Growth of Regional Acute Stroke Systems of Care in the United States in the First Decade of the 21st Century

Sarah Song, MD, MPH; Jeffrey Saver, MD

Background and Purpose—States and counties in the US began implementing regional systems of acute care in the first decade of the 21st century, whereby emergency medical services systems preferentially route acute stroke patients directly to primary stroke centers. The pace, geographic range, and population reach of regional stroke system implementation has not been previously delineated.

Methods—We performed a review of legislative archives, internet and media reports, consultation with American Heart Association/American Stroke Association and Centers for Disease Control staff, and phone interviews with state public health and emergency medical service officials from each of the 50 states.

Results—The first counties to adopt regional regulations supporting routing of acute stroke patients to primary stroke centers were in Alabama and Texas in 2000; the first states were Florida and Massachusetts in 2004. By 2010, 16 states had state-level legislation or regulations to enable emergency medical service routing to primary stroke centers, as did counties in 3 additional states. The US population covered by routing protocols increased substantially in the latter half of the decade, from 1.5% in 2000 to 53% of the US population by the end of 2010.

Conclusions—The first decade of the 21st century witnessed a remarkable structural transformation in acute stroke care: by the end of 2010, over half of all Americans were living in states/counties with emergency medical service routing protocols supporting the direct transport of acute stroke patients to primary stroke centers. Additional efforts are needed to extend regional stroke systems of care to the rest of the US. (Stroke. 2012;43:00-00.)

Key Words: all cerebrovascular disease ■ outcome research ■ emergency medicine and stroke ■ health policy

At the start of the 21st century, stroke was the third leading cause of death and the leading cause of disability among Americans. In 2000, a vision for regional organization of stroke care was first promulgated by the Brain Attack Coalition, launching the stroke center movement in the United States.1 The Brain Attack Coalition document recognized that the 2 interventions of proven value in acute stroke care, intravenous thrombolysis within 3 hours of onset and organized supportive care on a stroke unit, were not universally available; and, their successful implementation required institutional-level commitment from hospital administration to integrate stroke care by emergency physicians, stroke specialists, nursing, radiology, pharmacy, and additional support services. The Brain Attack Coalition recommended that emergency medical service (EMS) systems train paramedics to recognize stroke patients in the field and preferentially route ambulances directly to primary stroke centers that are certified to deliver standard acute stroke therapies reliably and rapidly. Subsequent policy and guideline statements from the American Heart Association/American Stroke Association and the Brain Attack Coalition refined recommendations for organization of regional systems of acute stroke care.2–6

The Joint Commission on Accreditation of Healthcare Organizations first began certifying primary stroke centers in December 2003. Other national hospital-certifying organizations, including Det Norske Veritas and Healthcare Facilities Accreditation Program, later developed similar certification programs. Some states, such as Florida and New Jersey, developed their own facility-certifying programs, generally with the Joint Commission-overlapping criteria.7

In the United States, EMS transport policies are largely determined by state and county, rather than by federal legislation and regulation. Given interest in collaborative efforts between EMS and neurologists in improving acute stroke outcomes, documenting trends in routing protocol policy expansion is essential for illustrating the growing recognition of the importance of regional stroke system development.

Methods

We identified stroke system routing protocol legislation or regulation in US states and counties in December 2010; and for jurisdictions with active regional stroke systems of care, this was the year of first passage of enabling legislation by the state legislature or adoption of enabling regulation by the applicable state or county authority. Resources queried included: online legislative databases, public...
health and emergency medical officials from each of the 50 states, staff tracking prehospital stroke-routing policies at the American Heart Association/American Stroke Association and the Centers for Disease Control, and county-level EMS or public health department officials. Initial queries using legislative databases were performed. Individuals from each state’s department of EMS and/or department of public health were contacted for verbal verification; the resulting preliminary list was compared with lists maintained by the American Heart Association/American Stroke Association and Centers for Disease Control. Discrepancies were investigated further with online searches and phone calls.

Populations were quantified using online US census databases from 2000 to 2010.

Results
In 2000, counties in Alabama and Texas first began routing acute stroke patients to stroke-designated hospitals. The first states to adopt policies supporting routing of acute stroke patients preferentially to primary stroke centers were Massachusetts and Florida in 2004. By 2010, 16 states, along with counties in 3 additional states, had acute EMS stroke-routing protocol policies (Figure 1). In 2000, 1.5% of the US population lived in areas that were covered by these routing protocols. By the end of the decade, 53% of the US population lived in areas that had legislation, regulations, or policies in support of EMS acute stroke-routing protocols (Table).

Population coverage in 2010 varied considerably by census region (Figure 2). The greatest coverage was in the West South Central region at 80%, and the lowest covered region was the East South Central region at 6%.

Conclusions
Regional stroke systems increased in adoption throughout the period from 2000 to 2010. Concurrent with the development and publication of policy statements, continued data demonstrating the effectiveness of thrombolytic therapy and organized stroke care,8–9 data publication from successful pilot projects in metropolitan Houston and New York City,10–11 launch of a stroke center certification process by The Joint Commission, the development of telemedicine for stroke, effective advocacy campaigns, and adoption of local and state policies and regulations to create stroke systems of care expanded throughout the decade.12

This study has limitations. We identified the year of legislation passage or regulation adoption, not the dates of actual implementation of routing in the field, which typically occurs after a delay of several months. Also, state- or county-level legislative/regulatory policies often enabled and promoted, but did not mandate, adoption of preferential EMS routing policies for acute stroke patients. Given the wide geographic variation in distances to hospitals, EMS legislation/regulation in the US frequently leaves final details and

<table>
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<th>Year</th>
<th>State/County</th>
<th>Population Covered (%)</th>
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<tbody>
<tr>
<td>2000</td>
<td>Alabama: Blount, Chilton, Jefferson, St Clair, Shelby, Walker, Winston County; Texas: Harris County</td>
<td>4 471 933 (1.5)</td>
</tr>
<tr>
<td>2003</td>
<td>New York: Queens, Kings County</td>
<td>290 326 418 (3)</td>
</tr>
<tr>
<td>2004</td>
<td>Massachusetts; Florida</td>
<td>293 655 404 (11)</td>
</tr>
<tr>
<td>2005</td>
<td>New York; Texas; Arizona: Maricopa County</td>
<td>71 024 756 (24)</td>
</tr>
<tr>
<td>2006</td>
<td>California: Santa Clara County</td>
<td>73 779 894 (25)</td>
</tr>
<tr>
<td>2007</td>
<td>Maryland; California: San Francisco County</td>
<td>81 189 754 (27)</td>
</tr>
<tr>
<td>2008</td>
<td>Missouri; Virginia; California: Alameda, San Mateo, Kern County</td>
<td>98 690 632 (32)</td>
</tr>
<tr>
<td>2009</td>
<td>Georgia; Illinois; New Jersey; North Dakota; Oklahoma; Rhode Island; Vermont; California: Los Angeles, Orange, Sacramento, San Diego County</td>
<td>154 585 210 (50)</td>
</tr>
<tr>
<td>2010</td>
<td>Utah; Washington; California: Nevada, Placer, Sutter, Yolo, Yuba, Colusa, Butte, Tehama, Shasta, Siskiyou County</td>
<td>164 705 539 (53)</td>
</tr>
</tbody>
</table>
mandating authority to county and other local EMS provider agencies. Another study limitation is the full details of each state and county’s EMS routing system policy are not explored, including which stroke center certifying bodies were specified (eg, The Joint Commission, state department of public health, county EMS agency, etc) and which patients could be rerouted (all, under 6 hours, under 3 hours, etc). A final limitation is that we confined our analysis to the United States, but the acute system of care movement has been international in scope over the past decade.

By 2010, over 147 million Americans still did not have assured access to hospitals certified to provide standard acute stroke care. This inequitable access to effective health care is an important challenge to the American health system, as the frequency of acute stroke is projected to increase with the aging of the US populace.12 The pattern of uptake of regional stroke systems from 2000 to 2010 suggests a greater tendency for early adoption by states and counties with greater population density. Fortunately, several advances make implementation of regional acute stroke systems in currently uncovered states and counties an achievable goal; these include stroke telemedicine, a growing cadre of vascular neurologists and neurohospitalists well-trained in acute stroke care, wide acceptance of the importance of routing patients directly to stroke centers by the national EMS leadership,13 and increasing penetration of US stroke center designation.14 If public health officials, legislators, hospital associations, and EMS medical directors work to ensure equitable access to proven, effective acute stroke care,15 regional acute stroke care system coverage for all Americans can be achieved within the next few years.

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