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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

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

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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. 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. 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. A complete description of the methods of case identification, data collection, and quality auditing methods have been previously reported.

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=1 515 546). 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. 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. 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.
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 $\chi^2$ 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.
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
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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      | <0.0001 |
| 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                 | 97.99        | 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, 0.93–0.99). 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,
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 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.

Our findings differ from reports that suggested there is a “July phenomenon.” 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. 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. 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
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. 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, and resident-based acute stroke protocols 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, 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 and persistent disability. Since academic centers have higher IV rtPA utilization, this phenomenon 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.

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) | 0.6842 |
| 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.
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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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            |                            | 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