ORIGINAL RESEARCH

Impact of an Expanded Hospital Recognition Program for Stroke Quality of Care

Paul A. Heidenreich, MD, MS; Xin Zhao, MS; Adrian F. Hernandez, MD, MHS; Lee H. Schwamm, MD; Eric Smith, MD, MPH; Mat Reeves, PhD; Eric D. Peterson, MD, MPH; Gregg C. Fonarow, MD

***Background*—**In 2009, the Get With The Guidelines-Stroke (GWTG-Stroke) program offered additional recognition if hospitals performed well on certain stroke quality measures. We sought to determine whether quality of care for all hospitals participating in GWTG-Stroke improved with this expanded recognition program.

***Methods and Results*—**We examined hospital-level performance on 6 quality of care (process) measures and 1 defect-free composite quality measure for stroke following expansion of the existing performance measure recognition program. Compliance with all measures improved following launch of the expanded program, and this rate increased significantly for all 9 measures. When evaluated as the relative rate of increase in use over time, process improvement slowed significantly ($P<0.05$) following launch of the program for 2 measures, and accelerated significantly for 1 measure. However, when evaluated as a gap in care, the decrease in the quality gap was greater following launch of the program for 5 of 6 (83%) measures. There was no evidence that other processes of stroke care suffered as the result of the increase in measures and expanded recognition program.

***Conclusions*—**While care for stroke continues to improve in this country, expanded hospital process performance recognition had mixed results in accelerating this improvement. However, the quality gap continues to shrink among those participating in provider performance programs. **(*J Am Heart Assoc*. 2017;6:e004278. DOI: 10.1161/JAHA.116.004278.)**

Key Words: awards • health care quality assessment • health care quality indicators • hospital performance • performance measure • stroke

The American Heart Association's Get With The Guidelines-Stroke (GWTG-Stroke) program has been developed to measure and improve the quality of care and outcome for patients hospitalized with stroke.[1–11] The program provides via performance achievement awards public recognition of hospitals with high performance on select performance measures for acute ischemic stroke. These measures of achievement include intravenous (IV) tissue plasminogen activator (tPA) within 3 hours (if symptoms onset to door is within 2 hours), use of antithrombotics, timing of antithrombotics, anticoagulation for atrial fibrillation, deep venous thrombosis prophylaxis, low-density lipoprotein (LDL) <100 mg/dL or statin treatment for patients with LDL ≥100 mg/dL, and smoking cessation counseling. Performance on these achievement measures has reached a high level.[1,2] In contrast, performance on several other quality measures that were not utilized as part of the hospital recognition criteria has been poor.[1]

In order to further improve stroke care, the GWTG-Stroke program expanded its recognition program by creating the Plus Awards in 2009. This program provides an added incentive by recognizing hospitals meeting 75% compliance on any 4 additional quality measures. The additional measures are dysphagia screening, stroke education, consideration of rehabilitation, door to tPA time within 1 hour, documentation of LDL cholesterol, intensive statin therapy, last known well to IV tPA time within 4.5 hours if onset to door is less than 3.5 hours, and reporting of the National Institutes of Health Stroke Severity Score.

We sought to evaluate the impact of the Plus awards on quality of stroke care for hospitals participating in GWTG-Stroke. We tested the hypothesis that performance on the quality measures for stroke improved at a faster rate following implementation of the Plus award program than prior to the

From the VA Palo Alto Health Care System, Palo Alto, CA (P.A.H.); Duke Clinical Research Institute, Durham, NC (X.Z., A.F.H., E.D.P.); Massachusetts General Hospital, Boston, MA (L.H.S.); University of Calgary, Alberta, Canada (E.S.); Michigan State University, Lansing, MI (M.R.); University of California Los Angeles, Los Angeles, CA (G.C.F.).

An accompanying Table S1 is available at http://jaha.ahajournals.org/content/6/1/e004278/DC1/embed/inline-supplementary-material-1.pdf

Correspondence to: Paul A. Heidenreich, MD, MS, 111C Cardiology, 3801 Miranda Ave, Palo Alto, CA 94306. E-mail: heiden@stanford.edu

Received July 14, 2016; accepted December 20, 2016.

Plus awards. In addition, we sought to exclude any unintended, negative impact on the pre-existing stroke performance measures following the launch of the PLUS awards.

Methods

GWTG-Stroke is a national voluntary stroke registry and performance improvement initiative from the American Heart Association. In GWTG-Stroke, participating hospitals use an internet-based patient management tool (Quintiles, Cambridge, MA) to collect data on consecutive acute ischemic stroke patients. The methods and quality auditing for GWTG-Stroke have been previously described in detail.

Table 1. Patient and Facility Characteristics of Patients Before and After Initiation of the Enhanced Recognition Program (Plus Awards)

Variable	PostMean	PreMean	Standardized Difference*
N	720 241	429 491	
Age, y	67.7	67.6	0.9
Female, %	51.0	51.7	−1.4
Race—White, %	70.4	72.0	−3.5
Race—Black, %	15.6	14.3	3.6
Insurance—Private, %	41.5	25.8	31.4
Insurance—Medicaid, %	8.6	4.2	15.6
Insurance—Medicare, %	30.0	18.8	23.3
No Insurance/Self, %	7.0	4.0	11.0
Emergency medical service, %	35.5	45.1	−19.3
Atrial fibrillation/flutter, %	13.8	12.7	3.2
Prosthetic heart valve, %	1.3	1.5	−1.3
Previous stroke/TIA, %	29.1	28.7	1.0
Coronary artery disease, %	23.3	24.4	−2.5
Carotid stenosis, %	3.7	3.9	−0.9
Diabetes mellitus, %	29.7	27.3	5.5
Peripheral vascular disease, %	4.0	4.0	0.3
Hypertension, %	72.5	71.0	3.5
Smoker, %	19.3	19.6	−0.7
Dyslipidemia, %	44.0	39.1	9.9
Heart failure, %	6.6	3.1	16.4
Sickle cell disease, %	0.1	0.0	1.8
Current pregnancy, %	0.1	0.0	1.2
Ambulate independently prior to current event, %	75.0	61.4	34.4
Stroke type—IS, %	60.6	52.7	15.9
Stroke type—TIA, %	29.0	36.0	−14.9
NIH Stroke Scale	4.0	4.0	0.7

IS indicates ischemic stroke; NIH, National Institutes of Health; TIA, transient ischemic attack.
*Some consider a standardized difference of 10% or more to be "clinically significant."

Plus Award Intervention

Prior to the introduction of the Plus Awards,[12] the recognition program for the GWTG-Stroke (Achievement Award) publically acknowledged hospitals reaching 85% compliance with each of the following measures: IV tPA within 3 hours (if last known well to IV tPA time is within 2 hours), early antithrombotics, appropriate antithrombotics, anticoagulation for atrial fibrillation, deep venous thrombosis prophylaxis, LDL cholesterol <100 mg/dL or statin treatment for patients with LDL ≥100 mg/dL, and smoking cessation counseling. For a hospital to also be recognized by the new Plus Award Program, they must both receive the established Achievement Award, and demonstrate 75% compliance for 12 consecutive months on 4 out of 8 stroke quality measures: dysphagia screening, stroke education, consideration of rehabilitation, door to tPA time within 1 hour, documentation of LDL cholesterol, intensive statin therapy, use of IV tPA by

Table 2. Comparison of Hospital Characteristics Before and After Launch of the New Quality Metrics (Plus Awards)

Variable	PostMean	PreMean	Standardized Difference
Outcome			
Discharge home, %	92.8	94.5	−6.9
LOS	3.8	4.0	−3.0
Ambulate independently at discharge, %	62.0	75.6	−33.2
Meeting all achievement measures, %	92.1	81.8	31.0
Hospital characteristics			
Annual volume of ischemic stroke admissions	261.6	261.2	0.3
Number of beds	456.4	460.1	−1.2
Region			
Northeast, %	27.6	25.8	4.0
Midwest, %	19.0	18.3	2.0
South, %	36.1	38.7	−5.4
West, %	17.3	17.2	0.2
Teaching hospital, %	61.9	62.0	−0.2
Rural location, %	3.5	3.2	1.6
PSC sites, %	53.7	55.9	−4.4

LOS indicates length of stay; PSC, primary stroke center certification.

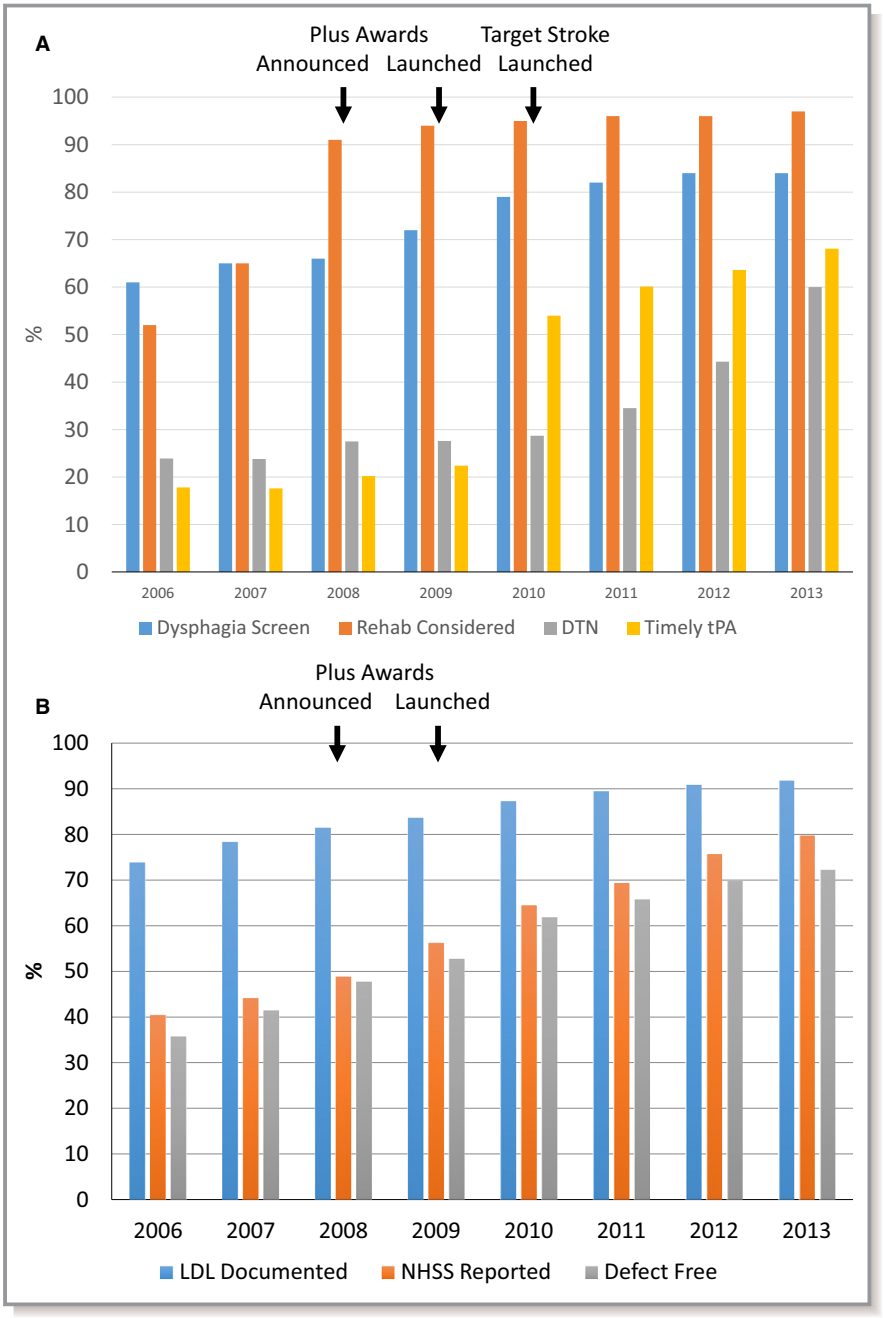

Figure 1. A and B, Trends in use of the quality metrics targeted as part of an expanded hospital recognition program are shown from 2006 to 2013. The program was announced in 2008 and launched in July 2009. All metrics increased over time. Timely reperfusion increased dramatically 1 year after the launch of the Plus awards, which was more closely linked to the launch of an additional program (Target Stroke) that targeted door-to-needle times (DTN). LDL indicates low-density lipoprotein; NHSS, National Institutes of Health Stroke Severity Score; tPA, tissue plasminogen activator.

4.5 hours if last known well to IV tPA time is within 3.5 hours, and reporting of the National Institutes of Health Stroke Severity Score. Prior to the initiation of the Stroke Plus awards, hospitals were provided details of their performance on these measures but there was no public recognition of high performers.

Study Population

A total of 2 480 993 patients with stroke were identified from January 2006 to December 2013. We excluded patients during the Plus award transition period (July 2009–December 2009, N=159 494), patients from sites that did not have

Table 3. Performance on Newer Quality Stroke Measures and Established Achievement Measures for Hospitals That Did (Plus Sites) and Did Not (Non-Plus Sites) Receive the Expanded Plus Award

Variable	Plus SitesMean	Non-Plus SitesMean	Standardized Difference
Quality measures (new)			
Dysphagia screen, %	85.1	69.9	36.9
Rehabilitation considered, %	96.7	92.4	18.9
Door-to-IV tPA time ≤1 hour, %	44.0	35.2	18.0
LDL documented, %	91.2	83.8	22.7
Onset IV tPA by 4.5 hours (if onset to door <3.5 hours), %	67.1	42.4	51.2
NIHSS reported, %	75.7	59.6	35.1
Defect-free measure quality, %	70.7	52.9	37.3
Achievement measures (established)			
Onset to IV tPA by 3 hours (if onset to door <2 hours), %	87.9	60.5	65.9
Early antithrombotics, %	97.7	96.2	8.5
Antithrombotics, %	98.4	97.2	8.4
Anticoagulation for AF, %	95.3	89.3	22.7
DVT prophylaxis, %	97.8	96.8	6.5
LDL 100 mg/dL or ND—statin, %	95.2	92.0	13.2
Smoking cessation, %	98.3	95.2	17.4
Defect-free measure, %	93.1	87.6	18.9

DVT indicates deep venous thrombosis; IV, intravenous; LDL, low-density lipoprotein; ND, not determined; NIHSS, National Institutes of Health Stroke Scale; tPA, tissue plasminogen activator.

patients in both the pre- (January 2006–June 2009) and postaward periods (January 2010–December 2013, N=239 190), patients who died prior to discharge (N=140 460), and patients who were transferred to other healthcare facilities or left against medical advice (N=792 117). Patients who died, transferred, or left against medical advice were older, were more likely to be female, and more likely to have comorbid conditions (Table S1). The primary analysis included 1 149 732 acute ischemic stroke patients from 1224 participating hospitals.

Outcomes

The primary outcomes were use of the quality measures in appropriate candidates. We excluded 2 measures with 12 months or less of pre-award data available (stroke education and intensive statin therapy). The 6 measures included in the analysis were dysphagia screening, consideration of rehabilitation, door to tPA time within 1 hour, documentation of LDL cholesterol, use of IV tPA by 4.5 hours if onset to door is within than 3.5 hours, and reporting of the National Institutes of Health Stroke Severity Score. A defect-free composite quality measure was also created.

All GWTG-Stroke participating institutions were required to comply with local regulatory and privacy guidelines and, if required, to secure institutional review board approval. Sites were granted a waiver of informed consent under the common rule as data were used primarily at the local site for quality improvement. The Duke Clinical Research Institute (Durham, NC) served as the data analysis center, and institutional review board approval was granted to analyze aggregate deidentified data for research purposes.

Statistical Analysis

Patient and hospital characteristics were summarized descriptively for the preprogram and postprogram periods. Standardized mean differences were calculated for the pre- and postaward periods. Piecewise (or segmented) logistic multivariable regression models were performed to track the trends over time of achievement measures in pre-, and post-Plus periods. The adjusted models account for differing hospital and patient characteristics over time. Characteristics included were (1) patient demographics: age, sex, race; (2) medical history: atrial fibrillation, prosthetic heart valve, previous stroke or transient ischemic attack, coronaPry artery disease or prior myocardial infarction, carotid stenosis, peripheral vascular disease, hypertension, dyslipidemia, and smoking; (3) hospital characteristics: annual stroke admission, bed size, region, hospital type (academic versus not), primary stroke center, urban/rural location. For each outcome, we provide the odds ratio (with 95% CI and *P*-value) per 3 calendar months as the rate of improvement during the preprogram period, the odds ratio (with 95% CI and *P*-value) per 3 months after program initiation, and a *P* value comparing these to evaluate if the rate of improvement significantly changed after program initiation. Both unadjusted and adjusted odds ratios and CIs are reported. The generalized estimating equation method with exchangeable working correlation matrix was applied to provide valid inference after accounting for the within-site correlation.[13]

Hospital characteristics were missing in <1%, and patients from these hospitals were excluded in multivariable models. All *P* values are 2-sided, with $P<0.05$ considered statistically significant. Analyses were performed using SAS software (version 9.2; SAS Institute, Cary, NC).

Table 4. Unadjusted and Adjusted Changes in Quality Measures in Pre- and Post-Plus Program

		Unadjusted				Adjusted*			
Outcome	Variable	OR	Lower 95% CI	Upper 95% CI	*P* Value	OR	Lower 95% CI	Upper 95% CI	*P* Value
Dysphagia screen	Calendar time: Pre-Plus (per quarter)	1.078	1.068	1.088	<0.0001	1.066	1.055	1.078	<0.0001
	Calendar time: Post-Plus (per quarter)	1.049	1.043	1.056	<0.0001	1.053	1.045	1.060	<0.0001
	Post vs Pre-Plus	0.974	0.962	0.986	<0.0001	0.987	0.973	1.001	0.0697
Rehabilitation considered	Calendar time: Pre-Plus (per quarter)	1.260	1.239	1.282	<0.0001	1.302	1.278	1.327	<0.0001
	Calendar time: Post-Plus (per quarter)	1.022	1.017	1.027	<0.0001	1.031	1.023	1.039	<0.0001
	Post vs Pre-Plus	0.811	0.796	0.827	<0.0001	0.792	0.774	0.809	<0.0001
Door-to-IV tPA time ≤1 hour	Calendar time: Pre-Plus (per quarter)	0.996	0.981	1.010	0.5708	0.997	0.983	1.010	0.6335
	Calendar time: Post-Plus (per quarter)	1.108	1.099	1.117	<0.0001	1.108	1.099	1.117	<0.0001
	Post vs Pre-Plus	1.113	1.091	1.134	<0.0001	1.112	1.092	1.132	<0.0001
LDL documented	Calendar time: Pre-Plus (per quarter)	1.072	1.066	1.078	<0.0001	1.085	1.076	1.094	<0.0001
	Calendar time: Post-Plus (per quarter)	1.043	1.038	1.048	<0.0001	1.053	1.047	1.060	<0.0001
	Post vs Pre-Plus	0.973	0.965	0.981	<0.0001	0.970	0.959	0.982	<0.0001
Onset IV tPA by 4.5 hours (if onset to door <3.5 hours)	Calendar time: Pre-Plus (per quarter)	1.137	1.124	1.150	<0.0001	1.134	1.122	1.146	<0.0001
	Calendar time: Post-Plus (per quarter)	1.120	1.112	1.128	<0.0001	1.125	1.116	1.133	<0.0001
	Post vs Pre-Plus	0.985	0.970	0.999	0.0423	0.992	0.978	1.006	0.2603
NIHSS reported	Calendar time: Pre-Plus (per quarter)	1.082	1.071	1.092	<0.0001	1.073	1.062	1.084	<0.0001
	Calendar time: Post-Plus (per quarter)	1.077	1.070	1.084	<0.0001	1.082	1.073	1.090	<0.0001
	Post vs Pre-Plus	0.996	0.983	1.008	0.5048	1.008	0.994	1.022	0.2566
Defect-free quality measure	Calendar time: Pre-Plus (per quarter)	1.094	1.086	1.101	<0.0001	1.084	1.076	1.091	<0.0001
	Calendar time: Post-Plus (per quarter)	1.051	1.047	1.056	<0.0001	1.054	1.049	1.059	<0.0001
	Post vs Pre-Plus	0.961	0.953	0.970	<0.0001	0.973	0.964	0.981	<0.0001

IV indicates intravenous; LDL, low-density lipoprotein; NIHSS, National Institutes of Health Stroke Scale; OR, odds ratio; tPA, tissue plasminogen activator.
*Variables in the model—age, sex, white race, insurance, medical history of atrial fibrillation, atrial flutter, chronic obstructive pulmonary syndrome or asthma, diabetes mellitus, hyperlipidemia, hypertension, peripheral vascular disease, prior myocardial infarction, cerebrovascular accident/transient ischemic attack, stroke, anemia, renal insufficiency, smoking, ischemic history, hospital size, hospital type, region, heart transplant, urban/rural location.

Results

The primary analysis compared treatment for 1 149 732 stroke patients (from 1224 hospitals) who were hospitalized in the preprogram period (January 2006–June 2009, N=429 491) or program (Plus Award) period (January 2010–December 2013, N=720 241). Patient and hospital characteristics for both groups are displayed in Tables 1 and 2. In general, differences in patient and hospital characteristics over time were small though often statistically significant because of the large sample size.

Quality Metrics and Plus Awards

Use of the 6 quality metrics are shown over time in Figure 1A and 1B. Use increased for all measures from before (2006–2009) to after initiation of the Plus Award program (2010–2015). Following the launch of the Plus Awards, 132 674 patients were admitted to hospitals receiving Plus Awards compared to 587 567 admitted to non-Award hospitals.

Compliance with all quality metrics use was considerably higher for patients hospitalized at the Plus Award facilities (Table 3). For hospitals recognized with the Plus Award compared to those not recognized, the absolute difference in quality measure performance ranged from 24.7% for use of IV tPA within 4.5 hours in patients arriving within 3.5 hours of last known well to 4.3% for assessed for rehabilitation (Table 3). Performance improved for all quality metrics after initiation of the Plus Award program.

Quality Measured by the Relative Increase in Use

The unadjusted and adjusted rates of increase per quarter for the preprogram period (January 2008–June 2009) were compared with the established program period (January 2010–December 2013) for the 6 quality measures (Table 4).

Adjustment had little impact on the observed odds ratios and confidence intervals. The odds ratio for receiving the recommended care increased significantly more rapidly for 1 measure in the post-Award period than the pre-Award period (IV tPA within 60 minutes), at a similar rate for 3 measures, and more slowly during the post-Award period than during the pre-Award period for 2 measures. For the defect-free composite measure, the rate of improvement was less in the post-Award period.

Quality Measured by the Relative Decrease in Gap in Care

When the yearly decrease in the quality gap (100%-baseline use) was averaged over the 3 pre-Plus years and compared with the 4 post-Plus years (Figure 2), 5 of 6 measures (as well as the composite measure) showed an acceleration in the average annual quality gap reduction following the launch of the Plus Awards.

Impact on Established Measures of Quality

There was no evidence of adverse impact on the established achievement measures (Figure 3A and 3B). Those hospitals receiving the new award (Plus Sites) had better performance on the established Achievement Measures (Table 3).

Discussion

We evaluated the impact of expanding the recognition program of the American Heart Association's GWTG-Stroke Program. We found that performance on the targeted measures improved after launch of the program and the performance of those hospitalized recognized with the Plus Award was considerably better than those not recognized. The rate of change in improvement did not increase for most measures. In fact, we found that the rate of improvement over time was slower for 2 measures and faster for 1 measure following the launch of the Plus awards than in the period before the Plus Awards. However, when measured as the relative decrease in the gap in care, the program was associated with most of the processes improving at an accelerated rate following launch of the program.

These findings demonstrate that the Plus Awards were effective in providing recognition for hospitals with superior performance on the quality measures that were the focus of the awards criteria. Those hospitals receiving the Plus Awards provided higher quality care as measured by all the quality measures compared to those hospitals not recognized. During the postaward period, clinically relevant improvements were observed in the performance for each quality measure. However, the relative rates of improvement in the postaward period were increased only for the IV tPA within 60-minute measure, which was the focus of a separate focused performance improvement initiative Target Stroke,[14,15] which remained similar for 3 measures, and actually decelerated for 2 quality measures.

There are several potential explanations for the decrease in the rate of improvement following the launch of the awards. Each of the process metrics has a ceiling at 100%, and "room" for additional improvement continually decreases as care improves. If changes in performance over time were small

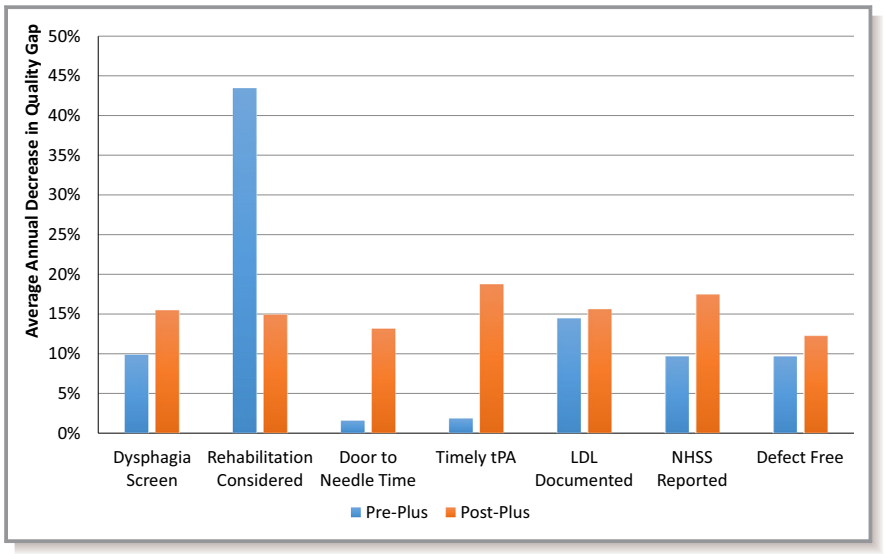

Figure 2. The average annual decrease in the quality gap (between baseline rate and 100%) for each quality measure is shown for the periods before and after the launch of the Plus Awards. LDL indicates low-density lipoprotein; NHSS, National Institutes of Health Stroke Severity Score; tPA, tissue plasminogen activator.

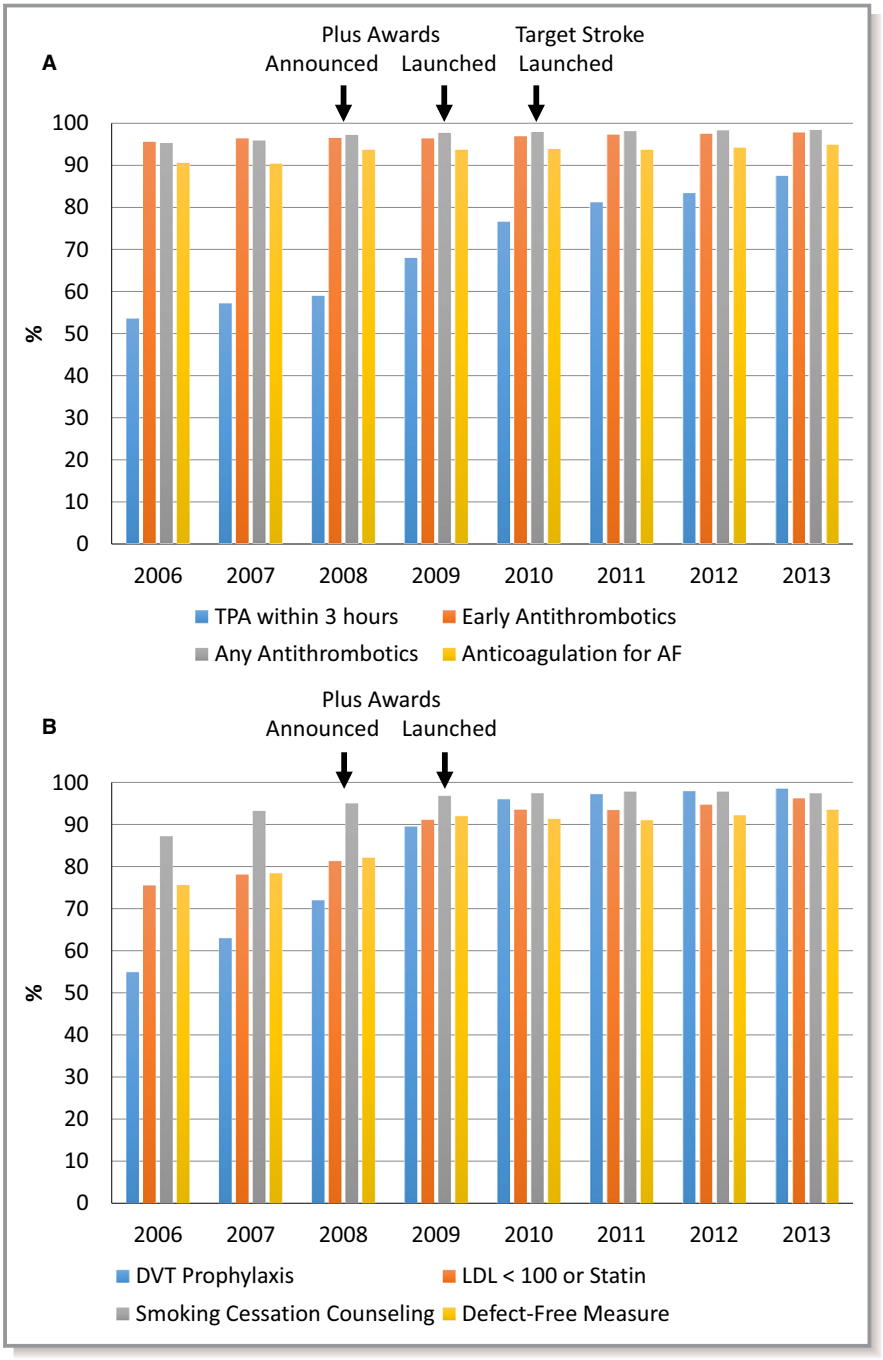

Figure 3. A and B, Trends in use of existing achievement measures that form the primary basis for hospital recognition. There was no evidence that the launch of the new quality measures drew attention away from the established measures. AF indicates atrial fibrillation; DVT, deep vein thrombosis; LDL, low-density lipoprotein; TPA, tissue plasminogen activator.

compared to the gap in care (current versus ideal state), then the examination of rates of change over time may reflect an impact of an intervention. However, we found that care was improving rapidly prior to the launch of the Plus awards. Thus, the impact of ceiling effects may have occurred regardless of the initiation of Plus awards.

Our findings provide guidance for those wishing to evaluate a new intervention when contemporaneous controls are not possible. If quality is stable or only slowly improving, then an analysis of rate of change over time may detect moderate or greater effects of an intervention. However, if the gap in care is rapidly decreasing at baseline, it may not be possible to

detect an incremental effect of any intervention. Measuring the decrease in the "care gap" may be more revealing if the process use is already over 50%.

Our results are consistent with a prior evaluation of the GWTG-Heart Failure enhanced Award program.[16] After the American Heart Association expanded their recognition program by adding additional heart failure quality measures, the investigators noted that care improved. However, as with the current analysis of stroke care, the rate of improvement in heart failure care did not increase after enhancement of the heart failure recognition program. Those metrics that were at a relatively low level prior to launch increased more rapidly than those metrics that were at a higher baseline level.

Other reasons for a slowed rate of increase following the launch of the Plus awards include that the GWTG-Stroke Performance Achievement Award remained the primary motivator for quality improvement even though compliance was already at a high level. Achievement measures usually have a stronger evidence base compared to quality measures that may also contribute to the hospitals' higher level of compliance for Achievement than quality measures. In contrast to the Performance Achievement Award recognition, the Plus awards may not have provided sufficient incentive for hospitals to focus additional meaningful performance improvement efforts on these processes. The hospitals may have felt that an additional award had insufficient value to devote resources to change practice. It is also possible the way the Plus Award recognition program was structured, with the option of which measures to select for recognition, was less effective for facilitating process improvement. The impact of any recognition program may be weakened by strong financial incentives being implemented by many payers including Medicare that began during the study (eg, readmissions reduction), but did not specifically involve patients hospitalized with stroke.[17]

One concern of expanding the number of measures used for recognition or pay for performance is that they will detract from existing measures. In our study there was the potential that hospitals would focus less on the more established (and important) quality measures for stroke care by redirecting resources toward improving the quality measures that were part of the expanded recognition program. However, our results do not provide any evidence of such an effect, as the existing Achievement measures also improved with the launch of the expanded program.

Limitations

There are several potential limitations of this study. The American Heart Association's use of the Plus Award program was nonrandomized, nor did it have a contemporaneous control. The baseline rates of use were often rapidly increasing at the time of the program launch, making it difficult to determine the incremental impact of the program. In addition, the time duration between pre and post measurement may be too short to detect important differences because of the Plus Award Program. The quality measures evaluated by the new recognition program were already reported, privately, to the individual hospitals. Hospitals participating in GWTG-Stroke may be more interested in quality improvement than other hospitals, and these hospitals may have already focused on many of the quality metrics. An additional award may have been a minimal incentive for these higher-performing hospitals. The GWTG-Stroke program is voluntary, and it is not clear whether an award program would have a similar impact if hospitals were mandated to participate.

In summary, we found that an expanded recognition program for the quality of stroke care, while providing recognition to hospitals with superior performance on quality measures, did not have a clear impact on accelerating improvements in care. While care improved compared to baseline, the rate of care improvement slowed for some measures. Importantly, the assessment of the program's impact was different if quality was measured as the relative increase in use or the relative decrease in nonuse (gap in care). Our findings demonstrate the difficulty in interpreting the impact of hospital or provider incentives when contemporaneous controls are not feasible.

Sources of Funding

The Get With The Guidelines–Stroke (GWTG-Stroke) program is provided by the American Heart Association. GWTG-Stroke has been funded in the past through support from Medtronic, GlaxoSmithKline, Ortho-McNeil, and the American Heart Association Pharmaceutical Roundtable. Dr Heidenreich is supported by a grant from the Veteran Administration's Quality Enhancement and Research Initiative 04-326.

Disclosures

Dr Schwamm reports research for PCORI (significant), NINDS (significant), Other: unpaid chair of GWTG Stroke clinical workgroup. Dr Fonarow reports research for PCORI (significant). The remaining authors have no disclosures to report.

References

1. Fonarow GC, Reeves MJ, Smith EE, Saver JL, Zhao X, Olson DW, Hernandez AF, Peterson ED, Schwamm LH; GWTG-Stroke Steering Committee and Investigators. Characteristics, performance measures, and in-hospital outcomes of the first one million stroke and transient ischemic attack admissions in Get With the Guidelines-Stroke. *Circ Cardiovasc Qual Outcomes*. 2010;3:291–302.
2. Fonarow GC, Liang L, Smith EE, Reeves MJ, Saver JL, Xian Y, Hernandez AF, Peterson ED, Schwamm LH; GWTG-Stroke Steering Committee &

Investigators. Comparison of performance achievement award recognition with primary stroke center certification for acute ischemic stroke care. *J Am Heart Assoc*. 2013;2:e000451. DOI: 10.1161/JAHA.113.000451.

3. Reeves MJ, Fonarow GC, Zhao X, Smith EE, Schwamm LH; Get With The Guidelines-Stroke Steering Committee & Investigators. Quality of care in women with ischemic stroke in the GWTG program. *Stroke*. 2009;40:1127–1133.
4. Leffert LR, Clancy CR, Bateman BT, Cox M, Schulte PJ, Smith EE, Fonarow GC, Kuklina EV, George MG, Schwamm LH. Treatment patterns and short-term outcomes in ischemic stroke in pregnancy or postpartum. *Am J Obstet Gynecol*. 2016;214:723.
5. Cumbler E, Wald H, Bhatt DL, Cox M, Xian Y, Reeves M, Smith EE, Schwamm L, Fonarow GC. Quality of care and outcomes for in-hospital ischemic stroke: findings from the National Get With The Guidelines-Stroke. *Stroke*. 2014;45:231–238.
6. Reeves MJ, Smith EE, Fonarow GC, Zhao X, Thompson M, Peterson ED, Schwamm LH, Olson D. Variation and trends in the documentation of National Institutes of Health Stroke Scale in GWTG-Stroke Hospitals. *Circ Cardiovasc Qual Outcomes*. 2015;8:S90–S98.
7. Tong D, Reeves MJ, Hernandez AF, Zhao X, Olson DM, Fonarow GC, Schwamm LH, Smith EE. Times from symptom onset to hospital arrival in the Get with the Guidelines-Stroke Program 2002 to 2009: temporal trends and implications. *Stroke*. 2012;43:1912–1917.
8. Xian Y, Fonarow GC, Reeves MJ, Webb LE, Blevins J, Demyanenko VS, Zhao X, Olson DM, Hernandez AF, Peterson ED, Schwamm LH, Smith EE. Data quality in the American Heart Association Get With The Guidelines-Stroke (GWTG-Stroke): results from a national data validation audit. *Am Heart J*. 2012;163:392–398.
9. Lewis WR, Fonarow GC, Grau-Sepulveda MV, Smith EE, Bhatt DL, Hernandez AF, Olson D, Peterson ED, Schwamm LH. Improvement in use of anticoagulation therapy in patients with ischemic stroke: results from Get With The Guidelines-Stroke. *Am Heart J*. 2011;162:692–699.
10. Ovbiagele B, Schwamm LH, Smith EE, Hernandez AF, Olson DM, Pan W, Fonarow GC, Saver JL. Recent nationwide trends in discharge statin treatment of hospitalized patients with stroke. *Stroke*. 2010;41:1508–1513.
11. Reeves MJ, Grau-Sepulveda MV, Fonarow GC, Olson DM, Smith EE, Schwamm LH. Are quality improvements in the get with the guidelines: stroke program related to better care or better data documentation? *Circ Cardiovasc Qual Outcomes*. 2011;4:503–511.
12. American Heart Association. GWTG Stroke-Recognition Criteria. Available at: http://www.heart.org/HEARTORG/Professional/GetWithTheGuidelines/GetWithTheGuidelines-Stroke/Get-With-The-Guidelines-Stroke-Recognition-Criteria_UCM_310337_Article.jsp#.WBAQVOArKM9. Accessed October 25, 2016.
13. Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther*. 2002;27:299–309.
14. Fonarow GC, Smith EE, Saver JL, Reeves MJ, Hernandez AF, Peterson ED, Sacco RL, Schwamm LH. Improving door-to-needle times in acute ischemic stroke: the design and rationale for the American Heart Association/American Stroke Association's target: stroke initiative. *Stroke*. 2011;42:2983–2989.
15. Fonarow GC, Zhao X, Smith EE, Saver JL, Reeves MJ, Bhatt DL, Xian Y, Hernandez AF, Peterson ED, Schwamm LH. Door-to-needle times for tissue plasminogen activator administration and clinical outcomes in acute ischemic stroke before and after a quality improvement initiative. *JAMA*. 2014;311:1632–1640.
16. Heidenreich PA, Zhao X, Hernandez AF, Yancy CW, Schwamm LH, Albert NM, Fonarow GC. Impact of an expanded hospital recognition program for heart failure quality of care. *J Am Heart Assoc*. 2014;3:e000950. DOI: 10.1161/JAHA.114.000950.
17. Gu Q, Koenig L, Faerberg J, Steinberg CR, Vaz C, Wheatley MP. The Medicare Hospital Readmissions Reduction Program: potential unintended consequences for hospitals serving vulnerable populations. *Health Serv Res*. 2014;49:818–837.

SUPPLEMENTAL MATERIAL

Table S1.

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+
Demographic								
Age*	Median	2082309	72.00	932577	76.00	1149732	69.00	<.0001
	25th		59.00		63.00		57.00	
	75th		82.00		84.00		80.00	
	Mean		69.99		72.82		67.69	
	STD		14.96		14.42		15.00	
	Missing(%)		0.00		0.00		0.00	
Sex	Female	1098446	52.75	508858	54.56	589588	51.28	<.0001
	Male	982016	47.16	422749	45.33	559267	48.64	
	Missing	1847	0.09	970	0.10	877	0.08	
Race	UTD	71438	3.43	32069	3.44	39369	3.42	<.0001
	Native Hawaiian or Pacific Islander	6826	0.33	2852	0.31	3974	0.35	
	White	1480970	71.12	664204	71.22	816766	71.04	
	Asian	54250	2.61	25592	2.74	28658	2.49	
	American Indian or Alaska Native	5955	0.29	2603	0.28	3352	0.29	
	Black or African American	321846	15.46	147766	15.84	174080	15.14	
	Hispanic	135121	6.49	54484	5.84	80637	7.01	
	Missing	5903	0.28	3007	0.32	2896	0.25	
Insurance Status	Not Documented	15469	0.74	6985	0.75	8484	0.74	<.0001
	Self Pay/No Insurance	102021	4.90	34626	3.71	67395	5.86	
	Medicare	595066	28.58	298385	32.00	296681	25.80	
	Medicaid	155275	7.46	74989	8.04	80286	6.98	
	Private/VA/Champus/ Other Insurance	693898	33.32	283812	30.43	410086	35.67	
	Missing	520580	25.00	233780	25.07	286800	24.94	
Arrival & Admission								

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+
Patient location when stroke symptoms discovered	ND or Cannot be determined	37870	1.82	17202	1.84	20668	1.80	<.0001
	Outpatient healthcare setting	19584	0.94	6598	0.71	12986	1.13	
	Stroke occurred while patient was an inpatient in your hospital	34986	1.68	23211	2.49	11775	1.02	
	Chronic health care facility	108398	5.21	86353	9.26	22045	1.92	
	Another acute care facility	89751	4.31	52287	5.61	37464	3.26	
	Not in a healthcare setting	1771635	85.08	737679	79.10	1033956	89.93	
	Missing	20085	0.96	9247	0.99	10838	0.94	
Patient Arrival Mode	ND or Unknown	47587	2.29	19083	2.05	28504	2.48	<.0001
	Transfer from other hospital	209970	10.08	114596	12.29	95374	8.30	
	Private transport/taxi/other from home/scene	647581	31.10	161621	17.33	485960	42.27	
	EMS from home/scene	1000732	48.06	551341	59.12	449391	39.09	
	Missing	176439	8.47	85936	9.21	90503	7.87	
Medical History [M]								
Atrial Fibrillation /Flutter	Yes	343012	16.63	189960	20.60	153052	13.42	<.0001
	No	1719090	83.37	731985	79.40	987105	86.58	
Prosthetic Heart Valve	Yes	29307	1.42	13307	1.44	16000	1.40	0.0157
	No	2032795	98.58	908638	98.56	1124157	98.60	
Previous Stroke/TIA	Yes	617829	29.96	287855	31.22	329974	28.94	<.0001
	No	1444273	70.04	634090	68.78	810183	71.06	
CAD/Prior MI	Yes	512307	24.84	241892	26.24	270415	23.72	<.0001

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+
	No	1549795	75.16	680053	73.76	869742	76.28	
Carotid Stenosis	Yes	76795	3.72	33439	3.63	43356	3.80	<.0001
	No	1985307	96.28	888506	96.37	1096801	96.20	
Diabetes Mellitus	Yes	617134	29.93	288754	31.32	328380	28.80	<.0001
	No	1444968	70.07	633191	68.68	811777	71.20	
PVD	Yes	91231	4.42	45588	4.94	45643	4.00	<.0001
	No	1970871	95.58	876357	95.06	1094514	96.00	
Hypertension	Yes	1522962	73.85	702564	76.20	820398	71.95	<.0001
	No	539140	26.15	219381	23.80	319759	28.05	
Smoker	Yes	359654	17.44	138613	15.03	221041	19.39	<.0001
	No	1702448	82.56	783332	84.97	919116	80.61	
Dyslipidemia	Yes	833210	40.41	352865	38.27	480345	42.13	<.0001
	No	1228892	59.59	569080	61.73	659812	57.87	
HF	Yes	136183	6.60	75442	8.18	60741	5.33	<.0001
	No	1925919	93.40	846503	91.82	1079416	94.67	
Sickle Cell	Yes	967	0.05	399	0.04	568	0.05	0.0310
	No	2061135	99.95	921546	99.96	1139589	99.95	
Current pregnancy	Yes	732	0.04	224	0.02	508	0.04	<.0001
	No	2061370	99.96	921721	99.98	1139649	99.96	
Medical History								
Medical History Panel Missing	Yes	20207	0.97	10632	1.14	9575	0.83	<.0001
	No	2062102	99.03	921945	98.86	1140157	99.17	
Diagnosis & Evaluation								
Ambulatory status prior to	ND	276802	13.29	138145	14.81	138657	12.06	<.0001

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+
current event	Unable to ambulate	57809	2.78	38991	4.18	18818	1.64	
	With assistance (from person)	86240	4.14	55961	6.00	30279	2.63	
	Able to ambulate independently (no help from another person) w/ or w/o devic	1370663	65.82	566500	60.75	804163	69.94	
	Missing	290795	13.97	132980	14.26	157815	13.73	
Stroke Diagnosis	Stroke not otherwise specified	32845	1.58	14699	1.58	18146	1.58	<.0001
	Intracerebral Hemorrhage	229433	11.02	158924	17.04	70509	6.13	
	Subarachnoid Hemorrhage	77677	3.73	42804	4.59	34873	3.03	
	Transient Ischemic Attack (< 24 hours)	426931	20.50	63588	6.82	363343	31.60	
	Ischemic stroke	1315423	63.17	652562	69.97	662861	57.65	
NIH Stroke Scale*	Median	1177938	4.00	525983	7.00	651955	2.00	<.0001
	25th		1.00		3.00		0.00	
	75th		9.00		15.00		5.00	
	Mean		6.68		9.99		4.01	
	STD		7.95		8.78		6.00	
	Missing(%)		43.43		43.60		43.30	
Ambulatory status on admission	ND	229131	11.00	111157	11.92	117974	10.26	<.0001
	Unable to ambulate	334212	16.05	238994	25.63	95218	8.28	
	With assistance (from person)	239782	11.52	115270	12.36	124512	10.83	
	Able to ambulate independently (no help from another person) w/ or w/o devic	430923	20.69	85985	9.22	344938	30.00	
	Missing	848261	40.74	381171	40.87	467090	40.63	
Medication Prior to								

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+
Admission								
No Medications prior to Admission	Yes	205076	9.85	87725	9.41	117351	10.21	.
	Missing	1877233	90.15	844852	90.59	1032381	89.79	
Antiplatelet	No/ND	605855	29.10	272652	29.24	333203	28.98	<.0001
	Yes	436793	20.98	190508	20.43	246285	21.42	
	Missing	1039661	49.93	469417	50.34	570244	49.60	
Anticoagulation	No/ND	921830	44.27	401195	43.02	520635	45.28	<.0001
	Yes	118677	5.70	61373	6.58	57304	4.98	
	Missing	1041802	50.03	470009	50.40	571793	49.73	
Antihypertensive	No/ND	615253	29.55	259663	27.84	355590	30.93	<.0001
	Yes	1285568	61.74	589254	63.19	696314	60.56	
	Missing	181488	8.72	83660	8.97	97828	8.51	
Cholesterol-reducer	No/ND	1223181	58.74	559530	60.00	663651	57.72	<.0001
	Yes	841740	40.42	363268	38.95	478472	41.62	
	Missing	17388	0.84	9779	1.05	7609	0.66	
Diabetic medication	No/ND	1429034	68.63	632904	67.87	796130	69.24	<.0001
	Yes	452549	21.73	207986	22.30	244563	21.27	
	Missing	200726	9.64	91687	9.83	109039	9.48	
Antithrombotic (antiplatelet or anticoagulation)	ND	22574	1.08	12781	1.37	9793	0.85	<.0001
	No	269697	12.95	118046	12.66	151651	13.19	
	Yes	307060	14.75	136980	14.69	170080	14.79	
	Missing	1482978	71.22	664770	71.28	818208	71.17	
Discharge Status								
Discharge Destination	8 - Not Documented or Unable to Determine (UTD)	322	0.02	322	0.03	0	0.00	<.0001
	7 - Left Against Medical Advice/AMA	14206	0.68	14206	1.52	0	0.00	

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+
	6 - Expired	140460	6.75	140460	15.06	0	0.00	
	5 - Other Health Care Facility	718818	34.52	718818	77.08	0	0.00	
	4 - Acute Care Facility	41100	1.97	41100	4.41	0	0.00	
	3 - Hospice - Health Care Facility	54635	2.62	0	0.00	54635	4.75	
	2 - Hospice - Home	20933	1.01	0	0.00	20933	1.82	
	1 - Home	1074164	51.59	0	0.00	1074164	93.43	
	Missing	17671	0.85	17671	1.89	0	0.00	
Length of Stay (transfer-in/out pts excluded)*	Median	1720119	3.00	709004	5.00	1011115	3.00	<.0001
	25th		2.00		3.00		2.00	
	75th		6.00		8.00		4.00	
	Mean		5.13		7.11		3.74	
	STD		6.68		8.38		4.69	
	Missing(%)		2.72		4.67		1.32	
Ambulatory Status	ND	56586	2.72	29972	3.21	26614	2.31	<.0001
	Unable to ambulate	254447	12.22	182980	19.62	71467	6.22	
	With assistance (from person)	439391	21.10	325280	34.88	114111	9.93	
	Able to ambulate independently (no help from another person) w/ or w/o devic	899509	43.20	128158	13.74	771351	67.09	
	Missing	432376	20.76	266187	28.54	166189	14.45	
Hospital Characteristics								
Annual Volume of Ischemic Stroke Admissions*	Median	2082309	229.71	932577	233.56	1149732	224.67	<.0001
	25th		155.60		158.93		153.21	
	75th		347.43		356.10		345.60	
	Mean		265.52		270.55		261.43	
	STD		154.90		157.81		152.38	
	Missing(%)		0.00		0.00		0.00	
Number of Beds*	Median	2081203	382.00	932124	394.00	1149079	374.00	<.0001

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+
	25th		264.00		268.00		260.00	
	75th		567.00		579.00		560.00	
	Mean		465.58		475.24		457.75	
	STD		326.64		330.59		323.19	
	Missing(%)		0.05		0.05		0.06	
Region	West	359489	17.26	161183	17.28	198306	17.25	<.0001
	South	743732	35.72	317389	34.03	426343	37.08	
	Midwest	400569	19.24	185011	19.84	215558	18.75	
	Northeast	578519	27.78	268994	28.84	309525	26.92	
Teaching Hospital	Yes	1321488	63.46	609258	65.33	712230	61.95	<.0001
	No	760025	36.50	323037	34.64	436988	38.01	
	Missing	796	0.04	282	0.03	514	0.04	
Rural Location	Yes	69491	3.34	30696	3.29	38795	3.37	0.0010
	No	2012768	96.66	901848	96.70	1110920	96.62	
	Missing	50	0.00	33	0.00	17	0.00	
Primary Stroke Center	Yes	1143914	54.93	517508	55.49	626406	54.48	<.0001
	No	938395	45.07	415069	44.51	523326	45.52	
Achievement Measure								
Onset to IV tPA by 3 Hour (if Onset to Door <2hr)	Yes	68642	77.84	39273	80.25	29369	74.84	<.0001
	No	19538	22.16	9667	19.75	9871	25.16	
Early Antithrombotics	Yes	943730	96.42	471791	95.88	471939	96.97	<.0001
	No	35005	3.58	20251	4.12	14754	3.03	
Antithrombotics	Yes	1454121	96.96	533915	95.95	920206	97.55	<.0001
	No	45634	3.04	22532	4.05	23102	2.45	
Anticoag for AF	Yes	201557	93.24	97264	92.94	104293	93.51	<.0001
	No	14624	6.76	7386	7.06	7238	6.49	
DVT Prophylaxis	Yes	679757	97.46	365085	97.33	314672	97.62	<.0001

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+
	No	17696	2.54	10018	2.67	7678	2.38	
LDL 100 or ND - Statin	Yes	856285	89.17	313542	88.87	542743	89.35	<.0001
	No	103960	10.83	39281	11.13	64679	10.65	
Smoking Cessation	Yes	292333	95.28	91919	93.67	200414	96.04	<.0001
	No	14472	4.72	6213	6.33	8259	3.96	
Defect-free Measure	Yes	1569072	87.77	638010	86.89	931062	88.39	<.0001
	No	218568	12.23	96290	13.11	122278	11.61	
Quality Measure								
Dysphagia Screen	Yes	1066995	78.79	531248	81.17	535747	76.56	<.0001
	No	287240	21.21	123246	18.83	163994	23.44	
Stroke Education	Yes	726560	83.04	2361	30.69	724199	83.50	<.0001
	No	148398	16.96	5333	69.31	143065	16.50	
Rehabilitation Considered	Yes	1239212	92.01	614889	95.27	624323	89.01	<.0001
	No	107565	7.99	30499	4.73	77066	10.99	
Door-to-IV tPA time <= 1hr	Yes	29826	37.62	16746	37.08	13080	38.33	0.0003
	No	49463	62.38	28415	62.92	21048	61.67	
LDL Documented	Yes	1304009	85.45	484086	84.59	819923	85.96	<.0001
	No	222063	14.55	88180	15.41	133883	14.04	
Onset IV tPA by 4.5 Hour (if Onset to Door < 3.5 Hour)	Yes	82705	47.24	46872	54.28	35833	40.38	<.0001
	No	92371	52.76	39473	45.72	52898	59.62	
NIHSS Reported	Yes	790403	63.19	397806	63.18	392597	63.19	0.9345
	No	460503	36.81	231804	36.82	228699	36.81	
Defect-Free Quality Measure	Yes	1107518	56.74	447619	53.90	659899	58.83	<.0001
	No	844549	43.26	382829	46.10	461720	41.17	

Variable	Level	Total N (2082309)	Overall	N (932577)	Patients excluded	N (1149732)	Study population	P-value+