Predictors of Increased Intravenous Tissue Plasminogen Activator Use Among Hospitals Participating in the Massachusetts Primary Stroke Service Program

Natalia S. Rost, MD, MPH; Eric E. Smith, MD, MPH; Muhammad A. Pervez, MD; Philip Mello; Paul Dreyer; Lee H. Schwamm, MD, FAHA

Background—We sought to determine if intravenous tissue plasminogen activator (IV tPA) use for acute ischemic stroke increased in Massachusetts in association with the Primary Stroke Service program, a statewide stroke center designation and quality improvement initiative.

Methods and Results—We analyzed prospectively acquired data from the Massachusetts Department of Public Health between October 2004 and June 2008, including 10,045 consecutive emergency department–based acute ischemic stroke encounters arriving ≤3 hours after stroke onset at 69 participating Massachusetts PSS hospitals. The overall rate of IV tPA use was 854 of 3866 (22.1%) of patients arriving ≤2 hours of symptom onset. IV tPA use increased steadily from 2005 (the first full year of the program) to 2008 (18.4%, 21.9%, 22.6%, 25.5%; P<0.001). Patients treated with IV tPA were more likely to be younger (72.3±14.1 versus 74.7±14.0 years, P<0.005) and to have presented after emergency medical services rerouting in July 2005 (96% versus 94%, P=0.009). Patients who arrived at hospitals with a performance achievement award from the Get With The Guidelines-Stroke program were more likely to receive IV tPA after versus before award recognition (28.1% versus 22.3%, P<0.001).

Conclusions—In this nearly complete capture of statewide data, rates of IV tPA improved significantly in Massachusetts from 2005 to 2008 in association with a state Primary Stroke Service designation program. Further studies are needed to confirm that treatment disparities exist for older acute ischemic stroke patients and that the rates of thrombolysis have increased above and beyond secular trends. (Circ Cardiovasc Qual Outcomes. 2012;5:00-00.)

Key Words: acute stroke ■ quality improvement ■ stroke management ■ thrombolysis

Intravenous tissue plasminogen activator (IV tPA) improves outcomes in patients with acute ischemic stroke (AIS); however, only a small proportion of eligible patients actually receive this treatment. Delay in patient arrival and inadequate hospital infrastructure or support contribute to low treatment rates. Multiple quality improvement (QI) initiatives aimed at improvement of AIS care have been implemented over the past decade to increase treatment rates, including the Centers for Disease Control and Prevention’s Paul Coverdell National Acute Stroke Registry (PCNASR), the American Heart Association (AHA)’s Get-With the Guidelines–Stroke (GWTG-S) program, state-based stroke center designation programs, and reorganization of emergency medical services (EMS) to screen for stroke symptoms and triage patients to stroke centers with prerarrival notification.

In Massachusetts, broad hospital participation in the PCNASR and GWTG-S played a major role in setting the standards for acute stroke care. The PCNASR, a state-based stroke QI registry, began by supporting development of a set of prototype registries in 2001. The initial PCNASR prototype in Massachusetts was the creation and implementation of the GWTG-S pilot. Since that time, the AHA and Massachusetts Department of Public Health (DPH) have been partners in the PCNASR implementation in Massachusetts.

Primary Stroke Service (PSS) designation was implemented by the Massachusetts DPH to facilitate the preparedness of each individual hospital for treatment of AIS patients, and by December 2005, 92% of Massachusetts hospitals achieved PSS designation based on documented implementation of the GWTG-S pilot. Since that time, the AHA and Massachusetts Department of Public Health (DPH) have been partners in the PCNASR implementation in Massachusetts.

This article was handled independently by Guest Editor Barbara G. Vickrey, MD, MPH. The Editors had no role in the evaluation of the article or the decision about its acceptance.

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Circ Cardiovasc Qual Outcomes is available at http://circoutcomes.ahajournals.org DOI: 10.1161/CIRCOU000000000000000
registry, performance review with local quality initiatives, community education, and an on-site verification by DPH personnel.\textsuperscript{11}

We sought to determine factors predictive of changing rates of tPA treatment in Massachusetts from 2004 to 2008.

WHAT IS KNOWN

- IV tPA improves outcomes in patients with acute ischemic stroke; however, only a small proportion of eligible patients actually receive this treatment.
- Multiple quality improvement initiatives aimed at improvement of acute stroke care have been implemented over the past decade to increase treatment rates.

WHAT THE STUDY ADDS

- This is the first report on changes in absolute rates of IV tPA treatment measured over time in a state-wide hospital sample.
- This report explores the relationship between the quality improvement award recognition and high absolute rates of tPA use for acute stroke.
- This unique state-wide sample analysis highlights the importance of public health initiatives in partnership with national quality improvement programs in the improvement of outcomes for stroke.

\section*{Methods}

\subsection*{Program Description and Quality of Care Definitions}

To increase the quality of AIS care provided in Massachusetts hospitals, including perceived geographic disparities in the rates of thrombolysis, the Massachusetts PSS Designation program was conceived in 2003 and implemented in 2005. All non-Federal Massachusetts acute care hospitals were eligible to participate. To be licensed as a PSS, hospitals were required to meet modified Brain Attack Coalition criteria relevant to emergency stroke care including (1) presence and availability of experienced acute stroke team, (2) emergency department (ED) experience in acute stroke, (3) 24-hour availability of rapid CT scanning and interpretation, (4) 24-hour availability of laboratory diagnostic testing, (5) availability of neurosurgical services ≤2 hours or request, (6) presence of written and annually reviewed stroke care pathways, (7) quality review and performance improvement activities including stroke registry, and (8) provision for continuing education in stroke.\textsuperscript{11-14}

All participating hospitals submitted applications with documentation of the required hospital resources, and the DPH personnel verified the presence of these resources by on-site inspection. Maintenance of PSS status is dependent on mandatory data reporting of the required hospital resources, and the DPH personnel provision for continuing education in stroke.\textsuperscript{11}

We conducted a retrospective review of data collected on patients between October 2004 and June 2008. Most sites used a combination of prospective ascertainment and retrospective data collection. Periodic on-site surveys have been conducted in response to complaints, serious incidents, certain negative data outliers, and all sites were recently revisited in 2010 for a relicensure assessment.

Sixty-nine of 70 acute care hospitals in Massachusetts ultimately achieved state PSS designation. The single nonparticipating hospital was a very small rural hospital with the lowest AIS volume in the state (10 IV tPA cases between 2002 and 2010). Hospitals joined the program in a rolling fashion: 4 hospitals were designated PSS in 2004, 63 hospitals in 2005, and 2 hospitals in 2007. No hospitals has subsequently dropped out of the program or failed to achieve relicensure.

Beginning in July 2005, the Massachusetts DPH mandated transport of suspected acute AIS patients to the nearest designated PSS hospital, potentially bypassing nearer facilities, for patients with symptom duration ≤2 hours.\textsuperscript{13}

Many hospitals also simultaneously participated in GWTG-S, a prospective, nonrandomized, national, AHA-sponsored QI stroke program that was designed and implemented in Massachusetts in 2001 and nationwide as of April 2004. At each hospital, trained personnel are instructed to use GWTG-S to collect data on consecutive patients admitted to the hospital with a principal clinical diagnosis of stroke or transient ischemic attack (TIA). Hospitals upload data via a web-based tool and can download on-demand reports of adherence on a variety of stroke measures, including all of the stroke measures endorsed by the National Quality Forum (NQF)\textsuperscript{7} as well as a series of additional quality, reporting, and demographic information. The provision of IV tPA to eligible patients presenting ≤2 hours of LSW time is one of these NQF-endorsed stroke measures. Hospitals that demonstrate ≥85% adherence on seven stroke “achievement measures” (those judged to be of highest scientific evidence) over 12 months are recognized with an achievement award.\textsuperscript{7} The 7 GWTG-S achievement measures are antithrombotics within 48 hours, antithrombosis at discharge, IV tPA in eligible patients ≤2 hours, deep venous thrombosis prophylaxis by day 2, warfarin for atrial fibrillation, statin therapy at discharge if LDL >100 mg/dL, and smoking cessation therapy (Table 1). All of these measures are NQF-endorsed stroke measures with the exception of smoking cessation therapy, which is not specifically endorsed for stroke but is endorsed by the NQF as a global inpatient measure. Two NQF-endorsed stroke measures, stroke education and assessment for rehabilitation, are included in GWTG-S but as “quality measures” that do not count toward performance achievement awards. Additional components of GWTG-S include organizational stakeholder and opinion leader meetings, prospective recruitment, collaborative workshops for hospital teams, hospital tool kits, and hospital recognition.\textsuperscript{7}

\section*{Study Population and Measurements}

We conducted a retrospective review of data collected on patients diagnosed with AIS based on the Massachusetts DPH PSS records between October 2004 and June 2008. Most sites used a combination of prospective ascertainment and retrospective data collection. The DPH did not formally audit data entry against medical records, although DPH onsite visits for certification were performed twice at

\begin{table}
\centering
\caption{Comparison of National Qualify Forum–Endorsed Measures for Stroke and the Joint Commission Primary Stroke Center and the American Heart Association's Get With The Guidelines–Stroke Programs}
\begin{tabular}{|l|l|l|}
\hline
Quality Indicator & JNC PSS & GWTG \\
\hline
IV tPA in eligible patients & $\ast$ & $\dagger\dagger$ \\
DVT prophylaxis by day 2 & $\ast$ & $\dagger\dagger$ \\
Warfarin for patients with atrial fibrillation & $\ast$ & $\dagger\dagger$ \\
Antithrombotics at discharge & $\ast$ & $\dagger\dagger$ \\
Antithrombotics within 48 h & $\ast$ & $\dagger\dagger$ \\
Dysphagia screen by day 2 & $\ast$ & $\dagger\dagger$ \\
Smoking cessation & $\ast$ & $\dagger\dagger$ \\
Stroke education & $\ast$ & $\dagger\dagger$ \\
Assessed for rehabilitation & $\ast$ & $\dagger\dagger$ \\
Statin at discharge if LDL >100 & $\ast$ & $\dagger\dagger$ \\
\hline
\end{tabular}
\end{table}

TJC indicates the Joint Commission; PSS, primary stroke service; GWTG, Get With The Guidelines initiative; IV tPA, intravenous thrombolysis with tissue plasminogen activator; DVT, deep venous thrombosis; and LDL, low-density lipoprotein.

$\ast$Indicates National Quality Forum endorsement; $\dagger$part of GWTG performance achievement award; $\ddagger$collected as part of the quality program.
Table 2. Frequency of IV tPA Use in All Patients Arriving ≤2 Hours With Acute Ischemic Stroke to the Massachusetts Primary Stroke Service Hospitals Between 2004 and 2008

<table>
<thead>
<tr>
<th>Discharge Year</th>
<th>Total Discharges</th>
<th>Arrival in ≤2 Hours</th>
<th>Arrived ≤2 Hours and Treated With IV tPA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>2004</td>
<td>38</td>
<td>0.38</td>
<td>13</td>
</tr>
<tr>
<td>2005</td>
<td>1904</td>
<td>18.95</td>
<td>692</td>
</tr>
<tr>
<td>2006</td>
<td>3153</td>
<td>31.39</td>
<td>1253</td>
</tr>
<tr>
<td>2007</td>
<td>3382</td>
<td>33.67</td>
<td>1270</td>
</tr>
<tr>
<td>2008*</td>
<td>1568</td>
<td>15.61</td>
<td>638</td>
</tr>
<tr>
<td>Total</td>
<td>10,045</td>
<td>100</td>
<td>3866</td>
</tr>
</tbody>
</table>

IV tPA indicates intravenous thrombolysis with tissue plasminogen activator.
*Represents data from the first half of 2008 (January to June) only.

Results

There were 10,983 AIS patient admissions during the study period. Excluded from analysis were 546 (4.9%) inpatient strokes, 4 (0.03%) patients aged <18 years, 37 (0.3%) patients who received IV tPA at another hospital, 25 (0.02%) with missing information on critical variables (age, IV tPA use, or discharge destination), and 306 (2.8%) patients with coding errors.

Between 2005 to 2008, there was a steady increase per year in the proportion of patients arriving ≤2 hours of AIS onset in the PSS database (36.3% in 2005 versus 40.7% in 2008, P<0.001) (Table 2). The proportion of patients arriving ≤2 hours and treated with IV tPA, expressed as a percentage of all stroke patients, increased from 6.7% in 2005% to 10.4% in 2008 (P=0.006). Among the patients who arrived ≤2 hours after stroke onset, the proportion treated with IV tPA increased from 18.4% in 2005% to 25.5% in 2008 (P=0.002) (Table 2).

Table 3 shows hospital data as well as patient characteristics and outcomes in the 10,045 patients with AIS. Of the 10,045 patients, 3866 (38.5%) presented to the ED ≤2 hours from symptom onset, and 854 of 3866 (22.1%) received IV tPA treatment. Characteristics associated with IV tPA use in patients arriving ≤2 hours included younger age (P<0.001), discharge year (P=0.002), presenting with AIS symptoms after the EMS rerouting was implemented (P<0.009), and presenting to a hospital that received a GWTG-S recognition award (P<0.001) (Table 4). There was a trend toward an association between larger hospital bed size and an increased likelihood of IV tPA treatment (P=0.08).

In multivariable analysis, age >80 years independently decreased the odds of having IV tPA treatment in those patients who presented ≤2 hours of their AIS symptoms and who were aged 80 to 89 (odds ratio [OR], 0.8; 95% confidence interval [CI], 0.7–0.9) as well as those ≥90 years of age (OR, 0.6; 95% CI, 0.4–0.8). There was a trend toward an increased rate of IV tPA use in patients transported after EMS rerouting began, but the effect was not significant (OR, 1.5; 95% CI, 0.9–2.2). Larger hospital bed size was not associated with a greater likelihood of IV tPA use after controlling for other variables. Presenting to a hospital later within the study period independently increased the odds of being treated with IV tPA (OR, 1.1 per each additional year; 95% CI, 1.03–1.2) (Table 5).
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and adherence to evidence based AIS care.

initiatives nationwide in order to increase the use of IV tPA data support the ongoing efforts to implement stroke QI coupled with a national quality improvement program. These

The rate of IV tPA use increased significantly from 2004 to 2008 (shown in Table 5), award status was independently associated with IV tPA use (adjusted OR, 1.4; 95% CI, 1.1–1.7), whereas the effect of calendar year was no longer significant.

Discussion
This review of statewide data from Massachusetts demonstrates a substantially higher rate of IV tPA use than previously reported in nationwide datasets, including those reported concurrently with our study timeline. Additionally, the rate of IV tPA use increased significantly from 2004 to 2008 in conjunction with a state designation program for PSS coupled with a national quality improvement program. These data support the ongoing efforts to implement stroke QI initiatives nationwide in order to increase the use of IV tPA and adherence to evidence based AIS care.

There were 29 hospitals that received a GWTG-S achievement award during the study period. Whereas characteristics of the award hospitals varied broadly, when compared with those without awards, awards hospitals were larger (P = 0.02), less likely to participate in televideo consultation (P = 0.04), more likely to be teaching hospitals (P < 0.001), and more likely to be a participant in the PCNCSR (P = 0.009). Patients seen at a hospital with an achievement award were more likely to receive IV tPA (Table 4). When we restricted the analysis to the 28 hospitals that received a GWTG-S achievement award during the study period (excluding 1 hospital with award recognition prior to PSS designation), the rate of IV tPA was higher after compared with before award recognition (28.1% versus 22.3%; P = 0.002). When award status was added to the multivariable model described previously (shown in Table 5), award status was independently associated with IV tPA use (adjusted OR, 1.4; 95% CI, 1.1–1.7), whereas the effect of calendar year was no longer significant.

The PSS program was launched in Massachusetts in 2004 at roughly the same time as the original pilot of TJC PSC program. At its inception, the PSC program was focused on rates of “IV tPA considered” rather than the rate of tPA administered and did not require mandatory data reporting. There was a strong feeling in Massachusetts of the need for state level data collection and reporting on acute stroke care. For both of these reasons, the Massachusetts DPH proceeded with the PSS offering, which was rapidly adopted by Massachusetts hospitals. Because there is significant overlap with the PSC program, and the PSS program was offered at a very low cost to sites, few Massachusetts hospitals chose to seek the additional certification and costs necessary for PSC status. However, it is likely that the rapid pace of adoption of the PSC program nationally drove Massachusetts hospitals to join some form of stroke center certification program, and they, by and large, chose PSS. Of the 69 PSS hospitals in the program during 2004 to 2008, 29 of 69 (42%) received an award from the AHA GWTG-S program for providing each of the achievement measure interventions for which they were eligible to ≥85% of GWTG-S patients, including IV tPA for those arriving ≤2 hours of onset.

PSS hospitals in the state of Massachusetts vary greatly in their characteristics, and in particular, their size, location, and affiliations. Despite the differences, they were all subject to the same DPH requirements and therefore all had to acquire resources necessary for provision of AIS care. Despite initial limitations, hospitals found solutions to existing barriers, including innovative strategies such as access to telemedicine consultations and interfacility transfer agreements. Although larger hospitals were more likely to be early adopters of the PSS program and more likely to provide IV tPA, this effect was mitigated when the GWTG-S award status was included in the model. This effect suggests that the award reflects actual increased rates of treatment with IV tPA (rather than simply documenting more contraindications) and that hospitals both large and small are able to achieve increased levels of IV tPA use.

Prior studies have indicated that statewide initiatives can improve quality outcomes; however, whereas the implementation of the regional systems of care is feasible, its effectiveness is still being elucidated. The Massachusetts data from 2004 to 2008 show a relatively high and increasing rate of IV tPA use compared with nationwide data, stroke registries, and nearby states. Administrative data from the Nationwide Inpatient Sample suggest that the overall IV tPA treatment rate among all AIS patients was 1% in 1999 to 2002 and had only increased to 3.4% by 2009. In the PCNCSR, pilot projects demonstrated that the rate of IV tPA use ranged from 2.7% to 8.5% across the pilot states, whereas the data from 2005 to 2007 showed that 3.6% of patients received IV tPA. Among the patients arriving ≤2 hours in the PCNCSR from 2005 to 2007, 20.6% received IV tPA. Data from the national GWTG-S program show that 16.0% of patients arriving ≤2 hours were treated with IV tPA in 2005, compared with 27.2% in 2008.

Statewide longitudinal data over time are mostly lacking; however, a recent study from New York State showed that IV tPA was given to 3.2% of ischemic stroke patients overall in
2005 and 2006, including to 4.8% of the patients admitted to state-designated stroke centers and 1.7% of the patients admitted to nonstroke centers. By comparison, the Massachusetts rate of IV tPA utilization in PSS hospitals increased from 6.7% to 10.4% of all ischemic strokes between 2005 to 2008, or 18.4% to 25.5% when expressed as a percentage of all AIS patients arriving ≤ 2 hours.

The Massachusetts rates exceed those observed in the national and New York–based studies and compare favorably to the rates of increase seen in the selected hospital populations participating in the PCNSAR and GWTG-S quality improvement initiatives, suggesting that the state-based program has been effective in encouraging IV tPA use in excess of national secular trends. The potential influence on the observed rate increase in IV tPA administration of other concomitant statewide QI initiatives adopted during the study period is difficult to ascertain, in large part because they share many common aspects. In Massachusetts, participation in the initial PCNASR phase that focused on performance measures and data element creation contributed fundamentally to development and statewide implementation of the AHA GWTG-Stroke pilot in 2001. Furthermore, the implementation of the Massachusetts Centers for Disease Control–funded Paul Coverdell Registry was done in partnership between the Massachusetts DPH and the AHA, and the in-hospital stroke QI initiative was renamed the “Stroke Collaborative Reaching for Excellence” (SCORE) program. The joint program uses the GWTG data platform to collect and report hospital data and performance to participating hospitals and to the state with the goal of creating a sustainable data-driven stroke QI collaborative that would further facilitate statewide efforts of stroke care QI through hospital-level policy and system change (http://www.scorema.org/index.html). To date, SCORE has utilized significant state resources to provide a number of training opportunities in order for participating hospitals to improve quality of stroke care. All hospitals enrolled in SCORE were PSS designated and again used the same data platform to report the PSS required elements to the Massachusetts DPH. In summary, it is quite likely that the effects of participation in these multiple coordinated statewide and nationwide programs is additive in Massachusetts. A different study design with control hospitals would be required to elucidate the differential impact of each initiative and is beyond the scope of this dataset.

### Table 4. Characteristics Associated With tPA Use in Univariate Analysis Among Acute Ischemic Stroke Patients Arriving ≤2 Hours After Last Seen Well to All Massachusetts Primary Stroke Service Hospitals (n=3866) (2004–2008)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>IV tPA (n=854)</th>
<th>No IV tPA (n=3012)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y, mean (SD)</td>
<td>72.3 (14.1)</td>
<td>74.7 (14.0)</td>
<td>0.005</td>
</tr>
<tr>
<td>Age ≤ 80 y</td>
<td>63%</td>
<td>55%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>80–89 y</td>
<td>30%</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>≥ 90 y</td>
<td>7%</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>51%</td>
<td>52%</td>
<td>0.67</td>
</tr>
<tr>
<td>Nonwhite race</td>
<td>12%</td>
<td>11%</td>
<td>0.63</td>
</tr>
<tr>
<td>Discharge year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>0.4%</td>
<td>0.3%</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>15%</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>32%</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>34%</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>19%</td>
<td>16%</td>
<td></td>
</tr>
<tr>
<td>After EMS rerouting began</td>
<td>96%</td>
<td>94%</td>
<td>0.009</td>
</tr>
<tr>
<td>Presented to hospital with GWTG award</td>
<td>32%</td>
<td>20%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Presented to hospital with televideo consultation</td>
<td>16%</td>
<td>18%</td>
<td>0.95</td>
</tr>
<tr>
<td>No. of beds, median (IQR)</td>
<td>223 (132–311)</td>
<td>205 (132–284)</td>
<td>0.08</td>
</tr>
<tr>
<td>Bed quartile</td>
<td></td>
<td></td>
<td>0.84</td>
</tr>
<tr>
<td>1st quartile (19–126 beds)</td>
<td>23%</td>
<td>24%</td>
<td></td>
</tr>
<tr>
<td>2nd quartile (132–192 beds)</td>
<td>20%</td>
<td>21%</td>
<td></td>
</tr>
<tr>
<td>3rd quartile (194–264 beds)</td>
<td>21%</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td>4th quartile (272–902 beds)</td>
<td>35%</td>
<td>28%</td>
<td></td>
</tr>
<tr>
<td>Presented to rural hospital ED</td>
<td>11%</td>
<td>12%</td>
<td>0.79</td>
</tr>
<tr>
<td>Presented to teaching hospital ED</td>
<td>41%</td>
<td>34%</td>
<td>0.35</td>
</tr>
</tbody>
</table>

IV tPA indicates thrombolysis with tissue plasminogen activator; EMS, emergency medical services; GWTG, Get With The Guidelines initiative; IQR, interquartile range; and ED, emergency department.

Table percentages represent column percentages. Significance testing is by univariate logistic regression using generalized estimating equations with an exchangeable working correlation matrix to account for clustering of patients within hospitals. A linear trend test was used for ordinal categorical variables (age categories, discharge year, and bed quartiles).
The GWTG-S program is a voluntary, nationwide QI initiative that showed consistently the benefits of prospective surveillance of patient care in stroke. Hospitals seeking GWTG-S award are subject to continuous commitment to excellence and improvement of, at minimum, inpatient quality of care for patients with stroke, as defined performance, safety measures. It may be that hospitals receiving award status were those sites most highly motivated to improve and that the specific stroke measures selected may have been less important than the organized award program itself. Ongoing efforts by the AHA to improve hospitals’ ability to treat eligible patients with IV tPA, within 60 minutes of ED arrival, may help identify hospital-level factors that are associated with high-performing sites and lend further insights into the role of award status.

Table 5. Multivariable-Adjusted Predictors of Intravenous Thrombolysis With Tissue Plasminogen Activator Use Among Acute Ischemic Stroke Patients Arriving ≤2 Hours After Last Seen Well to All Massachusetts Primary Stroke Service Hospitals (N=3866) (2004–2008)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Odds Ratio</th>
<th>95% Confidence Interval</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>80–89 y</td>
<td>0.8</td>
<td>0.7–0.9</td>
<td>0.007</td>
</tr>
<tr>
<td>≤90 y</td>
<td>0.6</td>
<td>0.4–0.8</td>
<td>0.002</td>
</tr>
<tr>
<td>Discharge year, per year</td>
<td>1.1</td>
<td>1.03–1.2</td>
<td>0.01</td>
</tr>
<tr>
<td>Discharge after EMS rerouting</td>
<td>1.5</td>
<td>0.9–2.2</td>
<td>0.08</td>
</tr>
<tr>
<td>Presented to hospital with telemedicine-enabled consultation</td>
<td>0.9</td>
<td>0.6–1.3</td>
<td>0.61</td>
</tr>
<tr>
<td>No. of beds, median</td>
<td>1.2</td>
<td>0.8–1.8</td>
<td>0.28</td>
</tr>
<tr>
<td>Admitted to teaching hospital</td>
<td>1.0</td>
<td>0.7–1.6</td>
<td>0.85</td>
</tr>
</tbody>
</table>

EMS indicates emergency medical services. Candidate variables were all those associated with intravenous thrombolysis with tissue plasminogen activator in the univariate analysis, with P<0.15. *Compared with reference tertile (age <80 years).

In our study, implementation of the EMS rerouting improved the odds of AIS being treated with IV tPA; however, this association did not remain significant when other independent predictors of thrombolysis were considered. Our data suggest that a plan for EMS rerouting may be effective in increasing IV tPA use but may not have been statistically significant because we had so few patients entered in the database before rerouting began. The EMS bypass policy itself probably encouraged rapid adoption of the PSS program. It was initiated shortly after PSS designation began, resulting in few patients being admitted to PSS-designated hospitals before the bypass policy came into effect. It is also possible that other factors such as age, hospital characteristics, or other confounders may have contributed to the loss of significance of the EMS bypass model term.

Patient advancing age is consistently associated with reduced rates of thrombolysis. Despite a lack of evidence that older patients are harmed by thrombolysis and the fact that advanced age is a relative contraindication to IV tPA, many centers offer IV tPA less frequently to older patients. The relationship between older age and decreased odds of thrombolysis is difficult to examine due to variations in interpretation and implementation of age-based restrictions on thrombolysis at the provider or hospital level. In our statewide sample, the odds of being treated with IV tPA decreased steadily by decade of age, as compared with the younger patients (<80 years of age at the time of their AIS). Local, regional, and nationwide acute stroke care may benefit in the future from prospective observations made in the comprehensive databases such as GWTG-S to overcome perceived obstacles to high quality of care in the elderly, who are the majority of AIS victims.

This study has several limitations. The data collection method in this study is based on site-level retrospective chart review by a trained data abstractor and therefore depends on the accuracy and reliability of chart documentation and the quality of abstraction. However, a recent data audit by the Massachusetts DPH of 78 variables in 1300 patient records at 58 PSS hospitals that are part of the Centers for Disease Control PCNASR and AHA GWTG-S found very high rates of data quality. In addition, the required data reporting is part of the state PSS designation; therefore we do not have data from hospitals prior to their PSS participation, and, due to nearly 100% participation, there is no comparison group. We do not have information on TJC Stroke Center certification. However, we anticipate that the effect of participation in each specific QI will be difficult to partition due to the high degree of overlap between the programs at each individual hospital, as was seen in this study with regard to GWTG award recognition and PCNASR program participation. Other larger studies with information on state-based, TJC, PCNASR, and GWTG-S participation will be needed to fully elucidate the independent effects of each program. We cannot exclude that some of the improvements in IV tPA use were related to secular trends and not the PSS stroke center designation program itself. However, even among the PSS hospitals, we found a further increase in rates of IV tPA use among hospitals that earned a GWTG-S achievement award, suggesting that QI programs did have an effect on rates of IV tPA delivery.

One advantage of our analysis is the nearly complete data capture from a geographically defined region, with lack of data from only the single smallest hospital in the state. Our findings suggest that IV tPA rates may have increased substantially since early studies showed little adoption of IV tPA for AIS at a nationwide level. Further studies will be needed to identify national and regional trends in IV tPA use.
and barriers to use. In summary, review of this statewide AIS dataset of early arriving patients demonstrates that successful participation in local and national QI initiatives such as GWTG-S and statewide stroke systems of care implementation that includes EMS rerouting had significant impact on the rates of thrombolysis for AIS in the state of Massachusetts. These data support the ongoing state-based efforts to implement QI initiatives in the context of stroke systems of care in order to increase the use of IV tPA.

Disclosures

Philip Mello is a quantitative analyst with the Massachusetts Department of Public Health. Dr Schwamm serves as the chair of the GWTG National Steering Committee (unpaid), a member of the AHA Primary Stroke Center advisory committee (unpaid), and as a stroke systems consultant to the Department of Public Health in Massachusetts (paid).

References

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Circ Cardiovasc Qual Outcomes. published online April 24, 2012;
Circulation: Cardiovascular Quality and Outcomes is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 1941-7705. Online ISSN: 1941-7713

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circoutcomes.ahajournals.org/content/early/2012/04/24/CIRCOUXTME.111.962829

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