

Stroke Hospital Characteristics in the Florida–Puerto Rico Collaboration to Reduce Stroke Disparities Study

Maria A. Ciliberti-Vargas, MPH, Hannah Gardener, ScD, Kefeng Wang, MS, Chuanhui Dong, PhD, Li Yi, MS, Jose G. Romano, MD, Mary Robichaux, MPH, Salina P. Waddy, MD, Ulises Nobo, MD, Sandra Diaz-Acosta, BA, Tatjana Rundek, MD, PhD, Michael F. Waters, MD, PhD, and Ralph L. Sacco, MD, MS

Objectives: Although disparities in stroke care and outcomes have been well documented nationally, state-based registries to monitor acute stroke care in Florida (FL) and Puerto Rico (PR) have not been established. The FL-PR Collaboration to Reduce Stroke Disparities (CReSD) was developed to evaluate race-ethnicity and regional disparities in stroke care performance. The objective of this study was to assess and compare hospital characteristics within a large quality improvement registry to identify characteristics associated with better outcomes for acute ischemic stroke care.

Methods: Trained personnel from 78 FL-PR CReSD hospitals (69 FL, 9 PR) completed a 50-item survey assessing institutional characteristics across seven domains: acute stroke care resource availability, emergency medical services integration, stroke center certification, data collection and use, quality improvement processes, FL-PR CReSD recruitment incentives, and hospital infrastructure.

Results: The rate of survey completion was 100%. Differences were observed both within FL and between FL and PR. Years participating in Get With The Guidelines-Stroke (8.9 ± 2.6 years FL vs 4.8 ± 2.4 years PR, $P < 0.0001$) and proportion of hospitals with any stroke center certification (94.2% FL vs 11.1% PR, $P < 0.0001$) showed the largest variations. Smaller hospital size, fewer years in Get With The Guidelines-Stroke, and lack of stroke center designation and acute stroke care practice implementation may contribute to poorer outcomes.

Conclusions: Results from our survey indicated variability in hospital- and system-level characteristics in stroke care across hospitals in Florida and Puerto Rico. Identification of these variations, which may explain potential disparities, can help clinicians understand gaps in stroke care

From the University of Miami Miller School of Medicine, Miami, Florida, ²University of Miami School of Architecture, Coral Gables, Florida, the National Institute for Neurological Diseases and Stroke, Bethesda, Maryland, Hospital HIMA San Pablo, Caguas, Puerto Rico, American Heart Association Greater Southeast Affiliate, San Juan, Puerto Rico, and the Barrow Neurological Institute, Phoenix, Arizona.

Correspondence to Ms Maria A. Ciliberti, UMMSM Clinical Research Building, 1120 NW 14th St, 13th Floor, Miami, FL 33136. E-mail: mciliberti@med.miami.edu. To purchase a single copy of this article, visit sma.org/smj-home. To purchase larger reprint quantities, please contact Reprintsolutions@wolterskluwer.com.

M.A.C.-V. and H.G. are considered first authors.

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Key Points

- The Florida-Puerto Rico Collaboration to Reduce Stroke Disparities study represents the first regional initiative of Florida and Puerto Rico hospitals with a focus on identifying race-ethnicity and regional disparities in acute stroke care.
- Survey results on characteristics of participating hospitals in the Florida-Puerto Rico Collaboration to Reduce Stroke Disparities provided important insight into ongoing analyses of temporal, regional, and race-ethnicity differences in acute stroke care among contributing Get With The Guidelines-Stroke (GWTG-S) hospitals in Florida and Puerto Rico.
- Compared with Puerto Rico hospitals, Florida hospitals were larger, more likely certified as stroke centers, and more likely to have participated in the GWTG-S program for a longer duration.
- In addition to fewer years in the GWTG-S program, differences among hospitals in Puerto Rico, primarily in stroke center certification and the implementation of acute stroke care practices, may contribute to identified disparities showing worse performance in nearly all GWTG-S predefined stroke performance metrics and poorer outcomes among patients in Puerto Rico compared with those in Florida.
- Implementation of targeted quality improvement programs, aimed at effecting change at the hospital or system level, may facilitate dissemination of the evidence-based care necessary to reduce disparities and improve overall stroke care.

and outcomes and targeted interventions to reduce identified disparities can be implemented.

Key Words: cerebrovascular disease/stroke, Get With The Guidelines-Stroke, health disparities, quality improvement, race and ethnicity

Although national and global mortality rates for stroke have decreased, disease burden secondary to incidence, long-term disability, and economic impact remains high.¹ With racial and ethnic minorities constituting nearly 28% of the US population, race-ethnicity disparities in acute stroke care resulting in significant differences in stroke outcomes continue to be concerning.²

The American Heart Association Get With The Guidelines-Stroke (GWTG-S) program is an ongoing national quality improvement (QI) initiative that monitors stroke performance indicators and provides opportunities to improve care. Participation in stroke registries such as GWTG-S has been shown to improve the overall delivery of acute stroke care and outcomes.³ The Florida-Puerto Rico Collaboration to Reduce Stroke Disparities (FL-PR CReSD) study, a National Institute of Neurological Disorders and Stroke-funded multicenter initiative, was developed to create high-impact culturally tailored interventions aimed at identifying race-ethnicity and regional disparities in stroke care in a diverse population. As such, the FL-PR Stroke Registry was created to leverage existing GWTG-S data and fill an important gap in stroke research as the first comprehensive examination of race-ethnicity and geographic disparities in stroke care in Florida and Puerto Rico. The registry can be used to plan interventions to reduce disparities specific to these regions.

Florida and Puerto Rico are made up of significant minority populations and can benefit from a stroke QI program focusing on race-ethnicity and regional disparities. In fact, the concentration of Hispanics in Florida and Puerto Rico make them ideal regions to study healthcare disparities.

In this article, we summarized the results of a survey completed by hospital representatives to characterize the hospitals within the FL-PR Stroke Registry. The survey results provide valuable information when relating the conclusions drawn from this study with other statewide registries, can help inform researchers about data representativeness, and can identify important hospital system confounders for analyses. In addition, it is essential to better understand individual and regional hospital characteristics to identify the possible root causes of disparities, which would then allow for the design of targeted interventions to reduce and ultimately eliminate stroke disparities in Florida and Puerto Rico.

Methods

Hospital Selection and Participation

For FL-PR Stroke Registry participation, each hospital received institutional approval and signed an amendment to

their existing GWTG-S agreement allowing the University of Miami access to a limited dataset of deidentified aggregate GWTG-S data. The University of Miami institutional review board approved the study.

As of April 2014, 78 hospitals were participating in the FL-PR Stroke Registry: 69 in Florida and 9 in Puerto Rico. These hospitals were asked to complete a 50-question Web-based survey on data elements not captured in GWTG-S. All 78 hospitals completed the survey.

Survey Design and Administration

The survey was administered electronically via SurveyMonkey (SurveyMonkey, Palo Alto, CA) and completed by trained hospital personnel responsible for data collection and abstraction. The survey consisted of seven sections: acute stroke care characteristics (designated stroke care team, stroke care unit, stroke-specific intensive care, dedicated neurological intensive care unit, existing written protocols for ischemic and hemorrhagic strokes, availability of neurological services), emergency medical services (EMS) integration (written plan for receiving stroke cases, EMS prenotification processes, information transfer with EMS protocols), hospital stroke certification (primary or comprehensive stroke center status, public education event participation, recent stroke-related research participation, receipt and provision of stroke-related telemedicine consultation), data abstraction and use (case identification, process for data abstraction and collection, case sampling), quality improvement opportunities, FL-PR Stroke Registry hospital recruitment incentives and challenges, and hospital infrastructure.

Data Analysis

The 78 hospitals included in the survey were divided by region: Florida (overall, south, west central, east central, and north and Panhandle combined) and Puerto Rico. Descriptive statistics were presented for all survey question responses. To compare Florida and Puerto Rico hospitals, χ^2 or Fisher exact tests were conducted with two-tailed *P* values reported for categorical variables and *t* tests for means or Kruskal-Wallis tests for medians were conducted for continuous variables.

Results

Hospital Characteristics Overview

Hospital characteristics, stratified by region in relation to size, academic affiliation, stroke center certification status, and years of participation in GWTG-S, are shown in Table 1. Overall, the Registry hospitals in Florida compared with Puerto Rico were larger (378 vs 169 median number of beds, *P* < 0.039) and have participated in GWTG-S for a longer period (8.9 ± 2.6 years FL vs 4.8 ± 2.4 years PR, *P* < 0.0001). These results are consistent at the patient level, regardless of race-ethnicity, as seen in Table 2. Most hospitals had achieved some level of stroke

Table 1. Overview of FL-PR Stroke Registry hospital characteristics

Characteristics	Florida, overall, n = 69	South, n = 28	West central, n = 18	East central, n = 13	North and Panhandle, n = 10	Puerto Rico, n = 9
No. beds						
Median (IQR)	378 (208–557)	380 (268–478)	248 (154–517)	320 (237–514)	540 (304–695)	169 (89–235)
Hospital type, n %						
Academic	20 (29.0)	4 (14.3)	3 (16.7)	9 (69.2)	4 (40.0)	2 (22.2)
Stroke center certification, n %						
PSC only	39 (56.5)	13 (46.4)	11 (61.1)	9 (69.2)	6 (60.0)	1 (11.1)
CSC	26 (37.7)	13 (46.4)	7 (38.9)	2 (15.4)	4 (40.0)	0
No certification of any kind	4 (5.8)	2 (7.1)	0	2 (15.4)	0	8 (88.9)
Years in GWTG-S, mean (SD)	8.9 ± 2.6	8.6 ± 2.2	10.6 ± 2.5	8.1 ± 3.0	8.0 ± 2.6	4.8 ± 2.4

CSC, Comprehensive Stroke Center; FL-PR, Florida-Puerto Rico; GWTG-S, Get With The Guidelines-Stroke; IQR, interquartile range; PSC, Primary Stroke Center; SD, standard deviation.

center certification. Table 3 provides further detailed information regarding primary and comprehensive stroke center certification across Florida and Puerto Rico hospitals. At completion of the survey, 84% of Florida Registry hospitals were at least a certified Primary Stroke Center (PSC). Among the remaining 16% (11 hospitals) with no PSC certification in Florida, only 4 reported no stroke center certification of any kind or ineligibility for stroke center certification (2 in east central Florida; 2 in southern Florida); 38% of Florida hospitals reported Comprehensive Stroke Center (CSC) certification and none were reported in Puerto Rico. In Florida, approximately 341,769 hospitalizations for stroke occurred from 2010 to 2014,⁴ > 25% of which (87,569 stroke cases) were captured in the FL-PR Stroke Registry.

The Joint Commission and the Florida Agency for Health Care Administration (AHCA) were the most common certifying bodies for attaining PSC and CSC certification. The Joint Commission served as the certifying body for Puerto Rico's sole PSC (difference between FL and PR in percentage of certified PSCs, $P = 0.0001$). Although the majority of Florida hospitals received singular PSC designation either via AHCA attestation (22%) or Joint Commission certification (29%), almost one-third reported dual PSC certification, mostly via The Joint Commission and AHCA. All CSCs in Florida reported designation via AHCA attestation, with <9% of hospitals reporting additional certification. Four of 10 Florida Registry hospitals in the

northern and Panhandle regions received CSC certification (2 through Joint Commission certification and all 4 via AHCA attestation; 3 located in the same county) compared with 13 and 9 CSCs (spanning 5 and 4 counties) in the southern and central regions, respectively. There were no CSCs in Puerto Rico.

Acute Stroke Care Hospital Characteristics

The treatment teams and resources available to care for stroke patients in hospitals in Florida and Puerto Rico are described in Table 4. Most of these hospitals (77% vs 67%, $P = 0.39$) had a designated acute stroke team defined as at least one physician and one other healthcare provider (eg, nurse) with 24-hour availability and the ability to see patients within 15 minutes of being called. Although most Florida hospitals provided stroke-specific intensive care and had a stroke unit, these services were rare in Puerto Rico, where only one hospital provided stroke-specific intensive care and four of nine hospitals reported having a stroke unit. Almost half of the participating Florida hospitals had a dedicated neurological intensive care unit, whereas the only institution in Puerto Rico that provided this service also was the island's sole certified stroke center.

In both Florida and Puerto Rico, hospitals having a larger number of beds were concentrated near coastal regions (Fig. 1A). A similar trend for years participating in GWTG-S

Table 2. Hospital-level characteristics of ischemic stroke patients in the FL-PR Stroke Registry cohort, 2010–2014

Characteristics	Overall, N = 58,864	FL Non-Hispanic white, n = 36,844	FL Non-Hispanic black, n = 10,536	FL Hispanic, n = 8207	PR Hispanic, n = 3277	P
No. beds, mean ± SD	555.6 ± 316.5	540.7 ± 308.2	641.5 ± 330.4	600.8 ± 337.1	333.0 ± 127.0	<0.0001
Academic hospital	30.8	28.5	33.0	32.3	13.3	<0.0001
Years in GWTG-S, mean ± SD	7.9 ± 2.3	8.2 ± 2.2	8.1 ± 2.1	7.2 ± 2.2	5.5 ± 1.7	<0.0001

FL-PR, Florida-Puerto Rico; GWTG-S, Get With The Guidelines-Stroke; SD, standard deviation.

Table 3. Distribution of stroke center certification by type in Florida and Puerto Rico

Hospital characteristics	Florida, overall, n = 69	South, n = 28	West central, n = 18	East central, n = 13	North and Panhandle, n = 10	Puerto Rico, n = 9
Primary Stroke Center certification, n (%)						
AHCA only	15 (21.7)	4 (14.3)	3 (16.7)	7 (53.8)	1 (10.0)	0
Joint Commission only	20 (29.0)	11 (39.3)	6 (33.3)	1 (7.7)	2 (20.0)	1 (11.1)
Other certification only	1 (1.5)	1 (3.4)	0	0	0	0
Dual certification	22 (31.9)	8 (28.6)	8 (44.4)	1 (7.7)	5 (50.0)	0
Comprehensive Stroke Center certification, n (%)						
AHCA only	20 (29.0)	11 (39.3)	5 (27.8)	2 (15.4)	2 (20.0)	0
Joint Commission + AHCA	3 (4.3)	1 (3.6)	0	0	2 (20.0)	0
Other certification + AHCA	3 (4.3)	1 (3.6)	2 (11.1)	0	0	0

AHCA, Florida Agency for Health Care Administration.

was seen in Florida, where hospitals participating for the longest period also were located near the coasts. A denser concentration of large hospitals (number of beds ≥ 450) that have participated in GWTG-S ≥ 6 years can be seen in the southern and central regions compared with the northern and Panhandle regions (Fig. 1B). In Puerto Rico, no hospitals have participated in GWTG-S for longer than 10 years and those that have participated the longest (6–10 years) were located near the San Juan metro region. Time in GWTG-S is associated with an increased odds of receiving each GWTG-S predefined stroke performance measure, although the benefit was not distributed equally. The greatest rates of improvement were seen in larger hospitals with more bed capacity, those with the largest annual stroke discharge rates, and those identified as teaching hospitals.³

In a regional comparison of GWTG-S performance metrics in FL and PR Registry hospitals, hospitals in Puerto Rico performed worse in nearly all observed metrics compared with Florida hospitals. The greatest absolute differences were seen in defect-free care, a GWTG-S composite measure indicating compliance with all predefined stroke metrics among eligible patients, and the achievement of tissue plasminogen activator

Table 4. Availability of stroke-specific resources among FL-PR Stroke Registry hospitals

Stroke resources	Florida overall, n (%) n = 69	Puerto Rico, n (%) n = 9
Designated acute stroke team	53 (76.8)	6 (66.7)
Provide stroke-specific intensive care	44 (63.8)	1 (11.1)
Dedicated neurological-ICU	34 (49.3)	1 (11.1)
Stroke unit	65 (94.2)	4 (44.4)
Receive stroke consultation via telemedicine (including weekends)	7 (10.1)	3 (33.3)
Provide stroke consultation via telemedicine (including weekends)	9 (13.0)	2 (22.2)

FL-PR, Florida-Puerto Rico; ICU, intensive care unit.

(tPA) administration within 60 minutes, regardless of hospital arrival time (Table 5). Most notably, differences in the Puerto Rican hospital infrastructure may have the greatest impact on the implementation of new stroke treatments such as the endovascular and intravenous management of acute ischemic stroke (0.22% of Puerto Rican patients receive intraarterial tPA vs 5.9% overall in FL). With hospitals in Puerto Rico having a considerably smaller number of beds and lacking availability of the stroke-specific resources necessary to provide optimal patient care, the use of telemedicine, known to enhance the administration of acute stroke therapies, was higher in Puerto Rico (22%) than in Florida (13%; $P < 0.01$).

Data Collection Processes

From 2010 to 2014, a total of 87,569 stroke cases were captured in the FL-PR Stroke Registry. Case identification may be conducted in a several ways, including prospective clinical identification, retrospective identification with *International Classification of Diseases, Ninth Revision* discharge codes followed by chart review to confirm case eligibility, or a combination.³ In total, 77% of Florida hospitals and 89% of Puerto Rican hospitals indicated a combination method as their main process for case identification. In addition, most Florida (48%) and Puerto Rican (78%) hospitals reported approximately equal GWTG-S data abstraction occurred concurrent with care and retrospectively.

GWTG-S provides hospitals the option of sampling cases, in the case of larger hospitals with high stroke volumes, compared with collecting data on all strokes. Despite this, survey results indicated that a majority of hospitals (77% FL, 89% PR) collected data on all patients presenting with a principal clinical diagnosis of stroke or transient ischemic attack.

EMS Integration

EMS practices among the participating hospitals in Florida and Puerto Rico are described in Table 6. A large proportion of hospitals, both in Florida and Puerto Rico, still lacked a written plan for receiving suspected stroke patients from EMS. Hospital prenotification of suspected stroke cases

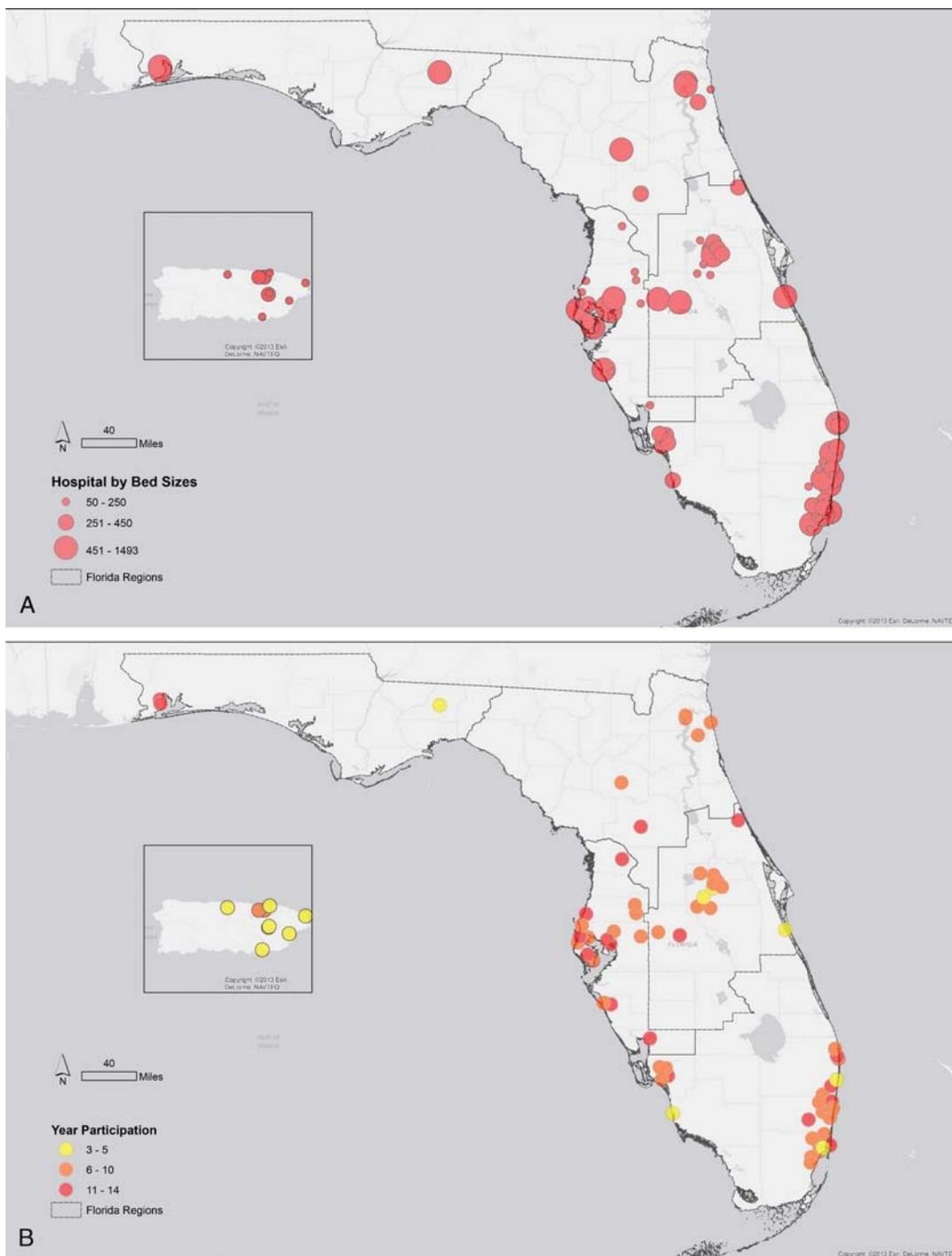


Fig. 1. (A) GIS of FL and PR hospitals by hospital bed size categorized into tertiles. FL, Florida; GIS, geographic information system; PR, Puerto Rico. (B) GIS map of FL and PR hospitals' years of participation in the GWTG-S program categorized into tertiles. FL, Florida; GIS, geographic information system; GWTG-S, Get With The Guidelines-Stroke; PR, Puerto Rico. Created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © 2013 Esri. All rights reserved.

by EMS was more commonly reported in Florida hospitals (62% always prenotified by EMS) than in hospitals in Puerto Rico (11% always prenotified by EMS; $P < 0.01$). This advanced notification led to the activation of the stroke team in 76%

of Florida hospitals and 33% of Puerto Rican hospitals ($P = 0.02$) and less frequently in the activation of written protocols in 66% and 44% of Florida and Puerto Rican hospitals, respectively ($P = 0.27$). Among hospitals that stated

Table 5. Acute stroke care metrics among ischemic stroke patients in the FL-PR Stroke Registry by region, 2015

2015 acute stroke performance metrics, %	Florida					Puerto Rico, n = 1358
	Overall, n = 15474	South, n = 5613	West central, n = 3987	East central, n = 3561	North + Panhandle, n = 2313	
Defect-free care	92.0	93.9	93.8	92.6	83.6	67.0
Door-to-CT within 25 min	40.5	52.7	35.7	30.3	40.1	27.6
IV tPA arrive by 2 h, treat by 3 h	95.0	97.7	94.6	91.6	89.9	62.7
IV tPA arrive by 3.5 h, treat by 4.5 h	85.3	89.2	90.4	71.6	88.3	65.5
IV tPA overall	12.6	15.6	10.4	10.8	11.9	11.5
IA tPA	5.9	8.3	3.6	6.0	3.8	0.22
DTN within 60 min	65.6	77.8	52.7	56.9	55.3	51.8
DTN within 45 min	38.5	53.1	24.6	25.5	27.6	19.2

CT, computed tomography; DTN, door-to-needle; IA, intraarterial; IV, intravenous; FL-PR, Florida-Puerto Rico; tPA, tissue plasminogen activator.

Table 6. Integration of EMS Among FL-PR Stroke Registry hospitals

EMS integration	Florida, overall (%), n = 69	Puerto Rico (%), n = 9
Written plan for receiving patients w/suspected stroke via EMS	57 (82.6)	6 (66.7)
Initial notification by EMS regarding suspected stroke case in transport		
Always	43 (62.3)	1 (11.1)
Sometimes	24 (34.8)	8 (88.9)
Never	2 (2.9)	0
If initial notification by EMS regarding suspected stroke case in transport, does it lead to stroke team notification? ^a		
Always	51 (76.1)	3 (33.3)
Sometimes	8 (11.9)	3 (33.3)
Never	8 (11.9)	3 (33.3)
If initial notification by EMS regarding suspected stroke case in transport, does it lead to activation of written stroke protocols?		
Always	44 (65.7)	4 (44.4)
Sometimes	11 (16.4)	2 (22.2)
Never	12 (17.9)	3 (33.3)
Does your EMS system leave a “stroke sheet” or “trip ticket/slip,” at the time of patient delivery?		
Yes, >50% of the time	46 (66.7)	4 (44.4)
Yes, <50% of the time	7 (10.1)	1 (11.1)
Varies by agency	11 (15.9)	2 (22.2)
Unsure	9 (13.0)	0
No	2 (2.9)	3 (33.3)
Does your EMS system bypass stroke patients directly to comprehensive stroke centers?		
Yes	26 (37.7)	NA
No	24 (34.8)	NA
Unsure	19 (27.5)	NA
Does your hospital share individual patient information/outcomes with EMS?		
Yes	49 (71.0)	1 (11.1)
No	9 (13.0)	7 (77.8)
Unsure	11 (15.9)	1 (11.1)

EMS, emergency medical services; FL-PR, Florida-Puerto Rico; NA, not applicable.

^an = 67 for Florida.

“always” receiving EMS prenotification and subsequently “always” activating their stroke teams (N = 40/69 in FL and N = 0/9 in PR), activation of written stroke protocols occurred “always” in 83% of facilities in Florida. The sharing of patient information and outcomes with EMS was common in Florida hospitals (71%), but rare in Puerto Rico (11%; $P < 0.01$).

Stroke Education

Most of the Registry hospitals (94% FL, 78% PR) reported providing at least one stroke-focused public education event in the past year. Fewer hospitals (45% FL, 44% PR) participated in stroke-related clinical research, other than the FL-PR Stroke Registry, within the previous year.

Discussion

This survey describes the 78 hospitals that make up the FL-PR Stroke Registry, the first comprehensive registry of Florida and Puerto Rico created to monitor longitudinal trends in disparities in acute stroke care. The Registry has been described in relation to participating hospital-level characteristics, including stroke center certifications, stroke care characteristics, data collection practices, stroke education, and EMS transfer processes. Survey results on participating hospital characteristics provide important insight into ongoing Registry analyses of temporal, regional, and race-ethnicity differences in acute stroke care among contributing GWTG-S hospitals in Florida and Puerto Rico.

Overall, in the Registry, hospitals in Florida compared with Puerto Rico were larger, were more likely academic and stroke-certified centers, and have participated in the GWTG-S program an average of 5 years longer. In addition to fewer years in the GWTG-S program, differences among PR hospitals, primarily in stroke center certification and the implementation of acute stroke care practices (eg, designated stroke team, stroke care protocols, availability of neurological services), may contribute to identified disparities showing worse performance in all GWTG-S predefined stroke performance metrics among patients in Puerto Rico compared with those in Florida overall.⁵ Despite absolute improvements over time, the rate of defect-free care was consistently lower in Puerto Rico compared with Florida, regardless of race-ethnicity, as shown in Figure 2.⁶ The widening gap in stroke care between Florida and Puerto Rico further underscores the need for increased healthcare resources in Puerto Rico and continued monitoring of disparities in various metrics of stroke care.

Stroke center certification status has been associated with benefits in acute stroke treatment processes, including more frequent utilization of acute stroke therapies, specifically increased rates of recombinant tissue-type plasminogen activator administration, which translates to better outcomes and standards of care.⁷ In addition, stroke center designation is associated with lower mortality for patients with acute ischemic stroke.⁸

In Florida, counties with the highest age-adjusted stroke mortality rates, ranging from 38.0 to 63.0 compared with the

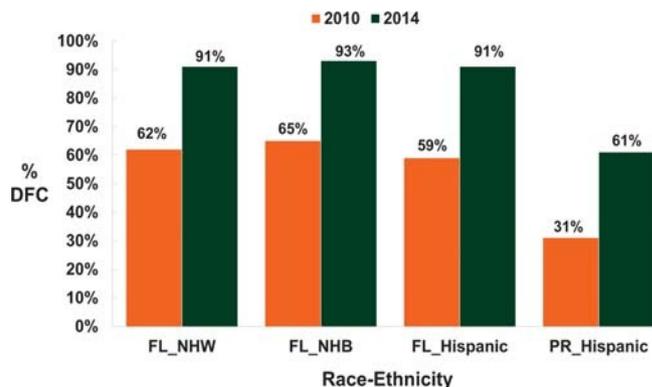


Fig. 2. Temporal improvement in DFC by race-ethnicity. DFC, defect-free care; FL, Florida; NHB, non-Hispanic black; NHW, non-Hispanic white; PR, Puerto Rico. Created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. Copyright © 2013 Esri. All rights reserved.

state total rate of 31.3 in 2011–2013, are located in the northern and Panhandle regions. The highest concentrations of PSCs and neurologists, however, are present in the southern and central regions.⁴ Whether this translates to better quality of care for stroke patients in these regions remains unknown. Although the FL-PR Stroke Registry fills an important gap in stroke research, the need for special stroke QI programs targeting areas where performance is suboptimal to reduce existing disparities continues. Increased efforts on the part of the FL-PR CReSD will target hospitals located in the southern and western regions of Puerto Rico and the northern and Panhandle regions of Florida where stroke burden is high and engagement in QI programs, including GWTG-S, is low.

An increased level of organized care, including the availability of resources such as designated acute stroke teams and stroke units, has been shown to improve the efficiency of stroke care and outcomes.⁹ Hospitals in Puerto Rico had a smaller number of beds and fewer acute stroke-related resources, which often necessitate the hiring of additional personnel with specialized training. Because of these recognized barriers, Puerto Rico faces challenges in delivering the standards of care required for improved acute stroke outcomes. Timeliness of tPA administration following acute ischemic stroke, a metric affected by suboptimal hospital infrastructure and processes,¹⁰ was associated with lower in-hospital mortality and intracranial hemorrhage, along with an increase in the percentage of patients discharged home.¹¹ The use of innovative and accessible technology such as telemedicine may allow these hospitals to be included in regional systems of stroke care and potentially minimize geographic disparities in access to care and decrease the burden of stroke.¹²

Although EMS utilization has been associated with more rapid evaluation and treatment of stroke, more than one-third of stroke patients fail to activate EMS.¹³ EMS transportation may enhance prenotification of the receiving hospital, stroke team activation, and facilitation of early imaging and thrombolytic

administration; therefore, a thorough understanding of the notification and transfer procedures and relation between EMS and treating hospitals is a vital part of the stroke care continuum.¹⁴ EMS operations and procedures in Florida and Puerto Rico differ greatly. In Florida, well-established prehospital stroke protocols and the creation of a standardized EMS tracking and reporting system (EMSTARS), representing >75% of the state's EMS volume and capturing >12 million records from 2007 to the present, allow for improvement in stroke care.¹⁵ In addition to facing many of the same challenges that affect EMS in the continental United States, including healthcare workforce shortages and long emergency department wait times, Puerto Rico faces unique challenges for improvement within their fragmented EMS system, including a lack of standardized stroke-specific systems of care, data collection, and prearrival protocols.¹⁶

Many hospitals both in Florida and Puerto Rico lacked a written plan and protocol for receiving suspected stroke patients from EMS. In addition, prenotification by EMS was less common in Puerto Rico. This is important because among several strategies proven to reduce door-to-needle times, ambulance prenotification to the receiving hospital with inbound patient details allows for early activation of the stroke team and reduces delays in thrombolysis equating to a greater likelihood of improved outcomes.¹⁷ In addition, QI efforts in the prehospital setting focused on reducing delays in patient arrival to the emergency department are necessary to reduce onset to thrombolysis treatment time and increase recombinant tissue-type plasminogen activator utilization.¹⁸

Accessing patient outcomes from receiving hospitals is a barrier in many EMS systems because of privacy concerns. Information sharing between EMS providers and the hospital is an important way to foster this critical treatment relationship and provide feedback to EMS that can be used to improve care in the future. As such, efforts to increase EMS accessibility to patient outcomes, particularly in Puerto Rico, where the survey results indicated that this was a rare occurrence, are needed.

Despite national and global decreases in stroke mortality and improvements in acute stroke therapy, the population—particularly those at risk of stroke, older members of the population, ethnic minority groups, and those with lower levels of education¹⁹—remains largely uninformed about stroke warning signs and risk factors. Most Registry hospitals reported providing at least one stroke public education event within the last year. Health education campaigns can increase community stroke awareness and may affect critical factors influencing stroke outcomes, including time-to-hospital presentation and pre- and poststroke risk factor modifications.

The desire to enhance the quality of care provided to patients was the main incentive for Registry participation both in Florida and Puerto Rico. In Puerto Rico a tie for the second-most important reason for Registry participation was access to/training in the GWTG-S tool and hospital recognition compared with Florida hospitals, which reported networking opportunities and information sharing. Additional efforts to enforce wider implementation

of evidence-based stroke QI programs such as GWTG-S could further improve acute stroke care in Puerto Rico.

The strengths of the Registry include the utilization of standardized data collected in the well-established GWTG-S database, the focus on the two geographically sizeable regions of Florida and Puerto Rico with large and diverse minority populations, and the unique focus on race-ethnicity disparities in acute stroke care. The limitations include lower GWTG-S participation rates and subsequent Registry participation in Puerto Rico, particularly in densely populated rural areas outside San Juan. Similarly, all Florida Registry hospitals were classified as urban and were concentrated mostly on the southern and western coastal regions of the state. In both Florida and Puerto Rico, involving smaller geographically isolated hospitals in stroke systems of care is important to minimize geographical disparities in access to care. Although the collected hospital survey data are important to interpret and possibly explain identified disparities in the Registry cohort, the descriptive analysis used to summarize and present results may make wider statewide and national GWTG-S hospital generalizations difficult.

Conclusions

The FL-PR Stroke Registry represents the first regional initiative of Florida and Puerto Rican hospitals with a focus on identifying race-ethnicity and regional disparities in acute stroke care. Survey results indicated variability in hospital- and system-level characteristics among Florida and Puerto Rican hospitals participating in the Registry. The identification of variations among hospital characteristics, which may explain potential disparities, can help clinicians understand gaps in stroke care and regional outcomes. Implementation of targeted QI programs, aimed at effecting change at the hospital or system level, may facilitate dissemination of the evidence-based care that is necessary to reduce disparities and improve overall stroke care.

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References

1. Writing Group Members; Mozaffarian D, Benjamin EJ, et al. Heart disease and stroke statistics—2016 update: a report from the American Heart Association. *Circulation* 2016;133:e38–e360.
2. Cruz-Flores S, Rabinstein A, Biller J, et al. Racial-ethnic disparities in stroke care: the American experience: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke* 2011;42:2091–2116.
3. Schwamm LH, Fonarow GC, Reeves MJ, et al. 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.

4. Florida Department of Health. FL Health CHARTS: Community Health Assessment Resource Tool Set; chronic diseases; stroke. www.floridacharts.com/charts/ChronicDiseases. Published 2013. Accessed May 28, 2015.
5. Sacco RL, Gardener H, Wang K, et al. Race-ethnic disparities in acute stroke care in the Florida-Puerto Rico Collaboration to Reduce Stroke Disparities Study. *J Am Heart Assoc* 2017;6:pii: e004073.
6. Sacco RL, Gardener H, Wang K, et al. Race-ethnic stroke disparities in the Florida-PR Collaboration to Reduce Stroke Disparities study—the NINDS Stroke Prevention Intervention Research Program. *Stroke* 2015;45(suppl 1): WP283.
7. Kleindorfer D, de los Rios La Rosa F, Khatri P, et al. Temporal trends in acute stroke management. *Stroke* 2013;44(6 Suppl 1):S129–S131.
8. Xian Y, Holloway RG, Chan PS, et al. Association between stroke center hospitalization for acute ischemic stroke and mortality. *JAMA* 2011; 305:373–380.
9. Smith EE, Hassan KA, Fang J, et al. Do all ischemic stroke subtypes benefit from organized inpatient stroke care? *Neurology* 2010;75: 456–462.
10. Cheng NT, Kim AS. Intravenous thrombolysis for acute ischemic stroke within 3 hours versus between 3 and 4.5 hours of symptom onset. *Neurohospitalist* 2015;5:101–109.
11. Fonarow GC, Zhao X, Smith EE, et al. 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.
12. Smith EE, Dreyer P, Prvu-Bettger J, et al. Stroke center designation can be achieved by small hospitals: the Massachusetts experience. *Crit Pathw Cardiol* 2008;7:173–177.
13. Ekundayo OJ, Saver JL, Fonarow GC, et al. Patterns of emergency medical services use and its association with timely stroke treatment: findings from Get With the Guidelines-Stroke. *Circ Cardiovasc Qual Outcomes* 2013;6:262–269.
14. Patel MD, Rose KM, O'Brien EC, et al. Prehospital notification by emergency medical services reduces delays in stroke evaluation: findings from the North Carolina stroke care collaborative. *Stroke* 2011;42:2263–2268.
15. Florida Department of Health. Florida's prehospital EMS tracking and reporting system. <http://www.floridaemstars.com>. Accessed May 28, 2015.
16. America's emergency care environment, a state-by-state report card. <http://www.emreportcard.org/uploadedFiles/ACEP-ReportCard-10-22-08.pdf.pdf>. Published 2014. Accessed May 28, 2015.
17. Meretoja A, Weir L, Ugalde M, et al. Helsinki model cut stroke thrombolysis delays to 25 minutes in Melbourne in only 4 months. *Neurology* 2013;81:1071–1076.
18. James M, Monks T, Pitt M, et al. Increasing the proportion of patients treated with thrombolysis: reducing in-hospital delays has substantially more impact than extension of the time window. *Cerebrovasc Dis* 2012;(suppl 2):602–603.
19. Jones SP, Jenkinson AJ, Leathley MJ, et al. Stroke knowledge and awareness: an integrative review of the evidence. *Age Ageing* 2010;39:11–22.