

AHA SCIENTIFIC STATEMENT

Identifying Best Practices for Improving the Evaluation and Management of Stroke in Rural Lower-Resourced Settings: A Scientific Statement From the American Heart Association

The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists.

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ABSTRACT: Considerable variation exists in the delivery of acute stroke care and stroke outcomes across settings and population groups. This is attributable in part to variation in resources among emergency departments in the United States, most notably in rural regions. Structural constraints of the US health care system, including the geographic distribution of where patients live relative to the location of hospitals and certified stroke centers, will continue to mean that many patients with stroke initially present to community emergency departments that have fewer stroke-related resources. These sites also tend to serve populations in rural areas who experience disparities in care and outcomes. Reducing health disparities related to stroke for populations in rural areas requires investment in these more remote community settings as the anchor of the stroke chain of survival for their respective communities. This scientific statement performs a critical appraisal examining challenges in rural stroke care related to access and variation in stroke-related capabilities for the acute phase of care to inform strategies and propose solutions. The scientific statement considers the value of expansion of Acute Stroke Ready Hospital and Primary Stroke Center certification in rural areas, the role of telehealth and improved transfer processes, as well as increased engagement and mentorship from larger, comprehensive centers to the rural hospitals to which they are connected. Multistakeholder collaboration and policy interventions need to be directed to enhance public awareness, impart staff training, grow infrastructure, enhance access to clinical expertise, streamline data management, and implement quality assessment and improvement programs.

Key Words: AHA Scientific Statements ■ delivery of health care ■ health resources ■ rural hospitals ■ rural population ■ stroke

Rural patients with stroke have higher mortality rates relative to urban patients.^{1–3} They have reduced access to treatment and worse functional outcomes of time-sensitive treatments, such as intravenous thrombolysis and mechanical thrombectomy.^{2,4} People with stroke who live in rural areas are also more vulnerable at baseline, with more patients enrolled in Medicaid, higher levels of disability relative to the urban stroke population, and more prevalent but less well-controlled risk factors, with disparities particularly compounded for Black patients residing in rural

areas.^{1,5–7} These challenges are further compounded by increased distances from care (Figure 1); >28 million people in the United States live >60 miles from a Primary Stroke Center (PSC) or Acute Stroke Ready Hospital (ASRH).⁸ Rural disparities in stroke care and outcomes may also be related to variation in resources and capabilities across sites of care, which are particularly pronounced in rural settings (ie, those with low, geographically diffuse populations). For example, of the 1109 rural emergency departments (EDs) open in 2019, only 206 (19%) were in a hospital with any level

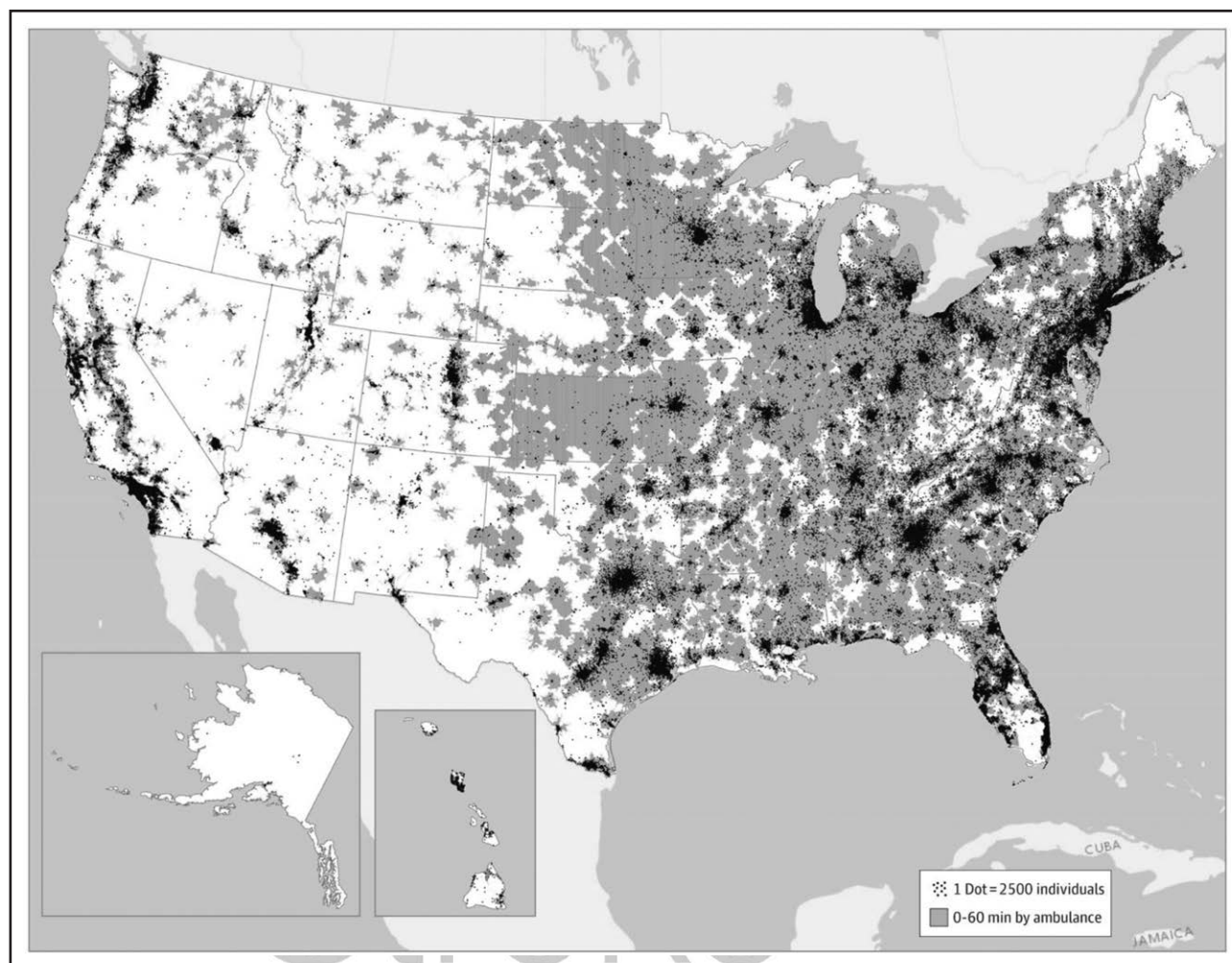


Figure 1. Estimated population access to acute stroke and telestroke centers in the United States in 2019.

US population access to emergency departments with acute stroke expertise, defined as confirmation of a hospital as an Acute Stroke Ready Hospital, a Primary Stroke Center, a Thrombectomy-Capable Stroke Center, or a Comprehensive Stroke Center, or an emergency department that receives telestroke services. Reprinted from Zachrison et al.⁸ Copyright © 2022 The Authors. This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited.

of stroke center (eg, Comprehensive Stroke Center, Thrombectomy-Capable Stroke Center, PSC, or ASRH status), versus 46% of EDs nationally (Figure 1).⁹ The existing rural PSCs are largely based on hospital self-initiation of certification rather than identification of need based on population.¹⁰ Furthermore, conversion to a stroke center of any kind is substantially more likely to be done by urban than by rural hospitals.¹¹ Overall, rural patients are less likely to receive care at stroke centers,¹ and more often present to uncertified community EDs with less robust staffing, fewer resources, and lack of major quality improvement (QI) efforts and interventions.^{1,2,12} Challenges in care delivery persist across the continuum, including thrombectomy access, inpatient care, and postacute care transitions. Rural patients more often travel outside of their local health care markets to receive postacute care.

This substantial variation in access to stroke-related resources for rural patients necessitates strategies to

improve care and reduce variability across broad and diverse geographic regions. Major efforts have been made to standardize acute stroke care delivery on regional and national levels. However, many of the most successful quality improvement programs (eg, Get With the Guidelines–Stroke) historically have had less representation from smaller, lower-resourced sites.¹³

Improving stroke outcomes and reducing rural health care disparities requires investment in these sites as anchors of the stroke chain of survival for their respective communities. This scientific statement presents a critical appraisal examining rural stroke care related to access and variation in stroke-related capabilities for the different phases of care. Overarching objectives are to generate consensus on strategies and propose solutions, including more expansive, accessible, collaborative QI efforts and strategies to monitor and improve performance and enhance delivery of care. Our goal is to inform future clinical engagement, research, and

system-level improvements across stakeholders, including clinicians, health system leaders, public health leaders, policymakers, research funding organizations, and other foundations.

THE COORDINATED STROKE SYSTEM OF CARE: CHALLENGES IN THE REMOTE SETTING AND POTENTIAL STRATEGIES

Role for Coordinated Systems of Care

Coordinated systems of stroke care involve early incorporation of and collaboration among all stakeholders, including those directly involved with providing stroke care in prehospital, acute, and postacute phases, as well as hospital administrators, regulatory agencies, payers, patients, caregivers, policymakers, and advocacy organizations. Coordinated regional stroke systems of care

have a pivotal role in optimizing patient outcomes.¹⁴ This can be particularly challenging in rural settings, which may be underresourced and have limitations imposed by geography (Figure 2).

Prehospital Setting

Challenges in the prehospital setting for patients with suspected stroke in rural and lower-resourced settings may have downstream effects on care. In particular, distance from health care and increased travel times to stroke-capable hospitals (ASRH and above) may delay reperfusion and definitive care.¹⁵ Strategies to address this challenge include supporting hospitals' transition to certified ASRH and stroke centers, use of air transport, and use of telestroke (Table 1).

People living in rural communities also have lower odds of arrival by emergency medical services (EMS) for stroke, despite the association with improved care and

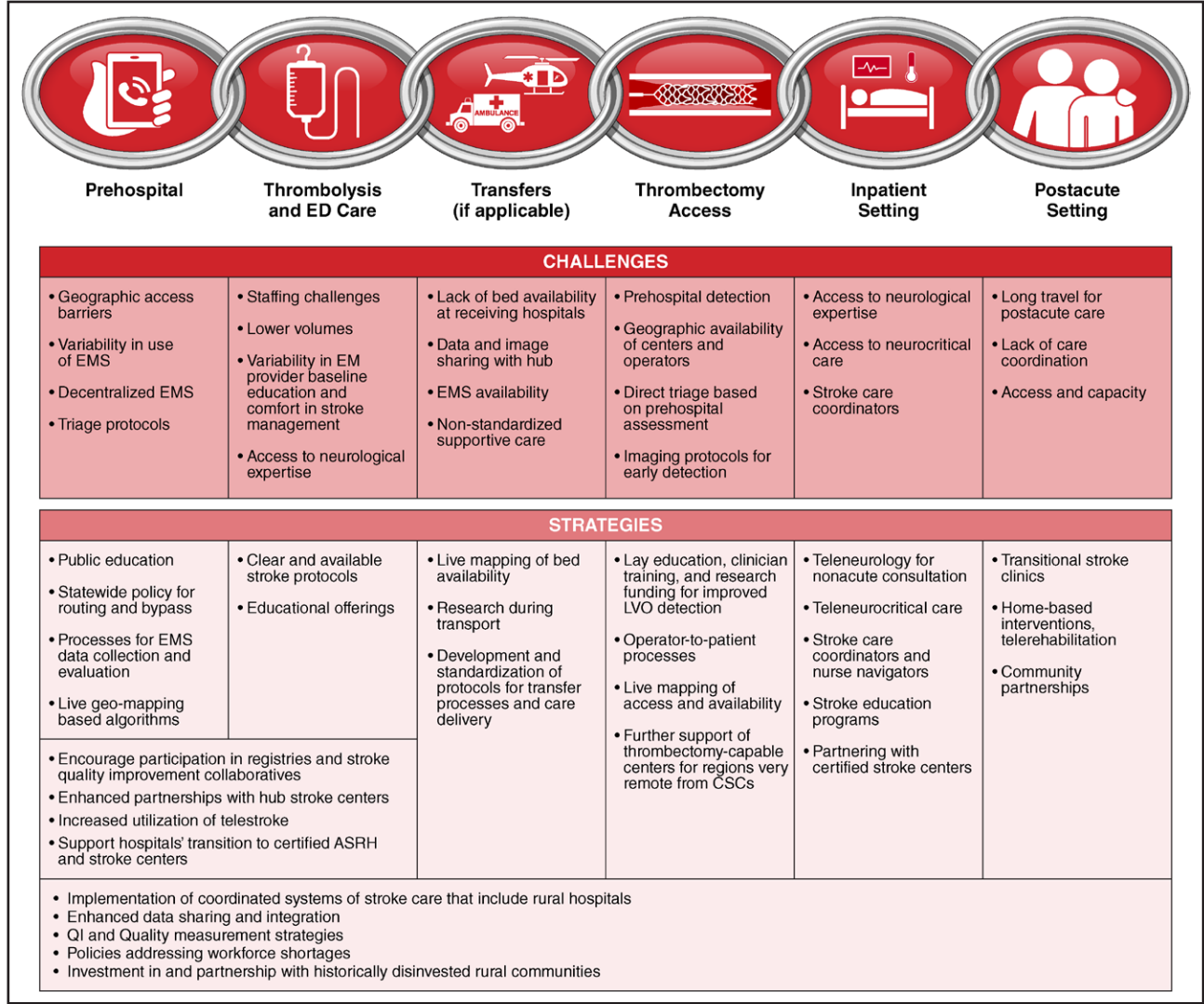


Figure 2. Potential strategies to address challenges in caring for patients with stroke in rural settings across the continuum of care.

ASRH indicates Acute Stroke Ready Hospital; CSC, Comprehensive Stroke Center; ED, emergency department; EM, emergency medicine; EMS, emergency medical services; LVO, large vessel occlusion; and QI, quality improvement.

Table 1. Potential Solutions to the Challenges Encountered in Remote and Rural Stroke Care Delivery Systems

Component of stroke system of care	Challenges encountered in this domain related to remote or rural stroke care delivery	Potential strategies to address these challenges	Level of intervention and target audience for incentivizing the strategy
Prehospital	Distance from expert care and increased travel times to stroke-capable hospitals	Supporting hospitals' transition to certified Acute Stroke Ready Hospitals or stroke centers	Championing from foundations such as the AHA, state departments of public health
		Using air transport	Individual EDs, hospitals, EMS agencies
		Implementing telestroke for remote specialist access	Individual EDs and hospitals, policymakers, regulators
	Lower use of EMS for prehospital transport	Creating behavior theory-informed, user-centered public campaigns	State departments of public health, CSCs and transfer-receiving hospitals, foundations such as the AHA
		Improving ambulance availability in rural settings	Investment in EMS pipeline, education, and infrastructure regionally by receiving hospital CSCs, state departments of public health, policymakers
	Decentralized EMS systems with variation in care delivery (eg, use of stroke assessment tools)	Creating a statewide policy for stroke assessment tool implementation and routing and bypass decisions, adapted for rural locations	Foundations such as AHA for ongoing advocacy, policymakers to guide change, state departments of public health for implementation of change
Providing a standardized methodology for collecting EMS data to facilitate evaluation processes and operational improvements		National EMS leadership organizations, foundations such as AHA for ongoing advocacy	
Thrombolysis and ED care	Variation in educational experience and qualifications of clinicians staffing EDs	Ensuring written and readily accessible site protocols for stroke care	Quality measure development by certifying organizations, investment in satellite sites by transfer-receiving hospitals, ongoing advocacy by foundations such as AHA
		Increasing educational offerings	Support of regional CSCs or sites' frequent transfer-receiving hospitals
		Participating in no- or low-cost quality improvement initiatives (eg, American College of Emergency Physicians E-QUAL Stroke Collaborative)	Individual EDs and hospitals
		Supporting hospitals' transition to certified Acute Stroke Ready Hospitals or stroke centers	Policymakers, state departments of public health
		Enhancing partnerships with hub stroke centers	Individual EDs and hospitals with support of regional CSCs or frequent transfer-receiving centers
		Increasing use of telestroke	Research funding related to implementation, payment policy changes for better incentivization
	Real or relative staffing shortages (eg, dependence on an on-call CT technologist or travelers rather than full-time staff)	Ensuring written and readily accessible site protocols for stroke care and rapid imaging transfer	Individual EDs and hospitals
		Considering the scope of practice laws, cross-state licensure policy	Foundations such as AHA for ongoing advocacy, policymakers to guide change
	Low annual stroke volumes	Performing mock stroke codes and computer-based simulation exercises	Support of regional CSCs or sites' frequent transfer-receiving hospitals
	Transfers	No-bed syndrome and diversion status	Creating an active national bed availability board in collaboration with AHA or national stroke systems to be available for EMS
Variation in transfer patterns and care delivered during transfer		Developing and sharing standardized protocols, taking into account longer transport distances, transfer decision-making, and care delivery during transport	Foundations such as AHA or CDC nationally, local leadership from CSCs or sites' frequent transfer-receiving hospitals

(Continued)

Table 1. Continued

Component of stroke system of care	Challenges encountered in this domain related to remote or rural stroke care delivery	Potential strategies to address these challenges	Level of intervention and target audience for incentivizing the strategy
Thrombectomy access	Geographic availability of accredited thrombectomy-capable centers	Creating a live map available for EMS and hospitals of the available TCCs, factoring in traffic and weather data, to facilitate appropriate and immediate transfer	State departments of public health
	MT operator availability	Creating processes to bring a CSC neurointerventionalist team to meet a patient in the nearest TCC if the CSC is far	Research funding organizations to support future research in stroke system of care organization
	Patient-level sociocultural and educational disparity and its effects on LVO recognition and the activation of LVO process	Providing more robust outreach in underrepresented and underserved regions to increase education on recognition of stroke and LVO and its effects, and increasing education and developing processes to decrease biases in stroke treatment for LVO	State departments of public health, CSCs and transfer-receiving hospitals, foundations such as the AHA
	Lack of standardized training for LVO detection for prehospital EMS and in-patient staff	Leveraging available online and in-person training programs through AHA and making it widely available and affordable for hospitals and EMS	Foundations such as AHA, state departments of public health
	Lack of research incorporating prehospital device and AI radiologic software recognition for LVO	Increasing funding for or subsidizing prehospital device and AI software research integration	Research funding organizations to support future research in prehospital device and AI software
	Transfer-related delays in access	Improving door-in-door-out time protocols	Individual EDs and hospitals with support of regional CSCs or frequent transfer-receiving centers
Inpatient setting	Access to inpatient neurologic expertise	Using teleneurology beyond the hyperacute phase of care	Individual EDs and hospitals
Postacute setting	Long travel distances for access to postacute care	Developing transitional stroke clinics	Regional CSCs or sites' frequent transfer-receiving hospitals
		Growing use of home-based interventions (eg, telerehabilitation)	Regional CSCs or sites' frequent transfer-receiving hospitals
		Building community partnerships for developing informal support groups	Regional CSCs or sites' frequent transfer-receiving hospitals, individual EDs and hospitals

AHA indicates American Heart Association; AI, artificial intelligence; CDC, Centers for Disease Control and Prevention; CSC, Comprehensive Stroke Center; CT, computed tomography; ED, emergency department; EMS, emergency medical services; LVO, large vessel occlusion; MT, mechanical thrombectomy; and TCC, Thrombectomy-Capable Stroke Center.

outcomes.¹⁶ Public awareness campaigns have shown temporary improvement in awareness of stroke signs and symptoms, yet effects have not been sustained.¹⁷ Behavior theory-informed, user-centered public campaigns considering characteristics of target populations and strategies for motivating behavior change may be worth exploring; improved ambulance availability is also needed in rural settings.

EMS organization in the United States is decentralized, as regulations and policies are formulated and implemented by local or state-based bodies rather than a central national entity. This has contributed to variations in the quality and accessibility of EMS, including variation in the existence and use of mandated statewide stroke assessment tools. There are discrepancies in how prehospital service is provided, and rural and lower-resource settings are also more dependent on less-trained volunteer EMS clinicians, with lower skill levels and less access to oversight and skill maintenance; more than half of EMS directors in small rural areas report volunteer-only staffing.¹⁸ Lack of standardized methodology in the collection of EMS data further limits the development of widely adoptable operational

improvement strategies. Potential solutions include the development of policy for implementation of stroke assessment tools, routing and bypass decisions, as well as standardized methodology for collection of EMS data.

Whereas several challenges in prehospital stroke care are exaggerated in rural, low-resourced settings, recent innovations for advancing prehospital management may be of particular value in this setting and warrant further research. This includes prehospital telemedicine and smartphone applications and artificial intelligence, which may be useful for improved stroke detection and identification of stroke attributable to large vessel occlusion (LVO), live geomapping-based algorithms, and optimized prehospital routing decisions.¹⁹ Models using mobile stroke units for prehospital triage in rural areas in collaboration with another ambulance or the transferring ED could also be a potentially effective modality in some geographic areas.²⁰ The success of such prehospital innovations strongly depends on recognizing varying regional resources and needs and adapting efforts to local environments. Priorities include establishing and standardizing prehospital protocols and regulation, developing effective behavioral theory-informed training

strategies, and evolving methods of funding EMS in lower-resource settings.

Thrombolysis and ED Care

Many challenges exist in the ED phase of stroke care in lower-resource rural settings, which less often have the resources and expertise of an ASRH or stroke center, and may contribute to lower use of thrombolysis and differences in quality of care delivery.^{9,21} Some rural regions have a shortage of board-certified emergency medicine physicians because of inability to hire or sustain them, being increasingly staffed by midlevel practitioners, with an increasing proportion of high-acuity patients seen by them.^{22–24} Even when EDs are staffed by emergency medicine physicians, variability in neurologic training in emergency medicine residencies²⁵ may contribute to decreased use of thrombolysis without the institutional structure and support of established stroke protocols and processes such as telestroke infrastructure.

These and other institutional barriers accentuate the challenges in hyperacute phase stroke care delivery experienced in the rural setting. Challenges also include relative staffing shortages (eg, an on-call versus on-site computed tomography technologist), a high reliance on per diem or traveler staffing with less familiarity with local systems of care, and low annual stroke volumes.²⁶ Such challenges may contribute to less efficient care and may affect patient outcomes. Mock stroke codes or simulation exercises may be useful for sites with low annual stroke volumes. Potential solutions related to workforce are discussed in detail in the following.

An essential strategy to enhance rural, resource-limited stroke systems is to grow the number of certified ASRHs, stroke centers, and Get With the Guidelines–Stroke participating sites by supporting them in the process (eg, through the American Heart Association Rural Health Initiative). Local, regional, and statewide stroke system policy changes and legislation may also increase the number of certified centers in the United States.²⁷ Treatment rates, diagnostic errors, compliance with care measures, and overall outcomes are likely to be improved with stroke center certification and registry participation.^{21,28} In addition, other societies, such as the American College of Emergency Physicians E-QUAL Network, offer no-cost QI resources for the ED phase of care to a large number of community EDs, which includes educational opportunities, toolkits and resources, data collection for feedback (based on measures aligned with Get With the Guidelines–Stroke and the Joint Commission), and opportunities for obtaining merit-based incentive payment system credits with the Centers for Medicare and Medicaid Services.²⁹

Enhanced Partnerships of Rural Centers With Their Hub Hospitals and Increased Telestroke Use

Enhanced partnerships of rural centers with their hub hospitals and increased telestroke use may support improved educational and communication efforts, as well as direct local interventions (Table 2), and tracking of quality and registry data with dedicated feedback and mentoring, helping overcome the structural and personnel barriers for participation in research to improve both the justice and enrollment efficiency of clinical trials (Table 3).³⁰ Other strategies include ensuring written and accessible site protocols for stroke care and other locally formulated initiatives (eg, recruitment of stroke champions, staff certification in Emergency Neurological Life Support protocols, mock codes). The US Department of Veterans Affairs National Telestroke Program is an example of a successful nationally scaled telestroke intervention.^{31,32} Future research will be valuable to identify optimal implementation strategies and understand how to better incentivize telestroke adoption among the sites that stand to benefit the most.³³



Interhospital Transfers

Given the mismatch between where patients live and seek care and where certified stroke centers exist,

Table 2. Engagement Opportunities for Receiving Hospitals to Improve Care at Satellite Sites

Education and communication
Perform general multidisciplinary educational activities (eg, conferences, code stroke simulation, staff huddles)
Provide specialized training of community clinicians to improve skills (eg, shadowing)
Streamline transfers by immediately linking not only the sending/receiving physicians but also bed navigators and aerial and ground transport coordinators
Share electronic medical record and radiology images through a smartphone application (eg, an application-facilitated interaction may facilitate more rapid thrombectomy care for large vessel occlusions)
Provide timely feedback to the transferring facility by various methods (eg, electronic platforms, registries of aggregate data) ^{30a}
Direct local interventions
Organize transition of care of patients with stroke to their community ³¹ to ensure adherence with secondary prevention interventions, including adequate blood pressure management and recognition of changes that would require rehospitalization
Identify a local champion to advance and support initiatives, including stroke certification
Subsidize the cost of stroke certification and a stroke coordinator and help with regulatory and organizational support
Establish teleneurology systems of care that include local telestroke support
Engage spokes as active participants in any decisions that affect the local system of care (eg, bypass of suspected large vessel strokes, early repatriation of patients)

Table 3. Engagement Opportunities for Receiving Hospitals to Improve Research at Satellite Sites

Engagement opportunities to improve research
Perform education through research activities to disseminate data from existing trials and benefits of stroke research among spoke clinicians
Promote tools from electronic medical records to identify patients for clinical trials
Facilitate inclusion of small hospitals in rural settings into existing research networks (eg, StrokeNet)
Coordinate with tertiary-based IRB to support hospitals that lack IRB for research
Use electronic consent platforms or telestroke video communications to consent and enroll patients in trials of interventions that can be delivered locally or upon arrival
Use tertiary-based air medical crews as coinvestigators to enroll patients in clinical trials of interventions that can be delivered during helicopter interhospital transfer or upon arrival ^{30b}

IRB indicates institutional review board.

interhospital transfers are critical. However, transfer processes do not optimally counteract geographic disparities in access.³⁴ For example, transfer decisions are often based on factors beyond distance or quality, including shared affiliation, competition, and hospital reputation,³⁵ and patient factors, such as insurance.³⁶ Moreover, the benefit of transfer for improved access varies by patient race and insurance.^{36,37} This may be attributable in part to differential acceptance of transfers, concerns related to cost of transport, or concerns related to a family member being transported far from their support network. Another critical issue is the availability of ambulances for transport in rural areas, where third-party interfacility transport services may be less accessible. Other transfer-related challenges include capacity and bed availability at receiving hospitals, inconsistent strategies for data and image sharing between sending and receiving sites, and non-standardized supportive care during transfer.

Improved coordination of the stroke system of care must be part of the solution. The American Heart Association call for improved systems of stroke care³⁸ includes improved configuration of health care systems (eg, where hospitals and resources are located, how health systems interact with their communities) as well as addressing policies that reinforce legacies of segregation and inequitable access.³⁹ Improving the function of the transfer network for more equitable access to high-quality stroke care requires attention to each of these points in the system. An active national bed availability board may be of value for sending sites in need of available receiving hospitals. Use of 9-1-1 services for interfacility transfer, although not generalizable to many rural areas because of resource constraints, may be considered in the development of transfer strategies where feasible. This strategy has been associated with reduced transfer times compared with using routine transfer ambulances in emergency transfers for other time-sensitive diseases.^{40,41}

In addition, there is a lack of standardized supportive care protocols to prevent and treat hemodynamic, respiratory, and neurologic complications during transfer, which are particularly important for patients after thrombolysis as well as those with an LVO, and must take into account longer transport distances from rural areas. Research during this phase of care, and the development, standardization, and sharing of such protocols for transfer processes, may be beneficial, including identification of optimal regionalization strategies (eg, drip-and-ship versus bypass) with attention to particular local contexts and clinical care during transfer.

Thrombectomy Access

Although mechanical thrombectomy (MT) for eligible patients is standard of care, several challenges limit timely access to high-quality MT in rural and under-resourced settings. First is the geographic availability of accredited thrombectomy-capable centers and disparity in their distribution. Only 20% of the population has access to a thrombectomy-capable center within 15 minutes and 31% within 30 minutes, with timely access challenges even more pronounced in rural areas.³⁴ The problem that rural patients less often present to thrombectomy-capable sites is only partially mitigated through interhospital transfers, as rural patients more often present to gap hospitals that do not transfer patients for thrombectomy.³⁴ One potential solution may be to create a live map for EMS and hospitals to use giving the location of available thrombectomy-capable centers, which may include traffic and weather conditions and operator availability.

Increasing access to thrombectomy also depends upon improved early identification of LVO stroke. Challenges in identification occur across the spectrum of care, from variation in EMS personnel training and knowledge⁴² to lack of standardized hospital-based clinical and imaging processes for identification and triage of LVO. Training in stroke severity assessment and consistent use of tools can improve identification and prenotification, improving ED preparedness and in-hospital workflow.¹⁹ Particularly in settings that have bypass protocols to facilitate direct transport to thrombectomy-capable centers, identification in the prehospital setting is paramount. In the ED setting, clinical and imaging protocols that include simultaneous vascular imaging improve LVO identification.^{43,44} For resource-limited sites that lack appropriately experienced 24/7 radiology staff, triaging patients to receive rapid computed tomography angiography on the basis of a focused LVO scale examination in the ED could be implemented.⁴⁴ Early identification of LVO stroke needs to be combined with parallel engagement of tertiary sites, including activation of the transfer process.

Strategies to improve door-in-door-out times for transferred patients to ensure timely thrombectomy

include established transfer agreements with receiving hospitals and the transferring ambulances. Many steps in the transfer process, including arranging transport, may be done in parallel with identifying an accepting receiving hospital.^{45,46} Rapid centralized sharing of images with the receiving hospital team may also improve workflow metrics. Although we recognize critical EMS workforce shortages, a strategy that keeps the initial transporting ambulance of a suspected stroke on standby until the computed tomography angiography is complete may also facilitate faster door-in-door-out times when feasible.⁴⁶ In more remote settings with longer distances, air transportation should be considered.⁴⁷ Depending on resource availability and regional hospital landscape, a mobile interventional stroke team traveling to the primary site could be developed.^{48,49}

Patients in rural areas are more likely to receive thrombectomy at PSCs, which have lower performance and outcomes than accredited thrombectomy centers, but are required to collect and report quality metrics pertaining to MT and maintain capabilities, including a 24/7 neurointerventional team, neurointensive care unit, and advanced neuroimaging.⁵⁰ Additional support of thrombectomy-capable centers located more proximally to regions that are remote from Comprehensive Stroke Centers would be beneficial.

Inpatient Care

Patients with stroke in rural hospitals have higher mortality rates than those in urban hospitals.^{1,2} Potential explanations include lower receipt of reperfusion and lower odds of care at a stroke center, with related resource differences, including lack of infrastructure for appropriate stroke imaging and neuromonitoring, lack of available stroke expertise because of inability to recruit or retain qualified multidisciplinary consultants, inadequate resources for pathologic assessment, lack of dedicated stroke units and neurocritical care, and possible differences in access to acute inpatient rehabilitation.^{1,51–53}

These differences are illustrated in gaps in performance on stroke quality measures, most notably stroke education, between metropolitan and nonmetropolitan hospitals.⁵⁴ Secondary stroke prevention measures, including antithrombotics, anticoagulation, statin use, and smoking cessation, are also important. The use of telestroke has been a key strategy to improve access to neurologic expertise and is associated with increased administration of thrombolytic therapy and improved patient outcomes.^{54,55} Extending the use of telemedicine throughout the hospital stay may help address the lack of neurologic expertise in inpatient care. Other opportunities for rural hospitals include investing in annual comprehensive stroke education programs, partnering with certified stroke centers, and using stroke care coordinators and nurse navigators.

Postacute Care Transitions

In one study,⁵⁶ >35% of US patients with stroke traveled outside their local health care market to receive post-acute care (ie, skilled nursing, inpatient rehabilitation, long-term care hospital services), and this proportion is likely much higher for rural residents. Improving the transition of care from hospital to home can be challenging for rural, lower-resourced areas, and the type of post-acute care received is different for rural patients, with fewer home health care or intermediate rehabilitation and more skilled nursing discharges.⁵⁷ In addition, pathologic evaluation of strokes of undetermined cause may remain inadequate because of lack of continuity of care and limited resources. Fragmented and disorganized postacute care contributes to poor patient outcomes, increased hospital readmission, decreased functional status, and increased caregiver burden.^{58,59} Support interventions using multiple approaches may be effective but require long-term commitments from stakeholders and likely additional personnel. Among patients discharged to home, the development of transitional stroke clinics could help bridge the gap between acute hospitalization and discharge disposition, but would need to take into account accessibility and travel distances. Stroke survivors in rural settings may also benefit from using home-based interventions, such as blood pressure monitoring and telerehabilitation, virtual support groups, and other forms of online support. Community partnerships with churches or other local organizations may also be opportunities to develop informal support groups.

CROSS-CUTTING SYSTEM ISSUES, POLICY IMPLICATIONS, AND KEY STRATEGIES FOR CONSIDERATION

Strategies Related to Designation and Improving Delivery of Care

The delivery of stroke care in rural areas may be improved by promoting stroke center designation through formal certification.⁶⁰ Data suggest that the evidence-based components of PSC designation are associated with higher quality of care and better patient outcomes. Barriers to the implementation of PSC designation in rural areas include low stroke volume and lack of neurologist coverage or financial resources for pursuing telemedicine.^{61,62}

Expansion of ASRH and PSC certification in rural areas may be facilitated by the availability of statewide or regional champions for stroke systems of care. However, these processes are costly and require dedicated human and structural resources. Although state-based certification has been implemented as an alternative to certification by nationally recognized stroke center certifying entities, there is considerable heterogeneity in the state

designation processes,⁶³ and it has been associated with lower performance and worse outcomes compared with the standard national designations.⁶⁴ Use of nationally recognized certifying bodies remains preferable. Regardless of designation or certification strategy, any future expansion of ASRH or PSCs in rural areas should be geographically efficient, considering population density and proximity of resources, and incentivizing strategies to optimize population coverage.¹⁰ It is important to ensure an equitable distribution of certified thrombectomy centers to ensure rural population coverage. Besides the direct effect on the quality of care delivered, designation changes also have implications for EMS transport of patients with suspected stroke. Increasing access to ASRHs and PSCs in remote settings should reduce pre-hospital transport time and time to thrombolysis.

Data Integration

Data integration involves combining data from multiple sources to create unified sets of information for operational and analytic uses. Many of the strategies aimed at improving access, quality, and outcomes are dependent on interoperable if not fully integrated data systems. For acute clinical care and interhospital transfers, real-time patient status information and imaging need to be available to the consulting or receiving hospital to streamline care upon arrival (eg, electronic medical record access and image sharing for MT) and improve safety. During hospitalization, availability of a patient's full clinical data can improve measurement and allow decision support integration to improve quality in real time. As artificial intelligence and other advances expand applications of decision support, data integration is crucial for both efficacy and safety. For transitions of care after a hospitalization, particularly when patients from rural areas may be discharged to care facilities closer to their homes but distant from the center where they received stroke care, data integration is crucial to ensuring that handoffs preserve continuity and care plans. Follow-up instructions (eg, pending or outstanding laboratory tests; planned advances to the medical regimen, such as medication uptitration; progress towards expected rehabilitation goals) should be communicated from the admitting hospital to the rehabilitation facility with high fidelity. Barriers to data integration include fragmented data collection systems, lack of standardization, and inadequate processes for securing and anonymizing data and ensuring good data quality.⁶⁵ Potential solutions include creation of a shared electronic medical record platform, creation of a standardized reporting form, and greater use of stroke registries.

Stroke registries provide the foundation for local, regional, or statewide continuous QI initiatives. Stroke center certification requires hospital-based registries to track trends, compliance with established clinical benchmarks, outcomes, and complications. Whereas registry

data collection may be challenging to support at resource-limited rural centers, it is essential for understanding the quality of care being provided. Many state departments of public health have established centralized mechanisms to collect hospital data, thereby creating a statewide stroke registry, which may be used to identify outcome differences or geographic or demographic health disparities. Broader registries may also offer comparative information at a regional or national level, with each providing opportunities for targeted interventions aimed at enhancing rates of defect-free care, reducing health disparities, reducing adverse outcomes, and improving overall care. The most expansive example is the Get With the Guidelines–Stroke registry, which has a rural hospital recognition program and EMS data integration.

QI and Quality Measurement

Successful approaches to QI strategies in rural, lower-resourced settings recognize the needs and limitations of these sites. QI programs designed for rural settings must take into account their challenges and resource limitations. For example, most sites will not have the budget for enrollment fees or the personnel to dedicate to detailed chart abstraction of every patient with stroke for registry participation. A program that has graduated, lowered, or waived enrollment fees, has specific recognition criteria for rural hospitals,⁶⁶ is provided at no cost to the sites, or requires abstraction on a limited number of patients with stroke (eg, 25 per year)²⁹ may be more accessible.

Another strategy may involve taking a more network-oriented approach. For example, regional referral centers could be included in QI development and implementation at the sites frequently sending patients to them through educational initiatives or similar investments. This may be particularly useful for sites in urban centers that care for a high proportion of patients who live in rural areas. Multiple online resources developed by various professional societies, such as the Advanced Stroke Life Support course by the American Heart Association, the Emergency Neurological Life Support course by the Neurocritical Care Society, and the Advanced Stroke Emergency Support course (for EDs or EMS) by the Society of Vascular and Interventional Neurology, could be used for this purpose.

Whether used for internal QI, benchmarking, or accountability, or tied to reimbursement, quality measurement approaches must likewise consider the particular setting and limitations of lower-resourced sites in rural settings. Smaller-volume centers may not have enough patients with stroke in a given reporting period for process or outcome-based measures for public reporting purposes; however, evaluating such measures locally for internal QI may still be of value for identifying areas for improvement. Structural measures (eg, presence of stroke protocol) may be more suitable for broad use provided that they adequately take into account variation in

resource availability. In addition, during measure development, particular attention should be given to transferred patients. Transferred patients are often excluded from measure denominators as outliers, but transferred patients often represent more vulnerable patients who initially presented to a less-resourced site and thus should be considered a population of high interest. Consideration of how transferred patients are attributed, whether to the sending or the receiving site, should be on a measure-by-measure basis. In addition, data from quality measurement processes may identify particularly high-performing rural or lower-resourced centers, which may then be a valuable source of data for future research to better understand approaches to best practice implementation in this setting (using a positive deviant methodology).

Policy Solutions

Several policy considerations may facilitate successful implementation of many of the proposed solutions. First, we must recognize patients in rural areas as an underserved population vulnerable to inefficient care and poor outcomes unless policies address specific workforce shortages.⁶⁷ This may include supporting training programs to enhance rural clinicians' ability to provide high-quality care for stroke, particularly as technologies and guidelines advance rapidly. Scope of practice laws, which differ substantially by state, can either facilitate or hinder care delivery, and may need to be different in rural versus urban areas to accommodate the realities of staffing remote facilities. Cross-state licensure systems could be updated to facilitate telehealth delivery, reducing barriers for rural clinicians and patients to receive consultative care from trusted partners.

Second, policies aimed at enhancing access to and use of telehealth could be considered.³³ Assistance with broadband access or satellite technology, dedicated infrastructure and equipment, and other capital investments at small facilities may be a consideration through expansion of existing grant programs,⁶⁸ state or federal payment programs, or waiver programs accessible through Medicaid or Medicare. Still, many small hospitals cannot afford video capabilities, so emergency phone consultation and imaging assessment should be considered forms of telestroke deserving appropriate reimbursement.

Third, policies may be developed to facilitate data sharing and integration. National data standards and data sharing requirements, some of which were implemented in the wake of the Health Information Technology for Economic and Clinical Health Act, have not kept pace with the rapid explosion of data use and availability nationwide. Requiring hospitals to participate in real-time data sharing consistently and systematically, rather than on an intermittent basis, as is required in many federal and state programs, could result in rural patients receiving more seamless care. This too might require infrastructure

funding for small rural facilities, to ensure their systems can be modernized and harmonized with larger facilities' systems. Statewide or regional work groups may also support improved data sharing and transfer processes within local contexts.⁶⁹

Fourth, many of the challenges related to health and health outcomes in rural communities are reflective of broader contextual issues around social determinants of health, economic opportunity, and community. Greater attention to investment and partnership for historically disinvested communities in rural settings, particularly those with a high proportion of individuals marginalized or disenfranchised on the basis of race, ethnicity, or income level, could have substantial effect. Integration of rural systems of care across disciplines (eg, trauma, pediatrics, obstetrics care, cardiac care) may enable more effective advocacy for systematic investments in shared resources, such as telehealth infrastructure, coordinators, or training opportunities.

SUMMARY AND CONCLUSIONS

In rural, lower-resource settings, disparities in stroke care pose challenges and affect many individuals. Strategic interventions and investments are needed to support the entire spectrum of prehospital, acute, and postacute stroke care for rural EMS, EDs, and hospitals, which are a critical lynchpin in the stroke care system. Identified strategies include expansion of ASRH and PSC certification in rural areas, which may be facilitated by statewide or regional stroke system champions. Engagement in and mentorship of rural hospitals by Comprehensive Stroke Centers with which they are connected through patient transfer may provide another key opportunity to improve clinical care and research. Multistakeholder collaboration including clinicians, health system leaders, public health leaders, policymakers, and research funding organizations is required. Related efforts and policy interventions should be directed to enhance public awareness, impart staff training, build stroke infrastructure, enhance access to clinical expertise, streamline data management, and implement quality assessment and improvement programs taking into account the challenges and needs of the rural setting.

ARTICLE INFORMATION

The American Heart Association makes every effort to avoid any actual or potential conflicts of interest that may arise as a result of an outside relationship or a personal, professional, or business interest of a member of the writing panel. Specifically, all members of the writing group are required to complete and submit a Disclosure Questionnaire showing all such relationships that might be perceived as real or potential conflicts of interest.

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Disclosures

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This table represents the relationships of writing group members that may be perceived as actual or reasonably perceived conflicts of interest as reported on the Disclosure Questionnaire, which all members of the writing group are required to complete and submit. A relationship is considered to be "significant" if (a) the person receives \$5000 or more during any 12-month period, or 5% or more of the person's gross income; or (b) the person owns 5% or more of the voting stock or share of the entity, or owns \$5000 or more of the fair market value of the entity. A relationship is considered to be "modest" if it is less than "significant" under the preceding definition.

*Significant.

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*Modest.
†Significant.

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