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ORIGINAL RESEARCH

Absence of July Phenomenon in Acute Ischemic Stroke Care Quality and Outcomes

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Background—Lower care quality and an increase in adverse outcomes as a result of new medical trainees is a concept well rooted in popular belief, termed the "July phenomenon." Whether this phenomenon occurs in acute ischemic stroke has not been well studied.

Methods and Results—We analyzed data from patients admitted with ischemic stroke in 1625 hospitals participating in the Get With The Guidelines–Stroke program for the 5-year period between January 2009 and December 2013. We compared acute stroke treatment processes and in-hospitals outcomes among the 4 quarters (first quarter: July–September, last quarter: April–June) of the academic year. Multivariable logistic regression models were used to evaluate the relationship between academic year transition and processes measures. A total of 967 891 patients were included in the study. There was a statistically significant, but modest (<4 minutes or 5 percentage points) difference in distribution of or quality and clinical metrics including door-to-computerized tomography time, door-to-needle time, the proportion of patients with symptomatic intracranial hemorrhage within 36 hours of admission, and the proportion of patients who received defect-free care in stroke performance measures among academic year quarters (P<0.0001). In multivariable analyses, there was no evidence that quarter 1 of the academic year was associated with lower quality of care or worse in-hospital outcomes in teaching and nonteaching hospitals.

Conclusions—We found no evidence of the "July phenomenon" in patients with acute ischemic stroke among hospitals participating in the Get With The Guidelines–Stroke program. **(*J Am Heart Assoc*. 2018;7:e007685. DOI: 10.1161/JAHA.117.007685.)**

Key Words: ischemic stroke • thrombolysis

Every summer ≈30 000 new physicians start their residency training in teaching hospitals throughout the United States.[1,2] This influx of new physicians is simultaneous with the exit of an equal or larger number of experienced individuals. Such a large turnover in residency programs has been found to be associated with reduction in medical productivity by increasing the resource utilization and has the potential to impact care quality, patient safety, and clinical outcomes.[3] This concern is well rooted not only in the medical community but also in the general public. The perceived danger of getting sick in July has been the subject of multiple news articles in the United States and abroad. This transition period has been referred to as the "July phenomenon."[4–6] Recent publications studying variables related to quality of care, including delays in diagnosis, intraoperative complications, and medication errors, found that early in the academic year (ie, starting in July) there was an increase in surgical complications,[7–9] medication errors,[10] and mortality.[11] The influence of the academic year transition period in acute stroke treatment has not been well studied. A single report in acute ischemic stroke found no evidence of monthly variation in mortality rates across several years in teaching hospitals.[12] Inexperienced physicians could potentially impact outcomes in ischemic stroke including by delays in diagnosis and treatment of patients with acute ischemic stroke. The objectives of this study were to determine whether the

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An accompanying Table S1 is available at http://jaha.ahajournals.org/content/7/3/e007685/DC1/embed/inline-supplementary-material-1.pdf

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Clinical Perspective

What Is New?

- This is one of the first studies to examine whether the quality of care in patients with stroke is impacted by when a patient arrives in the academic calendar year.

What Are the Clinical Implications?

- The quality of care provided for acute ischemic stroke is the same regardless of when patients present to the hospital.

transition into the new academic year is associated with reduced quality of care, including work-up and delivery of thrombolysis, and in-hospital clinical outcomes for patients with acute ischemic stroke.

Methods

The data, analytic methods, and study materials will not be made available to other researchers for purposes of reproducing the results. Study data are confidential and cannot be shared according to the terms of the contracts signed between participating hospitals and the American Heart Association.

Get With The Guidelines–Stroke Registry

Get With The Guidelines–Stroke (GWTG) is an American Heart Association/American Stroke Association voluntary program with the goal of improving the care and outcomes of patients with stroke and transient ischemic attacks through hospital-based performance improvement.[13] In the GWTG registry, cases and data are abstracted by trained hospital personnel instructed to identify consecutive patients admitted with acute ischemic stroke by either prospective clinical identification, retrospective identification using *International Classification of Disease (ICD*-9) discharge codes, or a combination.[13–17] Patient data are abstracted using an Internet-based Patient Management Tool (Outcome Sciences, Cambridge, MA). These include demographics, medical history, initial head computerized tomography (CT) findings, in-hospital treatment and events, discharge treatment and counseling, mortality, and discharge destination. Each participating institution received either human research approval to enroll cases in GWTG-Stroke without requiring individual patient consent under the common rule or a waiver of authorization and exemption from subsequent review by their Institutional Review Board. The Duke Clinical Research Institute serves as the data analysis center and has an agreement to analyze the aggregate de-identified data for research purposes.[15,16] A complete description of the methods of case identification, data collection, and quality auditing methods have been previously reported.[13–17]

Study Population

For this analysis, we excluded sites with missing medical history panel >25% of the time or patients with missing sex and included patients with ischemic stroke admitted to GWTG-Stroke hospitals with diagnosis of ischemic stroke from January 1, 2009 to December 31, 2013 (n=1 151 546). Admission year with 0 admissions in any of the 4 quarters per site were excluded. We excluded transfer-in patients (n=142 625), patients with discharge status missing, left against medical advice, not documented or unable to determine, or transfer-out patients (n=33 427), and missing hospital teaching status (n=7603). After exclusions, a total of 967 891 patients with acute ischemic stroke from 1696 hospitals were included.

Variables

Our primary quality metrics were door-to-CT times (DTC), the proportion of patients with ischemic stroke with brain imaging in <25 minutes (DTC <25), door-to-needle time (DTN), the proportion of IV rtPA (recombinant tissue-type plasminogen activator)–treated cases with door-to-needle time of <60 minutes (DTN <60), the proportion of patients with symptomatic intracranial hemorrhage within 36 hours of admission, and the proportion of patients who received defect-free care in stroke performance measures (DFC). DTC was defined as time in minutes from hospital arrival to acquisition of brain imaging. DTN was defined as time in minutes from hospital arrival to initiation of thrombolytic therapy administration. Symptomatic intracranial hemorrhage <36 was defined as a CT-documented hemorrhage related to clinical deterioration within 36 hours from admission.[18] DFC was defined as the proportion of patients who received all eligible interventions of the 7 predefined by GWTG-Stroke program as primary targets for quality improvement efforts.[19] Clinical end points included in-hospital mortality, discharge to home (versus all other dispositions), independent ambulatory status at discharge, length of stay >4 days, and IV rtPA treatment rate in those who arrived by 2 hours and were treated within 3 hours of symptom onset. Independent ambulatory status was defined as the ability to ambulate independently (no help from another person) with or without a device. IV rtPA arrive by 2 hour, treat by 3 hour was defined as percent of patients with acute ischemic stroke who arrive at the hospital within 120 minutes of time last known well, without contraindications or reasons for not giving IV tPA, who have tPA initiated at the hospital within 180 minutes of time last known well.[20]

Table 1. Baseline Characteristics by Admission Quarter of Patients With Ischemic Stroke by the Get With the Guidelines - Stroke Registry Form 2009 to 2013

Variable	Level	Overall	Jul–Sep	Oct–Dec	Jan–Mar	Apr–Jun	*P* Value
Total		967 891	242 505	243 961	239 309	242 116	
Demographic							
Age, y	Median y (Q1–Q3)	73 (61–83)	73 (61–83)	73 (62–83)	73 (61–83)	73 (61–83)	<0.0001
Sex, %	Female	52.27	52.04	52.49	52.52	52.01	<0.0001
Race, %	White	69.73	69.29	69.93	70.22	69.47	<0.0001
	Black	17.10	17.41	17.05	16.17	17.22	
	Hispanic	6.81	6.95	6.66	6.75	6.87	
	Asian	2.79	2.80	2.83	2.73	2.82	
	Other (includes UTD)	3.57	3.55	3.54	3.59	3.62	
Arrival mode, %	Private transport	39.90	41.04	39.15	38.70	40.72	<0.0001
	EMS	58.44	57.25	59.27	59.67	57.58	
	ND or Unknown	1.65	1.72	1.58	1.62	1.70	
Off hours arrival, %	Yes	43.72	43.89	43.39	43.60	43.99	<0.0001
Onset to arrival time	Median min (Q1–Q3)	193 (67–597)	195 (67–600)	190 (66–603)	196 (68–601)	190 (66–582)	<0.0001
NIHSS score	Median (Q1–Q3)	4 (1–10)	4 (1–9)	4 (1–10)	4 (2–10)	4 (1–10)	<0.0001
Medical history							
Atrial fibrillation, %	Yes	18.48	17.86	19.00	18.88	18.17	<0.0001
Prosthetic heart valve, %	Yes	1.34	1.33	1.35	1.34	1.34	0.8856
Previous stroke/TIA, %	Yes	31.34	31.51	31.33	31.17	31.36	0.0932
CAD/prior MI, %	Yes	25.74	25.42	25.70	26.04	25.81	<0.0001
Carotid stenosis, %	Yes	3.90	3.77	3.89	3.96	3.98	0.0010
Diabetes mellitus, %	Yes	32.98	33.30	32.78	32.80	33.05	0.0002
PVD, %	Yes	4.86	4.77	4.90	4.86	4.90	0.1275
Hypertension, %	Yes	76.38	76.28	76.50	76.38	76.37	0.3317
Smoker, %	Yes	17.60	18.28	17.14	17.16	17.82	<0.0001
Dyslipidemia, %	Yes	43.42	43.62	43.68	42.92	43.44	<0.0001
Heart failure, %	Yes	9.07	8.88	9.21	9.18	9.02	0.0001

CAD indicates coronary artery disease; EMS, emergency medical services; MI, myocardial infarction; ND, not determined; NIHSS, National Institutes of Health Stroke Scale; PVD, peripheral vascular disease; Q1–Q3, 25th to 75th percentiles; TIA, transient ischemic attack; UTD, unable to determine.

The primary exposure was the time period in the academic year, categorized by academic quarters: quarter 1 (Q1) July–September, quarter 2 (Q2) October–December, quarter 3 (Q3) January–March, and quarter 4 (Q4) April–June. A GWTG-Stroke participating hospital was considered to be a teaching hospital if it had an approved residency program and was listed as such in the American Hospital Association Annual Survey.[21]

Statistical Analysis

The baseline characteristics of the acute ischemic stroke population were compared across quarters using Pearson χ^2 tests for categorical variables and Kruskal–Wallis tests for continuous variables. We had an a priori hypothesis that our results would differ by hospital teaching status and further compared baseline characteristics in teaching and nonteaching hospitals. Multivariable logistic regression models with generalized estimating equations approach to account for within-hospital clustering were used for categorical outcomes. Multivariable linear regression models with generalized estimating equations were used for continuous outcomes. The normality of continuous outcomes was assessed and transformations were applied if appropriate. Multivariable models included interaction terms between quarter of admission and teaching status and were adjusted for the following potential patient-level confounders: age, sex, race-ethnicity, atrial fibrillation/flutter, previous stroke/transient ischemic attack,

Table 2. Outcomes by Admission Quarter for All Patients With Ischemic Stroke Admitted to GWTG Participating Hospitals

Variable	Level	Overall	Jul–Sep	Oct–Dec	Jan–Mar	Apr–Jun	*P* Value
Overall, n		967 891	242 505	243 961	239 309	242 116	
In hospital mortality, %	Yes	4.67	4.32	4.83	5.00	4.55	<0.0001
Home discharge, %	Yes	49.27	50.45	48.57	48.06	49.99	<0.0001
Independent ambulatory status at discharge, %	Yes	48.80	49.96	48.39	47.48	49.37	<0.0001
LOS >4 d, %	Yes	39.58	38.69	40.03	40.78	38.85	<0.0001
Door-to-CT time, min	Median (Q1–Q3)	48 (24–93)	48 (24–94)	46 (23–91)	49 (25–95)	49 (25–94)	<0.0001
Door-to-CT <25 min, %	Yes	25.39	25.58	26.68	24.51	24.78	<0.0001
Door-to-needle time	Median (Q1–Q3)	72 (55–95)	71 (54–95)	70 (54–95)	74 (56–97)	72 (54–95)	<0.0001
Door-to-needle time <60 min, %	Yes	33.05	33.56	34.68	30.32	33.46	<0.0001
Arrive by 2 and treated by 3 h, %	Yes	82.26	82.47	83.47	80.79	82.21	<0.0001
Early antithrombotic, %	Yes	96.93	96.97	97.06	96.71	96.97	<0.0001
VTE prophylaxis, %	Yes	97.35	97.42	97.42	97.20	97.32	0.0002
Antithrombotics, %	Yes	98.56	98.56	98.67	98.45	98.55	<0.0001
Anticoagulation for atrial fibrillation/flutter, %	Yes	94.69	94.62	94.75	94.84	94.54	0.3351
Smoking cessation, %	Yes	97.32	97.49	97.38	97.17	97.24	0.0295
LDL 100 or ND—statin, %	Yes	95.14	95.34	95.31	94.81	95.07	<0.0001
Defect-free measure, %	Yes	90.87	91.10	90.92	90.56	90.91	<0.0001
Symptomatic intracranial hemorrhage <36 h	Yes	4.51	4.43	4.63	4.51	4.49	0.8128

CT indicates computerized tomography; GWTG, Get With The Guidelines; LDL, low-density lipoprotein; LOS, length of stay; ND, not determined; Q1–Q3, 25th to 75th percentiles; VTE, venous thromboembolism.

coronary artery disease/prior myocardial infarction, carotid stenosis, diabetes mellitus, peripheral vascular disease, hypertension, dyslipidemia, smoking, arrival off hours versus on hours, and National Institutes of Health Stroke Scale. The following hospital-level covariates were also included: region, hospital teaching status, number of beds, annual ischemic stroke volume, annual IV rtPA volume, rural versus urban, primary stroke center status, and year of admission. While data were used for all 4 quarters, estimates were often produced specifically for April–June versus July–September comparison of interest. If a patient had an unknown status of medical history, it was imputed to "no" as we assumed the hospital personnel did not fill out these portions when none applied. Missing categorical variables were imputed to the most frequent category. National Institutes of Health Stroke Scale and missing hospital characteristics were not imputed and patients without these data were excluded from the multivariable models (32% were missing National Institutes of Health Stroke Scale and 0.02% of study population were missing hospital characteristics). All patient-level covariates were missing <1%. Multivariable models were repeated without adjustment of National Institutes of Health Stroke Scale. All analyses were performed by Duke Clinical Research Institute using SAS software version 9.3 (SAS Institute, Cary, NC).

Results

Demographic and clinical characteristics were similar across quartiles of year and are summarized in Table 1. The GWTG participating hospitals' characteristics are shown in Table S1. Teaching hospitals were larger (median bed number 450 versus 268), more likely to be a primary stroke center (53.6% versus 44.3%), with more annual stroke admissions (median 261 versus 173), and treated more patients with IV rtPA (annual rtPA volume median 19.4 versus 11.7) than nonteaching hospitals. Most teaching hospitals were located in the northeast (32.1%) and south (30.8%), whereas nonteaching hospitals were mostly located in the south (44.5%) and west (23.7%) of the United States.

The differences in distribution of primary and secondary outcomes are outlined in Table 2. Although there were statistically significant differences in most quality metrics and clinical end points across quarters, these results reflect the very large sample size and the actual differences across quarters were small and of limited clinical importance. However, clinically relevant differences were found when comparing patients admitted in the July–September versus the January–March quartiles. Patients admitted in the July–September quartile were more likely to be treated with rtPA within 60 minutes of arrival to the Emergency Room (DTN

Table 3. Outcomes by Admission Quarter for Patients With Ischemic Stroke Admitted to GWTG Participating Teaching Hospitals

Variable	Level	Overall	Jul–Sep	Oct–Dec	Jan–Mar	Apr–Jun	*P* Value
Teaching hospitals, n		564 472	142 065	141 868	138 825	141 714	
In-hospital mortality, %	Yes	5.04	4.71	5.21	5.37	4.87	<0.0001
Home discharge, %	Yes	48.83	50.09	48.03	47.51	49.67	<0.0001
Independent ambulatory status at discharge, %	Yes	48.38	49.48	47.99	46.98	49.05	<0.0001
LOS >4 d, %	Yes	41.30	40.41	41.87	42.49	40.46	<0.0001
Door-to-CT time, min	Median (Q1–Q3)	50 (25–99)	51 (25–101)	48 (24–97)	51 (25–100)	51 (25–100)	<0.0001
Door-to-CT <25 min, %	Yes	24.41	24.53	25.78	23.58	23.73	<0.0001
Door-to-needle time	Median (Q1–Q3)	70 (53–93)	70 (53–93)	69 (52–93)	72 (55–95)	70 (53–93)	<0.0001
Door-to-needle time <60 min, %	Yes	34.92	34.94	36.54	32.41	35.56	<0.0001
Arrive by 2 h and treated by 3 h, %	Yes	85.25	85.18	86.27	84.31	85.17	0.0008
Early antithrombotic, %	Yes	97.02	97.01	97.15	96.92	96.99	0.0405
VTE prophylaxis, %	Yes	97.57	97.67	97.60	97.41	97.61	0.0066
Antithrombotics, %	Yes	98.66	98.63	98.74	98.63	98.63	0.0431
Anticoagulation for atrial fibrillation/flutter, %	Yes	95.31	95.05	95.32	95.68	95.16	0.0282
Smoking cessation, %	Yes	97.59	97.81	97.61	97.36	97.56	0.0167
LDL 100 or ND—statin, %	Yes	95.79	95.91	95.92	95.58	95.73	0.0022
Defect-free measure, %	Yes	91.67	91.78	91.66	91.52	91.70	0.1113
Symptomatic intracranial hemorrhage <36 h	Yes	4.50	4.44	4.56	4.58	4.43	0.9128

CT indicates computerized tomography; GWTG, Get With The Guidelines; LDL, low-density lipoprotein; LOS, length of stay; ND, not determined; Q1–Q3, 25th to 75th percentiles; VTE, venous thromboembolism.

<60: 33.6% versus 30.3%), receive early antithrombotic treatment (97.0% versus 96.7%), be discharged home (50.5% versus 48.1%), be independent at discharge (50.0% versus 47.5%), and have a shorter hospital stay (length of stay >4 days: 38.7% versus 40.8%). These differences persisted when the sample was separated by teaching status. The differences in distribution of all outcomes are summarized in Tables 3 and 4 by hospital teaching status.

In multivariable analyses (Table 5) we found a small statistically significant increase in the risk of mortality for Q4 (April–June) when compared with Q1 (July–September) in teaching (adjusted odds ratio 1.04, 95% confidence interval CI, 1.01–1.08) and nonteaching hospitals (adjusted odds ratio 1.08, 95% confidence interval, 1.03–1.14). We also found a small statistical significant decrease in the proportion of patients with DCT <25 for Q4 when compared with Q1 in both teaching (adjusted odds ratio 0.96, 95% confidence interval, 0.93–0.98) and nonteaching hospitals (adjusted odds ratio 0.96, 95% confidence interval, 93–0.99). The association between admission quarter and mortality was not significantly different between teaching and nonteaching sites (*P*=0.47). No significant differences were seen in home discharge, independent status at discharge, length of stay >4 days, DFC, and symptomatic intracranial hemorrhage in <36 hours in both teaching and nonteaching hospitals for Q4 versus Q1 (Table 5). The associations between admission quarter and the above outcomes were not significantly different by site teaching status.

Discussion

Our study is one of the first to analyze the influence of academic calendar year on variables associated with the quality of acute stroke care provided among teaching and nonteaching hospitals. We evaluated process and quality variables as we believed these variables would likely be highly sensitive to the influence of the experience and comfort level of the trainee and have a high overall impact on clinical outcome. Our research focused on DCT <25, DTN <60, symptomatic intracranial hemorrhage <36, and DFC as these variables measure the quality of care patients with stroke receive on admission, hospital stay, and discharge and can readily identify areas where new trainees' inexperience impact patient care. Encouragingly, we did not find that evidence of delays in diagnosis (DCT <25), treatment with thrombolytic therapy (DTN <60), increase in complications (symptomatic intracranial hemorrhage), or decrease in quality (DFC) were found throughout the year. Though we found statistical significant differences in distribution of stroke mortality,

Table 4. Outcomes by Admission Quarter for Patients With Ischemic Stroke Admitted to GWTG Participating Nonteaching Hospitals

Variable	Level	Overall	Jul–Sep	Oct–Dec	Jan–Mar	Apr–Jun	*P* Value
Nonteaching hospitals, n		403 419	100 440	102 093	100 484	100 402	
In hospital mortality, %	Yes	4.16	3.76	4.30	4.48	4.10	<0.0001
Home discharge, %	Yes	49.88	50.96	49.33	48.80	50.43	<0.0001
Independent ambulatory status at discharge, %	Yes	49.39	50.56	48.95	48.18	49.83	<0.0001
LOS >4 d, %	Yes	37.20	36.28	37.50	38.44	36.60	<0.0001
Door-to-CT time, min	Median (Q1–Q3)	46 (23–86)	45 (23–85)	44 (22–84)	47 (24–89)	46 (24–86)	<0.0001
Door-to-CT <25 min, %	Yes	26.80	27.11	27.95	25.81	26.29	<0.0001
Door-to-needle time	Median (Q1–Q3)	75 (56–98)	74 (56–96)	73 (56–96)	77 (58–100)	75 (56–98)	<0.0001
Door-to-needle time <60 min, %	Yes	29.83	31.15	31.39	26.84	29.80	<0.0001
Arrive by 2 h and treated by 3 h, %	Yes	77.50	78.12	78.96	75.39	77.49	<0.0001
Early antithrombotic, %	Yes	96.80	96.91	96.94	96.43	96.93	<0.0001
VTE prophylaxis, %	Yes	97.04	97.14	97.18	96.90	96.91	0.0055
Antithrombotics, %	Yes	98.42	98.46	98.58	98.21	98.44	<0.0001
Anticoagulation for atrial fibrillation/flutter, %	Yes	93.87	94.05	94.00	93.74	93.68	0.5082
Smoking cessation, %	Yes	96.91	96.99	97.02	96.89	96.73	0.4524
LDL 100 or ND—statin, %	Yes	94.25	94.56	94.48	93.76	94.13	<0.0001
Defect-free measure, %	Yes	89.77	90.15	89.90	89.24	89.80	<0.0001
Symptomatic intracranial hemorrhage <36 h	Yes	4.53	4.41	4.75	4.37	4.59	0.6937

CT indicates computerized tomography; GWTG, Get With The Guidelines; LDL, low-density lipoprotein; LOS, length of stay; ND, not determined; Q1–Q3, 25th to 75th percentiles; VTE, venous thromboembolism.

discharge to home, length of stay, DCT, DTN, early antithrombotic, venous thromboembolism prophylaxis, antithrombotic medication at discharge, smoking cessation, statin use, and DFC across the academic quarters, these differences were small, not clinically significant, and not readily attributable to the influx of new physicians in training in teaching hospitals. In both teaching and nonteaching institutions, we found slightly higher mortality rate, longer length of stay, and smaller chance of home discharge but similar DTC and DTN times during the first 3 months of the calendar year, but with no clear increase during the beginning of the academic year.

This longitudinal variation is most probably the result of other factors not related to changes in the workforce, such as changes in weather or pollution. Experience in the United States, Japan, and Argentina[22–24] suggests an association between cold weather and stroke mortality. The authors of these reports hypothesized that in colder weather, patients with stroke may experience an increase in physiological stresses, have a higher risk of respiratory infections and influenza-like illnesses, and may arrive later to the hospital if weather influences road conditions. In our study we also found that completion of CT within 25 minutes was slightly less frequent in Q1 versus Q4, which may be related to nonworkforce issues. For example, completion of DCT may be influenced by census and crowding in the Emergency Department, which tends to be higher during winter months because of influenza-like illnesses and respiratory infections.[25]

Our findings differ from reports that suggested there is a "July phenomenon."[7–11] However, these results are consistent with other reports in neurology, obstetrics, critical care, internal medicine, neurosurgery, and trauma surgery in finding no evidence of an increase in mortality, length of stay, complication rates, or hospital costs associated with this transition period.[12,26–32] In addition, we went further, focusing on multiple process and quality variables as well as clinical outcomes in the studied population and did not find an increase in complications or deterioration of care related to the initiation of the academic year.

Our study has the strength of comparing multiple process and quality variables in a large sample and not only concentrating on mortality. Mortality in modern health care is an infrequent event that usually is the result of multiple system failures and usually cannot be attributed to a single element.[33] The lack of association between the "July phenomenon" and longer DTC, DTN, increased proportion of patients with symptomatic intracranial hemorrhage, and decreased proportion of patients receiving all eligible stroke

Table 5. Unadjusted and Adjusted Multivariate Logistic Regression Models for Teaching Hospitals Clinical Outcomes Between April–June Versus July–September

Clinical Outcome	Apr–Jun N (%)	Jul–Sep N (%)	Unadjusted OR (95% CI)	*P* Value	Adjusted OR (95% CI)	*P* Value
Teaching hospitals						
Mortality	6902 (4.9)	6692 (4.7)	1.04 (1.00–1.08)	0.0496	1.04 (1.01–1.08)	0.0202
Home discharge	70 393 (49.7)	71 159 (50.1)	0.98 (0.97–1.00)	0.0299	0.98 (0.96–1.01)	0.1343
Independent status	55 239 (49.1)	54 814 (49.5)	0.98 (0.96–1.00)	0.0767	0.98 (0.95–1.00)	0.0987
LOS >4 d	55 363 (40.5)	55 468 (40.4)	1.00 (0.99–1.02)	0.8039	0.99 (0.97–1.01)	0.1989
Door-to-CT acquisition time <25 min	25 277 (23.7)	26 097 (24.5)	0.96 (0.94–0.98)	0.0001	0.96 (0.93–0.98)	0.0009
Door-to-Needle time <60 min	3594 (35.6)	3588 (34.9)	1.03 (0.97–1.09)	0.4072	1.01 (0.95–1.08)	0.6482
Defect-free care	121 057 (91.7)	121 510 (91.8)	0.99 (0.96–1.02)	0.4213	0.98 (0.94–1.02)	0.2419
Symptomatic intracranial hemorrhage <36 h	542 (4.4)	559 (4.4)	1.00 (0.89–1.12)	0.9416	0.99 (0.88–1.12)	0.9081
Nonteaching hospitals						
Mortality	4114 (4.1)	3780 (3.8)	1.09 (1.04–1.15)	0.0005	1.08 (1.03–1.14)	0.0022
Home discharge	50 629 (50.4)	51 183 (51.0)	0.98 (0.96–1.00)	0.0206	1.00 (0.98–1.03)	0.9604
Independent status	39 338 (49.8)	39 080 (50.6)	0.97 (0.95–0.99)	0.0031	0.98 (0.95–1.02)	0.2843
LOS >4 d	35 918 (36.6)	35 651 (36.3)	1.01 (0.99–1.03)	0.1565	1.00 (0.98–1.03)	0.7601
DCT <25	19 527 (26.3)	20 015 (27.1)	0.96 (0.93–0.99)	0.0034	0.96 (0.93–0.99)	0.0158
DTN <60	1727 (29.8)	1832 (31.1)	0.93 (0.85–1.01)	0.0930	0.93 (0.85–1.02)	0.1274
Defect-free care	84 421 (89.8)	85 029 (90.1)	0.96 (0.94–0.99)	0.0040	0.98 (0.94–1.02)	0.3543
Symptomatic intracranial hemorrhage <36 h	314 (4.6)	307 (4.4)	1.05 (0.90–1.22)	0.5572	1.07 (0.91–1.26)	0.3905

Adjustment variables: age, sex, race, atrial fibrillation/flutter, previous stroke/transient ischemic attack, coronary artery disease/prior myocardial infarction, carotid stenosis, diabetes mellitus (combined), peripheral vascular disease, hypertension, dyslipidemia, smoking, arrival off hours vs on hours, National Institutes of Health Stroke Scale score, region, hospital type, number of beds, annual ischemic stroke volume, annual IV tissue-type plasminogen activator volume, rural vs urban, primary stroke center status, year of admission. CI indicates confidence interval; LOS, length of stay >4 d; OR, odds ratio.

interventions in the last quarter of the academic year probably has multiple explanations. Our study population was limited to GWTG-Stroke participating hospitals; active participation in this program has been associated with improved stroke care and adherence to stroke performance measures.[16] The high levels of institutional capacity and organization likely associated with GWTG-Stroke hospitals could compensate for any deleterious influence that inexperienced physicians may have on clinical outcomes. Furthermore, teaching hospitals have established orientation courses, safety policies, guidelines, checklists,[34] and resident-based acute stroke protocols[35] in preparation to the arrival of new trainees. These strategies plus a multidisciplinary stroke team and increased supervision by senior residents, fellows, and attending physicians can compensate for inexperience. Knowledge by the new trainees' supervisors, along with close monitoring early in the year, can increase guidelines compliance, hence increasing the chances of meeting time window goals in the treatment of patients with acute ischemic stroke.

Although our study has the benefit of a large sample from a validated as representative registry,[36] we acknowledge several potential limitations. Although we looked separately at academic teaching and nonteaching hospitals as defined by the American Hospital Association, we did not have data on whether the teaching hospitals identified had a neurology or emergency medicine residency program. We were therefore unable to analyze independently whether the "July phenomenon" might have been more evident in hospitals with these residencies. In hospitals without neurology programs, acute stroke care might be provided by trained neurologists or seasoned physicians, thereby decreasing the overall effect of new trainees. We were also unable to determine the proportion of patients who did not receive thrombolysis despite being eligible for treatment. Failure to treat patients with mild symptoms has been associated with worse short-term outcomes[37] and persistent disability.[38] Since academic centers have higher IV rtPA utilization,[38] this could create a shift towards better outcomes in teaching hospitals, potentially buffering any influence that new residents might have on outcomes. Residual measured or unmeasured confounding may have influenced some or all of these findings.

Conclusions

In a large nationwide acute stroke registry, we found no clinically significant differences in acute stroke treatment quality measures or clinical outcomes during the first 3 months of the academic year. No differences were noted by teaching hospital status. We conclude that the quality of care and clinical outcomes for acute ischemic stroke does not depend on the time of the academic year regardless of hospital teaching status among institutions participating in GWTG-Stroke.

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References

1. National Resident Matching Program. Results and data. 2015 Main residency match. Available at: http://www.nrmp.org/wp-content/uploads/2015/05/Main-Match-Results-and-Data-2015_final.pdf. Accessed April 17, 2015.
2. Barzansky B, Etzel S. Medical schools in the United States, 2008–2009. *J Am Med Assoc*. 2009;302:1349–1355.
3. Huckman RS, Song H, Barro JR. Cohort turnover and productivity: the July phenomenon in teaching hospitals. Working Paper. Harvard Business School; May 16, 2014.
4. Friedman R. Their coats are white, but their hands are green. New York Times. Available at: http://www.nytimes.com/2004/06/29/health/29case.html. Accessed October 8, 2015.
5. Brown T. Don't get sick in July. New York Times. Available at: https://opinionator.blogs.nytimes.com/2012/07/14/dont-get-sick-in-july/. Accessed October 8, 2015.
6. Rogers S. Will patients really die this week because of new NHS hospital doctors? The Guardian. Available at: https://www.theguardian.com/politics/reality-check/2012/aug/01/black-wednesday-new-nhs-hospital-doctors. Accessed October 8, 2015.
7. Englesbe M, Shawn P, Magee J, Gauger P, Schiffner T, Henderson WG, Khuri SF, Campbell DA. Seasonal variation in surgical outcomes as measured by the American College of Surgeons-National Surgical Quality Improvement Program (ACS-NSQIP). *Ann Surg*. 2007;246:456–465.
8. Dasenbrock HH, Clarke MJ, Thompson RE, Gokaslan ZL, Bydon A. The impact of July hospital admission on outcome after surgery for spinal metastases at academic medical centers in the United States, 2005 to 2008. *Cancer*. 2012;118:1429–1438.

9. Inaba K, Recinos G, Teixeira PGR, Barmparas G, Talving P, Salim A, Brown C, Rhee P, Demetriades D. Complications and death at the start of the new academic year: is there a July phenomenon. *J Trauma*. 2010;68:19–22.
10. Phillips D, Barker G. A July spike in fatal medication errors: a possible effect of new medical residents. *J Gen Intern Med*. 2010;25:774–779.
11. Young JQ, Ranji SR, Watchter RM, Lee CM, Niehaus B, Auerbach AD. "July effect": impact of the academic year-end changeover on patient outcomes. A systematic review. *Ann Intern Med*. 2011;155:309–315.
12. Alshekhlee A, Walbert T, DeGeorgia M, Preston DC, Furlan AJ. The impact of Accreditation Council for Graduate Medical Education duty hours, the July phenomenon, and hospital teaching status on stroke outcomes. *J Stroke Cerebrovasc Dis*. 2009;18:232–238.
13. LaBresh KA, Reeves MJ, Frankel MR, Albright D, Schwamm LH. Hospital treatment of patients with ischemic stroke or transient ischemic attack using the "Get With The Guidelines" Program. *Arch Intern Med*. 2008;168:411–417.
14. Marler JR, Tilley BC, Lu M, Brott TG, Lyden PC, Grotta JC, Broderick JP, Levine SR, Frankel MP, Horowitz SH, Haley EC Jr, Lewandowski CA, Kwiatkowski TP. Early stroke treatment associated with better outcome: the NINDS rt-PA stroke study. *Neurology*. 2000;55:1649–1655.
15. 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.
16. Schwamm LH, Fonarow GC, Reeves MJ, Pan W, Frankel MR, Smith EE, Elrodt G, Cannon CP, Liang L, Peterson R, Labresh KA. Get With the Guidelines-Stroke is associated with sustained improvement in care for patients hospitalized with acute stroke or transient ischemic attack. *Circulation*. 2009;119:107–115.
17. Fonarow GC, Reeves MJ, Smith EE, Saver JL, Zhao X, Olson DW, Hernandez AF, Peterson ED, Schwamm LH. 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.
18. The NINDS t-PA Stroke Study Group. Intracerebral hemorrhage after intravenous t-PA therapy for ischemic stroke. *Stroke*. 1997;28:2109–2118.
19. Reeves MJ, Fonarow GC, Zhao X, Smith EE, Schwamm LH. Quality of care in women with ischemic stroke in the GWTG program. *Stroke*. 2009;40:1127–1133.
20. Get With the Guidelines-Stroke 2015 fact sheet. American Heart Association/American Stroke Association. Available at: http://www.heart.org/idc/groups/heart-public/@wcm/@gwtg/documents/downloadable/ucm_310976.pdf. Accessed October 8, 2015.
21. HCUP NIS description of data elements. Healthcare Cost and Utilization Project (HCUP). Available at: www.hcup-us.ahrq.gov/db/vars/hosp_teach/nisnote.jsp. Accessed April 23, 2015.
22. Licthman JH, Jones SB, Wang Y, Leifheit-Limson EC, Goldstein LB. Seasonal variation in 30-day mortality after stroke: teaching versus nonteaching hospitals. *Stroke*. 2013;44:531–533.
23. Turin TC, Kita Y, Rumana N, Murakami Y, Ichikawa M, Sugihara H, Morita Y, Tomioka N, Okayama A, Nakamura Y, Ueshima H. Stroke case fatality shows seasonal variation regardless of risk factor status in a Japanese population: 15-year results from the Takashima Stroke Registry. *Neuroepidemiology*. 2009;32:53–60.
24. Diaz A, Gerschcovich ER, Diaz AA, Antia F, Gonorazky S. Seasonal variation and trends in stroke hospitalizations and mortality in a South American community hospital. *J Stroke Cerebrovasc Dis*. 2013;22:e66–e69.
25. Ward MJ, Farley H, Khare RK, Kulstad E, Mutter RL, Shesser R, Stone-Griffith S. Achieving efficiency in crowded emergency departments: a research agenda. *Acad Emerg Med*. 2011;18:1303–1312.
26. Van Walraven C, Jennings A, Wong J, Foster A. Influence of house-staff experience on teaching-hospital mortality: the "July phenomenon" revisited. *J Hosp Med*. 2011;6:389–394.
27. Barry W, Rosenthal G. Is there a July phenomenon? The effect of July admission on intensive care mortality and length of stay in teaching hospitals. *J Gen Intern Med*. 2003;18:639–645.
28. Claridge JA, Schulman AM, Sawyer RG, Ghezel-Ayagh A, Young JS. The "July phenomenon" and the care of the severely injured patient: fact or fiction? *Surgery*. 2001;130:346–353.
29. McDonald RJ, Cloft H, Kallmes D. Impact of admission month and hospital teaching status on outcomes in subarachnoid hemorrhage: evidence against the July effect. *J Neurosurg*. 2012;116:157–163.
30. Ford AA, Bateman BT, Simpson LL, Ratan RB. Nationwide data confirms absence of "July phenomenon" in obstetrics: it's safe to deliver in July. *J Perinatol*. 2007;27:73–76.
31. Myles T. Is there an obstetric July phenomenon? *Obstet Gynecol*. 2003;102:1080–1084.
32. Weaver K, Neal D, Hoh DJ, Mocco J, Barker FG, Hoh BL. The "July phenomenon" for neurosurgical mortality and complications in teaching hospitals: an analysis of more than 850 000 neurosurgical patients in the nationwide inpatient sample database, 1998 to 2008. *Neurosurgery*. 2012;71:562–571.
33. Jena AB, Sun EC, Romley JA. Mortality among high-risk patients with acute myocardial infarction admitted to US teaching-intensive hospitals in July. A retrospective observational study. *Circulation*. 2013;128:2754–2763.
34. Barach P, Philibert I. The July effect: fertile ground for systems improvement. *Ann Intern Med*. 2011;155:331–332.
35. Ford AL, Connor LT, Tan DK, Williams JA, Lee JM, Nassief AM. Resident-based acute stroke protocol is expeditious and safe. *Stroke*. 2009;40:1512–1514.
36. Reeves MJ, Fonarow GC, Smith EE, Pan W, Olson D, Hernandez AF, Peterson ED, Schwamm LH. Representativeness of the Get With the Guidelines-Stroke Registry: comparison of patient and hospital characteristics among Medicare beneficiaries hospitalized with ischemic stroke. *Stroke*. 2012;43:44–49.
37. Smith EE, Fonarow GC, Reeves MJ, Cox M, Olson DM, Hernandez AF, Schwamm LH. Outcomes in mild or rapidly improving stroke not treated with intravenous recombinant tissue-type plasminogen activator. Findings from Get With the Guidelines-Stroke. *Stroke*. 2011;42:3110–3115.
38. Moradiya Y, Crystal H, Valsamis H, Levine S. Thrombolytic utilization for ischemic stroke in US hospitals with neurology residency program. *Neurology*. 2013;81:1986–1995.

SUPPLEMENTAL MATERIAL

Table S1. Get-With-The-Guidelines Participating Hospitals by Teaching Status.

Variable	Level	Overall N=967891	Teaching Hospitals N=564472	Non-Teaching Hospitals N=403419
Region (%)	West	18.65	15.06	23.68
	South	36.49	30.78	44.49
	Midwest	18.62	22.12	13.72
	Northeast	26.24	32.05	18.11
Teaching Hospital	Yes	58.32	100	0
Number of beds	Median (Q1-Q3)	355 (244 – 533)	450 (325 – 639)	268 (186 - 367)
PSC status	Yes	49.68	53.56	44.25
Annual IS admissions	Median (Q1-Q3)	213.26 (144.80 – 321.94)	261.23 (171.32 – 366.91)	173.33 (122.48 – 239.79)
Annual tPA administration	Median (Q1-Q3)	15.53 (8.89 – 25.48)	19.35 (10.84 - 29.58)	11.70 (6.92 - 18.67)
% tPA given out of all IS admissions	Median (Q1-Q3)	7.69 (5.00 – 11.03)	8.44 (5.84 – 12.15)	6.70 (4.02 – 9.60)

PSC: primary stroke center. IS: ischemic stroke. rtPA: recombinant tissue type plasminogen activator