Get With the Guidelines–Stroke Is Associated With Sustained Improvement in Care for Patients Hospitalized With Acute Stroke or Transient Ischemic Attack

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Background—Adherence to evidence-based guidelines for treatment of stroke or transient ischemic attack is suboptimal. We sought to establish whether participation in Get With the Guidelines–Stroke was associated with improvements in adherence.

Methods and Results—This prospective, nonrandomized, national quality improvement program measured adherence to guideline recommendations in 322,847 hospitalized patients discharged with a diagnosis of ischemic stroke or transient ischemic attack. A volunteer sample of 790 US academic and community hospitals participated from 2003 through 2007. The main outcome measures were change in adherence over time to 7 prespecified performance measures and a composite measure (total number of interventions provided in eligible patients divided by total number of care opportunities among eligible patients). Generalized estimating equations were used to identify factors associated with improvement. Participation in Get With the Guidelines–Stroke was associated with improvements in the 7 individual and 1 composite measures from baseline to the fifth year: intravenous thrombolytics (42.09% versus 72.84%), early antithrombotics (91.46% versus 97.04%), deep vein thrombosis prophylaxis (73.79% versus 89.54%), discharge antithrombotics (95.68% versus 98.88%), anticoagulation for atrial fibrillation (95.03% versus 98.39%), lipid treatment for low-density lipoprotein >100 mg/dL (73.63% versus 88.29%), smoking cessation (65.21% versus 93.61%), and composite (83.52% versus 93.97%) (P<0.0001 for all comparisons). Multivariate analysis showed that time in Get With the Guidelines–Stroke was associated with a 1.18-fold yearly increase in the odds of fulfilling care opportunities that was independent of secular trends.

Conclusions—Get With the Guidelines–Stroke participation was associated with increased adherence to all stroke performance measures. Markedly improved stroke care was seen in all hospitals regardless of size, geography, and teaching status. (Circulation. 2009;119:107-115.)

Key Words: cerebral ischemia ■ risk factors ■ stroke ■ thrombolysis

Stroke is the third-leading cause of death and a leading cause of long-term disability. An estimated 700,000 strokes occur each year in the United States, 200,000 of which are recurrent stroke.1 Medical complications that occur during the inpatient phase of care reduce long-term functional outcomes, and low-cost strategies to reduce complications such as deep vein thrombosis and aspiration pneumonia are readily available.2,3 Despite widely available evidence supporting clinical interventions that improve health outcomes for patients hospitalized for acute ischemic stroke or transient ischemic attack (TIA), many patients do not receive these recommended interventions.4

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In the past decade, several organizations such as the American Academy of Neurology, the AHA, Joint Commission, and Centers for Disease Control and Prevention have promoted changes in the models of care delivery, including the formation of dedicated stroke centers of excellence, and have promoted
quality improvement efforts to reduce disparities in acute stroke care through increased adherence to guideline recommendations. However, publication of national consensus guidelines alone has generally not been sufficient to produce substantial changes in physician behavior or patient treatment.

The Get With the Guidelines (GWTG)-Stroke program was developed as a national stroke quality improvement program to address this treatment gap. We sought to establish whether broad hospital participation in the GWTG-Stroke program was associated with improvements in the quality of stroke care beyond those expected on the basis of secular trends and to identify factors that contributed to differences in performance between hospitals.

Methods

GWTG Program Design

From April 2003 through March 2004, hospitals in selected regions of 8 states (Massachusetts, Michigan, Ohio, Florida, Arizona, California, Georgia, and Pennsylvania) were invited to participate in the pilot implementation. Starting in April 2004, the program was made available to all US hospitals. Hospitals continued to join the program in a staggered manner over the course of 4 years. Hospitals were instructed to use GWTG-Stroke to collect data on consecutive patients admitted to the hospital with a principal clinical diagnosis of stroke or TIA. Case ascertainment of admissions for ischemic stroke or TIA was conducted by prospective clinical identification, retrospective identification with International Classification of Diseases, ninth revision, discharge codes (433.xx, 434.xx, and 436 for ischemic stroke; 435.xx for TIA) followed by chart review to confirm case eligibility, or a combination of both approaches. To ensure that patients assigned a TIA diagnosis truly had deficits caused by ischemia, hospitals were instructed to include TIA patients only if symptoms were still persistent at the time of hospital arrival, symptoms lasted less than 24 hours, and no alternative diagnosis was identified.

Data were collected with the Internet-based Patient Management Tool (Outcome, Inc, Cambridge, Mass). Data were coded, deidentified, and transmitted in a secure manner to maintain patient confidentiality compliant with federal privacy standards. Data were collected for each hospitalization, including patient demographics, medical history, initial head computed tomography findings, in-hospital treatment and events, discharge treatment and counseling, and discharge destination. The data collection tool supports concurrent data collection and retrospective data entry; concurrent collection was encouraged as a process improvement goal in each hospital. The data abstraction tool included predefined logic features and user alerts to identify potentially invalid format or value entry. Required fields were structured so that valid data must be entered before the data can be saved as a complete record and entered into the database. Range checks were used for inconsistent or out-of-range data and prompted the user to correct or review data entries that were outside a predefined range. All hospital personnel using the tool received individual passwords to create an audit trail for data entered or changed. Training in the use of the tool was provided online and via telephone for all users. Data collected by hospitals were not independently audited by external chart review.

Each participating institution received either human research holder and opinion leader meetings, hospital recruitment, collaborative workshops for hospital teams, hospital tool kits, and hospital recognition. Data collection, decision support, and hospital data feedback via multiple on-demand reports of performance on all key measures were done with the Internet-based Patient Management Tool. Hospitals were recruited to participate in the program by American Stroke Association (ASA) staff and volunteers both by direct contact with all of the acute care hospitals in their region as well by working with state hospital associations and departments of health. Workshops included didactic presentation of clinical trial evidence and the ASA guidelines for acute treatment and secondary prevention of stroke and other major vascular events followed by examples of successful hospital implementation. These workshops were given quarterly by ASA staff and volunteers with expertise in clinical science and quality improvement. Standardized quality improvement methodology based on the Model for Improvement were presented at each session. Simultaneous facilitated breakout sessions, a key part of the GWTG-Stroke workshops, allowed multidisciplinary teams from 6 to 8 hospitals to discuss barriers and potential solutions, to share tools and ideas each has developed, and to share results of their small tests of change. Typical team members included a stroke nurse, a quality improvement nurse, and a physician leader. Each team then developed a plan for testing and implementation and presented plans to other participants to create a sense of purpose, urgency, and accountability to this developing community of practice. Between workshops, hospital interactions continued via conference calls and e-mail exchanges.

Quality Measures

Measures assessed in this quality improvement program are listed in the online-only Data Supplement. Indicator-specific inclusion and exclusion criteria were applied to create a denominator of patients eligible for each specific indicator. Patients were excluded if insufficient information was available to assess eligibility or if a contra-indication was documented as the reason for not providing the intervention. The patients remaining in the denominator reflect those who should with certainty be candidates for the intervention in question.

Seven performance measures and 1 balancing or safety measure (symptomatic intracranial hemorrhage within 36 hours after intravenous thrombolysis [tissue plasminogen activator (tPA)]) were prospectively selected by the GWTG Steering Committee to measure the quality of inpatient stroke care on the basis of a combination of the strength of the evidence, clinical relevance, magnitude of the relationship between performance and outcome, and precision of the definition, its construct and content validity, and its feasibility. All measures reflect the proportion of eligible patients (those without documented reasons for nontreatment) who received the intervention described. Patients with documented reasons for nontreatment are excluded from analysis of each measure. The GWTG-Stroke performance measures are as follows: intravenous tPA in patients who arrive <2 hours after symptom onset, antithrombotic medication within 48 hours of admission, deep vein thrombosis prophylaxis within 48 hours of admission for nonambulatory patients, discharge use of antithrombotic medication, discharge use of anticoagulation for atrial fibrillation, treatment for low-density lipoprotein >100 mg/dL, in patients meeting National Cholesterol Education Program Adult Treatment Panel III guidelines, and counseling or medication for smoking cessation. In addition, a composite measure score was calculated using the method established by the Centers for Medicare and Medicaid Services in the Hospital Quality Incentive Demonstration Project. This composite score reflects a summary score of performance of all 7 individual performance measures. The composite score is defined as the total number of interventions performed among eligible patients divided by the total number of possible interventions among eligible patients.

The Get With the Guidelines (GWTG)-Stroke program was developed as a national stroke quality improvement program to address this treatment gap. We sought to establish whether broad hospital participation in the GWTG-Stroke program was associated with improvements in the quality of stroke care beyond those expected on the basis of secular trends and to identify factors that contributed to differences in performance between hospitals.
Statistical Analysis

Data used for these analyses include baseline and consecutive quarters of participation in the program from April 2003 through July 2007. The compliance for each of the 7 individual performance measures and the composite performance score were calculated at baseline and each consecutive “time in GWTG-Stroke” quarter. For measures with high baseline performance (those exceeding 90%), a relative reduction of failure rate also was calculated with the following formula: \( \text{year} 5\% - \text{baseline}\% / 100\% - \text{baseline}\% \). This formula displays the relative change compared with the limited available opportunity for absolute change in error reduction. The duration of participation in the program, called time in GWTG-Stroke, was assessed for each hospital in consecutive quarters and reported in years. For each hospital, the baseline period was made up of the first 30 admissions, and each subsequent 91 days were considered a quarter of time in GWTG-Stroke. In addition to program duration, we assessed secular trends based on actual calendar date of patient discharge. Percentages were used for categorical variables and medians with interquartile ranges for continuous variables. The trends over calendar years or time in GWTG-Stroke were assessed with the Cochran-Mantel-Haenszel row-mean score test for categorical variables and the Jonckheere-Terpstra test for continuous variables. The Cochran-Mantel-Haenszel is a parametric test sensitive to any difference in means across program quarters, and the Jonckheere-Terpstra test is a nonparametric test that is sensitive to any difference in the distribution of the ordered responses across quarters; both are also sensitive to linear trends.

The primary outcome was the increased use of guideline-based care for each of the individual measures. This was reported for each measure individually and for a composite score. The composite measure was used to summarize quality of care into a single variable for which we then explored the effects of patient- and site-specific variables. A multivariable logistic regression model was developed in which each opportunity contributed an observation. The output of this model was the probability of a care opportunity being fulfilled. Each type of opportunity was weighted equally because each opportunity contributes 1 observation to the model regardless of the measure from which the opportunity is drawn.

This multivariable logistic regression also was used to determine the independent effect of time in the GWTG program on the composite performance score, adjusted for secular trends (ie, calendar date, hospital characteristics, and patient characteristics. It is important to recognize that hospitals joined the program in a staggered manner over the course of the 4 years. Therefore, hospitals joining GWTG-Stroke in 2005 spent their first time in program quarter in a different secular environment than those who joined in 2003. This was the rationale for including the calendar quarter variable as a term in the model. Because hospital enrollment was staggered over time, the time in program and calendar time are not highly correlated (Pearson correlation = 0.41), allowing the independent effects to be estimated.

Each measure for which a patient was eligible contributed an observation in this analysis, and the outcome was a dichotomized variable with a value of 1 (measure met) or 0 (measure not met) indicating whether the care opportunity was fulfilled. For example, if a patient was eligible for 5 of the 7 performance measures and received 3 of them, this patient would have contributed 5 observations to the analysis data set. The standard generalized estimating equation method was used to account for within-hospital clustering.

The hospital calendar quarter and the time in GWTG-Stroke quarter of participation during which the patient was admitted were included as model variables, allowing determination of independent linear trends in composite measure performance. Other model variables included hospital characteristics (ie, US Census region, bed size as a continuous variable, teaching status per American Hospital Association database, and annual number of stroke discharges [0 to 100, 101 to 300, >300]) and patient characteristics (ie, age, gender, race, body mass index, atrial fibrillation, previous stroke/TIA, coronary artery disease or prior myocardial infarction, carotid stenosis, diabetes, peripheral vascular disease, hypertension, dyslipidemia, and smoking). To determine whether improvements in composite performance were distributed equally across all hospitals subtypes, we next added statistical interaction terms, between-hospital characteristics (bed size, teaching status, and region), and time in program to the adjusted model. Interactions were deemed significant at the \( P \leq 0.05 \) level.

To determine whether trends in adherence were affected by the performance of hospitals joining or dropping out of the program, a linear regression model was fitted to compare the performance of new hospitals joining the program each quarter (join-in sites) and hospitals that stopped submitting records each quarter (dropout sites) with all other remaining hospitals.

All \( P \) values are 2 sided, with values of \( P < 0.05 \) considered statistically significant. All analyses were performed by the statistical division of the Duke Clinical Research Institute using SAS software version 9.1.3 (SAS Institute, Cary, NC).

The authors had full access to and take full responsibility for the integrity of the data. All authors have read and agree to the manuscript as written.

Results

Over the first 4.25 years of the program (April 2003 to July 2007), 322,847 clinically identified patients with a clinical diagnosis of ischemic stroke or TIA were enrolled from 790 participating hospitals. Patients were excluded from analysis if they were enrolled at sites that admitted <30 patients (n = 2093) or at sites for which hospital characteristics were unavailable (n = 7924). Patients were excluded from individual measures on the basis of the previously defined measure logic. Patient demographics and vascular risk factors are shown in Table 1 and are comparable to those in other large registries of stroke incidence. The median age of the patients was 74 years (interquartile range, 61 to 82 years); 46.1% were men; and 75.1% were white. Of those enrolled, 73.2% presented with ischemic stroke and 26.8% with TIA.

The distribution of hospital characteristics is shown in Table 2. Academic and community hospitals of all sizes participated in GWTG-Stroke, and average bed size, annual stroke discharge volume, and proportion of teaching hospitals were similar over the program years. A shift occurred in the regional representation in GWTG, with increased numbers of hospitals in the Northeast and South versus West and Midwest from 2003 to 2007 (52.9% versus 64.3%; \( P = 0.02 \)).

Time in GWTG-Stroke was associated with a clinically meaningful and statistically significant improvement, with absolute increases in the 7 individual measures from baseline to year 5 ranging from 3.20% to 30.75% (\( P < 0.0001 \) for all comparisons) (Table 3 and the Figure). For measures with high baseline performance (>90%), absolute gains were smaller. However, substantial relative percent improvements from baseline to year 5 were observed. Early antithrombotics, discharge antithrombotics, and anticoagulation for atrial fibrillation showed relative reductions in failure rates of 65%, 74%, and 68%, respectively. In addition, a substantial and significant improvement was found in the composite measure score (\( P < 0.001 \) from baseline to year 5 (Table 3 and the Figure). Despite increased rates of intravenous tPA use (30.75%), the rate of symptomatic intracerebral hemorrhage among these patients remained low and did not change over the 5 years (range, 4.49% to 5.95%; \( P = 0.41 \)).
Multivariate analysis showed that time in GWTG-Stroke was associated with a 1.18-fold yearly increase in the odds of receiving each performance measure that was independent of secular trends ($P<0.0001$). Patients treated at all types of participating hospitals benefited from time in GWTG-Stroke, including those of different sizes, annual stroke discharge rates, teaching functions, or geographic regions (Table 4). However, the magnitude of benefit was not equally distributed. The greatest rates of improvement were seen in larger hospitals with more bed capacity, those with the largest annual stroke discharge rates, and those identified as teaching hospitals, as shown in Table 5.

By January 1, 2007, only 66 of the 790 hospitals included in the analysis had dropped out of the program (8.35% overall; mean, 0.52% per quarter). Sensitivity analyses suggested that the improvements observed in the composite measure were not due to join-in of better performers or dropout of poor performers. Compared with active sites, performance on the composite measure was not different for the join-in ($P=0.977$) or dropout ($P=0.887$) sites.

**Discussion**

This study is among the first to characterize national patterns of stroke and TIA care in the context of contemporary guidelines or to assess the influence of a national stroke quality improvement on a set of predefined performance measures. GWTG-Stroke implementation was associated with substantial and sustained improvements in hospital-based acute stroke care and secondary prevention across a large cohort of patients and hospitals. This is the largest report to date of acute stroke care among hospitalized patients and confirms the sustainability and generalizability of the improvements observed in the selected cohort of hospitals from the pilot phase of the program. In addition, the analyses suggest that the benefit resulting from participation...
in the program is independent of secular trends in stroke quality improvement.

GWTG–Stroke was associated with sustained and substantial absolute percentage improvements simultaneously in a wide variety of acute stroke care and secondary prevention performance measures over 4 consecutive years despite the large number of measures and the diverse nature of the participating hospitals. The study clearly shows the impact of the program on stroke and TIA patients hospitalized at participating sites and has broad implications for the possibility to improve stroke care substantially across the country.

It has been estimated that use of intravenous tPA improves the modified Rankin score of functional disability at 3 months by 1 grade in 1 of every 3 patients treated. An increase in the intravenous tPA treatment rate of 30% across the participating sites translates to a substantial expected decrease in functional disability in the population served. If patients continue to adhere to the prevention regimens after discharge, clinical trial data suggest that a substantial reduction in stroke recurrence may also be expected. In addition, even apparently modest increased odds of good care translates to thousands more care opportunities fulfilled when we consider the scope of the program and the number of stroke and TIA patients presenting to hospitals each year. These data also suggest that quality improvement efforts in acute stroke do not need to be limited to only a few domains at a time and that participation is sustainable in the current hospital regulatory and financial climate. In addition, substantial and sustained improvement was also found in the composite measure of performance, reflecting sustained improvement across the sum of all care measures.

### Table 3. Guideline Adherence to Individual Measures Over Time in the GWTG–Stroke Program

<table>
<thead>
<tr>
<th>Performance Measures</th>
<th>Baseline (n=18,961), %</th>
<th>Year 1+ (n=129,650), %</th>
<th>Year 2+ (n=93,380), %</th>
<th>Year 3+ (n=50,982), %</th>
<th>Year 4+ (n=27,779), %</th>
<th>Year 5+ (n=20,950), %</th>
<th>Change, Baseline to Year 5, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute interventions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV tPA for 2 h</td>
<td>42.09</td>
<td>53.46</td>
<td>65.00</td>
<td>69.10</td>
<td>72.65</td>
<td>72.84*</td>
<td>30.75</td>
</tr>
<tr>
<td>Early antithrombotics</td>
<td>91.46</td>
<td>94.20</td>
<td>96.04</td>
<td>96.26</td>
<td>96.76</td>
<td>97.04*</td>
<td>5.58</td>
</tr>
<tr>
<td>DVT prophylaxis</td>
<td>73.79</td>
<td>80.96</td>
<td>84.72</td>
<td>86.45</td>
<td>86.77</td>
<td>89.54*</td>
<td>15.75</td>
</tr>
<tr>
<td>Discharge interventions</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>D/C antithrombotics</td>
<td>95.68</td>
<td>97.10</td>
<td>98.30</td>
<td>98.52</td>
<td>98.62</td>
<td>98.88*</td>
<td>3.20</td>
</tr>
<tr>
<td>Anticoagulation for AF</td>
<td>95.03</td>
<td>96.94</td>
<td>97.85</td>
<td>98.46</td>
<td>97.51</td>
<td>98.39*</td>
<td>3.36</td>
</tr>
<tr>
<td>Lipid-lowering drug for LDL ≥100 mg/dL</td>
<td>73.63</td>
<td>77.86</td>
<td>81.65</td>
<td>83.35</td>
<td>84.53</td>
<td>88.29*</td>
<td>14.66</td>
</tr>
<tr>
<td>Smoking cessation</td>
<td>65.21</td>
<td>75.41</td>
<td>83.62</td>
<td>87.69</td>
<td>89.46</td>
<td>93.61*</td>
<td>28.40</td>
</tr>
<tr>
<td>System measure</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composite measure, mean±SD</td>
<td>83.52±26.58</td>
<td>87.85±22.82</td>
<td>90.63±19.93</td>
<td>91.49±19.22</td>
<td>91.99±18.78</td>
<td>93.97±16.05*</td>
<td>10.45</td>
</tr>
</tbody>
</table>

*IV indicates intravenous; DVT, deep vein prophylaxis; D/C, discharge; AF, atrial fibrillation; and LDL, low-density lipoprotein.

**All trends over time are significant at P<0.0001 using Cochran-Mantel-Haenszel row-mean score test for categorical outcomes and Jonckheere-Terpstra test for continuous outcomes. See Methods for definitions of composite measure.
opportunities, not just those that are the easiest to fulfill. The use of the summary score allows us to succinctly describe the impact of various interventions across the spectrum of stroke care.

Performance improvement varied across measures, with intravenous tPA use, lipid lowering, and smoking cessation showing the highest absolute percent change (14.66% to 30.75%) and antithrombotic use and anticoagulation for atrial fibrillation showing smaller absolute improvements (3.20% to 5.58%). However, it is worth noting that in these areas where baseline performance was already very high (e.g., >90%), the relative reductions in the failure rates of 65% to 74% suggest substantial improvement.

There have been relatively few large studies of quality of care for patients hospitalized with stroke. An initiative sponsored by the Centers for Medicare and Medicaid Services reported improvements in the use of anticoagulants for atrial fibrillation, antithrombotics at discharge, and avoidance of sublingual nifedipine among Medicare patients admitted with ischemic stroke or TIA.14 A study among Michigan Medicare beneficiaries suggested that a quality improvement initiative was associated with increased use of brain imaging during hospitalization and in deep venous thrombosis prophylaxis.24 Preventing Recurrence of Thromboembolic

Table 4. Multivariable Logistic Regression Model of Hospital Characteristics Associated With Composite Score Adherence in GWTG–Stroke

<table>
<thead>
<tr>
<th>Hospital Characteristic</th>
<th>Adjusted OR*</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time in GWTG–Stroke (per 1 y)</td>
<td>1.18</td>
<td>1.12–1.24</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Calendar time (per 1 y)</td>
<td>1.14</td>
<td>1.10–1.20</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Bed size (per 100 units)</td>
<td>1.00</td>
<td>0.97–1.03</td>
<td>NS</td>
</tr>
<tr>
<td>Teaching hospital</td>
<td>1.09</td>
<td>0.95–1.25</td>
<td>NS</td>
</tr>
<tr>
<td>Geographic region (all 4 regions)</td>
<td>0.90</td>
<td>0.74–1.09</td>
<td>NS</td>
</tr>
<tr>
<td>Annual stroke discharges</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–100</td>
<td>0.83</td>
<td>0.68–1.01</td>
<td>0.07</td>
</tr>
<tr>
<td>101–300</td>
<td>1.03</td>
<td>0.86–1.24</td>
<td>NS</td>
</tr>
<tr>
<td>&gt;300 (reference)</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

*Odds ratio (OR) was adjusted for the patient baseline characteristics set by fitting logistic regression models using generalized estimating equations accounting for within-hospital correlation. CI indicates confidence interval.

Table 5. Improvement in Composite Performance per Program Year in GWTG-Stroke by Hospital Type

<table>
<thead>
<tr>
<th>Hospital Characteristic</th>
<th>Adjusted OR*</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital bed capacity, n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–50</td>
<td>1.07</td>
<td>1.00–1.14</td>
<td>0.07</td>
</tr>
<tr>
<td>51–200</td>
<td>1.11</td>
<td>1.05–1.17</td>
<td>0.0003</td>
</tr>
<tr>
<td>201–300</td>
<td>1.14</td>
<td>1.08–1.20</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>301–400</td>
<td>1.17</td>
<td>1.11–1.23</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>&gt;400</td>
<td>1.30</td>
<td>1.20–1.40</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Annual stroke discharge volume, n</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–100</td>
<td>1.13</td>
<td>1.03–1.24</td>
<td>0.007</td>
</tr>
<tr>
<td>101–300</td>
<td>1.12</td>
<td>1.06–1.18</td>
<td>0.0001</td>
</tr>
<tr>
<td>&gt;300</td>
<td>1.28</td>
<td>1.18–1.38</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Teaching status</td>
<td></td>
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<tr>
<td>Teaching hospitals</td>
<td>1.14</td>
<td>01.08–1.21</td>
<td>&lt;0.0001</td>
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<tr>
<td>Nonteaching hospitals</td>
<td>1.12</td>
<td>1.05–1.20</td>
<td>0.0004</td>
</tr>
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</table>

*Odds ratio (OR) was adjusted for patient baseline characteristics and other hospital characteristics by fitting logistic regression models using generalized estimating equations accounting for within-hospital correlation. Only those hospital characteristics that demonstrated a significant interaction with the time in GWTG-Stroke variable are displayed. CI indicates confidence interval.
Events Through Coordinated Treatment (PROTECT) was a single-institution initiative that used tools, protocols, and physician education to significantly improve the provision of stroke secondary prevention therapies, counseling, and education before hospital discharge and to improve adherence at follow-up. The California Acute Stroke Pilot Registry of the Paul Coverdell National Acute Stroke Registry demonstrated that standardized stroke order sets can significantly improve adherence to guideline-based best practices.

None of these prior programs were of the size, national scope, or duration of the GWTG-Stroke program. All were limited by either their relatively small number of participating hospitals or their duration of participation. The present GWTG-Stroke study addresses many of these limitations through the large number of enrolled patients (≈322,000) and sites (≈790), 4-year program duration, use of prespecified evidence-based guidelines, and multivariate modeling to account for secular trends.

Nonetheless, the present study has limitations. Because program participation is voluntary, the observed findings may not be representative of hospitals that chose not to participate. The population in GWTG–Stroke is similar in racial makeup to the global US population, as reflected in the Census 2000 statistics, and has a similar proportion of stroke risk factors compared with other large stroke registries. The average length of stay and in-hospital mortality in GWTG–Stroke were similar to those observed in the 2000 Nationwide Inpatient Sample (length of stay, 5.19 days versus 4.7 days; in-hospital mortality, 4.21% versus 4.09%).

Improvements in care delivery were observed across all types of participating hospitals (Table 4), suggesting that the program benefits are likely generalizable to all hospital types.

Data reliability was enhanced by training and continuing education for data abstractors and built-in automated checks to identify erroneous, illogical data entries. Although no formal data reliability studies were performed within this quality improvement program, data reliability was assessed within the Michigan Paul Coverdell prototype, which used a very similar set of data elements during 2002. In that study, Reeves and colleagues found acceptable interrater reliability for most of the data elements.

A secular trend over time in improved stroke care delivery with an odds ratio of 1.14 per calendar year, independent of the timing of participation in GWTG–Stroke, was observed in our data. Reasons for this secular trend are speculative but could include improved physician adherence to published guidelines or improved stroke systems of care, including the formation of certified stroke centers. Even so, we were able to detect improvement associated with time spent in the GWTG–Stroke program that was independent of calendar time, or hospital and patient characteristics. Our study suggests that participation in the GWTG–Stroke program may be an effective method for increasing guideline adherence.

The greatest improvements were observed in larger hospitals with more bed capacity, those with the largest annual stroke discharge rates, and those with teaching functions. We did not study the reasons for this disparity across hospital types, but it has already been shown that for several complex medical conditions such as coronary artery bypass surgery, carotid endarterectomy, and treatment of subarachnoid hemorrhage, mortality rates are lower at hospitals that treat a larger number of cases. Better outcomes at these high-volume hospitals could be due to specialized services or greater physician or staff expertise. Further research is needed to better understand the effects of hospital subtypes and different quality improvement methodologies on stroke performance.

The GWTG–Stroke registry does not yet routinely collect postdischarge outcomes; therefore, we were unable to directly measure the impact of improved quality of care on clinical outcomes such as recurrent stroke or disability. Obtaining long-term outcomes data is challenging and resource intensive, and this additional financial and data burden may be a significant barrier to participation and long-term sustainability of a large national voluntary registry. A separate prospective observational study, the Adherence Evaluation After Ischemic Stroke Longitudinal (AVAIL) Registry, will seek to identify factors relating discharge adherence to long-term health outcomes in a subset of patients discharged from a voluntary cohort of GWTG hospitals.

The present study has important implications for public health policy. The data show that focused quality improvement efforts, coupled with data reporting in a structured learning environment, can have dramatic results. This effort is a voluntary, unfunded effort by hospitals interested in improving the quality of care they deliver. Increased support for stroke quality initiatives that produce substantial clinical improvements should translate into significant cost savings in the long run. The proposed adoption by the Centers for Medicare and Medicaid Services of stroke measures into the core measures program, as suggested by the inpatient prospective payment system preliminary update for 2010, has the potential to greatly expand efforts at stroke quality improvement. As a large segment of the population enters the eighth and ninth decades of life, stroke event rates will continue to rise even with improvements in stroke prevention. We must act now to improve hospital-based acute stroke treatment capabilities and secondary prevention strategies, including the certification of hospitals related to acute stroke treatment capability and the standardization of emergency medical service response to stroke. The effort to improve stroke systems of care has been underway for several years. Legislation currently before congress (the STOP Stroke Act) has the potential to accelerate the pace of implementation by providing funding to state agencies to develop and deploy stroke systems of care and to increase access for those most vulnerable populations that are currently underserved.

At the hospital level, physicians should move to adopt quality improvement programs such as GWTG–Stroke and request adequate support from hospital administrations to successfully execute the improvement process.

Despite the substantial progress observed in this study, significant opportunity for improvement remains. Even after 5 years, substantial care opportunities among patients discharged from GWTG hospitals remain unfulfilled (Table 3 and the Figure). Efforts that raise institutional awareness and bring additional financial and human resources to stroke care, including stroke center development or public reporting, may
help improve performance. Hospitals should enhance the reliability of their systems of care as they apply to all stroke patients to increase composite rates of care and to address disparities that may be far from ideal even when the rates for adherence on individual measures, or for certain subgroups, are relatively high.

Acknowledgments
We wish to thank all the hospital personnel and local quality improvement champions involved in GWTG-Stroke for their hard work and dedication to improving patient care over the past 4 years.

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Disclosures
Dr Schwamm has consulted on economic models of thrombolytic therapy for Research Triangle Institute. He has provided expert medical opinions in 4 malpractice lawsuits and is supported as a consultant on stroke systems development to the Massachusetts Department of Public Health. He serves as a member of the AHA’s GWTG Steering Committee. Dr Schwamm had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Dr Fonarow has received research grants from GlaxoSmithKline, National Health, Lung, and Blood Institute, and Pfizer; received honoraria from AstraZeneca, Bristol-Myers Squibb, GlaxoSmithKline, Merck, Novartis, Pfizer, Sanofi-Aventis, and Schering Plough; and served as a consultant for GlaxoSmithKline. Dr Fonarow serves as chair of the AHA’s GWTG Steering Committee. Dr Reeves is supported as a consultant to the Michigan Stroke GWTG Registry and serves as a member of the AHA’s GWTG Quality Improvement Subcommittee. Drs Pan and Liang have served as a member of the Duke Clinical Research Institute, which serves as the AHA GWTG data coordinating center. Dr Frankel has received honoraria from Continuing Medical Education events supported by the Bristol-Myers Squibb/Sanofi Pharmaceuticals Partnership. He serves as a member of the AHA’s GWTG Steering Committee. Dr Smith has received research support from the National Institutes of Health (K23, magnetic resonance imaging, stroke, and dementia) and Harvard University (positron emission tomography markers of dementia); and honoraria from Mitsubishi Pharma. He serves as a member of the AHA’s GWTG Science Subcommittee. Dr Ellrodt has served as a member of the AHA’s GWTG Steering Committee. Dr Cannon has received research support from Accumetrics, AstraZeneca, Bristol-Myers Squibb, GlaxoSmithKline, Merck, Sanofi-Aventis, and Schering Plough. Dr Cannon serves as a member of the AHA’s GWTG Steering Committee. Dr Peterson has received research support from BMS-Sanofi, Schering-Plough, Merck-Schering, and the AHA’s GWTG data coordinating center. Dr LaBresh has served as a member of the AHA’s GWTG Steering Committee.

References


CLINICAL PERSPECTIVE

Stroke is the third-leading cause of death and a leading cause of long-term disability. Despite widely available evidence supporting clinical interventions that improve health outcomes for patients hospitalized for acute ischemic stroke or transient ischemic attack, many patients do not receive these recommended interventions. Get With the Guidelines—Stroke is a program of the American Heart Association/American Stroke Association (AHA/ASA) to improve the quality of care of patients with stroke and transient ischemic attack. In this study, Get With the Guidelines—Stroke participation was associated with sustained and substantial improvements in a wide variety of acute stroke care and secondary prevention performance measures over >4 years across a spectrum of participating hospitals. This is the largest report to date of improvements in acute stroke care and confirms the sustainability and generalizability of the improvements observed in the pilot phase of the program. In addition, the analyses suggest that the benefit of the program was independent of secular trends in acute stroke care. The study shows the impact of the program on hospitalized stroke patients and has broad implications for the ability to improve stroke care across the country. If patients continue to adhere to secondary prevention regimens after discharge, clinical trial data suggest a substantial reduction in stroke recurrence applicable to many tens of thousands of patients each year. Increased support for stroke quality initiatives would likely yield substantial improvements in quality of care and clinical outcomes for stroke and transient ischemic attack and translate into substantial healthcare savings.
Get With the Guidelines–Stroke Is Associated With Sustained Improvement in Care for Patients Hospitalized With Acute Stroke or Transient Ischemic Attack
Lee H. Schwamm, Gregg C. Fonarow, Mathew J. Reeves, Wenqin Pan, Michael R. Frankel, Eric E. Smith, Gray Ellrodt, Christopher P. Cannon, Li Liang, Eric Peterson and Kenneth A. LaBresh

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The online version of this article, along with updated information and services, is located on the World Wide Web at:
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Data Supplement (unedited) at:
http://circ.ahajournals.org/content/suppl/2008/12/29/CIRCULATIONAHA.108.783688.DC1
Online Data Supplements: Expanded Methods

Appendix A. Measure Definitions for Eligible Patients*

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV t-PA 2 Hour</td>
<td>Patients presenting within 2 hours of symptom onset who receive IV tPA within 3 hrs of symptom onset</td>
</tr>
<tr>
<td>Early Antithrombotics</td>
<td>Antithrombotic therapy prescribed within 48 hours of hospitalization, including antiplatelet or anticoagulant therapy but not DVT prophylaxis doses of subcutaneous heparins</td>
</tr>
<tr>
<td>DVT Prophylaxis</td>
<td>Patients at risk for DVT (non-ambulatory) who received DVT prophylaxis by the 2nd hospital day, including warfarin, heparins(oid)s, other anticoagulants or pneumatic compression devices</td>
</tr>
<tr>
<td>D/C Antithrombotics</td>
<td>Antithrombotic therapy prescribed at discharge</td>
</tr>
<tr>
<td>Anticoagulation for AF</td>
<td>Anticoagulation prescribed at discharge for patients with atrial fibrillation documented during the hospitalization, including therapeutic doses of warfarin, heparin(oid)s or other anticoagulants.</td>
</tr>
<tr>
<td>LDL 100</td>
<td>Lipid lowering agent prescribed at discharge for patients with an indication per NCEP guidelines if LDL &gt; 100 mg/dl documented or patient taking lipid lowering agents on admission.</td>
</tr>
<tr>
<td>Smoking</td>
<td>Smoking cessation intervention (appropriate medication and/or counseling) provided at discharge</td>
</tr>
</tbody>
</table>

IS, ischemic stroke; LDL, low density lipoprotein cholesterol; RX, treatment; t-PA, tissue plasminogen activator

*Eligible patients are those without any medical contraindications (e.g., treatment intolerance, excessive risk of adverse reaction, patient refusal, or terminal illness/comfort care only) documented as reasons for non-treatment for each of the applicable measures. Discharge and subacute measures exclude patients who expire, are discharged to hospice or another short-term general hospital, leave against medical advice or in whom a discharge destination is blank or unable to be determined. The acute t-PA measures exclude patients with missing or erroneous onset, arrival or treatment times, those who began t-PA at an outside hospital, or who started t-PA after 180 min from onset. The LDL measure includes patients with an indication for lipid lowering based on the AHA Secondary Prevention Guidelines. Users are instructed to “see the ATP III guidelines for detailed instructions on calculating the LDL goal and initiating therapy [www.nhlbi.nih.gov].”