measures.
Main Findings: The measure estimates a hospital-level risk-standardized readmission rate (RSRR) of unplanned, all-cause readmission after admission for any eligible condition within 30 days of hospital discharge.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Centers for Medicare & Medicaid Services. CAHPS® survey for accountable care organizations participating in Medicare initiatives. CAHPS. https://acocahps.cms.gov/en/. Accessed March 11, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: Website
Objective: To describe the Consumer Assessment of Healthcare Providers and Systems (CAHPS) for ACOs Survey.
Main Findings: The CAHPS survey measures experience of care for ACOs participating in Medicare initiatives.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Centers for Medicare & Medicaid Services. Final policy, payment, and quality provisions changes to the Medicare Physician Fee Schedule for calendar year 2019. CMS.gov Newsroom. https://www.cms.gov/newsroom/fact-sheets/final-policy-payment-and-quality-provisions-changes-medicare-physician-fee-schedule-calendar-year. Published November 1, 2018. Accessed March 12, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Fact sheet
Objective: To outline the policy, payment, and quality provision changes to Medicare's Physician Fee Schedule (MPFS) for 2019.
Main Findings: The 2019 MPFS expanded the use of telehealth services for the treatment of opioid use disorder and other substance use disorders, added new codes to the list of telehealth services, and is finalizing policies related to telehealth services for beneficiaries with end-stage renal disease and to add mobile stroke units as originating sites.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

CMS Innovation Center. Health Care Innovation Awards: Project profile: Upper San Juan Health Service District. CMS.gov. https://innovation.cms.gov/initiatives/participant/Health-Care-Innovation-Awards/Upper-San-Juan-Health-Service-District.html. Updated March 19, 2019. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Website
Objective: To provide a profile of a Health Care Innovation Award project profile, the Upper San Juan Health Service District's "Southwest Colorado cardiac and stroke care" project in Colorado.
Main findings: The care delivery model will offer cardiovascular early detection and wellness programs, implement a telemedicine acute stroke care program, use telemedicine and remote diagnostics for cardiologist consultations, and upgrade and retrain its Emergency Medical Services Division staff to manage urgent care transports and in-home follow-up patient care for patients in medically underserved areas in Southwest Colorado.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

CMS Innovation Center. Health Care Innovation Awards round two: Project profile: University of Kansas Hospital Authority. CMS.gov. https://innovation.cms.gov/initiatives/participant/health-care-innovation-awards-round-two/university-of-kansas-hospital-authority.html. Updated March 19, 2019. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Website
Objective: To provide a profile of a Health Care Innovation Award project profile, the University of Kansas Hospital Authority's "Rural Clinically Integrated Network to Improve Heart Health and Stroke Survival for Rural Kansas" project in Kansas.
Main findings: The project forms a collaborative governance structure to create a trust environment through which independent providers serving Northwest Kansas can define and refine the entire care continuum for patients at risk for or who suffer from heart attack or stroke.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Centers for Medicare & Medicaid Services. Information on Medicare telehealth: Report to Congress on Telehealth Utilization and Future Opportunities. CMS.gov. https://www.cms.gov/About-CMS/Agency-Information/OMH/Downloads/Information-on-Medicare-Telehealth-Report.pdf. Published November 15, 2018. Accessed March 8, 2019.

Subtopic(s): Issues in Payment Policy; Results of Proposed or Similar Models
Type of Source: Report
Objective: To respond to the directive of the 21st Century Cures Act, Section 4012(a) by providing information about the populations of Medicare beneficiaries whose care may be improved by the expansion, activities by the Center for Medicare and Medicaid Innovation that examine the use of telehealth models, high-volume services that can be furnished using telehealth, and barriers that may prevent expansion of telehealth.
Main Findings: The overall rate of adoption of telehealth services is low but concentrated in the oldest populations (85+) and rural areas designated as Health Professional Shortage Areas. Telehealth is an emerging field, with the potential to lower costs and improve access to care in both emergent and chronic settings.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Literature review, analysis of current Medicare claims, and stakeholder interviews.

Centers for Medicare & Medicaid Services. Physician Fee Schedule. CMS.gov. https://www.cms.gov/medicare/medicare-fee-for-service-payment/physicianfeesched/. Last modified March 8, 2019. Accessed March 1, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: CMS Physician Fee Schedule
Objective: The CY2019 Physician Fee Schedule Final Rule updates payment policies, payment rates, and other provisions for services furnished under the MPFS on or after Jan. 1, 2019.
Main Findings: N/A

Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Centers for Medicare & Medicaid Services. Rural-urban disparities in health care in Medicare. https://www.cms.gov/About-CMS/Agency-Information/OMH/Downloads/Rural-Urban-Disparities-in-Health-Care-in-Medicare-Report.pdf. Published November 2018. Accessed March 18, 2019.

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Report
Objective: To determine all patient rural-urban differences in health care for the Medicare population, as well as by racial and ethnic group in 2017.
Main Findings: Medicare Advantage (MA) and Fee-for-Service (FFS) beneficiaries report similar patient care experiences in rural and urban areas with the exception of flu vaccination, but MA beneficiaries in rural areas have worse clinical care. Rural-urban differences in patient experience varied by race and ethnicity as well as coverage type, with Black MA and Hispanic FFS receiving the worst care. White MA and FFS beneficiaries have the same pattern of differences as beneficiaries overall. About half of all measures of patient care were worse in rural areas for all races and ethnicities.
Strengths/Limitations: Healthcare Effectiveness Data and Information Set (HEDIS) is only available for Medicare Advantage plans.
Generalizability to Medicare Population: Yes
Methods: Analysis of two data sets: the Medicare CAHPS, an annual CMS survey that focuses on health care experiences of Medicare beneficiaries, and HEDIS, which collects technical information from medical records and administrative data on quality of care.

Centers for Medicare & Medicaid Services, Center for Medicare and Medicaid Innovation. Value-based insurance design model request for applications for CY 2020. CMMI. https://innovation.cms.gov/Files/x/vbid-rfa2020.pdf. Accessed March 12, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Application
Objective: This is a request for applications for CMMI's Value-Based Insurance Design Model for 2020.
Main Findings: Telehealth networks are one of four model design elements.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Code of Federal Regulations. Telehealth services, 42 CFR § 410.78. https://www.law.cornell.edu/cfr/text/42/410.78. Accessed March 12, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Federal regulation
Objective: To define telehealth services
Main Findings: N/A
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A

Methods: N/A

Demaerschalk BM, Bobrow BJ, Raman R, et al. Stroke team remote evaluation using a digital observation camera in Arizona. Stroke. 2010;41(6):1251-1258.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: The main objective of the Stroke Team Remote Evaluation Using a Digital Observation Camera (STRokE DOC) Arizona TIME (The Initial Mayo Clinic Experience) trial was to determine the feasibility of establishing, de novo, a single-hub, multirural spoke hospital telestroke research network across a large geographical area in Arizona by replicating the STRokE DOC protocol.
Main Findings: It is feasible to extend the original STRokE DOC trial protocol to a new state and establish an operational single-hub, multispoke rural hospital telestroke research network in Arizona. The correct treatment decision was established in 87 percent of consultations: 89 percent by telephone, and 85 percent by telemedicine. The 90-day functions, differences in mortality, and rates of intracerebral hemorrhage were not statistically different.
Strengths/Limitations: The trial was not designed to have sufficient power to detect a difference between the 2 consultative modes: telemedicine and telephone-only. Findings may not be generalizable to different patient populations or different stroke care protocols; additional research is recommended.
Generalizability to Medicare Population: Yes (mean age 66 years)
Methods: Methods included prospective, single-hub, 2-spoke, randomized, blinded, controlled trial of a 2-way, site-independent, audiovisual telemedicine system designed for remote examination of adult patients with acute stroke versus telephone consultation to assess eligibility for treatment with intravenous thrombolysis. The primary outcome measure was whether the decision to give thrombolysis was correct. Secondary outcomes were rate of thrombolytic use, 90-day functional outcomes, incidence of intracerebral hemorrhages, and technical observations.

Donofrio PD, Barkley GL, Cohen BH, et al. How neurologists are paid. Neurol Clin Pract. 2015;5(5):397-404. doi:10.1212/CPJ.0000000000000182

Subtopic(s): Issues in Payment Policy
Type of Source: Journal article
Objective: To discuss neurologists' reimbursement for Medicare patients.
Main Findings: Neurologists face yearly reductions in reimbursement for services paid for by Medicare. This is due to cost-savings changes by Medicare, Medicaid, and third-party payers, code changes for chronic care, and the elimination of payment for consultations.
Strengths/Limitations: N/A
Generalizability to Medicare Population: Yes
Methods: Analysis of payment trends, reimbursements, and on-call pay.

Garcia MC, Faul M, Massetti G, et al. Reducing potentially excess deaths from the five leading causes of death in the rural United States. MMWR Surveill Summ. 2017;66. doi:10.15585/mmwr.ss6602a1

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Fact summary

Objective: To report statistics on the five leading causes of death.
Main Findings: There is a rural-urban gap in age-adjusted death rates, leading to excess death rates from the five leading causes of death in rural areas. Focuses on access alone is insufficient. To alleviate the gap, approaches should include strengthening the health care delivery system and increase integration of all services.
Strengths/Limitations: N/A
Generalizability to Medicare Population: Yes
Methods: Data analysis and literature review of death rates of the five leading causes of death.

Holguin E., Stippler M. Yonas H., Boyd D. Management of acute head trauma in rural locations: University of New Mexico Teleradiology Initiative for Mild Traumatic Brain Injury. IHS Prim Care Provid. 2011,36(5):99-104.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Primary care provider newsletter
Objective: To report the experience triaging acute mild head trauma in rural locations in New Mexico to University of New Mexico Hospital (UNMH), the only Level 1 trauma center in New Mexico with dedicated TBI care.
Main Findings: Teleradiology is feasible in rural areas to facilitate triage of patients with mTBI but is currently underutilized.
Strengths/Limitations: None described.
Generalizability to Medicare Population: N/A
Methods: Utilization of teleradiology from January 2010 to January 2011 was assessed by reviewing all head CT scans uploaded to the Online Medical Consultant System®.

Hospital Compare. Measures and current data collection periods. Medicare.gov. https://www.medicare.gov/hospitalCompare/Data/data-updated.html#MG16. Accessed March 8, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: Data sheet
Objective: To determine frequency of data collection and update frequency for Medicare's Hospital Compare tool for COPD, AMI, HF, PN, stroke, and coronary artery bypass graft (CABG).
Main Findings: N/A
Strengths/Limitations: N/A
Generalizability to Medicare Population: Yes
Methods: N/A

Howard G, Kleindorfer D, Cushman M, et al. Contributors to the excess stroke mortality in rural areas in the United States. Stroke. 2017;48(7):1773-1778.

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Journal article
Objective: To determine what the contributors are to excess stroke mortality in rural areas in the United States.
Main Findings: Stroke incidence was 1.23 times higher in large rural towns/cities and 1.30 times higher in small rural towns or isolated areas when adjusting for demographic factors relative to urban areas. There was no association of rural-urban status with case fatality, suggesting the difference is in stroke incidence.

Strengths/Limitations: The Reasons for Geographic and Racial Differences in Stroke (REGARDS) study is geographically heterogeneous and had more than 1,000 stroke events. However, the low distribution of the population in rural areas leads to less precise estimation of stroke risk and fatality. REGARDS only measured rural-urban status at baseline and did not account for moves. The participation rate is around 30 percent, leading to potential nonresponse bias.
Generalizability to Medicare Population: Yes
Methods: A longitudinal cohort study of 30,239 community-dwelling black and white participants older than 45 between 2003 and 2007 who had never had a stroke. The study oversampled black residents and residents who live in the Stroke Buckle (coastal plain of North Carolina, South Carolina, and Georgia) and the Stroke Belt (the remainder of North Carolina, South Carolina, and Georgia, as well as Tennessee, Alabama, Mississippi, Louisiana, and Arkansas).

HRSA. Health workforce projections: Neurology physicians and physician assistants. HRSA. https://bhw.hrsa.gov/sites/default/files/bhw/health-workforce-analysis/research/projections/BHW_FACTSHEET_Neurology.pdf. Published March 2017. Accessed March 8, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: Fact sheet
Objective: To determine the national supply and demand of neurology physicians and physician assistants from 2013 to 2025.
Main Findings: N/A
Strengths/Limitations: Some of the fact sheet is based on a model assumption that base care will not change for neurology, and health care utilization will be at similar rates. There is no geographical distribution of providers taken into account.
Generalizability to Medicare Population: N/A
Methods: Model study using National Center for Health Workforce Analysis' Health Workforce simulation model.

Hussain MS, Collins D. Cleveland Clinic Telestroke Network at year 5: Lessons learned. Cleveland Clinic. https://consultqd.clevelandclinic.org/cleveland-clinic-telestroke-network-year-5-lessons-learned/. Published September 22, 2016. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Online article
Objective: To determine the outcomes of Cleveland Clinic's Telestroke Network after five years.
Main Findings: Cleveland Clinic's Telestroke Network has 16 percent utilization of intravenous tissue plasminogen activator (tPA) versus a national average of 3 to 5 percent use. This program also keeps patients in their communities, reducing transfers and keeping patients close to their families and with local physicians. These local physicians also feel confident in their abilities to administer tPA in a timely manner. Fifteen hospitals or freestanding emergency departments (EDs) now have access to remote stroke specialists.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Not described.

Itrat A, Taqui A, Cerejo R, et al. Telemedicine in prehospital stroke evaluation and thrombolysis: Taking stroke treatment to the doorstep. JAMA Neurol. 2016;73(2):162-168. doi:10.1001/jamaneurol.2015.3849

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: To test the feasibility of a mobile stroke treatment unit (MSTU) that uses telemedicine and remote physician presence.
Main Findings: Ninety-nine of 100 patients were evaluated successfully, with the last being routed to the closest ED after a crew error. CT completion from the emergency room door was 13 minutes on average, and intravenous thrombolysis was completed in 32 minutes on average when an MSTU was used. This was significantly shorter than the control group.
Strengths/Limitations: Previous mobile health unit studies were conceptual and feasibility studies, and this observational study was successful. The MTSU populations closely matched city demographics. However, the sample size is small, and there is no data on canceled dispatches. The MTSU protocol was also highly sensitive to any patients that may be having an acute stroke; only 33 of the evaluations initially represented acute ischemic stroke.
Generalizability to Medicare Population: Partial (treatment group median age 62, control group median age 64)
Methods: Prospective observational study between July 18 and November 1, 2014, in Cleveland, Ohio, in the Cleveland Clinic Health System. Vascular neurologists evaluated the first 100 patients by telemedicine, and a neuroradiologist remotely evaluated images via mobile CT.

Kaufman BG, Thomas SR, Randolph RK, et al. The rising rate of rural hospital closures. J Rural Heal. 2016;32(1):35-43. doi:10.1111/jrh.12128.

Subtopic(s): Problems in Care Delivery
Type of Source: Journal article
Objective: To determine the impact of hospital closures on rural communities.
Main Findings: Due to the financial market crash of 2009, rural hospitals closed at a rapid rate between 2010 and 2014. Critical access hospitals (CAHs)had lower levels of profitability, capital, patient volume, and staff availability. Other rural hospitals also had smaller markets and populations to care for. About half of the hospitals have converted to an alternative or more limited health care delivery model.
Strengths/Limitations: Findings were consistent with media reports that closures of rural hospitals were in line with profitability.
Generalizability to Medicare Population: N/A
Methods: Comparison cohort study of CAHs and other rural hospitals that closed with hospitals that stayed open in the same time range.

Lees K, Bluhmki E, von Kummer R, et al. Time to treatment with intravenous alteplase and outcome in stroke: an updated pooled analysis of ECASS, ATLANTIS, NINDS, and EPITHET trials. Lancet. 2010;375:1695-1703.

Subtopic(s): Problems in Care Delivery
Type of Source: Journal article
Objective: To examine the effect of time to treatment with recombinant tissue plasminogen activator (rtPA) on therapeutic benefit and clinical risk. Early administration of intravenous rtPA

after ischemic stroke improves outcome. Previous analysis of combined data from individual patients suggested potential benefit beyond 3 hours from stroke onset. The authors reexamined the effect of time to treatment with intravenous rtPA (alteplase) on therapeutic benefit and clinical risk by adding recent trial data to the analysis.
Main Findings: Odds of a favorable outcome increased as onset to start of treatment decreased, with the highest odds being between zero to 90 minutes. No benefit of rtPA was seen after 270 minutes.
Strengths/Limitations: None described.
Generalizability to Medicare Population: Yes (median age 68 years)
Methods: The authors added data from ECASS III (821 patients) and EPITHET (100 patients) to a pool of common data elements from six other trials of alteplase for acute stroke (2,775 patients). They used multivariate logistic regression to assess the relation of stroke onset to start of treatment (OTT) with treatment on favorable three-month outcome (defined as modified Rankin score 0-1), mortality, and occurrence and outcome of clinically relevant parenchymal hemorrhage. The presence of an arterial occlusion was inferred from the patient's symptoms and absence of hemorrhage or other causes of ischemic stroke. Vascular imaging was not a requirement in the trials. All patients with confirmed OTT within 360 minutes were included in the analysis.

Leira EC, Hess DC, Torner JC, Adams HP. Rural-Urban Differences in Acute Stroke Management Practices : A Modifiable Disparity. *Archives of neurology (Chicago)*. 2008;(7):887.

Subtopic(s): Problems in Care Delivery
Type of Source: Journal article
Objective: To review the problems and potential solutions that exist in three aspects of the current rural stroke care system: prehospital care, rural local hospital emergency department care, and interhospital transfer of patients and subsequent reception at a larger tertiary care institution, which often involve long distances and considerable time.
Main Findings: Acute stroke management practices in rural areas are suboptimal, which creates an unacceptable health disparity between urban stroke patients and their rural counterparts. The current gap in rural-urban stroke management practices could be overcome with a comprehensive strategy that addresses the existing issues, including further education of rural caregivers, remote support from tertiary care institutions, and implementation of future acute clinical trials that test the rural strategies to stroke care.
Strengths/Limitations: None described.
Generalizability to Medicare Population: N/A
Methods: The authors conducted a PubMed search to identify all the articles published from 1997 to 2007 that addressed acute stroke, paramedics, ambulances, emergency services, and interhospital transportation pertaining to the US rural, urban, or nonurban environment.

Lewin Group. CMS comprehensive care for Joint Replacement Model: Performance year 1 evaluation report. CMS.gov. https://innovation.cms.gov/Files/reports/cjr-firstannrpt.pdf. Published August 2018. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Evaluation report

Objective: To present findings in a first annual report from the early stages of Comprehensive Care for Joint Replacement (CJR) model implementation based on episodes included in the first performance year (episodes initiated on or after April 1, 2016, that ended by December 31, 2016).
Main Findings: Despite its short tenure, the CJR model achieved a statistically significant reduction in total episode payments due to reductions in institutional post-acute care (PAC) use. At the same time, quality of care, as measured by readmission rates, ED visits, and mortality, was maintained. Interviewees from CJR participant hospitals reported that they chose to respond to the model by beginning planning earlier, educating patients about discharge to less-intensive PAC settings, and coordinating with PAC providers.
Strengths/Limitations: Although the mandatory, randomized design of the CJR model resulted in a control group that closely matched the treatment group on characteristics thought to influence episode payment and quality, there could be unobserved differences that affect the accuracy of estimates of the differential change in outcome measures between CJR and control episodes. The evaluation includes numerous outcomes, which increases the risk of rejecting the null hypothesis of no effect when in reality the null hypothesis is true. The analysis of the site visit and provider telephone interview data provide descriptions of themes, patterns, or taxonomies in response to our protocols, which may not represent all CJR participants.
Generalizability to Medicare Population: Yes
Methods: This report used a variety of data sources and methods to evaluate the impact of the CJR model during the first performance year. Secondary data sources, such as claims and enrollment data, were used to construct key outcome measures to examine changes in payments, utilization, quality, and patient mix. The primary analytic method for these quantitative data was difference-in-differences (DiD) with risk adjustment to control for any remaining differences between the CJR and control group. The authors also collected primary data from site visits and telephone interviews with providers.

Lewin Group. CMS bundled payments for Care Improvement Initiative models 2-4: Year 5 evaluation & monitoring annual report. CMS.gov. https://downloads.cms.gov/files/cmmi/bpci-models2-4-yr5evalrpt.pdf. Published October 2018. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Evaluation report
Objective: To provide a summative evaluation of the Bundled Payments for Care Improvement (BPCI) initiative, incorporating all analyses conducted during the five-year evaluation contract, and to describe the experience under BPCI for more than three years of the initiative, from the fourth quarter (Q4) of 2013 through Q4 2016.
Main Findings: Under the BPCI initiative, Medicare payments declined for most clinical episodes, and more than half of the relative payment reductions were statistically significant. The declines were primarily due to relative reductions in the use of post-acute care. The Medicare payment reductions occurred under Model 2 and 3 and across participant types as well as a range of surgical, acute, and chronic clinical episodes. Quality of care, measured as ED visits, mortality, and readmissions, was not affected in the vast majority of clinical episodes. Changes in functional status did not differ between beneficiaries in BPCI episodes and comparison beneficiaries, based on survey results, although fewer BPCI beneficiary respondents reported the highest level of satisfaction with their care.
Strengths/Limitations: The primary analytic approach is dependent on how well the comparison group represents what would have happened absent the BPCI initiative. For some combinations,

the comparison episodes were not as close a match as the authors would like. Sensitivity analyses also suggested that the statistical significance of some results may have been due to the chance selection of particular comparison episodes. The evaluation of the BPCI initiative is not complete. There are seven more quarters of claims and assessment data to evaluate.
Generalizability to Medicare Population: Yes
Methods: Findings in this report are based on analyses of Medicare claims and enrollment data, PAC provider patient assessments, awardee-submitted data, beneficiary surveys, participant interviews, and participant site visits.

Ma VY, Chan L, Carruthers KJ. Incidence, prevalence, costs, and impact on disability of common conditions requiring rehabilitation in the United States: Stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, osteoarthritis, rheumatoid arthritis, limb loss, and back pain. Arch Phys Med Rehabil. 2014;95(5):986-995.e1. doi:10.1016/j.apmr.2013.10.032

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Review article
Objective: To determine the incidence, prevalence, cost, and outcomes of common conditions that require rehabilitation.
Main Findings: Traumatic brain injury holds the highest direct and indirect costs due to lower age of onset and severe future disability potential. Stroke, while the most common cause of disability, is second in impact on future limitations.
Strengths/Limitations: Data sources are not always current, therefore costs and inflation adjustment is not as accurate. Not all costs and disability are attributed to a single diagnosis as represented in the tables.
Generalizability to Medicare Population: N/A
Methods: Literature review, data analysis, and cost analysis of stroke, spinal cord injury, traumatic brain injury, multiple sclerosis, osteoarthritis, rheumatoid arthritis, limb loss, and back pain cases.

Mathematica Policy Research. Evaluation of the round two Health Care Innovation Awards (HCIA R2): Third annual report. https://downloads.cms.gov/files/cmmi/hcia2-yr3evalrpt.pdf. Published June 2018. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Evaluation report
Objective: To evaluate 38 programs funded under round two of the Health Care Innovation Awards (HCIA R2). Thirty-nine organizations received three-year cooperative agreements as of September 2014 to implement models to improve health and quality of care for Medicare, Medicaid, and Children's Health Insurance Program beneficiaries.
Main Findings: Half of the awardees met at least 90 percent of their enrollment goals, and two-thirds implemented their service delivery models effectively. However, progress was mixed in payment model development and program sustainment. Early impact studies found low favorable effects on program utilization and expenditures.
Strengths/Limitations: The programs were diverse in delivery models, target populations, and care settings, making synthesis difficult. CMS allowed awardees to make program changes during the cooperative agreement with documentation. Early impact studies do not show the true impact of all programs.
Generalizability to Medicare Population: Yes

Methods: Five-year evaluation of 38 HCIA R2 programs through the awardees' self-reports, telephone interviews, program enrollment data, and Medicare claims data.

Mayo Clinic. Stroke—Diagnosis and treatment. Mayo Clinic. https://www.mayoclinic.org/diseases-conditions/stroke/diagnosis-treatment/drc-20350119. Published 2019. Accessed March 8, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: Fact/resource sheet
Objective: To describe stroke diagnosis, treatment, recovery, rehabilitation, and treatment outcomes.
Main findings: Stroke may be diagnosed by physical examination, blood tests, computerized tomography (CT) scan, magnetic resonance imaging (MRI), carotid ultrasound, cerebral angiogram, or echocardiogram. Treatment depends on whether the stroke is ischemic or hemorrhagic. Ischemic stroke treatment may include intravenous injection of tPA.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

MedPAC. Chapter 16: Mandated report: telehealth services and the Medicare program. In: Report to the Congress: Medicare Payment Policy. Washington DC: MedPAC; 2018:469-506. http://www.medpac.gov/docs/default-source/reports/mar18_medpac_entirereport_sec.pdf. Accessed March 12, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Report to Congress
Objective: To describe how Medicare and commercial insurance plans cover telehealth services. This report also explains the demographics of Medicare beneficiaries that are using telehealth services and how expanding coverage can reduce overall cost, increase access, and improve quality of health care.
Main Findings: Medicare's coverage of telehealth services is broad and flexible, though somewhat limited under the MPFS, under which providers bear little financial risk for increasing service use. By contrast, coverage of telehealth by commercial insurance plans was variable in 2017, with few plans covering a comprehensive set of services. In general, commercial plans have not found strong evidence that telehealth services reduce costs or improve outcomes. Therefore, policymakers should take a measured approach to further incorporating telehealth into Medicare by evaluating individual telehealth services to assess their capacity to address the Commission's three principles of cost reduction, access expansion, and quality improvement.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Qualitative and quantitative research methods.

Moreno A, Schwamm LH, Siddiqui KA, et al. Frequent hub–spoke contact is associated with improved spoke hospital performance: Results from the Massachusetts General Hospital Telestroke Network. Telemed J E Health. 2017;24(9):678-683. doi:10.1089/tmj.2017.0252

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: To determine the level of contact necessary between spoke hospitals and their hubs.

Main findings: Among 375 patients, the median door-to-needle time was 76 minutes. Higher frequency of hub-and-spoke connections is significantly associated with lower door-to-needle times. There were 1.3 minutes saved per 10 additional consults in spoke hospitals.
Strengths/Limitations: This study was conducted in a single network and had a limited number of subjects. While there was time saved on a system level, there was no way to determine the individual level of tPA treatment. However, the spokes varied in size and encompassed a wide range of time.
Generalizability to Medicare Population: N/A
Methods: Data analysis of a hub-and-spoke system in 16 spoke hospitals in the Partners Telestroke Network in Massachusetts General Hospital between 2006 and 2015. All tPA-treated AIS patients, with and without telestroke consultations, were included in the study.

Moya M, Valdez J, Yonas H, Alverson DC. The impact of a telehealth web-based solution on neurosurgery triage and consultation. Telemed J E Health. 2010;16(9):945-949. doi:10.1089/tmj.2010.0044.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: To determine the proportion of patients transferred from rural hospitals after a telemedicine consultation, and if any management or transportation decisions were altered regardless of transfer decision.
Main Findings: The study showed 44 percent of potential transfers were avoided by using telemedicine consults. It also showed 44 percent of consulted cases had a change in management recommendations, excluding the transfer decision.
Strengths/Limitations: There is a small sample size; 39 consultations were analyzed. Evaluations were limited to tertiary care providers, and not the referring institutions.
Generalizability to Medicare Population: N/A
Methods: Web-based program to consult with and provide digital images to neurologists.

Müller-Barna P, Hubert GJ, Boy S, et al. TeleStroke units serving as a model of care in rural areas: 10-year experience of the TeleMedical Project for Stroke Care. Stroke. 2014;(9):2739.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: The TeleMedical Project for integrative Stroke Care (TEMPiS) was established in 2003 as a TeleStroke Unit network to overcome this barrier in Southeast Bavaria/Germany. Evaluation of its implementation between 2003 and 2005 had revealed improved process quality and clinical outcomes compared with matched hospitals without TeleStroke Units. This study provides data on the sustainability of these effects.
Main Findings: TeleStroke Units can provide sustained high-quality stroke care in rural areas. Within the covered area, network implementation increased the number of patients with stroke and transient ischemic attack treated in hospitals with (Tele-) Stroke Units substantially from 19 percent to 78 percent. Intravenous thrombolysis use increased while medium onset-to-treatment times decreased over the time analyzed.
Strengths/Limitations: Because of non-modifiable regional structures of the model studied, the transfer of this concept to other rural regions is limited.
Generalizability to Medicare Population: No

Methods: Effects on the stroke care of the local population were analyzed by using data from official hospital reports. Prospective registries from 2003 to 2012 describe processes and outcomes of consecutive patients with stroke and transient ischemic attack treated in TEMPiS hospitals. Quality indicators assess diagnostics, treatment, and outcome. Rates and timeliness of intravenous thrombolysis as well as data on teleconsultations and secondary interhospital transfers were reported over time.

National Institute of Justice. Chapter 3: Estimated costs and savings of an operational telemedicine configuration. In: Telemedicine Can Reduce Correctional Health Care Costs: An Evaluation of a Prison Telemedicine Network. Washington DC: U.S. Department of Justice; 1999. https://www.ncjrs.gov/pdffiles1/175040.pdf. Accessed March 12, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Research report
Objective: To provide cost breakdowns and cost savings of a telemedicine system in a federal prison.
Main Findings: While the initial cost of the equipment and personnel to implement telemedicine systems is high, the savings through averted external consultations and transportation is enough to offset the cost. At the observed level of 104 patients a month, telemedicine saved $102 per patient, including equipment and personnel costs.
Strengths/Limitations: Cost estimates are for a range of encounters; therefore, savings can range based on the condition presented. This technology was as of January 1998, and technology advances since then can reduce the upfront cost of telemedicine services.
Generalizability to Medicare Population: N/A
Methods: Data analysis and literature review of telemedicine in a federal prison system.

National Quality Forum. Cost and resource use 2016-2017 final technical report. National Quality Forum. http://www.qualityforum.org/Cost_and_Resource_Use.aspx. Accessed March 19, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: Report
Objective: To describe health care costs and resource use in the United States between 2016 and 2017.
Main findings: Though health care spending is increasing year after year, the United States continues to rank low in life expectancy, chronic disease prevalence, and quality care domains. Providing incentives that can reduce cost and deliver efficient care need to be identified to improve value and health outcomes.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Evaluation of Total Resource Use Population-Based Index, Total Cost of Care Population-Based Index, and Medicare Spending per Beneficiary by hospital.

National Stroke Association. Hemorrhagic stroke. National Stroke Association. https://www.stroke.org/understand-stroke/what-is-stroke/hemorrhagic-stroke/. Accessed March 5, 2019.

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Fact sheet

Objective: To describe rates of hemorrhagic stroke.
Main Findings: Fifteen percent of strokes are hemorrhagic but account for 40 percent of all stroke deaths.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Nebraska Legislature. Nebraska Revised Statute Chapter 71 Section 4209, Stroke system of care task force; duties. https://nebraskalegislature.gov/laws/statutes.php?statute=71-4209. Effective July 19, 2018.

Subtopic(s): Issues in Payment Policy
Type of Source: State statute
Objective: To outline the objective of the stroke system of care task force in Nebraska.
Main Findings: The department shall establish a stroke system of care task force to address matters of triage, treatment, and transport of possible acute stroke patients. The task force shall include representation from numerous different stakeholder programs with the state department.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Nguyen C, Jia J. Mobile stroke units: The next frontier in stroke treatment. Pract Neurol. January 2018. http://practicalneurology.com/2018/01/mobile-stroke-units/. Accessed March 19, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: Online journal article
Objective: To understand the use of mobile stroke units
Main Findings: Mobile stroke unit (MSU) usage has expanded in the United States. Ambulances are equipped with portable CT, point-of-care laboratory testing, access to a vascular neurologist, and select medications necessary to treat a stroke.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Literature review of existing MSUs.

NORC at the University of Chicago. First annual report: Next Generation Accountable Care Organization (NGACO) model evaluation. https://innovation.cms.gov/Files/reports/nextgenaco-firstannrpt.pdf. Published August 2018. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Evaluation report
Objective: To present initial descriptive and analytic findings for the 18 Next Generation ACOs (NGACO) that launched in 2016, were active for at least one quarter, and were financially responsible in the model's first performance year (PY1).
Main Findings: In PY1, 2016 NGACO providers reduced spending for their beneficiaries by $100.08 million (1.7 percent). Most of the decline in spending could be attributed to reduced Medicare spending on post-acute care, most notably on spending in skilled nursing facilities that reached statistical significance for three ACOs. Early findings show a significant reduction in

Medicare Part A and B spending, totaling $100.09 million. There was a significant relative reduction in inpatient hospital days and evaluation and management visits (outside acute care hospital and ED settings). There was a significant relative increase in beneficiaries receiving annual wellness visits. Impact on measures of spending, utilization, and quality of care were favorable for most of 18 NGACOs in PY1, with few showing significant findings. The authors calculated a net reduction in Medicare spending totaling $62.12 million from NGACOs in 2016, corresponding to a decrease of $11.20 per beneficiary per month (PBPM), or 1.1 percent.
Strengths/Limitations: Limitations include the potential impact on modeling of the wide variation in Medicare spending among our study sample and the influence of spillover (ACO-affiliated providers delivering care to both aligned beneficiaries and comparators) and of other value-based purchasing models, including other CMMI initiatives.
Generalizability to Medicare Population: Yes
Methods: Analysis of program documents and of interviews and surveys with ACO leadership were conducted to identify organizational characteristics, NGACO model features selected for PY1 (2016), and selected market characteristics, as well as to describe early implementation experience. Impact was measured using Medicare claims and a DiD design.

NORC at the University of Chicago. Third annual report: HCIA Disease-Specific evaluation. CMS.gov. https://downloads.cms.gov/files/cmmi/hcia-diseasespecific-thirdannualrpt.pdf. Published February 2016. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Evaluation report
Objective: This report discusses the subset of 18 Health Care Innovation Awards (HCIA) projects targeting patient populations who have specific diseases or diagnostic profiles. For this environmental scan, two relevant awardees were identified: the Ochsner Clinic Foundation in Louisiana and the Upper San Juan Health Service District in Colorado.
Main Findings:

- Ochsner Clinic Foundation developed its programs to coordinate stroke care from admission to the ED through outpatient rehabilitation. The mixed-methods analysis suggests that Ochsner's approach to coordinated stroke care offered limited reduction in utilization and improved the quality of care for stroke patients.
- Upper San Juan Health Service District's low volume of patients made it challenging to evaluate outcomes. The evaluation demonstrates that USJHSD might have succeeded in achieving one of its main goals, which was to reduce the number of specialty care transports by air. A combination of neurological telemedicine and critical care paramedicine enabled stroke patients to be transferred to a closer tertiary care center by ground transportation. Patients and their caregivers highly preferred this approach. The program was also able to administer thrombolytic therapy in a more timely manner to some patients (n = 4), and this is expected to achieve lifetime cost savings for those patients. Finally, qualitative outcomes measures such as patient satisfaction and public recognition for its new programs led to institutional support for program sustainability.

Strengths/Limitations:

- Ochsner Clinic Foundation: Approximately two-thirds of participants enrolled in Ochsner's intervention received coverage through MA plans and other private insurance. The authors did not have data to include these beneficiaries in the analysis, so the analyses may not reflect the overall impact of the Stroke Central program.

- Upper San Juan Health Service District: The small number of individuals in the wellness analysis limited the ability to detect quantitative changes in utilization measures. Since the analysis of the telemedicine program is based on one follow-up point, it does not capture any long-term improvements in health status or any decreases in cost and utilization that are attributable to thrombolytic therapy facilitated by telemedicine. Finally, the researchers lacked a comparison group and were unable to determine if USJHSD differentially affected outcomes relative to usual care.

Generalizability to Medicare Population: Yes
Methods: Gathered and analyzed qualitative data (in-person and telephone interviews with program leadership, staff, enrolled participants, and caregivers, as well as focus groups with participants and caregivers) and quantitative data (claims data from the CMS Chronic Condition Data Warehouse CCW to capture information on health care costs and utilization for participants [treatment group] and an identified comparison group).

North Dakota Legislative Branch. Century Code t23c43, Chapters 23-43: Stroke centers and care. https://www.legis.nd.gov/cencode/t23c43.pdf. Accessed March 21, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: State statute
Objective: To define North Dakota's statutes on stroke centers and stroke care.
Main Findings: The statute outlines the duties of the state health officer; the criteria to quality as a comprehensive stroke center, primary stroke center, or acute stroke-ready hospital; plans for a standardized stroke-triage assessment tool; the plan on how to ensure continuous improvement of quality of care for stroke patients; and the establishment of the state department of health stroke care task force.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Office of Health Policy, Office of the Assistant Secretary for Planning and Evaluation (ASPE), U.S. Department of Health and Human Services. Report to Congress: Current state of technology-enabled collaborative learning and capacity building models. ASPE, Office of the Assistant Secretary for Planning and Evaluation. https://aspe.hhs.gov/system/files/pdf/260691/ECHOAct-ConsolidatedReportToCongress.pdf. Published February 2019. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Government report
Objective: To share findings with Congress on 1) how technology-enabled collaborative learning and capacity-building models are being used to address health care workforce capacity-building and quality improvement objectives; 2) what the existing evidence base tells us about the effectiveness of these models in achieving these objectives; and 3) where there are gaps in the evidence base that warrant further evaluation.
Main Findings: Use of these models is widespread across the Department of Health and Human Services (HHS), and empirical evidence for their impact on patient and provider outcomes is positive yet modest. The absence of standardized information collection hampers research on effectiveness. To date, funding has focused on model implementation, with some funding toward evaluation in recent years; HHS believes strengthening the evidence base would be helpful.

Strengths/Limitations: This search focused only on hub locations and not on the necessarily much higher number of spoke sites involved with each hub. It is possible that some initiatives were not captured. Many initiatives contained minimal information online, making it difficult to determine whether they met the inclusion criteria. Many projects also use different names in different settings, creating risk of duplicate entries.
Generalizability to Medicare Population: N/A
Methods: The authors compiled an inventory of existing Project ECHO (Project Extension for Community Healthcare Outcomes) and ECHO-Like Models (EELM), conducted an evidence review to compile what is known in the published literature about EELM, convened a technical expert panel, and estimated the cost to fully evaluate EELM.

RTI International. State Innovation Models (SIM) Round 2: Model design final report. CMS.gov. https://innovation.cms.gov/files/reports/sim-designrd2-final.pdf. Published August 2017. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Model design report
Objective: To evaluate CMMI's State Innovation Models' State Health System Innovation Plans (SHSIPs) in round two, the pre-test/model design stage.
Main Findings: Eighteen of the Round 2 Model Design states proposed an expansion of telehealth, including eight states that propose connecting patients and primary care providers in rural and frontier areas with specialists using telehealth.
Strengths/Limitations: N/A
Generalizability to Medicare Population:
Methods: The RTI team reviewed and abstracted data from the State Health System Innovation Plan (SHSIPs) and other model design documents for 21 states. The team used data from the SHSIPs, state data, and supporting document submissions, and state web sites to complete a data abstraction template that RTI had developed with CMMI's input for each of the awardees. These data abstractions, along with the SHSIPs and supporting data, were used to identify cross-state themes and answer three research questions.

Sam W, Sung Bae L, Carol P, et al. Remote evaluation of acute ischemic stroke: Reliability of National Institutes of Health Stroke Scale via Telestroke. Stroke. 2003;(10):e188. doi:10.1161/01.STR.0000091847.82140.9D.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Journal article
Objective: The Remote Evaluation for Acute Ischemic Stroke (REACH) program was developed to address obstacles to tPA use in rural settings. A key component of stroke assessment in the REACH system is the National Institutes of Health Stroke Scale (NIHSS) evaluation. We sought to determine whether, using the REACH system, NIHSS values of bedside and remote evaluators would correspond.
Main Findings: The NIHSS can be reliably performed over the REACH system. NIHSS ranged from 1 to 24. Correlations between bedside and remote locations were very strong, and *t* tests indicate that the means were not different.

Strengths/Limitations: None described. This research is the first step in developing an easy-to-use tool for both the community hospital staff and consulting physicians. This REACH system is now being tested in rural community hospitals in Georgia.
Generalizability to Medicare Population: N/A (sample demographics not described)
Methods: Twenty patients were recruited. On obtaining consent, a neurologist performed a bedside NIHSS evaluation on each patient. Within one hour, using any broadband-connected workstation—either office or home personal computer and a landline phone to speak with the patient—a second neurologist remotely evaluated the patient through the REACH system. Paired *t* tests and Pearson correlation coefficients were used to examine NIHSS reliability performed bedside and remotely.

Sauser-Zachrison K, Land T, Soare TW, Christie A, Nasuti L, Schwamm LH. Abstract TP300: tPA administration affects stroke patient disposition and mortality. Stroke. 2016;47(suppl_1):ATP300-ATP300. doi:10.1161/str.47.suppl_1.tp300

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Journal article
Objective: To determine the period that acute ischemic stroke (AIS) stroke patients have for disability-reducing treatment and their rates of discharge, 30-day, and 1-year mortality. Shorter onset-to-arrival (OTA) time is critical for AIS patients potentially eligible for disability-reducing treatment, including intravenous tPA and endovascular thrombectomy.
Main Findings: Patients arriving within 3.5 hours are more likely to be discharged to home, and patients treated with tPA are more likely to be discharged to home and have lower one-year mortality.
Strengths/Limitations: The only hospitals included were 60 Coverdell Registry hospitals in Massachusetts.
Generalizability to Medicare Population: Unknown (abstract only)
Methods: Prospective study of all AIS patients in 60 Coverdell Registry hospitals in Massachusetts from 2005–2013, excluding patients without documented arrival or onset time.

Schwartz J, Wang Y, Qin L, et al. Incorporating stroke severity into hospital measures of 30-day mortality after ischemic stroke hospitalization. Stroke. 2017;48(11):3101-3107. doi:10.1161/STROKEAHA.117.017960.

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Journal article
Objective: CMS publicly reports a hospital-level stroke mortality measure that lacks stroke severity risk adjustment. This study's objective was to describe novel measures of stroke mortality suitable for public reporting that incorporate stroke severity into risk adjustment.
Main Findings: The authors developed three quality measures that demonstrate better discrimination than the existing CMS stroke mortality measure, adjust for stroke severity, and could be implemented in a variety of settings.
Strengths/Limitations: Get With The Guidelines-Stroke (GWTG-Stroke) is a voluntary registry. NIHSS is taken at the admitting hospital, so the score may not reflect the initial stroke severity.
Generalizability to Medicare Population: N/A
Methods: The authors linked data from the American Heart Association/American Stroke Association GWTG-Stroke registry with Medicare FFS claims data to develop the measures. They used logistic regression for variable selection in risk model development. They developed three

risk-standardized mortality models for patients with acute ischemic stroke, all of which include the NIHSS score: one that includes other risk variables derived only from claims data (claims model); one that includes other risk variables derived from claims and clinical variables that could be obtained from electronic health record data (hybrid model); and one that includes other risk variables that could be derived only from electronic health record data (electronic health record model).

Steine S, Finset A, Laerum E. A new, brief questionnaire (PEQ) developed in primary health care for measuring patients' experience of interaction, emotion and consultation outcome. Fam Pract. 2001;18(4):410-418. doi:10.1093/fampra/18.4.410.

Subtopic(s): Problems in Care Delivery
Type of Source: Journal article
Objective: To develop a new patient experience questionnaire (PEQ) that is specific to consultations.
Main Findings: The PEQ emphasizes what patients value the most (e.g., interaction, emotions, and outcome) and may represent a valuable tool for doctors who want feedback from their patients on the function of their doctor-patient relationships. A final questionnaire was produced with 18 items on five dimensions: communication; emotions; short-term outcome; barriers; and relations with the auxiliary staff. The validity and reliability estimates were highly satisfactory. Patients had less than optimal communication or communication barriers in 48 to 70 percent of visits. Less than helpful staff experiences were reported in 55 percent of the visits. Patients reported no positive experiences in 24 percent of visits, and 48 percent had low knowledge and perceived results of their outcomes.
Strengths/Limitations: The questionnaire was developed in Norway, where patient focus is in the forefront. However, this questionnaire provides patient feedback regardless of the health system it is within.
Generalizability to Medicare Population: Limited
Methods: The questionnaire was developed in Norwegian primary care in three main phases: patient focus groups, testing to reduce questions from 110 questions to 25 questions, and distribution to 1,092 patients. The final questionnaire was produced with 18 questions asking about communication, emotions, short-term outcome, barriers, and relations with auxiliary staff.

Switzer JA, Demaerschalk BM, Xie J, Fan L, Villa KF, Wu EQ. Cost-effectiveness of hub-and-spoke telestroke networks for the management of acute ischemic stroke from the hospitals' perspectives. Circ Cardiovasc Qual Outcomes. 2013;6(1):18-26. doi:10.1161/CIRCOUTCOMES.112.967125

Subtopic(s): Issues in Payment Policy
Type of Source: Journal article
Objective: To assess the cost-effectiveness of a hub-and-spoke telestroke network.
Main Findings: The results of this study suggest that a telestroke network may increase the number of patients discharged home and reduce the costs borne by the network hospitals. Hospitals should consider their available resources and the network features when deciding whether to join or set up a network. Each year, a telestroke network was associated with $358,435 in cost savings; each spoke had $109,080 in cost savings, whereas the hub had positive costs of $405,121. However, cost sharing can be arranged so that each hospital could achieve an equal amount of cost savings ($44,804 per year). Results were sensitive to the number of

spokes, marginal treatment costs in spokes and rates of transfer, and endovascular stroke therapies.
Strengths/Limitations: Sensitivity analysis allows for an accurate model when determining the number of spokes in the system. However, this study focuses on the cost savings of intravenous thrombolysis and endovascular stroke therapies and does not include subacute care and rehabilitation. Some hospitals may not be fully equipped to manage additional stroke patients. Discharge destinations were not directly reported in the trials, so conservative assumptions were made.
Generalizability to Medicare Population: N/A
Methods: A model was developed to compare costs and effectiveness with and without a telestroke network over a five-year time horizon. The model considered differences in rates of teleconsultations, intravenous thrombolysis, endovascular stroke therapies, and spoke-to-hub transfers. These inputs were estimated through the use of data from Georgia Health Sciences University and Mayo Clinic telestroke networks.

U.S. Department of Health and Human Services. Report to Congress: Demonstration project on community health integration models in certain rural counties: Interim report 2018. HRSA Health Resources & Services Administration. https://www.hrsa.gov/sites/default/files/hrsa/ruralhealth/reports/FCHIP-Interim-Report-September-2018.pdf. Published September 2018. Accessed March 19, 2019.

Subtopic(s): Results of Proposed or Similar Models
Type of Source: Evaluation report
Objective: To present the background, design, and structure of the Frontier Community Health Integration Project Demonstration (FCHIP) and preliminary findings from the first year in an interim report.
Main Findings: For the telehealth intervention, as reported by the eight participating sites, efforts in the first project year were largely start-up in nature, though common operational and administrative challenges often beyond the scope of Medicare policy did limit change. The majority of participating CAHs are implementing the telehealth intervention. The sites developed protocols, purchased equipment, identified distant site provider networks, and made the community aware of the services. The number of times that the eight participating sites served as originating sites to host telehealth services grew from one in the year prior to the demonstration project to 57 encounters by the end of the first year. This intervention also presented the most operational challenges for the facilities, although these challenges would exist regardless of the demonstration. The participating CAHs identified credentialing issues, access to and capacity limits of distant site practitioners, not being in the same health care networks of potential distant site practitioners, and resistance by local practitioners as reasons for not seeing greater increases in the hosting of telehealth services despite their increased capabilities.
Strengths/Limitations: The preliminary findings from the first year of demonstration are descriptive in nature and primarily based on information provided by the sites. Results focus on access to care, coordination of care, and quality of care. Since FCHIP does not collect these data for some of the measures from an independent source (e.g., claims) and the data reflect only the start-up year of FCHIP, there is insufficient evidence to draw conclusions at this time.
Generalizability to Medicare Population: Yes
Methods: The independent evaluator visited the demonstration sites in June and July 2017 to interview a variety of stakeholders, including hospital leadership (e.g., chief executive officer,

chief financial officer, and medical director); affiliated providers; and hospital administrative support staff. Furthermore, there are some findings based on qualitative data collected in the provision of technical assistance to the sites, including site visits completed in June 2017, and limited quantitative data from the participating CAHs' quarterly submissions of quality measures.

VisuWell. Oklahoma Telemedicine & Telehealth Reimbursement Overview. 2019. VisuWell. https://visuwell.io/telemedicine-reimbursement/oklahoma-telemedicine-telehealth-reimbursement-overview/. Accessed March 20, 2019.

Subtopic(s): Issues in Payment Policy
Type of Source: Website/fact sheet
Objective: To provide an overview of Oklahoma's telemedicine and telehealth reimbursement policies, including provider eligibility, CPT codes, and parity law. The information is also divided between state law and health insurance payers.
Main Findings: Differences exist in telehealth reimbursement policies based on the payer.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: N/A

Whetten J, van der Goes DN, Tran H, Moffett M, Semper C, Yonas H. Cost-effectiveness of Access to Critical Cerebral Emergency Support Services (ACCESS): a neuro-emergent telemedicine consultation program. J Med Econ. 2018;21(4):398-405. doi:10.1080/13696998.2018.1426591.

Subtopic(s): Results of Proposed or Similar Models; Problems in Care Delivery
Type of Source: Journal article
Objective: To assess the clinical and economic outcomes of the ACCESS program in providing services to rural New Mexico from a health care payer perspective.
Main Findings: The analysis demonstrates potential savings and improved quality of life associated with the use of ACCESS for patients presenting to rural hospitals with AIS. The use of ACCESS decreased neuro-emergent stroke patient transfers from rural hospitals to urban settings from 85 percent to 5 percent (no tPA) and 90 percent to 23 percent (tPA), while stroke specialist reading of patient CT/MRI imaging within three hours of onset of stroke symptoms increased from 2 percent to 22 percent. Results indicate that use of ACCESS has the potential to save $4,241 ($3,952–$4,438) per patient and increase quality adjusted life years (QALYs) by 0.20 (0.14–0.22). This increase in QALYs equates to ~73 more days of life at full health. The cost savings and QALYs are expected to increase when moving from a 90-day model to a lifetime model.

Strengths/Limitations: One of the major limitations of this study is that the results are only valid if the assumptions hold, as it is with most cost-effective analysis (CEA) studies. This CEA is limited by the current literature data and the present state of the authors' experience with their teleneurology program. Conservative assumptions were made under uncertainties. The analysts used current national averages for costs and outcomes, when in reality these vary from region to region. Lastly, it was assumed that diagnosis had the same accuracy for both those in the program and those outside the program.
Generalizability to Medicare Population: N/A (sample demographics not described)

Methods: A decision tree model was constructed using findings from the ACCESS program and existing literature, the likelihood that a patient will receive tPA, cost of care, and resulting QALYs. Data from the ACCESS program includes emergency room patients in rural New Mexico from May 2015 to August 2016. Outcomes and costs have been estimated for patients who were taken to a hospital providing neurological telecare and patients who were not.

Xu J, Murphy SL, Kochanek KD, Bastian B, Arias E. Deaths: final data for 2016. Natl Vital Stat Rep. 2018;67(5).

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Journal article/report
Objective: To present final data on 2016 death rates and trends by demographics.
Main Findings: In 2016, 2,744,248 deaths were reported, a decrease of 0.6 percent from 2015. Life expectancy overall, and by ethnicity and gender, have decreased by less than one-half percent. The 15 leading causes of death remained the same as 2015. The infant mortality rate has not changed significantly since 2015.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Data analysis of all resident death certificates and causes of death by ICD-10 codes.

Yale New Haven Health Services Corporation/Center for Outcomes Research & Evaluation. 2016 condition-specific measures updates and specifications report hospital-level 30-day risk-standardized readmission. http://aann.org/uploads/Condition_Specific_Readmission_Measures.pdf. Published March 2016. Accessed March 8, 2019.

Subtopic(s): Problems in Care Delivery
Type of Source: Report
Objective: To describe condition-specific readmission measures, and report hospital-level 30-day risk-standardized readmission rates following acute myocardial infarction (AMI), chronic obstructive pulmonary disease (COPD), heart failure (HF), pneumonia (PN), and stroke.
Main Findings: N/A
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Literature review and data analysis for condition-specific outcomes on 30-day readmission rates.

Yang Q, Tong X, Schieb L, et al. Vital signs: Recent trends in stroke death rates—United States, 2000–2015. *MMWR Morb Mortal Wkly Rep*. 2017;66(35):933-939. doi:10.15585/mmwr.mm6635e1

Subtopic(s): Epidemiology of Emergency Cerebral Conditions
Type of Source: Journal article
Objective: To examine trends and patterns in recent stroke death rates among U.S. adults age ≥35 years by age, sex, race/ethnicity, state, and census region.
Main Findings: Between 2000 and 2008, there were consistent decreases in stroke death rates between 3 and 6 percent. As of 2013, there has been a 2.5 percent increase per year until 2015. There was a statistically significant increase among Hispanics (5.8 percent) and in the South Census Region (4.2 percent). The reasons for the rate change are unclear and can come from various factors. There could have been a change in prevalence or management of stroke risk

factors, such as obesity, diabetes, unhealthy diets, smoking, hypertension, and physical activity. There was also a severe influenza season in 2014–2015.
Strengths/Limitations: There are a various limitations of the study. The underlying cause of death on death certificates can be misclassified, age-standard stroke death rates are only appropriate for comparisons across populations and over time, there was only one trend analysis, excess stroke deaths were estimated by assuming declines would be consistent, and the effect the severe influenza seasons have on future cardiovascular events is unclear. However, this study determines interventions to continue the decline of stroke death rates.
Generalizability to Medicare Population: Yes
Methods: Trends in the rates of stroke as the underlying cause of death during 2000–2015 were analyzed using data from the National Vital Statistics System. Joinpoint software was used to identify trends in stroke death rates, and the excess number of stroke deaths resulting from unfavorable changes in trends was estimated.

Yang, T. Telehealth parity laws. Health Aff. 2016. DOI: 10.1377/hpb20160815.244795.

Subtopic(s): Issues in Payment Policy
Type of Source: Policy brief
Objective: To explain the reforms in telehealth parity, where treatment has to be equivalent for analogous services, and outline which policies are increasing telehealth access.
Main Findings: Without parity laws for telehealth services, providers have little incentive to implement these services. As the United States moves toward an integrated health care delivery model, telehealth systems allow for increased access to high-quality care regardless of region, with lower costs.
Strengths/Limitations: N/A
Generalizability to Medicare Population: N/A
Methods: Policy review of current telehealth systems and criticisms of the current models.

Yip MP, Chang AM, Chan J, Mackenzie AE. Development of the telemedicine satisfaction questionnaire to evaluate patient satisfaction with telemedicine: A preliminary study. J Telemed Telecare. 2003;9:46-50.

Subtopic(s): Problems in Care Delivery
Type of Source: Journal article
Objective: To develop a questionnaire for patient satisfaction of telemedicine services.
Main Findings: Initial evidence was found for the reliability and validity of the Telemedicine Satisfaction Questionnaire (TSQ). Predictive validity gave further support for the conclusion that the TSQ measured patient satisfaction with telemedicine. The three major factors identified in the present study were consistent with one of the most significant predictors of patient satisfaction with telemedicine: the ability to meet patients' health care needs. Health care needs could be perceived as the quality of actual care received, the similarity of telemedicine to face-to-face interaction, and the perceived quality of the interaction.
Strengths/Limitations: Since the TSQ evaluated in this study was the Chinese version, further reliability and validity testing of the TSQ is needed. Replication of this study's finding with other ethnic groups will enhance its generalizability. Validity testing with other convergent and divergent measures would strengthen the TSQ as an instrument to measure patient satisfaction with telemedicine.
Generalizability to Medicare Population: Partial (34 percent of the sample were age 60–70)

Methods: Items related to patient satisfaction with telemedicine were identified through a review of the literature. The internal consistency and the intraclass correlation coefficient were used to evaluate the reliability of the proposed instrument. Content validity was examined using a panel of experts. The questionnaire was tested with 38 subjects.

III. Research Questions, Data Sources, Key Words, and Search Term Table

The environmental scan includes a review of information from existing peer-reviewed and non-peer-reviewed publications. We conducted a formal search of major medical, health services research, and general academic databases. We also conducted targeted searches of content available in the grey literature. We reviewed the websites of professional associations/societies and CMS for relevant evaluation reports and program documentation. The table below lists the research questions motivating this environmental scan as well as the sources and search terms used.

Table 1. Search Strategy

Research Questions	Preliminary Search Terms	Sources
Epidemiology of Emergency Cerebral Conditions		
Clearly define the issue/population by addressing the following: 1. What is the prevalence of emergency cerebral conditions, including stroke (ischemic, hemorrhagic) and traumatic brain injury (TBI)? How frequently do patients present to emergency departments with neurological symptoms? a. What is the prevalence in rural and underserved areas? 2. How many Medicare beneficiaries live in rural and underserved areas, as defined by lacking immediate access to neurology or neurosurgery specialty care? a. What are the characteristics of these beneficiaries? Note: Depending on specificity of the literature on this point, we may need to use rural beneficiaries as a proxy and add a disclaimer to the e-scan. 3. What are the characteristics of Medicare beneficiaries who require emergent cerebral care? 4. What health outcomes, including mortality, are associated with emergency cerebral conditions? a. What disparities exist between urban beneficiaries and beneficiaries living in rural or underserved areas?	Medicare prevalence + Stroke Cerebral emergency Cerebral vascular emergency Neurologic emergency Traumatic brain injury (TBI) Medicare stroke disparities + Urban, rural, medically underserved area Demographic characteristics Outcomes, complications, mortality + Stroke Cerebral emergency Cerebral vascular emergency Neurologic emergency Traumatic brain injury (TBI)	PubMed Google Scholar Sources cited in proposal MMD tool American Academy of Neurology American Heart Association/American Stroke Association
Issues in Payment Policy		
5. Describe the current landscape of telemedicine services and reimbursement for neurology care (e.g., direct-to-consumer, provider-to-provider, remote patient monitoring). 6. What are Medicare FFS payment rules on telemedicine? a. What services are covered, including for emergency cerebral conditions? b. What are the requirements related to rural/urban areas, originating and distant site, etc.? 7. What are Medicare Advantage payment rules on telemedicine? 8. What are Medicaid rules on telemedicine? a. Note NM Medicaid covers ACCESS as of January 1, 2019	Telemedicine/telehealth + policy, payment, coverage, services, reimbursement + Fee-for-service (FFS) Medicare Medicare Advantage Medicaid	MedPAC March 2018 report CMS telehealth report to Congress Medicare coverage database MLN training resources MLN telestroke resources CMMI Medicare Claims Processing Manual Medicaid policies report Medicaid policies page

Research Questions	Preliminary Search Terms	Sources
9. What is Medicare reimbursement for the in-person physician consult covered under the ACCESS model? 10. What, if any, other payment models exist to address telemedicine and/or emergency cerebral conditions? 11. What are the technology- and equipment-related costs of telemedicine?		HRSA Proposed and final rule–Section 50325 of the Bipartisan Budget Act of 2018 (acute stroke telehealth services)
Problems in Care Delivery		
12. Describe the need for tele-neurology services (e.g., lack of specialty providers, etc.) 13. What costs and health consequences are associated with inadequate access to cerebral specialists (e.g., cost of air/ambulance transfer, treatment time delay)? 14. Is there support for the validity of quality metrics or outcomes proposed for use in the model? a. Portion of patients with neuro-emergent conditions transported from spoke hospital to tertiary referral centers b. Imaging results for acute stroke patients within 45 minutes c. Timeliness of emergency medicine care (Time to written and verbal treatment recommendation in the ER) d. Hospital-wide all-cause unplanned-readmission measure e. Rate of tPA administration for stroke patients f. Patient experience questionnaire (PEQ) g. Telemedicine Satisfaction Questionnaire (TSQ) h. CAHPS patient experience survey i. Confidence of hub-and-spoke providers to make treatment decisions and care for neuro-emergent patients (self-assessment) j. Monthly chart review for quality and outcomes k. Feedback system for consulting provider to raise technical issues with software	Neurologist, neurosurgeon availability, capacity, adequacy + Rural area Medically underserved area Medicare telemedicine/telehealth uptake, utilization Telestroke Stroke quality/performance measures/metrics Tissue plasminogen activator (tPA) administration Acute stroke patient imaging Patient experience questionnaire (PEQ) Telemedicine Satisfaction Questionnaire (TSQ) CAHPS patient experience survey	Cochrane NCQA CMS Measures Inventory Tool PubMed Google Scholar CMMI Sources cited in proposal CMS telehealth report to Congress ASPE telehealth report to Congress MedPAC American Heart Association/American Stroke Association Rural Telehealth Research Center Center for Connected Health Policy Rural Health Research Gateway

Results of Proposed or Similar Models		
15. What are the results of evaluations of ACCESS or ACCESS precursors? a. CMMI HCIA round 2 evaluation b. Partnership with Indian Health Service hospital c. Does this evaluation assess payment for the model (vs. evidence of effectiveness and costs)? 16. What are the results of other models or demonstrations that address stroke or cerebral emergencies (e.g., telestroke models)? 17. What are the results of other models or demonstrations that include a telemedicine component (e.g., Project ECHO)? Note: The e-scan will focus on telestroke models, though Project ECHO and other major telemedicine models that are identified will be briefly summarized.	Telestroke/tele-neurology model, program, demonstration, outcomes, results, findings	Google Scholar PubMed CMMI Sources cited in proposal Federal telehealth compendium CRS report

Three NORC staff members between March 1, 2019, and March 20, 2019, conducted more than 75 searches of major medical and academic databases, including PubMed and the University of Chicago Library; government websites including MedPAC, CMS, and CMMI; and Google Scholar. Searches were generally restricted to the past five years, except when conducting searches on programs that predate this time period (e.g., landmark telestroke studies or ACCESS precursor models). Human filtering was conducted on search results based on whether the title and abstract of the materials found matched inclusion criteria.

UNMHSC ACCESS proposal: Follow-up literature review requested by the PRT

May 13, 2019

1. What evidence is there that rural hospitals are referring neurology patients out to tertiary care facilities who could be cared for locally with telemedicine services? What is the volume of patients transferred from rural hospitals for neurology care?

Clinical evaluations by skilled neurological specialists are imperative to meeting the need for a rapid response to neuro-emergent conditions (e.g., tPA administration for ischemic stroke cases). Rural and medically underserved populations often lack sufficient access to neurological specialists compared to urban areas (American Academy of Neurology, 2012). Rural and underserved emergency departments (EDs) tend to transfer high-risk patients to larger hospital systems, due to either a lack of expertise or supplies required (Leira et al., 2008).

NORC conducted a deeper dive into the literature for evidence on the degree to which rural hospitals transfer neurology patients to urban hospitals and, to extent possible, determine if telemedicine services facilitate more local care of neurology patients. In summary, total ED patient transfers from any hospital to another have been increasing since at least 2006, from 3.4 per 100 ED visits in 2006 to 7.6 per 100 ED visits in 2014. With that timeframe the rate of transfer was highest between rural and urban/teaching hospitals than other inter-hospital transfers. Research suggests that rural hospitals are three times more likely to transfer ischemic stroke patients than urban-teaching facilities (George et al., 2018).

Telemedicine practices have been shown to decrease the number of overall transfers out of the rural hospital in several studies, anywhere from a 44 percent to 80 percent reduction in neuro-emergent transfers. One study specifically tracked how many unnecessary transfers were avoided due to telemedicine practices. Albeit few cases, this studied determined that 11 of 25 cases (44%) that would have been accepted prior to teleneurology intervention could be appropriately care for at the rural spoke hospital (Moya et al., 2010). Two studies employing retrospective reviews (Yi et al., 2018) and simulation models (Boulouis et al., 2017) suggest many stroke transfers for thrombectomy could be avoided by conducting and reading imaging studies at the referring facilities.

The table on the next page presents a summary of the literature on transfers found during the review.

Short Reference	Type of Study (Timeframe)	Methods	Findings
Title: Medical University of South Carolina Telestroke: A Telemedicine Facilitated Network for Stroke Treatment in South Carolina—A Progress Report			
Al Kasab et al., 2017*	Program evaluation, no comparison group May 2008 – April 2016	Patient records from participating hospitals, NIHSS data, and MUSC-collected metrics evaluated to measure consultations, transfers, and time-to-treatment over study timeframe	Over study timeframe, there were 7,705 consultations and 1,643 transfers. The percentage of consultations that resulted in transfers dropped from 48% in 2009 to 16% in 2015, thought to be a result of increased comfort providing treatment at rural hospitals due to specialty consults in real time.
Title: Emergency Medical Services for Acute Ischemic Stroke: Hub-and-Spoke Model Versus Exclusive Care in Comprehensive Centers			
Bekelis et al., 2018	Instrumental variable analysis (2009 – 2015)	Using New York Statewide Planning and Research Cooperative System (SPARCS) database, studied three cohorts and conducted analysis on differences in mortality, discharge to a facility, and length of stay.	A total of 128,122 patients were identified for inclusion. 14,450 patients were transferred within a hub-and-spoke model to a stroke care facility. These patients did not have significant differences in mortality or other analyzed outcomes from patients who presented at a stroke-capable facility.
Title: Teleneurology Service Provided Via Tablet Technology: 3-Year Outcomes and Physician Satisfaction			
Harper et al., 2018	Quantitative analysis of primary data (February 2014 - May 2017)	Data collection at hub (Vanderbilt University Medical Center) and entry using REDCap online tool, basic tabulations using tool conducted	3,626 teleneurology consultations were conducted, of which 87% were kept at originating facility and not transferred to VUMC for treatment. One specific facility previously transferred 100% of neurology patients to VUMC whereas after implementation of teleneurology they only transferred 40% of patients.
Title: Stroke and Helicopter Emergency Medical Service Transports: An Analysis of 25,332 Patients			
Hutton et al., 2015.	Quantitative descriptive analysis (2004 – 2011)	Structured review of existing electronic clinical and logistical records of HEMS transports	Over the study timeframe, 25,332 transfers were suspected or confirmed cerebrovascular accidents. Transports overall for cerebrovascular accidents increased from 1.39% of all transports to 3.85% over study timeframe. 79% of these transports were to primary stroke centers. Of inter-facility transports to primary stroke centers, 69% of them originated from a facility in a "super-rural" locality.
Title: Report to the Congress Medicare Payment Policy: Chapter 16 Mandated Report: Telehealth services and the Medicare program			
MedPAC, 2018.	Interviews with health system representatives (Not specified)	Interview, type not specified	Telestroke services have the potential to reduce the volume of hospital-to-hospital transfers, which can delay treatment or impair quality. Representatives stated that telestroke programs had a large impact on retaining patients at local hospitals, making local physicians more comfortable with administering stroke procedures, and decreasing “door-to-needle” times, which improved outcomes for stroke patients.

Title: The Impact of a Telehealth Web-Based Solution on Neurosurgery Triage and Consultation			
Moya et al., 2010*	Prospective evaluation of 39 head trauma cases (Nov 2007 – Oct 2008)	Statistical analysis to determine whether the trial program observed more or less than 25% reduction in transfers (i.e. the predicted proportion of transfers based on estimates from UNMH's experience)	44% of transports were avoided due to program. 25 of the 39 cases would have been accepted for transfer under normal procedures. After CT consult but prior to transfer, 11 of those 25 cases were kept at rural hospital for care (44%).
Title: Third Annual Report: HCIA Disease-Specific Evaluation (Upper San Juan Health Services District)			
NORC, 2016*	Pre-post area-level analysis of stroke patients (July 2012 - July 2014)	Medicare FFS claims analysis on small number of patients; results should be interpreted with caution.	Reported significant decrease in the proportion of specialty care transportations (SCTs) by air ambulances in post period; reported statistically significant decrease in cost per SCT but overall cost of SCTs increased significantly.
Title: Cost-effectiveness of Access to Critical Cerebral Emergency Support Services (ACCESS): a Neuro-Emergent Telemedicine Consultation program			
Whetten et al., 2018*	Decision tree modeling (May 2015 – Aug 2016)	Developed decision tree model to measure cost and effectiveness of possible outcomes. Data used were patient records from participating hospitals.	777 consultations were included in the analysis. The program decreased transfers from 85% prior to study to only 5% (no tPA administration) and 90% to 23% (tPA administration) with slight increases in estimated quality of life. The estimated cost savings through the ACCESS program was $4,241 per patient.

2. Do patients in rural areas experience disparities in care for cerebral events (e.g. access to care, delays in diagnosis, or lower quality care) compared to their urban peers?

Note: This literature review focused on stroke, as much of the literature discussed stroke and few studies were identified for other conditions. Stroke is a leading cause of death in the US as well as a source of serious long-term disability. In 2009, 66 percent of people hospitalized for stroke were age 65 and over. Stroke reduces mobility in more than half of stroke survivors age 65 and over.[1]

Disparities in access to care. A systematic review on urban-rural differences in stroke care and outcomes found convincing but not unanimous evidence to suggest that patients in rural areas receive less acute stroke care than those in urban areas (Dwyer et al., 2019). Below, we describe evidence on disparities in stroke care among rural patients. These disparities are attributed to multiple factors.

Access to facilities

- Rural patients often must travel greater distances than urban patients to the nearest facility and therefore may present at the emergency department longer after the time of symptom onset (Trent et al., 2018). Rural facilities may be unable to administer tPA within the recommended timeframe if patients with acute ischemic stroke do not present to the emergency department promptly.
- There are significant gaps in access to certified primary stroke centers in rural areas, though patients in underserved urban areas face gaps as well (Albright et al., 2010).
- The rate of rural hospital closures has increased over the past 10 years (Kaufman et al., 2016). Rural hospital closures can reduce access to care, particularly emergency care, for residents; lead to an outmigration of physicians and other health care professionals; and exacerbate gaps in access to specialty care (Wishner et al., 2016).

Provider and staff shortages

- There are provider shortages in rural areas, including neurologist shortages. For example, while there are 11.02 neurologists per 100,000 people in Washington D.C., there are only 1.78 neurologists per 100,000 in Wyoming (American Academy of Neurology, 2012).
- Rural facilities have greater difficulty ensuring 24 hour neurology coverage and therefore rely more on primary care physicians to provide services in rural emergency departments (Slade et al., 2012; Leira et al., 2008). These physicians may have reservations about making the decision to administer tPA.

Quality of Stroke Care

- Due to inadequate staffing and access to equipment, rural patients are less likely than those in urban areas to receive stroke unit care, brain imaging within 24 hours, carotid imaging, and consultations from neurologists, physiotherapists, occupational therapists and speech language pathologists, or to be transferred to inpatient rehabilitation facilities (Koifman et al., 2016).
- Common barriers in rural Stroke Belt[2] emergency departments to administering alteplase within the recommended 60-minute door-to-needle timeframe include coordinating across the stroke team,

[1] Centers for Disease Control and Prevention. (2017). Stroke Facts. https://www.cdc.gov/stroke/facts.htm

[2] In this study, the Stroke Belt is defined as an eight-state region with elevated stroke mortality rates that includes Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee.

triage staff recognizing the symptoms of acute ischemic stroke, and obtaining a neurology consult (Jauch et al., 2018).

- Rural facilities often lack financial resources for equipment and may not have 24 hour access to diagnostic services including lab testing and CT scanners. Rural hospital delays in stroke services may be due to transport delays and ancillary service delays, including access to radiology and laboratory services (Joubert et al., 2008).
- Adherence to evidence-based stroke treatment guidelines is poor in some rural facilities (Lichtman et al., 2012).

Disparities in thrombolysis. In addition to disparities in access to care, there are geographic disparities in utilization of thrombolysis (including administration of tPA and rtPA/alteplase). Below we present evidence on disparities in thrombolysis.

- A study on rural-urban differences in tPA utilization among acute ischemic stroke patients found that geographic disparities increased over the 2000-2010 study period (Gonzales et al., 2017). There are several potential contributors to this growing disparity, including growth of primary stroke centers in urban areas, disparities in preventive care, and patient delays due to lower stroke knowledge.
- According to Hospital Compare quality performance data, non-metropolitan hospitals perform worse than metropolitan hospitals on all assessed stroke care quality measures, with the greatest disparity in alteplase (rt-PA) administration for eligible patients (Seabury et al., 2017).
- Nationwide Inpatient Sample (NIS) hospitalization data from 2005–2010 shows increasing thrombolysis use in both urban and rural hospitals, with a higher rate of increase in urban hospitals (George et al., 2015). Patients admitted to stroke centers are much less likely to live in rural areas and the adjusted odds of receiving thrombolysis for patients admitted to rural facilities are significantly less compared to their urban counterparts, a finding that contrasts previous research. This study suggests that rural-urban disparities are not improving and in fact may be increasing in rural areas.

Disparities in outcomes. The systematic review on urban-rural differences in stroke care and outcomes found inconsistent evidence on disparities in outcomes (Dwyer et al., 2019). The reviewed studies examined outcomes including mortality, readmission, and measures related to functional status, discharge destination, and severe complications during admission. Evidence on disparities in neurological outcomes is described below.

- One study found higher risk-standardized 30-day mortality rates at critical access hospitals (CAH) than non-CAHs among Medicare fee-for-service (FFS) beneficiaries age 65 and over with a primary discharge diagnosis of ischemic stroke, but similar risk-standardized 30-day readmission rates (Lichtman et al., 2012).
    - Higher CAH mortality rates may be due to longer travel time for rural patients; relative lack of available and readily mobilized emergency medical services; economic and geographic constraints of CAHs; patient characteristics including age, insurance status, access to primary care services, and knowledge of stroke warning signs and risk factors; and inadequate clinical skills among CAH staff due to low volume of stroke cases.
- A study on excess stroke mortality in rural areas attributed the 30 percent higher stroke mortality in rural areas to higher stroke incidence rather than case fatality (Howard et al., 2017).

Stroke risk factors in rural areas include higher incidence of diabetes and hypertension as well as factors associated with lower socioeconomic status.

- One study of traumatic brain injury (TBI) patient fatality rates across the United States found that there were 13 more deaths per 100,000 people in the most rural urban influence code[3] (UIC) compared to the most urban UIC (Brown et al., 2019). Reasons for this disparity may include differences in resource availability and lower adherence to evidence-based guidelines for TBI in resource-limited and rural areas.

The 2019 systematic review determined that some differences in outcomes may be attributable to patient and facility-level characteristics, such as stroke patient volume. However, to the extent that low stroke patient volume is more common in rural facilities, this disparity may be relevant to the problem described in UNMHSC's ACCESS Telemedicine proposal.

References

1. Albright KC, Branas CC, Meyer BC, et al. ACCESS: Acute Cerebrovascular Care in Emergency Stroke Systems. Arch Neurol. 2010;67(10):1210–1218. doi:10.1001/archneurol.2010.250
2. Al Kasab S, Adams RJ, Debenham E, et al. Medical University of South Carolina Telestroke: A Telemedicine Facilitated Network for Stroke Treatment in South Carolina—A Progress Report. *Telemed J E Health.* 2017; 23(8):674-677. doi: 10.1089/tmj.2016.0229
3. American Academy of Neurology. Neurology workforce data. doi:10.1056/NEJMhpr1107519.
4. Bekelis K, Missios S, Coy S, et al. Emergency medical services for acute ischemic stroke: Hub-and-spoke model versus exclusive care in comprehensive centers. *Journal Clin Neurosci.* 2019;60:12-16. doi: 10.1016/j.jocn.2018.10.031
5. Boulouis G, Siddiqui KA, Lauer A, et al. Immediate Vascular Imaging Needed for Efficient Triage of Patients With Acute Ischemic Stroke Initially Admitted to Nonthromectomy Centers. Journal of *American Heart Association.* 2017;2297-2300. doi: 10.1161/STROKEAHA.117.017607
6. Brown JB, Kheng M, Carney NA, Rubiano AM, Puyana JC. Geographical disparity and traumatic brain injury in America: Rural areas suffer poorer outcomes. *J Neurosci Rural Pract.* 2019;10(1):10. doi:10.4103/jnrp.jnrp_310_18
7. Dwyer M, Rehman S, Ottavi T, et al. Urban-rural differences in the care and outcomes of acute stroke patients: Systematic review. *Journal of the Neurological Sciences*. 2019;397:63-74. doi:10.1016/j.jns.2018.12.021.
8. Gebhardt JG, Norris TE. Acute stroke care at rural hospitals in Idaho: challenges in expediting stroke care. *J Rural Health.* 2006;22:88–91.
9. George BP, Doyle SJ, Albert GP, et al. Interfacility transfers for US ischemic stroke and TIA, 2006-2014. *Neurology*. 2018. 90(1): 1561-1569. Doi: 10.1212/WNL0000000005419.

[3] Urban Influence Codes are based on the Office of Management and Budget's delineation of Metropolitan (metro) and Micropolitan (micro) statistical areas; micropolitan areas are further classified by adjacency and noncore nonmetro counties are classified by adjacency and population of the county's largest town. The 2013 Urban Influence Codes are based on the OMB metropolitan classification announced in February 2013, which in turn are based on population data from the 2010 Census of Population and commuting data from the 2006-2010 American Community Survey (ACS).

10. George BP, Asemota AO, Dorsey ER, et al. United States trends in thrombolysis for older adults with acute ischemic stroke. *Clinical Neurology and Neurosurgery*. 2015;139:16-23. doi:10.1016/j.clineuro.2015.08.031
11. Gonzales S, Mullen MT, Skolarus L, Thibault DP, Udoeyo U, Willis AW. Progressive rural–urban disparity in acute stroke care. *Neurology*. 2017;88(5):441-448. doi:10.1212/WNL.0000000000003562
12. Harper K, McLeod M, Brown SK, et al. Teleneurology Service Provided Via Tablet Technology: 3-Year Outcomes and Physician Satisfaction. *Rural and Remote Health.* 2019; 19(1): 4743. doi:10.22605/RRH4743
13. Howard G, Kleindorfer DO, Cushman M, et al. Contributors to the Excess Stroke Mortality in Rural Areas in the United States. *Stroke*. 2017;48(7):1773-1778. doi:10.1161/STROKEAHA.117.017089
14. Hutton F, Fleming J, Youngquist S, et al. Stroke and Helicopter Emergency Medical Service Transports: An Analysis of 25,332 Patients. *Air Medical Journal Associates.* 2015; 34(6):348-356. doi: 10.101/jamj.2015.06.011
15. Jauch EC, Huang DY, Gardner AJ, Blum JL. Strategies for improving outcomes in the acute management of ischemic stroke in rural emergency departments: a quality improvement initiative in the Stroke Belt. *Open Access Emergency Medicine*. 2018;10:53-59. doi:10.2147/OAEM.S160269
16. Joubert J, Prentice LF, Moulin T, Liaw S-T, Joubert LB, Preux P-M, et al. Stroke in rural areas and small communities. *Stroke* 2008;39:1920-1928. https://doi.org/10.1161/STROKEAHA.107.501643
17. Kaufman BG, Thomas SR, Randolph RK, et al. The rising rate of rural hospital closures. *J Rural Heal*. 2016;32(1):35-43. doi:10.1111/jrh.12128.
18. Koifman J, Hall R, Li S, Stamplecoski M, Fang J, Saltman AP, et al. The association between rural residence and stroke care and outcomes. *J Neurol Sci*. 2016; 363:16–20.
19. Leira EC, Hess DC, Torner JC, Adams HP. Rural-Urban Differences in Acute Stroke Management Practices : A Modifiable Disparity. *Archives of neurology* (Chicago). 2008;(7):887.
20. Lichtman, JH, Leifheit EC, Wang Y, Goldstein LB. Hospital Quality Metrics: "America's Best Hospitals" and Outcomes After Ischemic Stroke. *Journal of Stroke and Cerebrovascular Diseases.* 2019;28(2):430-434. doi: 10.1016/j.jstrokecerebrovasdis.2018.10.022
21. MedPac. Report to the Congress Medicare Payment Policy: Chapter 16 Mandated Report: Telehealth services and the Medicare program. 2018.
22. Moya M, Valdez J, Yonas H, Alverson DC. The Impact of a Telehealth Web-Based Solution on Neurosurgery Triage and Consultation. *Telemed J E Health*. 2010; 16(9):945-9. doi: 10.1089/tmj.2010.0044
23. NORC. Third Annual Report: HCIA Disease-Specific Evaluation (Upper San Juan Health Services District). 2016.
24. Okon N, Rodriguez DV, Dietrich D Oser CS, Blades LL, Burnett AM, Russell JA, Allen MJ, Chasson L, Helgerson SD, Gohdes D, Harwell TS. Availability of diagnostic and treatment services for acute stroke in frontier counties in Montana and Northern Wyoming. The Journal of Rural Health. 2006;22:237–241.

25. Seabury S, Bognar K, Xu Y, Huber C, Commerford SR, Tayama D. Regional disparities in the quality of stroke care. *The American Journal of Emergency Medicine*. 2017;35(9):1234-1239. doi:10.1016/j.ajem.2017.03.046
26. Slade, Catherine P., Laurence J. O'Toole, and Eunju Rho. "State Primary Stroke Center Policies in the United States: Rural Health Issues." *Telemedicine and E-Health* 18, no. 3 (February 22, 2012): 225–29. https://doi.org/10.1089/tmj.2011.0141.
27. Trent SA, Morse EA, Ginde AA, Havranek EP, Haukoos JS. Barriers to Prompt Presentation to Emergency Departments in Colorado after Onset of Stroke Symptoms. *West J Emerg Med*. 2018;20(2):237–243. doi:10.5811/westjem.2018.10.38731
28. Wishner J, Solleveld P, Rudowitz R, Paradise J, Antonisse L. A Look at Rural Hospital Closures and Implications for Access to Care. 2016. Kaiser Family Foundation and the Urban Institute.
29. Whetten J, van der Goes DN, Tran H, et al. Cost-effectiveness of Access to Critical Cerebral Emergency Support Services (ACCESS): a Neuro-Emergent Telemedicine Consultation program. *J Med Econ*. 2018;21(4):398-405. doi: 10.1080/13696998.2018.1426591.
30. Yi J, Zielinki D, Ouyang B, et al. Predictors of false-positive stroke thrombectomy transfers. *J NeuroIntervent Surg.* 2017;9:834-836. doi: 10.1136/neurintsurg-2017-013043