Journal of the American Heart Association

CONTEMPORARY REVIEW

Addressing Disparities in Acute Stroke Management and Prognosis

M. Carter Denny, MD, MPH*; Nicole Rosendale, MD*; Nicole R. Gonzales, MD; Thabele M. Leslie-Mazwi, MD; Sandy Middleton, RN, PhD

ABSTRACT: There are now abundant data demonstrating disparities in acute stroke management and prognosis; however, interventions to reduce these disparities remain limited. This special report aims to provide a critical review of the current landscape of disparities in acute stroke care and highlight opportunities to use implementation science to reduce disparities throughout the early care continuum. In the prehospital setting, stroke symptom recognition campaigns that have been successful in reducing prehospital delays used a multilevel approach to education, including mass media, culturally tailored community education, and professional education. The mobile stroke unit is an organizational intervention that has the potential to provide more equitable access to timely thrombolysis and thrombectomy treatments. In the hospital setting, interventions to address implicit biases among health care providers in acute stroke care decision-making are urgently needed as part of a multifaceted approach to advance stroke equity. Implementing stroke systems of care interventions, such as evidence-based stroke care protocols at designated stroke centers, can have a broader public health impact and may help reduce geographic, racial, and ethnic disparities in stroke care, although further research is needed. The long-term impact of disparities in acute stroke care cannot be underestimated. The consistent trend of longer time to treatment for Black and Hispanic people experiencing stroke has direct implications on long-term disability and independence after stroke. A learning health system model may help expedite the translation of evidence-based interventions into clinical practice to reduce disparities in stroke care.

Key Words: disparities ■ equity ■ implementation science ■ stroke

By the time stroke occurs in some populations, the consequences of existing health care disparities have already been in play. One manifestation of this is Hispanic and Black people presenting with stroke at a much younger age. In the ERICH (Ethnic and Racial Variation in Intracerebral Hemorrhage) trial, an observational intracerebral hemorrhage study, Black and Hispanic people presented with intracerebral hemorrhage at a much younger age than their White counterparts (median age 57 years, 58 years, and 71 years, respectively).[1] The BASIC (Brain Attack Surveillance in Corpus Christi) Project demonstrated similar age disparities between non-Hispanic White and Mexican American people with ischemic stroke.[2] In addition to differences in age at presentation, demographic data in studies frequently demonstrate differences in baseline education, income, vascular risk factors, and insurance coverage. We acknowledge that addressing health disparities in stroke will require policy change and addressing social determinants of health,[3] which is beyond the scope of this article. As clinicians and researchers, however, there are interventions we can incorporate on the individual and organizational level to address equity in acute stroke care.

There are now abundant data demonstrating disparities in acute stroke management and prognosis; however, interventions to reduce these disparities remain limited. Additionally, implementation of the

The opinions expressed in this article are not necessarily those of the editors or of the American Heart Association.

Correspondence to: M. Carter Denny, MD, MPH, MedStar Georgetown University Hospital, Department of Neurology, 3800 Reservoir Rd NW, PHC 7, Washington, DC 20007. Email: marycarter.denny@medstar.net

*M. C. Denny and N. Rosendale contributed equally as co-first authors.

This work is based on the authors' presentation at the HEADS-UP Symposium, February 7, 2023.

This article was sent to Neel S. Singhal, MD, PhD, Associate Editor, for review by expert referees, editorial decision, and final disposition.

For Sources of Funding and Disclosures, see page 8.

JAHA is available at: www.ahajournals.org/journal/jaha

Nonstandard Abbreviations and Acronyms

MSU	mobile stroke unit

evidence-based recommendations that do exist remains challenging, with scarce data on the comparative effectiveness of strategies to address disparities. The 8 Ds of stroke care (detection, dispatch, delivery, door, data, decision, drug, and disposition) can be a framework for approaching the initial steps of acute stroke care during which there is a complex interplay between the individual, organization, and other structures driving disparities (Figure).[4] Breaking down this complex relationship into its components, identifying appropriate metrics of success, and having robust data collections systems that are routinely interrogated to drive iterative change is essential to monitor and achieve equity.

During the 2023 Health Equity and Actionable Disparities in Stroke: Understanding and Problem-Solving (HEADS-UP) Pre-Symposium to the American Heart Association International Stroke Conference, researchers came together to discuss how to most effectively use implementation science to advance stroke equity. Implementation science is the scientific study of methods for the successful uptake of evidence-based practices into health care policy and clinical care.[5] This review aims to extend that conversation by providing critical review of the current landscape of disparities in acute stroke care and highlighting opportunities to use implementation science to reduce disparities throughout the early care continuum. Although this review will largely focus on racial or ethnic inequities as that is where the preponderance of research exists, it is important to acknowledge that members of other historically oppressed communities, such as lesbian, gay, bisexual, transgender, queer; lesbian, gay, bisexual, transgender, questioning+ people, disabled people, or those who live in rural communities, also experience disparities in stroke.[6,7] These communities comprise a diverse range of people with a variety of personal and social identities that interconnect to create differing experiences of discrimination and privilege within society.[8] The role of intersectionality in stroke equity, therefore, is also essential to acknowledge and incorporate into interventions. We hope that through this critical discussion of evidence-based stroke care across the acute stroke care continuum, from prehospital management to the hospital course, we can advance the conversation of how to move the field from describing disparities to working to abolish them.

Prehospital STROKE CARE

Acute stroke care begins with recognizing the signs and symptoms of stroke and activating emergency medical services (EMS). Delay in the time to presentation is a significant barrier to thrombolytic treatment. Interventions to educate communities about the signs and symptoms of stroke and the importance of activating EMS may increase the number of people eligible for acute stroke treatment and improve the time to treatment initiation.[9]

Detection: Stroke Symptom Recognition

Generally, there is a lack of knowledge among patients regarding stroke signs and symptoms and the time-limited treatment options available for stroke. This knowledge gap is particularly pronounced in Black and Hispanic populations.[10,11] This disparity is a function of access to information as well as the forms in which that information is presented. There have been several examples of community-based, culturally tailored educational interventions aimed at improving knowledge of stroke signs and symptoms and intent to activate EMS.[12,13] These studies have demonstrated sustained improvement in knowledge around stroke signs and symptoms and stated intent to activate EMS rapidly[12–14]; however, there remains a gap between intent and action that is difficult to address. In addition, there are barriers to implementation and sustainability of these interventions. A systematic review of stroke warning campaigns noted that the studies that were

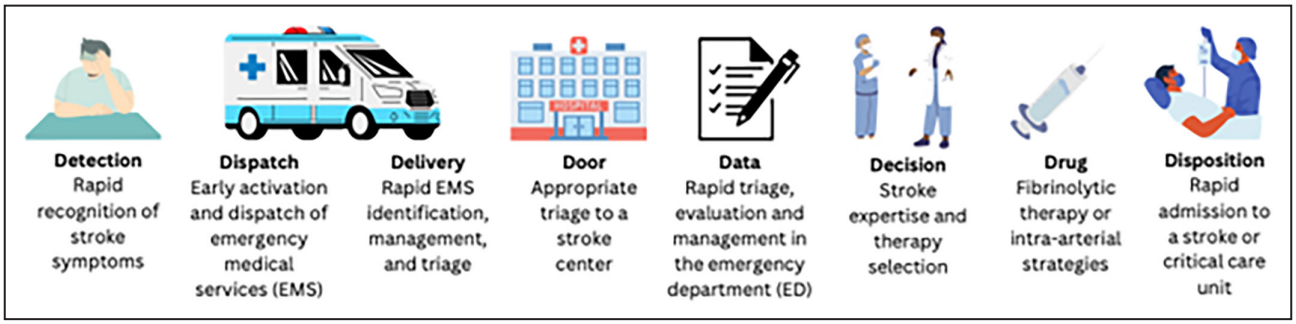

Figure. **The 8 Ds of stroke care.**

successful in reducing prehospital delays employed a multilevel approach to education, including mass media, targeted community education, and professional education.[15] In their review, the authors found that the TLL Temple Foundation Stroke Project in east Texas demonstrated the largest and most sustained behavioral change in thrombolysis rate. The Temple project was a community and professional behavioral intervention project designed to increase the proportion of patients with stroke treated with approved stroke therapy.[16] The educational intervention program incorporated input from stroke survivor focus groups to develop a behavioral intervention tailored to identified themes contributing to delays in presentation.

International efforts have been similarly limited. Mass media campaigns in the United Kingdom, Ireland, Australia, and Japan based on the FAST mnemonic (face drooping, arm weakness, speech difficulty, time to call 911) demonstrated the mixed findings of increased use of EMS and increased stroke presentations but no change in thrombolysis rates. Sustainability, cost, and lack of tailored messages remain barriers.[17] The recent expansion of FAST to the BE-FAST mnemonic[18] (balance, eyes) is an important step in the extension of stroke education, as BE-FAST is inclusive of more stroke symptoms. The recent development and ongoing dissemination of the Spanish language stroke symptom acronyms RÁPIDO in the United States,[19] Ponte PILAS in Latin America,[20] and CORRE in Colombia[21] represent important shifts toward reaching Spanish-speaking people at risk for stroke. However, stroke symptom acronyms must be delivered in forms and formats that are maximally accessible to all.

In addition to educating the community, it is also important to educate emergency responders on the recognition of stroke. In a study evaluating race- and sex-based differences in prehospital recognition of stroke symptoms by EMS providers, investigators found that EMS correctly recognized stroke symptoms among Hispanic and Asian people less frequently compared with non-Hispanic White people and in women less frequently compared with men.[22] There are a number of potential contributors to this disparity, including the contribution of implicit bias, language discordance, and stroke education that relies on recognition of particular patterns of signs and symptoms.[22] An educational intervention using a 30-minute online module coupled with performance feedback led to improved stroke recognition, hospital prenotification, and faster tissue plasminogen activator delivery; however, improvements were not sustained.[23]

One critique of educational interventions is that they are not consistently guided by health behavior theory, or an understanding of health behaviors and the context in which they occur.[24,25] Incorporating these concepts into educational interventions is an important step toward ensuring sustainable change[17]; however, it may still require addition levels of intervention. The Stroke Ready community-based participatory research intervention, for example, which incorporated a theory-based health behavior intervention and optimization of stroke care in a safety-net emergency department (ED), found that the ED component was associated with increased thrombolysis use, whereas the community component was not.[26] The combination of a history of systemic oppression[27] and recent medical misinformation[28] have produced a lack of trust in medical establishments that must also be overcome.

Dispatch and Delivery: EMS Use and Triage

EMS is underused for stroke overall; however, it is estimated that White people use EMS for transportation to health care facilities more frequently than Black, Asian, and Hispanic people.[29,30] There are numerous barriers to activating EMS in the setting of stroke symptoms, including fear generated by the symptoms themselves that can affect decision-making, perception of the seriousness of the symptoms, prior negative experiences in accessing health care that can lead to avoidance, distrust in the health care system, racism, and cost concerns.[29] In rural settings, another barrier is the lack of consistent EMS availability.[31] The rapid delivery of an individual experiencing stroke symptoms is an essential step in the stroke care pathway. In fact, a discrete-event simulation model of the stroke care process from symptom onset through thrombolysis found that reducing the time from stroke onset to ED arrival by 30 minutes raised the proportion of treatable patients by 7.7%, an increase that was more significant than adding computed tomography scanners (1.5%) or increasing the number of available neurologists from 4 to 8 (1.44%).[32]

Although educational interventions may lead to some improvement in these disparities, individual-level interventions alone are insufficient. One potential organizational intervention to improve EMS use and efficiency is the mobile stroke unit (MSU), which blends the stroke care steps of delivery, door, data, decision, and drug into a single integrated workflow. The BEST-MSU (Benefits of Stroke Treatment Delivered Using a Mobile Stroke Unit) clinical trial demonstrated that patients who received treatment on a MSU had less disability compared with standard management.[33] Moreover, time from last known well was shorter (median 72 minutes versus 108 minutes) and rates of thrombolysis were higher in the MSU-treated group compared with those in the standard management group (97.1% received tissue plasminogen activator versus 79.5%, respectively).[33] Similar positive results

have been demonstrated in MSU services internationally. They improve prehospital triage of people experiencing stroke,[34] which can lead to appropriate routing to a stroke center and avoid the delay in care associated with interhospital transfer. MSU models have also been adapted to local settings based on the needs of that community.[35] Adaptations include nonneurologist emergency responders,[36] a rendezvous model where the MSU meets EMS to cover large rural areas, and an air-MSU to provide services to rural areas.[37] Of note, the BEST-MSU trial is one of the few MSU trials to report data from a racial and ethnically diverse population, with 39.4% Black and 16.9% Hispanic participants. A prespecified analysis by race and ethnicity demonstrated that treatment with a MSU can address known disparities in thrombolysis treatment metrics.[38] In particular, MSU management led to more frequent thrombolytic treatment across racial and ethnic identity groups; however, the increase was most dramatic for Hispanic people. Similarly, MSU treatment reduced the time to treatment across all groups, but the effect was more significant for Black and Hispanic individuals.

Despite the demonstrated benefit of MSU models of care, however, there remain barriers to their widespread implementation. The financial burden of implementing and maintaining MSUs can limit their viability, particularly in rural areas or where lower case volume limits the financial benefit. MSUs also require a collaborative relationship between EMS and stroke centers, which can be challenging in the setting of for-profit or privatized health care systems.[39]

ACUTE STROKE THERAPIES

Acute stroke treatment is directed toward recanalization and reperfusion of threatened tissue. This goal is accomplished with intravenous thrombolysis or procedurally with thrombectomy. As with other areas of stroke, there are clear disparities in the use of these therapies.[40] These disparities undercut the impact of the single most effective disability-reducing intervention available for stroke. Disparity exists in various domains. Approximately 20% of Americans (60 million people) live in rural areas and are subject to lower rates of thrombectomy treatment.[41] Racial and ethnic disparities are well documented: Black and Hispanic people have lower rates of treatment with thrombolysis or mechanical thrombectomy and longer time to treatment with thrombolysis and are less likely to be transferred to an endovascular-capable center than White people.[30] Separating this from socioeconomic disparities (due to race or geography) is challenging. Access to thrombectomy is also uneven for people with disabilities, where exclusion from therapy is a common challenge despite evidence of benefit of treatment.[42] Gender disparities in thrombectomy access were the subject of a recent scientific statement from the American Heart Association.[43]

The emergent and extraordinarily time-sensitive nature of acute ischemic stroke care means that patients' treatment decisions are pressured and constrained to what is offered to them. This makes stroke care vulnerable to systemic disparity (such as structural racism or geographic disparity) and a range of provider and interpersonal biases. It must be acknowledged despite holding egalitarian beliefs outwardly, health care providers have implicit biases based on race, ethnicity, gender identity, sexual orientation, educational attainment, and disability, among others.[44,45] Implicit biases among health care providers affects patient–provider communication, patient satisfaction, and clinical decision-making.[44,46–48] Interventions in the health care setting to reduce implicit bias and mitigate its adverse impact on marginalized communities are few and to date have not demonstrated a sustained effect.[49] Therefore, the approach to address disparity in thrombolysis and thrombectomy care must be broad and inclusive, with several levels that require both intervention and further study.

Door: Acute Treatment Access and Hospitals

Currently, stroke systems of care are built in hierarchical fashion. The goal of the system is that intravenous thrombolysis is available to patients at the lowest levels of that hierarchy, namely acute stroke ready hospitals. These acute stroke ready centers possess EDs with computed tomography scanners, medication, and the ability to call in stroke expertise. However, hospital quality is nonuniform and Black and Hispanic people are more likely than White people to receive care at low-quality hospitals with worse clinical outcomes,[50] including reduced exposure to acute stroke treatments.[51,52] Additionally, studies have demonstrated racial disparities in time to triage after arrival to the ED, even after adjusting for arrival by EMS, in the likelihood of being transferred to an endovascular center,[30] and in door-in-door-out times, or the time a patient spends in the initial ED before transfer.[53]

Variability in several domains is a feature of national stroke care. These include care quality in triage areas, culture related to stroke and protocols, quality improvement initiatives, and collaboration. A combination of systematic hospital certification and quality improvement initiatives combined with education to reduce provider biases will help, although systematic study of these interventions is limited. Race concordant providers and patients are generally preferred by patients,[54] but whether this improves stroke care quality is unknown. Telemedicine[55] and telerobotics[56]

are poised to play an increasingly important role in acute stroke management in rural communities, and digital equity concerns will need to be addressed.[57,58] Legislation and funding are necessary to ensure this potential impact is realized.

Decision and Drug: Diagnosis and Eligibility

To be offered acute treatment, an accurate diagnosis of stroke must be made and in a timely fashion allowing acute treatment. It remains uncertain if the expanded time windows for eligibility have improved disparities.[59] Thrombectomy is procedural and requires consent from the patient or surrogate decision makers, with many facilities still pursuing consent for intravenous thrombolysis. Both explicit and implicit bias may reduce the probability of stroke identification for patients on the basis of race, gender, prior disability, socioeconomics, or other variables; however; the extent that provider bias contributes to disparities has not yet been fully elucidated in health disparities literature. Communication with patients and families might also decrease their likelihood of accepting therapy, either because of content or context of informed consent. In fact, racial disparities in rates of thrombolysis declination have been found, although the reasons for these disparities remain unknown. Centering treatment decisions around treatment effect rather than perception of overall prognosis is an effective technique to reduce the impact of bias.[43]

HOSPITAL COURSE

Disposition: Patient Experience, Secondary Prevention, and Hospital Discharge

Structural racism, interpersonal biases, lack of culturally inclusive care, and discordance in patient–provider identity (across race, ethnicity, gender, primary language or other identities) all contribute to worse experiences of care for minoritized populations.[27,60,61] Among people with Medicaid, Black individuals consistently report worse patient care experiences compared with both non-Hispanic White and Hispanic individuals.[62] Women with a history of stroke had greater odds of reporting that they would not receive adequate care in the ED based on their gender compared with women without a history of stroke.[63] The degree to which different populations experience disparities in hospital experience after stroke, however, has yet to be fully explored. Using creative and accessible data gathering strategies, such as text message-based surveys, and integrating this practice systematically into hospital systems may be an avenue to more fully understand and actively address patient-reported experiences of discrimination in health care.[64]

An essential component of acute hospitalization is initiation of appropriate secondary stroke prevention medications. A 2022 study using data from the CARES (Caring for Adults Recovering from the Effects of Stroke) study found that there were no race or sex differences in discharge prescription rates of secondary stroke medications in that cohort. After 1 year, however, Black participants were more likely to have discontinued antithrombotics than White participants.[65] Other studies have found disparities in the rates of antithrombotic prescriptions at discharge, use of anticoagulation for secondary stroke prevention in the setting of atrial fibrillation, and use of lipid-lowering medications for Black and Hispanic people after stroke.[50] Interventions to improve pharmacoequity in stroke are limited. Education and awareness campaigns to improve postdischarge adherence are important; however, education alone is unlikely to be the sole solution. Other considerations include implicit bias training for clinicians to gain insight into disparate prescribing patterns and policy-level interventions to reduce the cost of medications.[66]

Although not formally recognized within the 8 Ds framework, postacute care after stroke is also an essential component of acute stroke care, particularly given the impact of early rehabilitation on long-term stroke outcomes. Stroke is a leading cause of severe adult disability and two thirds of stroke survivors require medical rehabilitation services after hospital discharge.[67,68] Disparities by race, ethnicity, insurance status, and geography exist in access to and outcomes within medical rehabilitation.[69–72] In the 2021 transitions of care coordination study, for example, survivors of stroke in Washington, DC with Medicaid had longer acute care hospital lengths of stay and were less likely to be discharged to acute inpatient rehabilitation than those with Medicare or commercial insurance.[73] Indeed, insurance coverage may be a significant driver of disparities in access to poststroke rehabilitation services. A study of the use of inpatient rehabilitation services within Medicare beneficiaries found no disparities between Black and White survivors of stroke,[74] and a study of poststroke outpatient rehabilitation use within the Veterans Affairs medical system found that Black veterans had higher odds of physical therapy and occupational therapy referrals and visits than non-Hispanic White veterans.[75]

There is a dearth of literature on interventions to reduce disparities in poststroke rehabilitation. Telerehabilitation may be a promising avenue to address geographic disparities, although, as with telemedicine, digital equity remains a concern.[76] Multilevel interventions to simultaneously address policy issues, such as reimbursement for rehabilitation services, as well as community-level and individual-level factors,

such as neighborhood safety to enhance poststroke exercise programs and patient-level education on appropriate poststroke rehabilitation, are likely necessary to more fully address ongoing disparities.

SYSTEMS OF CARE INTERVENTIONS

Several examples exist of effective systems of care interventions for stroke. In 2014, the Ministry of Health of the Republic of Lithuania implemented a comprehensive national policy to improve access to reperfusion therapy for patients with acute ischemic stroke across Lithuania. Elements of the policy included establishment of a national network of acute stroke centers, reorganization of the flow of patients with acute ischemic stroke, creation of a coordinated inventory of the stroke diagnostic and management methods, requirements for accreditation of primary stroke centers and comprehensive stroke centers and creation of the Stroke Integrated Care Management Committee under the Ministry of Health responsible for coordinating new financial incentives, monitoring stroke care performance measures, and providing quarterly reports to the Ministry of Health for quality improvement. This national policy led to an increase in intravenous thrombolysis and endovascular thrombectomy rates and an increased proportion of ischemic stroke cases evaluated in comprehensive stroke centers or primary stroke centers. Additionally, there was a decrease in door-to-needle time trend (68 minutes in 2014 to 43 minutes in 2019).[77] More broadly across Europe, the recent Quality in Acute Stroke Care Europe study was a unique collaboration between the European Stroke Organisation, the European Acute Networks Striving for Excellence in Stroke (Angels) Initiative, and the European Registry of Stroke Care Quality to implement nurse-led acute stroke care protocols to improve management of fever, hyperglycemia, and swallowing in the first 72 hours of stroke. This resulted in successful international scale-up of the Fever, Sugar, and Swallowing Protocols into 64 hospitals within 17 European countries demonstrating a 32% absolute improvement in overall adherence with the Fever, Sugar, and Swallowing Protocols. Of note, improvements also were achieved in 12 Eastern European countries where inequalities in stroke care exist and where people often have limited or no access to reperfusion therapy.[78] Although these interventions demonstrate the potential impact of systems-level interventions, it remains uncertain if these types of interventions are effective at narrowing disparities in care within populations.

In the United States, states with legislation for designating stroke centers and regulating stroke triage had higher primary stroke center percentages than the states without legislation.[79] The Centers for Disease Control and Prevention performed an impact analysis of stroke systems of care state policy interventions aimed to improve access to time-sensitive stroke treatment. States with at least 1 stroke systems of care policy in effect demonstrated better performance than expected in the stroke metrics of higher proportion of certified primary stroke centers, higher timely brain imaging rates, lower in-hospital costs, and lower in-hospital mortality.[80] The report outlines specific policy interventions that predicted better stroke outcomes, for example, requirements for a stroke systems of care task force and a statewide continuous quality improvement data and reporting system.

IMPACT OF DISPARITIES IN ACUTE STROKE CARE

The long-term impact of disparities in acute stroke care cannot be underestimated. Pooled patient-level data from 7 endovascular thrombectomy trials by the HERMES (Highly Effective Reperfusion Using Multiple Endovascular Devices) collaboration demonstrated that every 10 minutes of earlier treatment resulted in a median of 39 additional days of disability-free life and 106 additional days of life in functional independence.[81] The consistent trend of longer time to treatment for Black and Hispanic people experiencing stroke, therefore, has direct implications for long-term disability and independence after stroke. There are also economic consequences in the form of costs associated with prolonged care and rehabilitation for those not receiving timely treatment.[82,83] The impact is not merely on the patient and their family but on the entire community. Disparities in poststroke mortality have consistently been found across racial and ethnic identities and geographic location.[84] Moreover, the public health burden of stroke, as measured by disability-adjusted life years ranks higher in Black people than Hispanic and White people.[85] Person-centered outcomes, and specifically health-related quality of life, are increasingly recognized as key components of understanding the public health impact of stroke and other diseases on communities. Racial and ethnic disparities have been reported in health-related quality of life among survivors with stroke, with lower health utility scores among Black and Hispanic people with stroke as compared with White people.[86]

EVIDENCE IN ACTION: CLOSING THE GAP BETWEEN RESEARCH AND IMPLEMENTATION

Achieving successful knowledge translation and implementation of evidence-based interventions

in clinical practice is often difficult.[87] The evidence translation gap is highlighted by the estimated 17 years it takes for 14% of original research to be implemented into clinical practice.[88] The stroke discipline is not immune to the evidence translation gap despite advancements in acute stroke therapies.[89] Implementation research has been identified as a solution to closing this gap as it improves access, reorganizes and coordinates systems of care, assists clinicians and patients to change behaviors, provides reminders and point-of-care decision support tools, and strengthens the patient–clinician relationship.[90] Importantly, implementation research within neurology has the potential to increase uptake of evidence-based interventions into practice by focusing on the clinicians using the research, the context in which implementation occurs, and the factors influencing implementation.[91,92] Implementation research can also generate new knowledge about barriers to uptake of proven interventions into routine clinical care, and what strategies are effective in overcoming those barriers.[78] However, implementation of evidence-based interventions into practice is a complex process with estimated failure rates of between 30% and 90%.[93] Based on prior studies, a number of pragmatic strategies have been shown to improve implementation research success at the local level (Box 1).[94]

A potential strategy for integrating these varied components is through a stroke learning health system. A learning health system is an evolution in the quality improvement process where there is routine evaluation of data collected within a health care system that then informs clinical decision-making through interdisciplinary expertise in consultation with patients, families, and community stakeholders.[95] It is unique in its adaptability and lack of a time-limited focus, which is typically characteristic of quality improvement initiatives.[92] In stroke, the scope of a learning health system could encompass prevention, acute treatment, or even a holistic approach to improve the experience and outcomes from symptom onset to the patient's return to the community.[92] One example comes from the Implementation of Best Practices for Acute Stroke Care-Developing and Optimizing Regional Systems of Stroke Care (IMPROVE) stroke care project, which sought to increase the use of thrombolysis and reduce door-to-needle times in 9 hub hospitals and their spoke sites across 4 US states. This group engaged the public, EMS, and acute stroke hospitals to create a living document version of the manual of operations that could be updated with new knowledge from published evidence or the consortium itself in concert with up-to-date data to evaluate program effectiveness.[96] In another example, the Chinese Stroke Center Alliance arose from the recognition of the need to improve access to high-quality stroke care broadly and to monitor performance in an iterative fashion to identify interventions that performed best for particular subgroups of people.[97]

Advancing health equity and eliminating health disparities is increasingly a goal of implementation researchers to ensure equitable evidence-based interventions. However, without considering external contextual factors, such as policy and politics, in the implementation process, advancing health equity will be unsuccessful.[98] Despite having the pragmatic strategies mentioned previously to drive implementation at the local level, support from national level stakeholders plays a critical role in influencing implementation research success locally. This can be achieved only if implementation research is prioritized by those in positions of power such as health administrators and policy makers. Adequate investment and a stronger commitment to implementation research by government bodies is needed.[90] As stroke clinicians and researchers, it is time we consider who at the national level are the change agents to better manage inequities in stroke and bring this important focus to the forefront of the health agenda. Additionally, our engagement and investment with specialty societies allows advocacy with a single unified voice at the highest levels. This recognition has increasingly led to support for formal advocacy training within specialty societies,[99] incorporation of diverse skill sets in committees such as advisory councils,[100] and collaboration between specialty societies to achieve the desired legislative outcomes.

Box 1. Strategies to Improve Implementation of Stroke Care Interventions

Develop a shared agenda amongst researchers and different health care stakeholders.
Use a conceptual framework to guide the implementation process.
Evaluate the implementation process to make the business case.
Empower operational experts (implementers) to deploy the intervention to existing providers.
Enable and guide adaptations to the intervention to promote end-user acceptance.
Build capacity for wide-scale implementation and sustainability.

CONCLUSIONS

The acute stroke environment is particularly suited to protocols and process improvement, and the impact of these efforts in reducing disparity in care is large. The consequence of reducing the burden of

disease in our populations, especially those at greatest risk, demands action from us as a stroke community. Improving the quality of care in populations made most vulnerable will raise the bar for stroke care across the board. Fortunately, there are several individual- and organizational-level interventions with proven benefit, such as the consistent use of licensed interpreters, that can be implemented with the appropriate allocation of resources and support. Future research must capitalize on the burgeoning field of implementation science to identify the most effective strategies to ensure the success and sustainability of interventions and ensure inclusive and consistent data collection for those not currently represented within stroke disparities data, such as lesbian, gay, bisexual, transgender, queer; lesbian, gay, bisexual, transgender, questioning+ people. As the American Heart Association celebrates its centennial and looks toward the next century of advances in vascular health, equity must remain a central focus in both the short-term and long-term vision.

ARTICLE INFORMATION

Affiliations

Department of Neurology, Georgetown University School of Medicine, Washington, DC (M.C.D.); Department of Neurology, MedStar Health, Washington, DC (M.C.D.); Department of Neurology (N.R.), and Weill Institute for Neurosciences (N.R.), University of California San Francisco, San Francisco, CA; Department of Neurology, University of Colorado Anschutz Medical Campus, Aurora, CO (N.R.G.); Department of Neurology, University of Washington, Seattle, WA (T.M.L.-M.); Nursing Research Institute, St Vincent's Health Network Sydney, St Vincent's Hospital Melbourne and Australian Catholic University, Darlinghurst, Australia (S.M.); and School of Nursing, Midwifery and Paramedicine, Australian Catholic University, Darlinghurst, Australia (S.M.).

Sources of Funding

This article was not directly funded. M. Carter Denny receives research funding from MedStar Health Research Institute and the National Institute on Disability, Independent Living, and Rehabilitation Research. Nicole Rosendale receives research funding from the American Academy of Neurology.

Disclosures

M. Carter Denny receives royalty payments for authorship of *Acute Stroke Care, 3rd edition* from Cambridge University Press and is on the speaker's bureau for Abbott Laboratories. Nicole Rosendale receives compensation for her role as Associate Editor of DEI for Continuum and royalty payments for chapter authorship from McGraw-Hill. Nicole R. Gonzales receives compensation as Associate Editor of Diversity, Equity and Inclusion for the journal *Neurology*. The remaining authors have no disclosures to report.

REFERENCES

1. Kittner SJ, Sekar P, Comeau ME, Anderson CD, Parikh GY, Tavarez T, Flaherty ML, Testai FD, Frankel MR, James ML, et al. Ethnic and racial variation in intracerebral hemorrhage risk factors and risk factor burden. *JAMA Netw Open*. 2021;4:e2121921. doi: 10.1001/jamanetworkopen.2021.21921
2. Li C, Baek J, Sanchez BN, Morgenstern LB, Lisabeth LD. Temporal trends in age at ischemic stroke onset by ethnicity. *Ann Epidemiol*. 2018;28:686–690.e2. doi: 10.1016/j.annepidem.2018.07.010
3. Churchwell K, Elkind MSV, Benjamin RM, Carson AP, Chang EK, Lawrence W, Mills A, Odom TM, Rodriguez CJ, Rodriguez F, et al. Call to action: structural racism as a fundamental driver of health disparities: a presidential advisory from the American Heart Association. *Circulation*. 2020;142:e454–e468. doi: 10.1161/CIR.0000000000000936
4. Ashcraft S, Wilson SE, Nyström KV, Dusenbury W, Wira CR, Burrus TM; American Heart Association Council on Cardiovascular and Stroke Nursing and the Stroke Council. Care of the patient with acute ischemic stroke (prehospital and acute phase of care): update to the 2009 Comprehensive nursing care scientific statement: a scientific statement from the American Heart Association. *Stroke*. 2021;52:e164–e178. doi: 10.1161/STR.0000000000000356
5. Moise N, Cené CW, Tabak RG, Young DR, Mills KT, Essien UR, Anderson CAM, Lopez-Jimenez F; American Heart Association Council on Epidemiology and Prevention; Council on Hypertension; and Stroke Council. Leveraging implementation science for cardiovascular health equity: a scientific statement from the American Heart Association. *Circulation*. 2022;146:e260–e278. doi: 10.1161/CIR.0000000000001096
6. Cruise C, M'Carthy NM, Ganesh A, Lashewicz B. Imperfect patients: disparities in treatment of stroke patients with premorbid disability. *Can J Neurol Sci*. 2022;50:826–837. doi: 10.1017/cjn.2022.341
7. Diaz MA, Rosendale N. Exploring stroke risk factors and outcomes in sexual and gender minority people. *Neurol Clin Pract*. 2023;13:e200106. doi: 10.1212/CPJ.0000000000200106
8. Crenshaw K. Demarginalizing the intersection of race and sex: a Black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. *Univ Chic Leg Forum*. 1989;1989:139–167.
9. Boden-Albala B, Quarles LW. Education strategies for stroke prevention. *Stroke*. 2013;44:S48–S51. doi: 10.1161/STROKEAHA.111.000396
10. Morgenstern LB, Steffen-Batey L, Smith MA, Moyé LA. Barriers to acute stroke therapy and stroke prevention in Mexican Americans. *Stroke*. 2001;32:1360–1364. doi: 10.1161/01.STR.32.6.1360
11. Willey JZ, Williams O, Boden-Albala B. Stroke literacy in Central Harlem. *Neurology*. 2009;73:1950–1956. doi: 10.1212/WNL.0b013e3181c51a7d
12. Kleindorfer D, Miller R, Sailor-Smith S, Moomaw CJ, Khoury J, Frankel M. The challenges of community-based research. *Stroke*. 2008;39:2331–2335. doi: 10.1161/STROKEAHA.107.508812
13. Williams O, Leighton-Herrmann Quinn E, Teresi J, Eimicke JP, Kong J, Ogedegbe G, Noble J. Improving community stroke preparedness in the HHS (Hip-Hop Stroke) randomized clinical trial. *Stroke*. 2018;49:972–979. doi: 10.1161/STROKEAHA.117.019861
14. Morgenstern LB, Gonzales NR, Maddox KE, Brown DL, Karim AP, Espinosa N, Moyé LA, Pary JK, Grotta JC, Lisabeth LD, et al. A randomized, controlled trial to teach middle school children to recognize stroke and call 911. *Stroke*. 2007;38:2972–2978. doi: 10.1161/STROKEAHA.107.490078
15. Mellon L, Doyle F, Rohde D, Williams D, Hickey A. Stroke warning campaigns: delivering better patient outcomes? A systematic review. *Patient Relat Outcome Meas*. 2015;6:61–73. doi: 10.2147/PROM.S54087
16. Morgenstern LB, Staub L, Chan W, Wein TH, Bartholomew LK, King M, Felberg RA, Burgin WS, Groff J, Hickenbottom SL, et al. Improving delivery of acute stroke therapy. *Stroke*. 2002;33:160–166. doi: 10.1161/hs0102.101990
17. Kelly KM, Holt KT, Neshewat GM, Skolarus LE. Community interventions to increase stroke preparedness and acute stroke treatment rates. *Curr Atheroscler Rep*. 2017;19:64. doi: 10.1007/s11883-017-0695-5
18. Aroor S, Singh R, Goldstein LB. BE-FAST (balance, eyes, face, arm, speech, time). *Stroke*. 2017;48:479–481. doi: 10.1161/STROKEAHA.116.015169
19. Castro A, Leal AA, Montiel TC, Sharrief A, Denny MC, Beauchamp JES. RAPIDO: promoting stroke awareness among Spanish speakers. *Nursing*. 2022;52:46–50. doi: 10.1097/01.NURSE.0000803488.93481.a2
20. Ponte PILAS; infórmate sobre los síntomas del ataque cerebral. Portal de Noticias - Universidad San Francisco de Quito (USFQ). Published October 30, 2018. Accessed October 16, 2023. https://noticias.usfq.edu.ec/2018/10/ponte-pilas-informate-sobre-los.html
21. Moreno AP, Camargo L, Gaitán G, Castillo EE, Pabón SA, Shelach S, Gargiulo P, Caldichoury N, López N. Effectiveness of a digital application to improve stroke knowledge for kids. *Neurología (Engl Ed)*. 2023;38:278–283. doi: 10.1016/j.nrleng.2021.10.006

22. Govindarajan P, Friedman BT, Delgadillo JQ, Ghilarducci D, Cook LJ, Grimes B, McCulloch C, Johnston SC. Race and sex disparities in prehospital recognition of acute stroke. *Acad Emerg Med*. 2015;22:264–272. doi: 10.1111/acem.12595
23. Oostema JA, Chassee T, Baer W, Edberg A, Reeves MJ. A brief educational intervention improves emergency medical services stroke recognition. *Stroke*. 2019;50:1193–1200. doi: 10.1161/STROKEAHA.118.023885
24. Glanz K, Bishop DB. The role of behavioral science theory in development and implementation of public health interventions. *Annu Rev Public Health*. 2010;31:399–418. doi: 10.1146/annurev.publhealth.012809.103604
25. Rejeski WJ, Fanning J. Models and theories of health behavior and clinical interventions in aging: a contemporary, integrative approach. *Clin Interv Aging*. 2019;14:1007–1019. doi: 10.2147/CIA.S206974
26. Skolarus LE, Bailey S, Corches CL, Sales AE, Lin CC, Bi R, Springer MV, Oliver A, Robles MC, Brooks T, et al. Association of the Stroke Ready community-based participatory research intervention with incidence of acute stroke thrombolysis in Flint, *Michigan. JAMA Netw Open*. 2023;6:e2321558. doi: 10.1001/jamanetworkopen.2023.21558
27. Bailey ZD, Krieger N, Agénor M, Graves J, Linos N, Bassett MT. Structural racism and health inequities in the USA: evidence and interventions. *Lancet*. 2017;389:1453–1463. doi: 10.1016/S0140-6736(17)30569-X
28. Hill JA, Agewall S, Baranchuk A, Booz GW, Borer JS, Camici PG, Chen P-S, Dominiczak AF, Erol Ç, Grines CL, et al. Medical misinformation. *Circulation*. 2019;139:571–572. doi: 10.1161/CIRCULATIONAHA.118.039193
29. Zachrison KS, Nielsen VM, de la Ossa NP, Madsen TE, Cash RE, Crowe RP, Odom EC, Jauch EC, Adeoye OM, Richards CT. Prehospital stroke care part 1: emergency medical services and the stroke systems of care. *Stroke*. 2023;54:1138–1147. doi: 10.1161/STROKEAHA.122.039586
30. Ikeme S, Kottenmeier E, Uzochukwu G, Brinjikji W. Evidence-based disparities in stroke care metrics and outcomes in the United States: a systematic review. *Stroke*. 2022;53:670–679. doi: 10.1161/STROKEAHA.121.036263
31. Gebhardt JG, Norris TE. Acute stroke care at rural hospitals in Idaho: challenges in expediting stroke care. *J Rural Health*. 2006;22:88–91. doi: 10.1111/j.1748-0361.2006.00004.x
32. Stahl JE, Furie KL, Gleason S, Gazelle GS. Stroke: effect of implementing an evaluation and treatment protocol compliant with NINDS recommendations. *Radiology*. 2003;228:659–668. doi: 10.1148/radiol.2283021557
33. Grotta JC, Yamal J-M, Parker SA, Rajan SS, Gonzales NR, Jones WJ, Alexandrov AW, Navi BB, Nour M, Spokoyny I, et al. Prospective, multicenter, controlled trial of mobile stroke units. *N Engl J Med*. 2021;385:971–981. doi: 10.1056/NEJMoa2103879
34. Wendt M, Ebinger M, Kunz A, Rozanski M, Waldschmidt C, Weber JE, Winter B, Koch PM, Freitag E, Reich J, et al. Improved prehospital triage of patients with stroke in a specialized stroke ambulance. *Stroke*. 2015;46:740–745. doi: 10.1161/STROKEAHA.114.008159
35. Mathur S, Walter S, Grunwald IQ, Helwig SA, Lesmeister M, Fassbender K. Improving prehospital stroke services in rural and underserved settings with mobile stroke units. *Front Neurol*. 2019;10:159. doi: 10.3389/fneur.2019.00159
36. Hov MR, Røislien J, Lindner T, Zakariassen E, Bache KCG, Solyga VM, Russell D, Lund CG. Stroke severity quantification by critical care physicians in a mobile stroke unit. *Eur J Emerg Med*. 2019;26:194–198. doi: 10.1097/MEJ.0000000000000529
37. Walter S, Zhao H, Easton D, Bil C, Sauer J, Liu Y, Lesmeister M, Grunwald IQ, Donnan GA, Davis SM, et al. Air-mobile stroke unit for access to stroke treatment in rural regions. *Int J Stroke*. 2018;13:568–575. doi: 10.1177/1747493018784450
38. Czap AL, Rajan SS, Yamal JM, Jacob A, Wang M, Parker S, Sambursky J, Bowry R, Grotta JC, Sharrief AZ, et al. Abstract 88: mobile stroke unit management associated with reduction in racial disparities in stroke treatment metrics. *Stroke*. 2024;55:A88. doi:10.1161/str.55.suppl_1.88
39. Navi BB, Audebert HJ, Alexandrov AW, Cadilhac DA, Grotta JC;. PRESTO (Prehospital StrokeTtreatment Organization) Writing Group. Mobile stroke units: evidence, gaps, and next steps. *Stroke*. 2022;53:2103–2113. doi: 10.1161/STROKEAHA.121.037376
40. Otite FO, Saini V, Sur NB, Patel S, Sharma R, Akano EO, Anikpezie N, Albright K, Schmidt E, Hoffman H, et al. Ten-year trend in age, sex, and racial disparity in tPA (Alteplase) and Thrombectomy use following stroke in the United States. *Stroke*. 2021;52:2562–2570. doi: 10.1161/STROKEAHA.120.032132
41. Hammond G, Luke AA, Elson L, Towfighi A, Joynt Maddox KE. Urban–rural inequities in acute stroke care and in-hospital mortality. *Stroke*. 2020;51:2131–2138. doi: 10.1161/STROKEAHA.120.029318
42. Ganesh A, Fraser JF, Gordon Perue GL, Amin-Hanjani S, Leslie-Mazwi TM, Greenberg SM, Couillard P, Asdaghi N, Goyal M; American Heart Association Stroke Council. Endovascular treatment and thrombolysis for acute ischemic stroke in patients with premorbid disability or dementia: a scientific statement from the American Heart Association/American Stroke Association. *Stroke*. 2022;53:e204–e217. doi: 10.1161/STR.0000000000000406
43. Ospel JM, Schaafsma JD, Leslie-Mazwi TM, Amin-Hanjani S, Asdaghi N, Gordon-Perue GL, Couillard P, Hadidi NN, Bushnell C, McCullough LD, et al. Toward a better understanding of sex- and gender-related differences in endovascular stroke treatment: a scientific statement from the American Heart Association/American Stroke Association. *Stroke*. 2022;53:e396–e406. doi: 10.1161/STR.0000000000000411
44. Vela MB, Erondu AI, Smith NA, Peek ME, Woodruff JN, Chin MH. Eliminating explicit and implicit biases in health care: evidence and research needs. *Annu Rev Public Health*. 2022;43:477–501. doi: 10.1146/annurev-publhealth-052620-103528
45. Cooper LA, Saha S, van Ryn M. Mandated implicit bias training for health professionals—a step toward equity in health care. *JAMA Health Forum*. 2022;3:e223250. doi: 10.1001/jamahealthforum.2022.3250
46. Peek ME, Lopez FY, Williams HS, Xu LJ, McNulty MC, Acree ME, Schneider JA. Development of a conceptual framework for understanding shared decision making among African-American LGBT patients and their clinicians. *J Gen Intern Med*. 2016;31:677–687. doi: 10.1007/s11606-016-3616-3
47. Green AR, Carney DR, Pallin DJ, Ngo LH, Raymond KL, Iezzoni LI, Banaji MR. Implicit bias among physicians and its prediction of thrombolysis decisions for black and white patients. *J Gen Intern Med*. 2007;22:1231–1238. doi: 10.1007/s11606-007-0258-5
48. Maina IW, Belton TD, Ginzberg S, Singh A, Johnson TJ. A decade of studying implicit racial/ethnic bias in healthcare providers using the implicit association test. *Soc Sci Med*. 2018;199:219–229. doi: 10.1016/j.socscimed.2017.05.009
49. Sabin JA. Tackling implicit bias in health care. *N Engl J Med*. 2022;387:105–107. doi: 10.1056/NEJMp2201180
50. Schwamm LH, Reeves MJ, Pan W, Smith EE, Frankel MR, Olson D, Zhao X, Peterson E, Fonarow GC. Race/ethnicity, quality of care, and outcomes in ischemic stroke. *Circulation*. 2010;121:1492–1501. doi: 10.1161/CIRCULATIONAHA.109.881490
51. Hsia AW, Edwards DF, Morgenstern LB, Wing JJ, Brown NC, Coles R, Loftin S, Wein A, Koslosky SS, Fatima S, et al. Racial disparities in tissue plasminogen activator treatment rate for stroke. *Stroke*. 2011;42:2217–2221. doi: 10.1161/STROKEAHA.111.613828
52. Rinaldo L, Rabinstein AA, Cloft H, Knudsen JM, Castilla LR, Brinjikji W. Racial and ethnic disparities in the utilization of thrombectomy for acute stroke. *Stroke*. 2019;50:2428–2432. doi: 10.1161/STROKEAHA.118.024651
53. Stamm B, Royan R, Giurcanu M, Messe SR, Jauch EC, Prabhakaran S. Door-in-door-out times for Interhospital transfer of patients with stroke. *JAMA*. 2023;330:636–649. doi: 10.1001/jama.2023.12739
54. Meghani SH, Brooks JM, Gipson-Jones T, Waite R, Whitfield-Harris L, Deatrick JA. Patient–provider race-concordance: does it matter in improving minority patients' health outcomes? *Ethn Health*. 2009;14:107–130. doi: 10.1080/13557850802227031
55. Hatcher-Martin JM, Adams JL, Anderson ER, Bove R, Burrus TM, Chehrenama M, O'Brien MD, Eliashiv DS, Erten-Lyons D, Giesser BS, et al. Telemedicine in neurology: Telemedicine Work Group of the American Academy of Neurology update. *Neurology*. 2020;94:30–38. doi: 10.1212/WNL.0000000000008708
56. Panesar SS, Volpi JJ, Lumsden A, Desai V, Kleiman NS, Sample TL, Elkins E, Britz GW. Telerobotic stroke intervention: a novel solution to the care dissemination dilemma. *J Neurosurg*. 2019;132:971–978. doi: 10.3171/2019.8.JNS191739
57. Brewer LC, Fortuna KL, Jones C, Walker R, Hayes SN, Patten CA, Cooper LA. Back to the future: achieving health equity through health informatics and digital health. *JMIR Mhealth Uhealth*. 2020;8:e14512. doi: 10.2196/14512

58. Sharma P, Patten CA. A need for digitally inclusive health care service in the United States: recommendations for clinicians and health care systems. *Perm J*. 2022;26:149–153. doi: 10.7812/TPP/21.156
59. Wallace AN, Gibson DP, Asif KS, Sahlein DH, Warach SJ, Malisch T, Lamonte MP. Racial disparity in mechanical thrombectomy utilization: multicenter registry results from 2016 to 2020. *J Am Heart Assoc*. 2022;11:e021865. doi: 10.1161/JAHA.121.021865
60. Powe NR, Cooper LA. Disparities in patient experiences, health care processes, and outcomes: the role of patient-provider racial, ethnic, and language concordance. The Commonwealth Fund. 2004. Accessed October 27, 2023. https://www.commonwealthfund.org/publications/fund-reports/2004/jul/disparities-patient-experiences-health-care-processes-and
61. Trivedi AN, Ayanian JZ. Perceived discrimination and use of preventive health services. *J Gen Intern Med*. 2006;21:553–558. doi: 10.1111/j.1525-1497.2006.00413.x
62. Nguyen KH, Wilson IB, Wallack AR, Trivedi AN. Racial and ethnic disparities in patient experience of care among nonelderly Medicaid managed care enrollees. *Health Aff (Millwood)*. 2022;41:256–264. doi: 10.1377/hlthaff.2021.01331
63. Stamm B, Royan R, Madsen TE. Association of prior stroke with health care perceptions of adequate emergency care in women. *Stroke*. 2023;55:301–304. doi: 10.1161/STROKEAHA.123.044967
64. Agarwal AK, Sagan C, Gonzales R, Nijim S, Merchant RM, Asch DA, South EC. Assessing experiences of racism among Black and White patients in the emergency department. *J Am Coll Emerg Physicians Open*. 2022;3:e12870. doi: 10.1002/emp2.12870
65. Sheehan OC, Dhamoon MS, Bettger JP, Huang J, Liu C, Rhodes JD, Clay OJ, Roth DL. Racial differences in persistence to secondary prevention medication regimens after ischemic stroke. *Ethn Health*. 2022;27:1671–1683. doi: 10.1080/13557858.2021.1943321
66. Levine DA, Duncan PW, Nguyen-Huynh MN, Ogedegbe OG. Interventions targeting racial/ethnic disparities in stroke prevention and treatment. *Stroke*. 2020;51:3425–3432. doi: 10.1161/STROKEAHA.120.030427
67. Lawrence ES, Coshall C, Dundas R, Stewart J, Rudd AG, Howard R, Wolfe CDA. Estimates of the prevalence of acute stroke impairments and disability in a multiethnic population. *Stroke*. 2001;32:1279–1284. doi: 10.1161/01.STR.32.6.1279
68. Feigin VL, Owolabi MO, Feigin VL, Abd-Allah F, Akinyemi RO, Bhattacharjee NV, Brainin M, Cao J, Caso V, Dalton B, et al. Pragmatic solutions to reduce the global burden of stroke: a World Stroke Organization–Lancet Neurology Commission. *Lancet Neurol*. 2023;22:1160–1206.
69. Grimaldi PL. Inpatient rehabilitation facilities are now paid prospective rates. *J Health Care Finance*. 2002;28:32–48.
70. Kramer AM, Kowalsky JC, Lin M, Grigsby J, Hughes R, Steiner JF. Outcome and utilization differences for older persons with stroke in HMO and fee-for-service systems. *J Am Geriatr Soc*. 2000;48:726–734. doi: 10.1111/j.1532-5415.2000.tb04745.x
71. Carter GM, Relies DA, Ridgeway GK, Rimes CM. Measuring function for Medicare inpatient rehabilitation payment. *Health Care Financ Rev*. 2003;24:25–44.
72. Koifman J, Hall R, Li S, Stamplecoski M, Fang J, Saltman AP, Kapral MK. The association between rural residence and stroke care and outcomes. *J Neurol Sci*. 2016;363:16–20. doi: 10.1016/j.jns.2016.02.019
73. Zimmerman WD, Grenier RE, Palka SV, Monacci KJ, Lantzy AK, Leutbecker JA, Geng X, Denny MC. Transitions of care coordination intervention identifies barriers to discharge in hospitalized stroke patients. *Front Neurol*. 2021;12:573294. doi: 10.3389/fneur.2021.573294
74. Horner RD, Hoenig H, Sloane R, Rubenstein LV, Kahn KL. Racial differences in the utilization of inpatient rehabilitation services among elderly stroke patients. *Stroke*. 1997;28:19–25. doi: 10.1161/01.STR.28.1.19
75. Ellis C, Hyacinth HI, Beckett J, Feng W, Chimowitz M, Ovbiagele B, Lackland D, Adams R. Racial/ethnic differences in poststroke rehabilitation outcomes. *Stroke Res Treat*. 2014;2014:e950746. doi: 10.1155/2014/950746
76. Towfighi A, Boden-Albala B, Cruz-Flores S, El Husseini N, Odonkor CA, Ovbiagele B, Sacco RL, Skolarus LE, Thrift AG; American Heart Association Stroke Council; Council on Cardiovascular and Stroke Nursing; Council on Cardiovascular Radiology and Intervention; Council on Clinical Cardiology; Council on Hypertension; Council on the Kidney in Cardiovascular Disease; and Council on Peripheral Vascular Disease. Strategies to reduce racial and ethnic inequities in stroke preparedness, care, recovery, and risk factor control: a scientific statement from the American Heart Association. *Stroke*. 2023;54:e371–e388. doi: 10.1161/STR.0000000000000437
77. Masiliūnas R, Vilionskis A, Bornstein NM, Rastenytė D, Jatužis D. The impact of a comprehensive national policy on improving acute stroke patient care in Lithuania. *Eur Stroke J*. 2022;7:134–142. doi: 10.1177/23969873221089158
78. Middleton S, Dale S, McElduff B, Coughlan K, McInnes E, Mikulik R, Fischer T, Van der Merwe J, Cadilhac D, D'Este C, et al. Translation of nurse-initiated protocols to manage fever, hyperglycaemia and swallowing following stroke across Europe (QASC Europe): a pre-test/post-test implementation study. *Eur Stroke J*. 2023;8:132–147. doi: 10.1177/23969873221126027
79. Uchino K, Man S, Schold JD, Katzan IL. Stroke legislation impacts distribution of certified stroke centers in the United States. *Stroke*. 2015;46:1903–1908. doi: 10.1161/STROKEAHA.114.008007
80. Division for heart disease and stroke prevention. Assessing the impact of state stroke systems of care policy interventions. Centers for Disease Control and Prevention. 2022. https://www.cdc.gov/dhdsp/docs/ssoc_evaluation_brief-508.pdf
81. Kunz WG, Hunink MG, Almekhlafi MA, Menon BK, Saver JL, Dippel DWJ, Majoie CBLM, Jovin TG, Davalos A, Bracard S, et al. Public health and cost consequences of time delays to thrombectomy for acute ischemic stroke. *Neurology*. 2020;95:e2465–e2475. doi: 10.1212/WNL.0000000000010867
82. de Havenon A, Bangad A, Aldridge C, Southerland AM, Sheth KN. Abstract TMP52: racial and ethnic disparities in hospitalization cost after accounting for the influence of hospital length of stay. *Stroke*. 2023;54:ATMP52. doi: 10.1161/str.54.suppl_1.TMP52
83. Jacobs M, Ellis C. Healthcare cost and race: analysis of young women with stroke. *Int J Equity Health*. 2023;22:69. doi: 10.1186/s12939-023-01886-7
84. Flynn A. Differences in geographic patterns of absolute and relative Black–White disparities in stroke mortality in the United States. *Prev Chronic Dis*. 2022;19:E63. doi: 10.5888/pcd19.220081
85. McGrath RP, Snih SA, Markides KS, Faul JD, Vincent BM, Hall OT, Peterson MD. The burden of health conditions across race and ethnicity for aging Americans. *Medicine (Baltimore)*. 2019;98:e17964. doi: 10.1097/MD.0000000000017964
86. Xie J, Wu EQ, Zheng Z-J, Croft JB, Greenlund KJ, Mensah GA, Labarthe DR. Impact of stroke on health-related quality of life in the noninstitutionalized population in the United States. *Stroke*. 2006;37:2567–2572. doi: 10.1161/01.STR.0000240506.34616.10
87. Curtis K, Fry M, Shaban RZ, Considine J. Translating research findings to clinical nursing practice. *J Clin Nurs*. 2017;26:862–872. doi: 10.1111/jocn.13586
88. Green LW. Making research relevant: if it is an evidence-based practice, where's the practice-based evidence? *Fam Pract*. 2008;25:i20–i24. doi: 10.1093/fampra/cmn055
89. Harrison J, Timoroksa A-M, Gregary B, Hill JE. Adopting evidence-based guidelines for acute stroke care: barriers and enablers for health professionals. *Br J Neurosci Nurs*. 2020;16:8–11. doi: 10.12968/bjnn.2020.16.1.8
90. Woolf SH. The meaning of translational research and why it matters. *JAMA*. 2008;299:211–213. doi: 10.1001/jama.2007.26
91. Peters DH, Adam T, Alonge O, Agyepong IA, Tran N. Implementation research: what it is and how to do it. *BMJ*. 2013;347:f6753.
92. Cadilhac DA, Bravata DM, Bettger JP, Mikulik R, Norrving B, Uvere EO, Owolabi M, Ranta A, Kilkenny MF. Stroke learning health systems: a topical narrative review with case examples. *Stroke*. 2023;54:1148–1159. doi: 10.1161/STROKEAHA.122.036216
93. Jacobs SR, Weiner BJ, Reeve BB, Hofmann DA, Christian M, Weinberger M. Determining the predictors of innovation implementation in healthcare: a quantitative analysis of implementation effectiveness. *BMC Health Serv Res*. 2015;15:6. doi: 10.1186/s12913-014-0657-3
94. Kilbourne AM, Glasgow RE, Chambers DA. What can implementation science do for you? Key success stories from the field. *J Gen Intern Med*. 2020;35:783–787. doi: 10.1007/s11606-020-06174-6
95. Easterling D, Perry AC, Woodside R, Patel T, Gesell SB. Clarifying the concept of a learning health system for healthcare delivery organizations: implications from a qualitative analysis of the scientific literature. *Learn Health Syst*. 2021;6:e10287. doi: 10.1002/lrh2.10287

96. Ehrlich ME, Kolls BJ, Roettig M, Monk L, Shah S, Xian Y, Jollis JG, Granger CB, Graffagnino C. Implementation of best practices—developing and optimizing regional systems of stroke care: design and methodology. *Am Heart J*. 2020;222:105–111. doi: 10.1016/j.ahj.2020.01.004
97. Jiang L, Krumholz HM, Li X, Li J, Hu S. Achieving best outcomes of patients with cardiovascular diseases in China by enhancing the quality of medical care and establishing a learning health care system. *Lancet*. 2015;386:1493–1505. doi: 10.1016/S0140-6736(15)00343-8
98. Snell-Rood C, Jaramillo ET, Hamilton AB, Raskin SE, Nicosia FM, Willging C. Advancing health equity through a theoretically critical implementation science. *Transl Behav Med*. 2021;11:1617–1625. doi: 10.1093/tbm/ibab008
99. American Academy of Neurology. Palatucci Advocacy Leadership. 2023. Accessed October 25, 2023. https://www.aan.com/education/palatucci-advocacy-leadership-forum
100. American Heart Association. Stroke Council. 2023. Accessed October 25, 2023. https://professional.heart.org/en/partners/scientific-councils/stroke