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JOURNAL OF THE AMERICAN HEART ASSOCIATION

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Recommendations of the Northeast Cerebrovascular Consortium**

Toby Gropen, Zainab Magdon-Ismail, David Day, Shannon Melluzzo, Lee H. Schwamm and on behalf of the NECC Advisory Group

*Stroke* 2009;40;1793-1802; originally published online Mar 19, 2009;

DOI: 10.1161/STROKEAHA.108.531053

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ISSN: 1524-4628

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# Regional Implementation of the Stroke Systems of Care Model

## Recommendations of the Northeast Cerebrovascular Consortium

Toby Gropen, MD; Zainab Magdon-Ismael, Ed.M, MPH; David Day, BS;  
Shannon Melluzzo, BA; Lee H. Schwamm, MD; on behalf of the NECC Advisory Group

**Background and Purpose**—The Northeast Cerebrovascular Consortium was established to examine regional disparities and recommend strategies to improve stroke care based on the Stroke Systems of Care Model.

**Methods**—An annual summit was first held in 2006, bringing together public health officials, researchers, physicians, nurses, health professionals, state legislators, and advocacy organizations. Best practices and evidence-based interventions within each of the Stroke Systems of Care Model components were presented. Six writing groups were tasked with cataloging each state's current activities and identifying goals for the region.

**Results**—There were significant variations in the delivery of stroke care, particularly in urban versus rural areas, as evidenced by the availability of designated stroke centers and neurologists, and stroke-related death rates. Recommendations to address variations in care delivery included the use of a common stroke data collection system, unified community education criteria, improvements to emergency medical services dispatch and training, adoption of prehospital care measures, creation of a web-based central repository of acute stroke protocols and order sets, a regional atlas of stroke resources and capabilities, a stroke patient "report card" to promote adherence to secondary prevention strategies, and explicit standards for rehabilitation services.

**Conclusions**—Significant disparities in the delivery of stroke care across the 8 state-region have been identified. Northeast Cerebrovascular Consortium demonstrates that multistate regional collaboration is a viable process for developing specific regional recommendations to address those disparities. Northeast Cerebrovascular Consortium is assessing the usefulness of the Stroke Systems of Care Model as a framework for implementing a regional approach to stroke across the continuum of care. (*Stroke*. 2009;40:1793-1802.)

**Key Words:** regional implementation ■ stroke ■ stroke systems

More efficient and tightly integrated systems for stroke care are needed. In 2002, a task force sponsored by the National Institutes of Neurological Disorders and Stroke of the National Institutes of Health published recommendations calling for greater coordination and better support mechanisms for the various components and professionals involved in both prehospital and acute stroke care.<sup>1</sup> In 2005, an American Heart Association task force on the development of stroke systems described the fragmentation of stroke care, defined the key components of a stroke system, and recommended methods for encouraging the implementation of stroke systems of care.<sup>2</sup> The task force defined 7 key components of the Stroke Systems of Care Model (SSCM): primordial and primary prevention; community education; notification and response of emergency medical services; acute stroke treatment; subacute stroke treatment and secondary prevention; rehabilitation; and continuous quality improvement activities.

The northeastern United States has the lowest stroke incidence and age-adjusted stroke mortality rate in the country.<sup>3</sup> However, there is considerable geographic, demographic, and economic diversity across the Northeast along with variability in stroke care resources and delivery. Increasing access to high-quality stroke care for all patients is one of the central goals of the SSCM. To date, initiatives to improve care delivery in the Northeast have included grass roots education and health screening campaigns; stroke center designation through legislative action or public health regulation; and emergency medical service (EMS) stroke-specific training and triage.

Although stroke system oversight and accountability can be coordinated at the state or national level, regional coordination may contribute significantly to system improvement. The Northeast Cerebrovascular Consortium (NECC) was established as an independent organization in 2006 to bring

Received July 8, 2008; final revision received October 10, 2008; accepted November 4, 2008.

From the Long Island College Hospital (T.G.), Brooklyn, NY; American Stroke Association (Z.M.-I., D.D., S.M.), Dallas, Tex; and Massachusetts General Hospital (L.H.S.), Boston, Mass.

Correspondence to Toby Gropen, MD, Chairman, Department of Neurology and Director, Stroke Center, Long Island College Hospital, 339 Hicks Street, Brooklyn, NY 11201. E-mail tgropen@chpnet.org

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Stroke is available at <http://stroke.ahajournals.org>

DOI: 10.1161/STROKEAHA.108.531053

together key stakeholders in the Northeast states (Connecticut, Massachusetts, Maine, New Hampshire, New Jersey, New York, Rhode Island, Vermont) to (1) identify regional variations in systems of stroke care delivery; (2) develop a series of recommendations based on the SSCM framework; (3) implement the recommendations; and (4) assess the impact of implementation of the SSCM in the Northeast.<sup>4</sup> This initial report focuses on the results of the first 2 phases.

## Methods

Key aspects of NECC methodology include local participation and ownership of decisions with an emphasis on stroke care policy and system changes, consensus-building, regional sharing of experiences and collaboration, and continuous quality improvement. Local participation and ownership of decisions in NECC is modeled after prior efforts of the American Stroke Association (ASA). From 1997 to 2002, the ASA's "Operation Stroke" program focused on bringing together hospitals, healthcare professionals, and emergency medical systems professionals in the large metropolitan US markets to improve the quality of care for patients with acute stroke. In 2003, as focus shifted from local initiatives to regional efforts to address systems change, the ASA supported a coalition of volunteers from Massachusetts, Maine, New Hampshire, Upstate New York, Vermont, and Rhode Island in creating the "Northeast Stroke Task Force" (NEST). NEST provided the foundation and the necessary framework for the ultimate establishment of NECC.

NECC aspires to develop partnerships among stroke volunteers, state governments, and public and nonprofit agencies. In 2005, a 4-year blueprint was developed using the SSCM framework to increase collaboration across the Northeast to improve patient outcomes in the prevention, treatment, and rehabilitation of stroke (see supplemental Appendix I, available online at <http://stroke.ahajournals.org>). From the inception, it was envisioned that NECC would bring together key stakeholders from each of the 8 Northeast states to affect policy and system changes in stroke care (see supplemental Appendix II).

Regional sharing of experiences and collaboration is fostered by a number of activities, including annual regional conferences and regional representation on NECC committees. The Inaugural Summit of NECC was entitled "Envisioning an Integrated, Multi-State, Regional Stroke System of Care: Designing the Blueprint." Representatives from all 8 NECC states met in Boston on September 13, 2006.<sup>4</sup> The Summit was jointly sponsored by the ASA and the National Stroke Association in collaboration with the Massachusetts Department of Public Health. Each NECC state presented a stroke care "state-of-the-state" address organized according to the SSCM framework. For many states, this was the first time that the state department of health had systematically reviewed their stroke care delivery methods and had the opportunity to share experiences and learn from their neighbors.

As the fiscal agent of NECC, the ASA led the effort to secure external funds in support of the Summit and has assisted in the coordination of NECC and its 4 main committees comprised of invited representatives from across the region and spanning the components of the SSCM. These committees are governed by consensus and include a NECC Advisory Council to guide overall strategic direction, a Planning Committee to develop and approve the conference agendas, a Grant Review Committee to judge proposals and award funds, and a NECC Writing Committee to develop and document recommendations (see supplemental Appendix II). Committee members were invited and chairs were chosen all by consensus, and the membership has evolved over time.

A Grant Award program, supported by the NECC through unrestricted funding of \$20 000 annually from corporate sponsors, solicits 1-year proposals that help further the goals of the NECC in any of the defined areas of the SSCM. It is designed to promote collaboration and best practice-sharing and to build relationships across the NECC member states. Proposals that involve interagency collaboration are favored as well as projects that involve collabora-

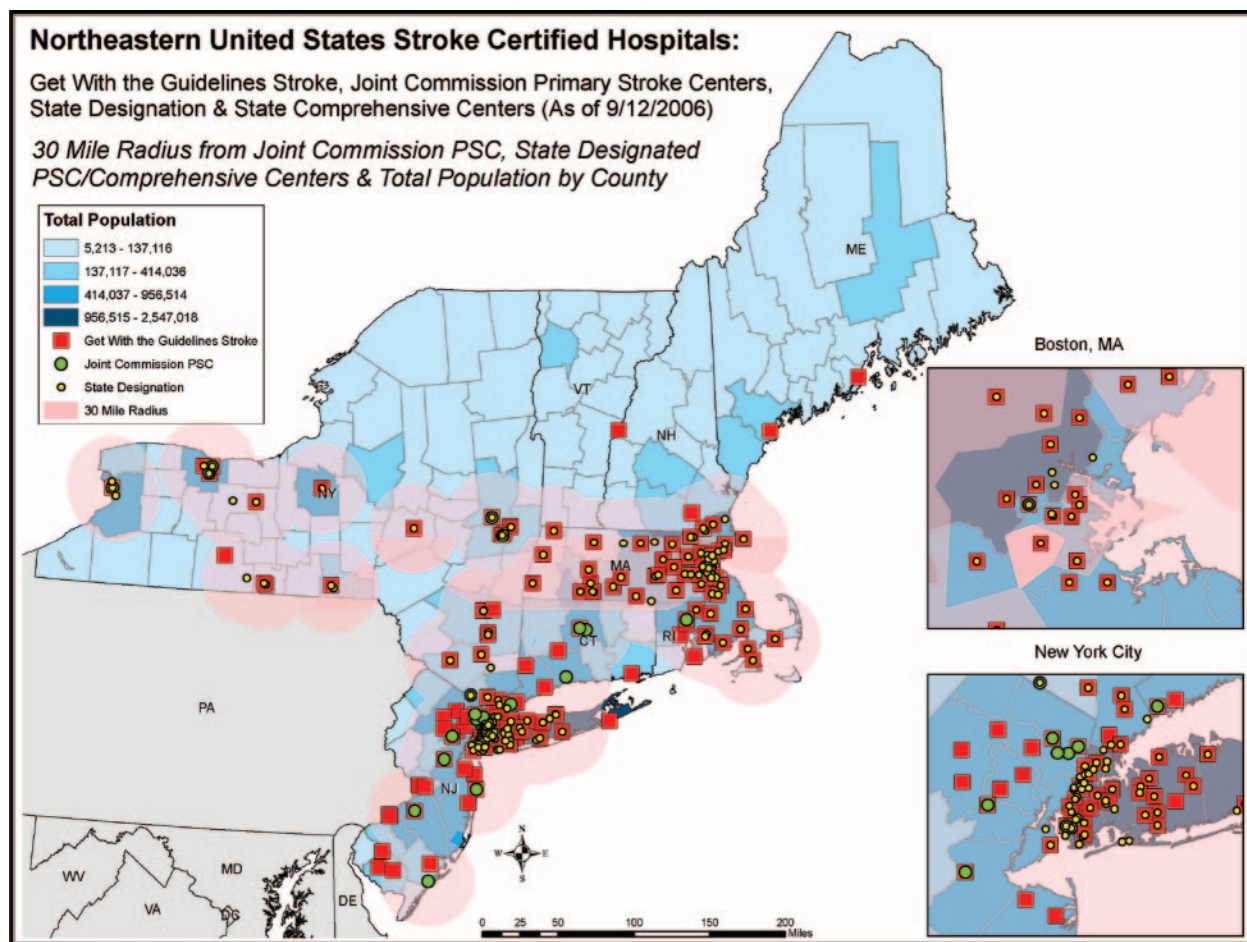
tion or mentorship relationships with another state that is part of the NECC. Strong consideration is given to projects that address stroke in regions where stroke initiatives and resources are limited. All funded recipients present a summary of their project at the subsequent Annual NECC Summit.<sup>4</sup>

Writing Committee groups were asked to develop specific recommendations for each of the content areas in the SSCM for regional or multistate collaboration. Best practices and evidence-based interventions within each of the SSCM domains were presented by local and regional experts. Six writing groups were tasked with cataloging each state's current activities and identifying goals for the region. Publicly available healthcare data files were integrated with geospatial data to create geographical information systems (GIS) maps of the distribution of stroke care resources across the NECC region (see Figures 1 to 3).<sup>5</sup> Data on state-certified stroke centers were obtained from respective NECC state departments of health (G. Palmeri, Massachusetts Department of Public Health, personal communication, April 15, 2008; N. Barhydt, New York State Department of Health, personal communication). Data on Joint Commission Primary Stroke Centers was obtained from the Joint Commission and data on hospitals participating in the American Heart Association's Get With The Guidelines-Stroke program was obtained from the American Heart Association (Z. Magdon-Ismail, American Heart Association, personal communication, April 15, 2008).<sup>6</sup> For a county to be considered within 30 miles of a designated stroke center, at least a portion of the county needed to be covered by at least one Joint Commission or state-designated stroke center. Counties were classified as urban or rural according to Office of Management and Budget categories. Counties were defined as urban if they were classified as metro and defined as rural if they were classified as nonmetro based on the 9-part county codification. Stroke mortality per 100 000 persons aged 35+ by quintile (1, 61 to 113; 2, 114 to 123; 3, 124 to 133; 4, 134 to 146; 5, 147 to 241), neurologist per 10 000 persons age 65+ by quintile (1, 0; 2, 0.3 to 1.5; 3, 1.6 to 2.5; 4, 2.6 to 4.2; 5, 4.3 to 84.9), and short-term general hospitals with rehabilitation care services by quartile (1, 0; 2, 1; 3, 2 to 3; 4, 4 to 29) were recorded according to the 2002 Atlas of Stroke Mortality published by the Centers for Disease Control and Prevention. Population data, index of racial and ethnic diversity (range, 0 to 100 with 100 most diverse), and median household income by quartile in dollars (1, \$30 117 to \$45 243; 2, \$45 244 to \$55 931; 3, \$55 932 to \$73 535; 4, \$73 536 to \$100 485) were 2007 estimates from ESRI, Inc (Redlands, Calif) based on the 2000 US Census. Univariate analysis of continuous variables was by independent *t* test, ordinal, or rank order variables by  $\chi^2$  or Wilcoxon rank sum. Multivariable analysis included 3 characteristics (median household income, diversity index, and urban/rural classification) that were all significant in univariate analyses and was performed by logistic regression for dichotomous outcome variables and linear regression for continuous outcome variables. Multivariable results are reported as ORs with 95% CIs (lower, upper limit).

After each NECC Summit, each state's current stroke care activities in the SSCM were catalogued. Continuous quality improvement methods were applied to the implementation goals as well as the structure of NECC itself based on feedback from the states and stakeholders, and new goals were identified. After the Summit, the Writing Committee groups met and developed recommendations for regional implementation to address variations in care delivery.

## Results

At the NECC 2006 Summit, best practices and current evidence-based guidelines were presented.<sup>4</sup> The different organizational structures within each state relevant to stroke care were compared, and current efforts in stroke systems of care development were catalogued. In addition, cross-border opportunities for care and common criteria for stroke center designation were discussed as well as prior experiences with "pay for performance" in cardiovascular and cerebrovascular disease and challenges related to collection of outcomes data



**Figure 1.** GIS map of the distribution of population in relation to a 30-mile radius to stroke-certified hospitals across the NECC region derived from publicly available healthcare data files from 2006 integrated with other geospatial data<sup>5,6</sup> (G. Palmeri, Massachusetts Department of Public Health, personal communication, April 15, 2008; N. Barhydt, New York State Department of Health, personal communication, April 15, 2008; Z. Magdon-Ismail American Heart Association, personal communication, April 15, 2008).

in a Health Insurance Portability and Accountability Act-constrained environment. At the NECC 2007 Summit, presentations included the national trauma system as an example of a disease-specific systems of care model, the impact of reimbursement on patterns of acute stroke care, novel approaches to primary prevention in white and minority populations, and updated guidelines on the treatment of intracerebral hemorrhage.<sup>4</sup> Methods for common data collection were reviewed, and data on disparities in care were presented. Many of these presentations are available for review by the public on the NECC web site ([www.thenecc.org](http://www.thenecc.org)).

After the 2006 NECC Summit, significant regional variations in baseline (before September 13, 2006) stroke care delivery were identified in each component of the SSCM as detailed in each subsequent subsection. Examples of disparity in the distribution of stroke care resources across NECC as a function of population demographics are displayed in Table 1 and in Figures 1 to 3 with respect to stroke center availability. Writing Committee group recommendations for regional implementation to address these variations in care delivery were finalized in February 2008 and are presented in Table 2 as a set of overarching recommendations followed by SSCM component-specific items.

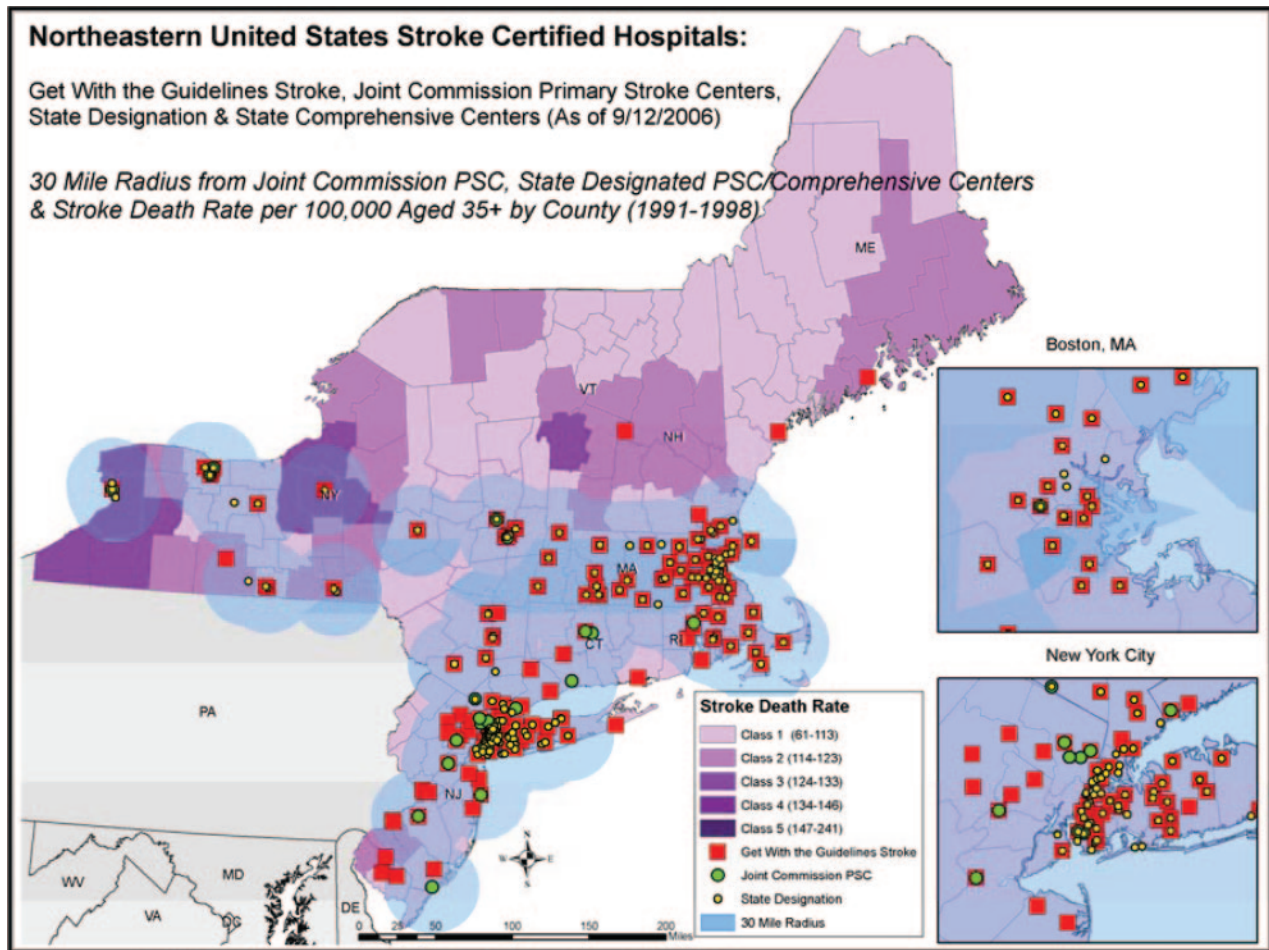
## Primordial and Primary Prevention

### Baseline Activities

Quantitative data are not available. All NECC states had primordial prevention programs focused on obesity, exercise, and nutrition and risk factor education programs focused on hypertension, diabetes, and smoking cessation. Most NECC states and cities have legislation aimed at reducing exposure to secondhand smoke.<sup>7</sup> Throughout the Northeast, nonprofit agencies such as the ASA, National Stroke Association, and others were working to educate primary care providers and at-risk patients about stroke prevention. Only some states (Connecticut, Massachusetts, New Jersey, and New York) had education or intervention programs specifically targeting minorities.

### Recommendations

The SSCM states that a stroke system should develop support mechanisms and tools to assist communities, patients, and providers in initiating and adhering to prevention regimens applicable to the population as a whole with a focus on educational programs to target high-risk populations. Primary care providers can play a critical role in providing individualized education to their patients about risk of stroke and



**Figure 2.** GIS map of the distribution of stroke mortality in relation to a 30-mile radius to stroke-certified hospitals across the NECC region derived from publicly available healthcare data files from 2006 integrated with other geospatial data<sup>5,6</sup> (G. Palmeri, Massachusetts Department of Public Health, personal communication, April 15, 2008; N. Barhydt, New York State Department of Health, personal communication, April 15, 2008; Z. Magdon-Ismail American Heart Association, personal communication, April 15, 2008).

therapeutic lifestyle changes that can be made to reduce the risk. The 3 key interventions are listed in Table 2.

## Community Education

### Baseline Activities

Quantitative data are not available. Traditional hospital- and community-based educational programs were present throughout the region. These programs often relied on educational resources and materials created by third parties such as federal agencies or advocacy organizations and generally did not include an evaluation component. All hospitals receiving Stroke Center Designation from the Joint Commission or state-based programs in New York, New Jersey, or Massachusetts were required to provide community stroke prevention education programs at least twice per year; however, frequently these did not include an evaluation component.<sup>8-11</sup> Regional variability in community education is also suggested by the initial presence of the American Heart Association's Power to End Stroke program in only 4 of the 8 states (Connecticut, Massachusetts, New Jersey, and New York)<sup>12</sup> and presence in only 4 states (Connecticut, Massachusetts, Maine, New York) of warning sign and EMS

activation media campaigns. Additionally, a 1400-person randomized clinical trial was launched in New York City in 2005 to test the efficacy of an intensive behavioral intervention to decrease time from stroke onset to emergency treatment.<sup>13</sup>

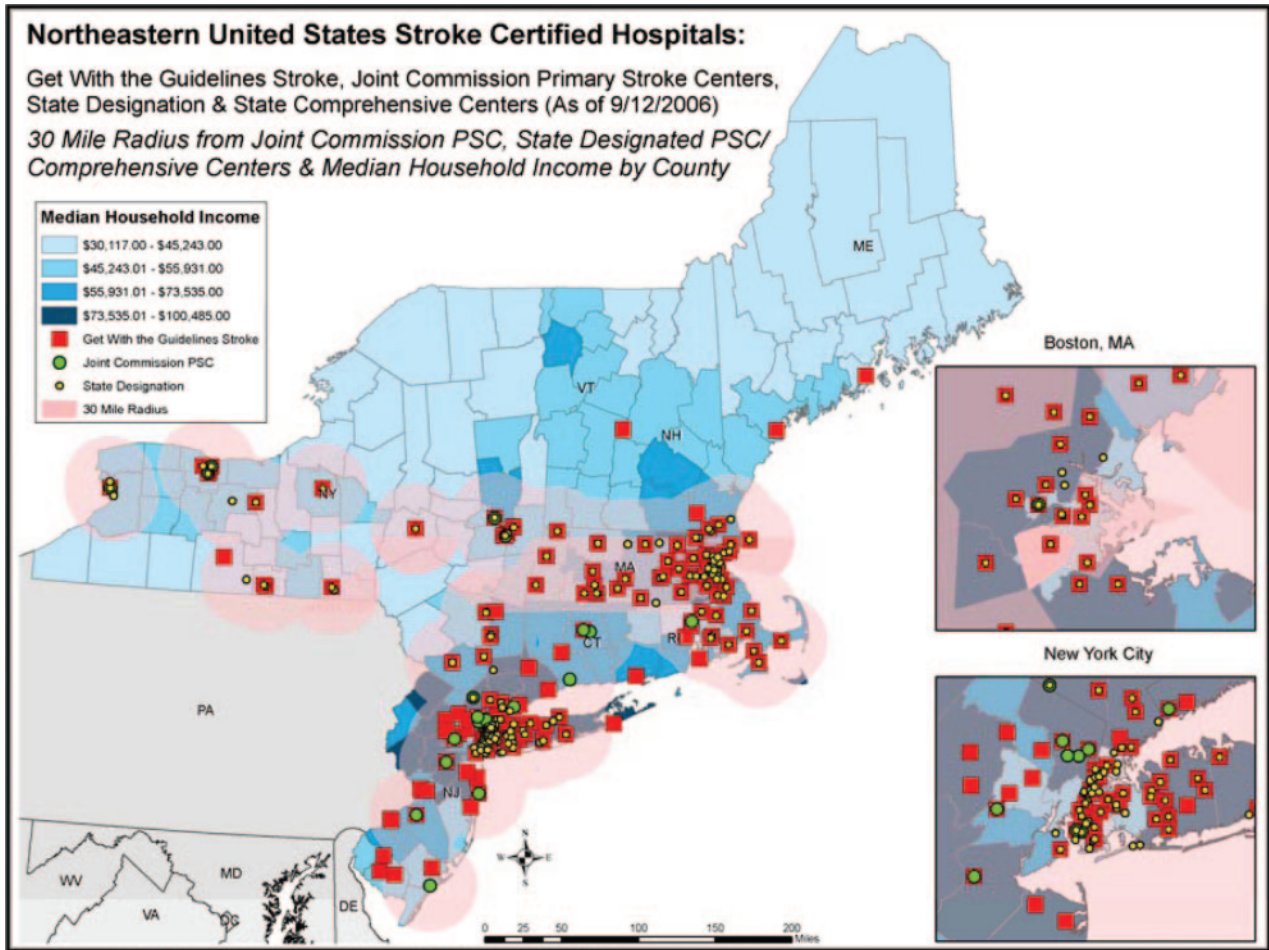
### Recommendations

Community-based outreach programs need to develop and implement culturally appropriate strategies that increase awareness of stroke risk and warning signs, the importance of timely action in calling 911, and the role of therapeutic lifestyle changes to reduce stroke risk. This is especially important among populations in which disparities in healthcare delivery currently exist. Every NECC state and local media market has specific challenges and populations that need to be addressed. The 5 key recommendations are listed in Table 2.

## Notification and Response of EMSs

### Baseline Activities

There are limited data regarding the type (eg, emergency medical technicians, fire, police, volunteer) and level (basic life support, advanced life support) of EMS response to stroke. Few states or cities within the NECC region currently



**Figure 3.** 2006 GIS map of the distribution of median household income in relation to a 30-mile radius to stroke-certified hospitals across the NECC region derived from publicly available healthcare data files from 2006 integrated with other geospatial data<sup>5,6</sup> (G. Palmeri, Massachusetts Department of Public Health, personal communication, April 15, 2008; N. Barhydt, New York State Department of Health, personal communication, April 15, 2008; Z. Magdon-Ismail American Heart Association, personal communication, April 15, 2008).

had a unified regional EMS response to acute stroke, and the organization of EMS agencies and providers was fragmented and highly variable with 2 notable exceptions. As part of the New York State Stroke Center Designation Project, EMS triaged patients with acute stroke to state-based designated stroke centers in the boroughs of Brooklyn and Queens starting in May 2003.<sup>14</sup> This program was expanded to New York State in 2004. The Boston Operation Stroke Study laid

the groundwork for the State-based Primary Stroke Service designation program, which began in July 2005, that required EMS diversion to stroke centers for selected patients with acute stroke throughout the state.

**Recommendations**

A recent ASA policy statement recommended a series of implementation strategies for EMS within the SSCM to

**Table 1. Disparities in Access to Stroke Services Between Rural and Urban Counties in the Northeast States**

Characteristic	Rural (n=59)	Urban (n=91)	P
Population, mean	57 922	433 805	<0.001
Diversity index, median (IQR)	9 (7–16)	28 (16–54)	<0.001
Household income, median (IQR)	\$42 402 (39 378–49 322)	\$55 610 (48 409–68 172)	<0.001
Designated Stroke Center within 30 miles of county	44.1%	92.3%	<0.001
Designated Stroke Centers per 100 000 persons, median (IQR)	0 (0–7.32)	2.18 (1.23–4.27)	0.03
Stroke death quintile, median (IQR)	1 (1–2)	1 (1–1)	<0.001
Neurologist per 10 000 persons age 65+ quintile, median (IQR)	2 (2–4)	4 (3–5)	<0.001
Short-term rehabilitation in an acute care hospital quartile, median (IQR)	2 (2–3)	2 (1.5–3)	0.9461

IQR indicates interquartile range.

**Table 2. Consensus Recommendations for the Implementation of the SSCM in the Northeast Region****Overarching recommendations**

1. The NECC should create and maintain an online repository of materials related to the components of the SSCM that is freely available to download. These materials should include information about NECC, prior conference presentations and agendas, current recommendations, and any consensus tools or products developed for use in the NECC states.
2. NECC should foster continuous quality improvement within each domain of the SSCM and be itself subject to the same. Patient outcomes after stroke should be collected and reviewed by facilities annually as part of internal quality improvement activities. NECC states should work together to ensure that these quality improvement activities are carried out routinely and that exchange of information among providers (eg, EMS, acute hospital, rehabilitation, home care, primary care) is not hampered by local, state, or federal privacy regulations.
3. NECC should encourage the implementation of state stroke task forces (or equivalent) in all 8 states, push for adherence to national and regional standards, identify and promote best practices, and be sensitive to the different financial needs and geographic challenges represented across the region.
4. Quality or performance data elements or measures should adhere to the definitions and metrics of the harmonized consensus measure set approved by the ASA, The Joint Commission (TJC), and the Centers for Disease Control and Prevention (CDC).
5. All NECC states should contribute to create and maintain an annually updated regional inventory and atlas of stroke services across the SSCM components and make this information available to providers and the public. This should include a list of the
  - a. EMS providers who provide stroke-specific dispatch at the highest level of priority, the stroke point of entry plans for EMS, rules for diversion of stroke patients, and hospital-to-hospital triage and transfer protocols.
  - b. Acute and subacute stroke treatment capabilities of all acute care hospitals in the region such as availability in person or through telemedicine of relevant specialty services (eg, stroke neurology, endovascular or interventional neuroradiology, neurosurgery, and vascular surgery) and rehabilitation services.
  - c. Inpatient rehabilitation services and follow-up care provided at all postacute facilities (inpatient rehabilitation hospital, skilled nursing facility, long-term acute care facility) and their level of certification, including the methods for transitioning patients and their caregivers from inpatient to outpatient areas, and the presence of dedicated stroke follow-up clinics.
  - d. Poststroke resources available in the community for outpatient services, home care for stroke recovery, community-based exercise programs, and stroke support groups.

**Primary and Primordial Prevention**

1. Continuing medical education of providers through traditional and e-learning venues should be delivered to increase primary care physician awareness of, and adherence to, stroke prevention guidelines.
2. NECC should partner with experts to develop a standardized, simple communication tool to assist healthcare providers in illustrating for patients their current modifiable risk factor profile and their individualized targets for adherence. This patient "report card" should include specific goals for body mass index, physical activity, blood pressure, cholesterol, blood glucose and other relevant laboratory studies as well as the medications prescribed for stroke prevention.
3. NECC public health partners, including state governments and nonprofit advocacy organizations, should dedicate resources to better educate at-risk patients about stroke and modifiable risk factors, join together to provide primary care physicians with the tools and resources that are necessary to fully educate their at risk patients, and continue to pursue public policies that encourage smoking cessation, promote physical activity and proper nutrition, and provide better access to health screening and disease prevention programs.

**Community Education**

1. Hospital or community-based prevention messaging should continue to be a required activity in any stroke center designation program within the NECC region and specific evaluation components should be developed and implemented to measure effectiveness.
2. Stroke community education programs should be concept tested and an evaluation plan should be in place before broad dissemination. Resources should be dedicated to annually monitor the impact of such interventions with a special emphasis on high-risk populations and/or those with documented disparities in care.
3. Local prevention messaging should be supplemented by NECC regional prevention messaging using an appropriate combination of earned and paid media as well as Public Service Advertisements and organized grass roots initiatives leveraging materials across the region and purchasing at the regional level.
4. NECC state legislatures should dedicate revenues to assist state public health agencies in developing media campaigns that raise awareness of stroke risk, the preventable nature of stroke, stroke warning signs, the treatable nature of stroke, the importance of activation of the emergency medical system when a stroke is suspected, and the need for follow-up medical care after hospital discharge.
5. Advocacy organizations within the NECC region should continue to pursue state and federal public policy changes that focus on reducing stroke risk factors, including, but not limited to, tobacco use, physical inactivity, hypertension, and obesity.

**Notification and Response of EMS**

1. Current E-911 and wireless 911 coverage across the entire Northeast Region should be assessed, and state and federal funding should be provided to ensure maximum coverage.
2. Appropriate standards should be developed and implemented to require that all phone systems (landline, multiline or enterprise telephone systems, and wireless) provide sufficient information to EMS dispatch call centers (ie, public safety answering points) to identify caller number and location.
3. Traditional, e-learning, and blended training programs should be used to ensure EMS telecommunicators recognize signs and symptoms as reported by callers. EMS should use stroke-specific, nationally recognized dispatch algorithms and educational resources. Stroke education materials should reflect current national guidelines, and training should be conducted on an ongoing basis with the frequency based on local training requirements and resource availability.
4. Linguistic services for EMS should be enhanced to ensure service delivery to patients and callers who do not speak English as their primary language.

*(Continued)*

**Table 2.** Continued

5. The dispatch, treatment, and transport protocols as well as triage assessment tools and continuing education requirements should be catalogued across NECC. State EMS directors or their equivalent should be invited to join a NECC Task Force to develop unified consensus set of protocols, training requirements, and stroke scales that should be used in the triage, treatment, and transport of patients with stroke across the region. These protocols should address rural versus urban/suburban differences as well as diversion to designated centers where appropriate.
6. All EMS personnel should be trained in the use of a validated stroke screening tool (eg, Los Angeles Prehospital Stroke Screen, Cincinnati Stroke Scale), and systems should be implemented to ensure that all EMS Patient Care Reports and the results of stroke screening tools are available on emergency department (ED) arrival.
7. Stroke experts in the region should play an active role in the training of EMS personnel in stroke triage and prehospital treatment protocols with a specific goal of ensuring that all EMS providers complete a minimum of 2 hours of instruction annually on stroke assessment and care as part of their required continuing education for certification and relicensure.
8. Regionwide goals for EMS response time should be established and monitored. EMS response time and on-scene time should be measured and reported for all suspected patients with stroke.
9. All NECC states should collect and report all relevant data elements for scene calls involving stroke treatment, triage, and transport in a manner consistent with the National EMS Information System data dictionary, including but not limited to the key time intervals (symptom onset/last known well, call received, scene arrival, ED arrival).

**Acute Stroke Treatment**

1. All NECC states should define the criteria a hospital must meet to be an appropriate receiving facility for EMS transport of patients with suspected acute stroke (ie, primary and/or comprehensive stroke centers designated by the state or other accrediting body). All patients transported by EMS with suspected acute stroke should be preferentially triaged to and treated at acute stroke capable facilities wherever feasible. States should implement strategies such as telemedicine and air-medical transport if necessary to ensure access to an appropriate level of acute care for all patients with stroke.
2. All hospitals and facilities that provide emergency services will be involved in the care of patients with acute stroke. Those facilities without stroke center status should have prespecified interhospital transfer protocols and state-approved action plans for the triage and treatment or transport of patients with stroke as appropriate.
3. Standardized, evidence-based approaches and prespecified standing stroke care pathways from various hospital types (eg, rural, critical access, community, urban, and tertiary care) should be collected and shared across NECC.
4. NECC hospitals should collect data on the quality of acute stroke care in a consistent manner across the region using the common data elements and performance measures approved by the CDC, ASA, and TJC. Hospitals and states should compare their performance against other peer organizations within NECC and use these data to help departments of health and legislative bodies drive system change across the region.
5. Within each state and region, hospitals with specialized resources and trained personnel consistent with the published guidelines for Primary and Comprehensive Stroke Centers should collaborate and coordinate acute stroke care with other facilities to ensure access to appropriate stroke care for all patients.

**Subacute Care and Secondary Prevention**

1. A regional aggregate and deidentified assessment of adherence to hospital-based subacute care and secondary prevention performance measures should be compiled and reported periodically based on readily available data sources (eg, Get With The Guidelines–Stroke [GWTG–Stroke], Paul Coverdell National Acute Stroke Registry, state sources).
2. Up-to-date educational resources and “best practices” for hospital-based stroke prevention and education should be gathered from hospitals across the NECC. This material should be made freely available in a forum that supports interactive dialogue among individuals involved in stroke care.
3. A uniform discharge packet should be developed that includes patient and caregiver education materials covering the 5 areas specified in the harmonized consensus measure set (AHA, CDC, TJC) and systems established to ensure that all patients have an opportunity for face-to-face discussion during the inpatient admission.
4. In addition to the inpatient care delivered, the goals of secondary prevention should be summarized as part of the inpatient record and made available to the primary care physician, other generalist, or specialist primarily responsible for the long-term care of the patient. Ideally, the goals of secondary prevention should be communicated to the patient in a manner similar to that used by the primary prevention “report card.”
5. Pilot programs should be developed to explore the feasibility of secondary stroke prevention clinics in the delivery of comprehensive services, provider education, and as a resource for the management of complex or unusual cases.
6. All patients with transient ischemic attack and minor stroke are at risk for stroke and other major vascular disease outcomes, especially in the first few weeks after the index event. These patients should be treated with equal urgency as those with more disabling events.

**Rehabilitation**

1. All hospitalized patients with stroke should be assessed for and referred to the appropriate level of poststroke care. Whether state-based, regional, or national, primary stroke centers should require the provision of basic rehabilitation assessment and services (eg, physical, occupational, and speech therapy), and comprehensive stroke centers should be required to provide these rehabilitation services on-site or as part of a formal stroke care network with prespecified relationships.
2. Every stroke patient’s functional status should be assessed during inpatient hospitalization with a standardized screening and assessment tool. NECC states should collectively select a single instrument to be used by all sites.
3. States within NECC should develop a uniform set of stroke rehabilitation quality measures to be piloted in all postacute settings where rehabilitation occurs such as Skilled nursing facilities, inpatient rehabilitation hospitals, and long term acute care facilities. These measures should include rates of adherence to key guideline-based interventions in the treatment of patients with stroke, and appropriate targets for adherence should be established at the institutional and regional level. Inpatient rehabilitation hospitals should obtain certification in stroke rehabilitation by external credentialing agencies or seek equivalent designation. Similar criteria should be developed for the other postacute settings to permit comparable certification.
4. Advocacy organizations should focus on ensuring that adequate rehabilitation resources exist within the NECC region, that adequate insurance benefits exist to fairly compensate for the cost of this postacute care, and that these benefits are readily accessible to those patients who require services.

increase access to facilities capable of treating acute stroke.<sup>15</sup> The NECC recommendations define specific actions consistent with these general recommendations to increase the likelihood that patients will be transported to the nearest stroke center for evaluation and care provided a stroke center is located within a reasonable transport distance and transport time. The 9 key interventions are listed in Table 2.

## Acute Stroke Treatment

### Baseline Activities

All 8 NECC states had conducted a formal or informal hospital stroke capacity survey addressing available hospital services, including specialist coverage. Three states (Massachusetts, Maine, and New York) had taken steps to address the shortage of neurologists in rural areas by supporting increased access to care through telemedicine-enabled stroke consultation. This had been accomplished through telemedicine grants to rural hospitals (Massachusetts, New York) and collaboration with nonprofit hospitals (Massachusetts and Maine) or for-profit telemedicine companies (Massachusetts, New York). Three of the states had state-based primary stroke center designation programs; the Massachusetts and New York programs used regulatory approaches and in New Jersey a legislative approach was used with legislation passed in May 2004 with implementation in 2006. Massachusetts is the one NECC state that participated in the Centers for Disease Control and Prevention's Paul Coverdell National Acute Stroke Registry.<sup>16</sup> New Jersey is the only NECC state to have developed criteria for Comprehensive Stroke Center designation.<sup>9</sup>

Significant variations in access to acute stroke care across the region were identified and are shown in Table 1 and GIS Figures 1 to 3. In univariate analyses (Table 1), major differences between urban and rural counties existed in diversity index, household income, stroke death rates, access to neurologists, access to at least one designated stroke center (all  $P<0.001$ ), and numbers of designated stroke centers per 100 000 persons ( $P=0.03$ ). In univariate analyses, compared with counties without access to a designated stroke center, counties with a designated stroke center within 30 miles had mortality in the lowest quintile more often (79.1% versus 52.5%,  $P=0.001$ ) and had a significantly higher median household income ( $P<0.0001$ ). In multivariable analysis, independent predictors of living within 30 miles of a designated stroke center were greater diversity index (OR, 1.15 [1.07 to 1.25] per incremental point;  $P<0.001$ ) and rural location (OR, 0.29 [0.10 to 0.91];  $P=0.04$ ) with a trend toward median household income (OR, 1.20 [0.91 to 4.36];  $P=0.08$ ). Rural location, median income, and diversity index were not independent predictors of stroke mortality.

Figure 1 depicts access to a designated stroke center within a 30-mile radius versus population. In September 2006, 177 hospitals had been certified as a stroke center either as a Joint Commission Primary Stroke Center or as a formal stroke center by state-based criteria. The map also shows those hospitals that implemented the Get With The Guidelines–Stroke quality improvement program. Although 90% of the population in 2006 was within 30 miles of a certified stroke center, there were vast areas of the region, including the

populations of whole states, that were not. Figure 2 depicts access to a designated stroke center within a 30-mile radius versus quintiles of stroke mortality by county according to the Centers for Disease Control and Prevention Atlas of Stroke Mortality. Figure 3 depicts access to a designated stroke center within a 30-mile radius versus median household income.

### Recommendations

A regional stroke system organized according to the SSCM maintains a transparent inventory of the acute stroke treatment capabilities and limitations of all hospitals in the region and makes this information available to providers and the public. It also ensures that all hospitals and facilities that could be involved in the care of patients with acute stroke (including those without stroke center status) have action plans for the triage and treatment or transport of patients with stroke as appropriate. The 5 key interventions are listed in Table 2.

## Subacute Care and Secondary Prevention

### Baseline Activities

Stroke units have been shown to reduce morbidity and mortality of stroke.<sup>17</sup> In 2006, however, the actual numbers and composition of these stroke units across NECC was unknown, except those required as part of national and most state-based stroke center designation programs (see Figures 1 to 3). State and national stroke center designation programs as well as quality improvement programs were also measuring aspects of subacute hospital-based stroke care. There was, however, little published data on the details of their implementation, process and outcome measures, or data collection and case ascertainment methodology with the exception of data on the implementation process and performance of state-based stroke centers designated in Brooklyn and Queens.<sup>14</sup> Furthermore, few states had an organized statewide plan for stroke quality improvement, and there was little attention paid to developing systems to link acute inpatient hospital care to postdischarge care at rehabilitation facilities or residential environments.

Some NECC states with state-based stroke center designation programs had built-in secondary prevention guidelines in accordance with the ASA Guidelines. Many hospitals across the region also participated in Get With The Guidelines–Stroke and/or had sought Joint Commission Primary Stroke Center Certification. In general, however, participation in these programs was highest within the states with active stroke center designation programs (see Figures 1 to 3).

### Recommendations

Subacute care not only involves the prevention of in-hospital complications and recurrent stroke and initiation of stroke prevention education, but also is the critical linkage between acute care and postdischarge care environments. It should address modifiable risk factors, patient and family education, transitions to appropriate follow-up care, and strategies to monitor and improve long-term patient adherence to guideline-based risk reduction interventions. The 6 key interventions are listed in Table 2.

## Rehabilitation

### Baseline Activities

As shown in Table 1, there were no differences in access to short-term general hospitals with rehabilitation care services (although there were more than 50% of counties without available data). In general, inpatient or postacute rehabilitation had not been a required service specified in stroke center certification programs; in fact, only New Jersey had identified plans to require rehabilitation services for the designation of both primary and comprehensive stroke centers.

### Recommendations

Results of randomized, controlled trials comparing stroke unit care with general medical ward care suggest that incorporation of rehabilitation into stroke unit care is one of the key components resulting in reduction in disability.<sup>17</sup> The SSCM emphasizes the use of standardized screening evaluations of all patients, periodic assessment of rehabilitation services and resources within the stroke system, referral of patients to the most appropriate level and setting of rehabilitation, and appropriate follow-up and primary care for patients discharged to home. The 4 key interventions are listed in Table 2.

## Discussion

NECC demonstrates that multistate regional collaboration is a viable process for developing specific regional recommendations for improved stroke care. There are other regional stroke networks in the United States (eg, the Delta States Stroke Consortium, Great Lakes Regional Stroke Network, Stroke Belt Consortium, Greater Cincinnati–Northern Kentucky Stroke System, Tri State Stroke Network, and Northwest Regional Stroke Network) and other countries (eg, the Bavarian and Canadian Stroke Networks<sup>18–22</sup>). All of the US regional stroke networks rely on local participation and ownership of decisions, collaboration across state lines, and partnership among state governments and public and nonprofit agencies. NECC, like other stroke networks, leverages the expertise of individuals and state entities to focus on changes in stroke care.

However, unlike the other consortia, the NECC has chosen to focus more on system and policy changes to accelerate the growth of regional collaboration rather than on patient and provider education. In addition, leveraging the high density of hospitals in the region participating in national stroke quality improvement initiatives, NECC is poised to be the first US stroke network to implement a uniform regional data collection and performance measurement system. A recent review of stroke systems of care reinforces that harmonization of efforts by the major healthcare organizations to collect data on hospital-based stroke care and to improve care will lead to broader implementation of these programs and better patient outcomes. Health policy changes are needed at the state, regional, and federal level to increase funding for stroke education and provider reimbursement, improve provider capabilities, and address shortages of acute stroke expertise nationwide.<sup>23</sup>

NECC has identified variations in the delivery of stroke care across the 8-state region in almost every component of

the SSCM. Rural populations throughout the region had significantly less access to neurologists and designated stroke centers and higher stroke-related death rates. Although we acknowledge the lack of quantitative data for stroke care activities related to primary and primordial prevention, community education, and notification and response of EMS as a limitation, the qualitative data suggest significant heterogeneity in available services and resources. In addition, the variation in distribution of designated stroke centers is important, because it is likely that stroke center designation impacts on multiple components of the SSCM. The variation in distribution of designated stroke centers is amply demonstrated by use of GIS maps. However, our results also highlight the lack of accurate and current data on stroke care delivery in the northeastern United States. In the future, NECC will create metrics for each Stroke System of Care Recommendation and generate GIS maps to track system progress.

NECC is the first organized effort to attempt regional implementation of the SSCM. Translating the general recommendations of the SSCM into specific actionable goals and working across the region to implement these changes is a formidable task. It is anticipated that successful implementation of the NECC recommendations will create a standardized regional approach to stroke in the prehospital, inpatient, and outpatient domains that will help reduce the disparities in stroke care that have been identified. The leadership of the NECC believes that the consortium will help facilitate the flow of information across public health departments and other state agencies to catalyze action in states that have been slower in developing and implementing standards for acute stroke care. This is a work in progress and the difficult next steps of defining the most relevant markers of system progress and implementing the consensus recommendations lie ahead. It remains to be seen if this process will lead to synergies across the region and more rapid adoption of strategies shown to be successful in other states within NECC.

## Acknowledgments

The NECC thanks the following for their support of the development of the NECC and the genesis of the article: Ralph Sacco, MD, Elsbeth Kalendarian, DDS, MPH, Janet Prvu Bettger, Sc.D, Ben Weittenhiller, MBA, and the American Heart Association.

## Sources of Funding

The NECC conferences were supported in part by Centers for Disease Control and Prevention Conference Grant 5 U13 DP001176-02. The following commercial sponsors contributed funds to support the Northeast Cerebrovascular Consortium annual meetings but had no input into the conference planning or manuscript content, preparation or analyses: AstraZeneca Pharmaceuticals, Inc, Forest Research Institute, Genentech, HealthSouth, Innovative Neurotronics, Medivance, National Stroke Association, Novo Nordisk, NuStep, PDL Pharma, and Pfizer.

## Disclosures

T.G.: former speaker for Boehringer Ingelheim; L.H.S.: paid consultant on stroke systems of care to the Massachusetts Department of Health.

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