

A National Study of USA Stroke Unit Characteristics in Stroke Certified Hospitals

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Abstract

Background

Stroke units (SU) are a requirement for USA certified stroke center hospitals, based largely on European data demonstrating improved outcomes when patients are segregated with management provided exclusively by interdisciplinary stroke specialists. We aimed to conduct a first-ever survey of American SUs to document the availability and operational characteristics of these specialized units within the USA.

Methods

Ethics approval was obtained for a national SU survey; mailing lists were assembled from publicly available data on websites of American stroke center certifying agencies. Survey items were developed from required elements for Australian, British, and Canadian SUs, and USA guidelines and scientific statements. Certified hospitals were mailed return postage paid surveys. Returned data were entered and analyzed in SPSS (IBM v. 28) using descriptive statistics, Chi Square, and Mood's Median Test of difference.

Results

Surveys were returned from 47 of 50 states, the District of Columbia, and Puerto Rico. Only 34% of responding hospitals had SUs, with CSCs most commonly (44.9%) possessing a SU ($p < 0.001$). Of the 261 hospitals lacking a SU, 39% did not maintain dedicated hospital beds for stroke patients. In hospitals with SUs, a median 24 (IQR 15, 25) beds were available, but only 14.7% of SUs allowed the stroke medical director or nurse manager to control SU bed assignment. Only 18.4% of SUs admitted thrombolysis patients directly from the emergency department (ED), with 11.8% admitting thrombectomy patients directly from the catheterization lab. However, 51.5% admitted ICH patients directly from the ED and 10.3% admitted stable/slow to wean mechanically



ventilated stroke patients. Registered nurse (RN) staffing on SUs was a median of 4 patients to 1 RN on both the day (IQR 3, 4.25) and night (IQR 3, 5) shifts, with a reduction to a median of 2 (IQR 2, 2.125) and 2 (IQR 2, 2) patients respectively to 1 RN for acute thrombolysis or mechanical thrombectomy patients. Few (median 2% [IQR 0, 10%]) SU RNs were professionally certified as specialist stroke nurses, and only 36% of stroke centers considered SU RNs to be stroke team members.

Conclusions

Few stroke certified hospitals in the USA have SUs, with many patients receiving care on general, multi-purpose hospital units. Additional study is warranted to understand barriers, strengths, and the impact of SUs as they evolve in response to new American guideline recommendations.

Keywords: Stroke unit, acute stroke, inpatient stroke, stroke centers.

Introduction

Stroke Units (SU) are widely acknowledged as the first effective evidence-based treatment for ischemic and hemorrhagic stroke. Since the 1960s, investigators throughout the world,¹⁻¹⁴ including the United States (USA),¹⁻⁴ have explored the impact of SUs on patient outcomes, with the first clinical trials emerging from European investigators in the 1980s through 1990s,⁵⁻⁸ and the first USA published guidance on SU development and implementation emerging in 1977.¹⁵ Despite early American interest, rapid uptake of SUs has occurred primarily outside the USA, with ongoing study of SU impact demonstrating the substantial positive outcomes of stroke patient segregation on units that are directed by specialized interdisciplinary stroke teams.

Numerous studies have examined how SUs outside the USA operate;^{5-14,16-29} to date, no one single factor has been identified that explains the benefit of SUs, suggesting that it is the combined synergistic effect of segregation with expert interdisciplinary assessment, management, and stroke team

oversight that explains the superiority of SUs over usual care. In fact, the outcomes of patient management within segregated specialist SUs have also been compared to those achieved by “traveling” stroke teams that manage patients on a variety of patient units, showing the clear superiority of SUs in reducing mortality, avoidance of complications, and ultimately improving functional outcomes;^{20,21,28} these findings supported the 2026 revision of more lenient versions of the USA guidelines that had allowed “dedicated beds” on a variety of units, with the new guidelines now limiting care to within only a specialized SU.³⁰

There is relative consistency in the operation of SUs in English-speaking countries outside the USA due to establishment of criteria that standardizes requirements for where and how care is provided to patients with a stroke diagnosis.³¹⁻³³ However, to date, no study has examined the prevalence and the operational characteristics of SUs within the USA. Therefore, we undertook a national survey of USA stroke centers certified by The Joint Commission (TJC) or Det Norske Veritas (DNV) to estimate the gap in USA SU care



and to describe unit characteristics in relation to international SU models.

Methods

Ethics approval was obtained for the conduct of a national SU survey to examine the availability and operations of these specialized units among hospitals that had successfully certified as either a primary stroke center (PSC), thrombectomy-capable stroke center (TSC), or comprehensive stroke center (CSC) in the USA. A 70-item fully de-identified survey was developed from review of SU required operational structure and process elements identified in guidelines from Australia, the United Kingdom, and Canada.³¹⁻³³ The survey was divided into sections detailing the following: 1) Demographics – a total of 19 items including state location and level of stroke services offered, stroke center certifying body, annual volume of stroke patient admissions, procedural capabilities, and leadership characteristics; 2) SU availability – a total of 3 items including presence or absence of a dedicated SU, or in the event of no SU, details about where acute stroke patients were managed (those hospitals lacking a dedicated SU were not required to continue the survey beyond this section); 3) SU operational characteristics – a total of 48 items focused on bed capacity, control of SU bed assignment, unit interdisciplinary leadership, monitoring capabilities, the types of stroke patients managed, nurse : patient staffing ratios based on care needs (e.g. tissue plasminogen activator [tPA] drug treatment, etc.), and specialist interdisciplinary provider characteristics and training. Once complete,

the survey was internally piloted by members of the investigative team to ensure clarity and completeness of item representation, and was ultimately revised to its final form. Partial funding for the survey was obtained from the Beta Theta chapter of Sigma Theta Tau International.

A certified USA stroke center mailing list was assembled from publicly available information provided on TJC and the DNV stroke center certification websites; addresses were verified and corrected as necessary through review of each stroke center hospital's website. Verified stroke center hospitals were mailed return-postage-paid surveys; hospitals not responding to the survey were approached a total of 3 times for survey completion. Participation in the survey was voluntary and consent was implied if survey data were returned.

Deidentified data were entered and analyzed in SPSS (IBM version 28). Descriptive statistics were used to present unit prevalence and characteristics, and Chi Square and Mood's Median Tests were used to examine differences in characteristics by stroke centers with or without a SU.

Results

Surveys were mailed to 1441 verified certified stroke centers (204 DNV and 1237 TJC), with return of 397 (27.6%) surveys from 47 of 50 states (excluding Massachusetts, Vermont, and Wyoming), the District of Columbia, and Puerto Rico. Table 1 presents prevalence data for SUs in the USA, with only 34.3% of responding hospitals admitting to having a SU.

Table 1: USA Stroke Center Hospitals With or Without Stroke Units

Characteristic	Response
Does your stroke center hospital have a dedicated Stroke Unit? n (%):	
Yes	136 (34.3%)
No	259 (65.2%)
No response	2 (0.5%)
For hospitals lacking a Stroke Unit, are there dedicated beds for stroke patients on a specific unit? n (%):	
Yes	106 (26.7%)
No	155 (39.0%)
Not applicable; we have a dedicated Stroke Unit	136 (23.3%)
For hospitals lacking a Stroke Unit, where are stroke patients admitted in your hospital? n (%):	
General Medicine Unit	40 (10.1%)
General Medical – Surgical Unit	51 (12.8%)
General Neurology Unit	52 (13.1%)
General Neurology – Orthopedics Unit	23 (5.8%)
Medical – Surgical Telemetry Unit	48 (12.1%)
Variety of hospital units with open beds	31 (7.8%)
Transferred to higher level of care hospital	1 (0.2%)
Other unit	13 (3.3%)
Not applicable; our hospital has a Stroke Unit	136 (34.3%)
No response	2 (0.5%)

Note: Hospitals admitting to not having a stroke unit n=259; 2 responders left the question blank and therefore were counted as not having a stroke unit; total n=261 for no stroke unit.

For hospitals lacking a SU, only 40.6% responded that they had dedicated beds for acute stroke patients somewhere in their hospital. Hospitals without a SU admitted acute stroke patients to a variety of inpatient hospital units, with 7.8% responding that they admit patients to any open bed.

Table 2 presents hospital characteristics by SU status. Hospitals with SUs were significantly more likely to be CSC or TSC certified (X^2 55.9, $p < 0.001$), with more licensed hospital beds (MMT X^2 36.8, $p < 0.001$), and higher annual stroke patient volume (MMT X^2 45.2, $p < 0.001$), more stroke coordinators (MMT X^2 21.9, $p < 0.001$), more fellowship-trained vascular

neurologists (X^2 47.4, $p < 0.001$), neurosurgeon coverage (X^2 30.9, $p < 0.001$), endovascular coverage (X^2 47.6, $p < 0.001$), higher annual tPA (alteplase or tenecteplase) treatment volume (MMT X^2 44.4, $p < 0.001$), more endovascular thrombectomy treatments (MMT X^2 8.6, $p = 0.003$), and less telemedicine use (X^2 22.6, $p < 0.001$).

Table 3 details unit characteristics within only those hospitals with SUs (n=136). Most (90.4%) SUs were “open,” admitting more than just acute stroke patients, with a median bed size of 24 (IQR 15, 25) beds, and only 14.7% of units placed bed assignment under the control of the stroke medical director or stroke nurse manager. About a quarter of



Table 2: Sample Characteristics by USA Stroke Unit

Characteristic	Overall (n=397)	Hospitals with a Stroke Unit (n=136; 34.3%)	Hospitals Lacking a Stroke Unit (n=261; 65.7%)	Differences
Certification Level, n (%):				
Comprehensive	104 (26.2%)	61 (44.9%)	43 (16.5%)	χ^2 55.9 $p \leq 0.001$
Thrombectomy-capable	60 (15.1%)	27 (19.9%)	33 (12.6%)	
Primary	224 (56.4%)	45 (33.0%)	179 (68.6%)	
Acute Stroke Ready	1 (0.25%)	0	1 (0.4%)	
Not certified	4 (1.0%)	2 (1.5%)	2 (0.8%)	
No response	4 (1.0%)	1 (0.7%)	3 (1.1%)	
Certifying Body, n (%):				
The Joint Commission	344 (86.6%)	114 (83.8%)	230 (88.0%)	χ^2 4.7 $p = 0.198$
Det Norske Veritas	49 (12.3%)	22 (16.2%)	27 (10.2%)	
Accreditation Commission for Healthcare	1 (0.3%)	0	1 (0.4%)	
Not certified	2 (0.5%)	0	2 (0.8%)	
Missing	1 (0.3%)	0	1 (0.4%)	
Licensed Hospital Beds, mean $\pm$ sd; (IQR)	385 $\pm$ 250 Median 326 (204, 503)	511 $\pm$ 275 Median 457 (312, 645)	320 $\pm$ 210 Median 270 (181, 412)	MMT χ^2 36.8 $p \leq 0.001$
Licensed Neurocritical Care Beds, mean $\pm$ sd; (IQR)	5 $\pm$ 9 Median 0 (0, 8.5)	9 $\pm$ 11 Median 6 (0, 18)	3 $\pm$ 7 Median 0 (0, 0)	MMT χ^2 44.3 $p \leq 0.001$
Annual Stroke Patient Volume, mean $\pm$ sd; (IQR)	467 $\pm$ 369 Median 355 (193, 648)	671 $\pm$ 431 Median 593 (345, 903)	361 $\pm$ 280 Median 280 (162, 514)	MMT χ^2 45.2 $p \leq 0.001$
Number of Stroke Coordinators, mean $\pm$ sd; (IQR)	1 $\pm$ 0.8 Median 1 (1, 1)	1.3 $\pm$ 0.7 Median 1 (1, 1)	1.1 $\pm$ 0.5 Median 1 (1, 1)	MMT χ^2 21.9 $p \leq 0.001$
Annual ischemic stroke volume, mean $\pm$ sd; (IQR)	383 $\pm$ 293 Median 300 (164, 594)	540 $\pm$ 343 Median 453 (302, 697)	301 $\pm$ 225 Median 236 (136, 426)	MMT χ^2 51.2 $p \leq 0.001$
Annual tPA treatment volume, mean $\pm$ sd; (IQR)	60 $\pm$ 65 Median 38.5 (21, 78)	91 $\pm$ 84 Median 68 (37, 112)	44 $\pm$ 44 Median 31 (17, 54)	MMT χ^2 44.4 $p \leq 0.001$
Annual mechanical thrombectomy volume, mean $\pm$ sd; (IQR)	41 $\pm$ 44 Median 28 (5, 63)	52 $\pm$ 47 Median 38 (13, 80)	32 $\pm$ 39 Median 18 (0, 53)	MMT χ^2 8.6 $p = 0.003$
Stroke Physician Leader, n (%):				
Fellowship-trained vascular neurologist	138 (34.8%)	77 (56.6%)	61 (23.4%)	χ^2 47.4 $p \leq 0.001$
General neurologist	137 (34.5%)	32 (23.5%)	105 (40.2%)	
Internal medicine physician	101 (25.4%)	22 (16.2%)	79 (30.3%)	
Intensivist physician	5 (1.3%)	3 (2.2%)	2 (0.8%)	
Emergency physician	4 (1.0%)	0	4 (1.5%)	
Other physician specialty	4 (1.0%)	1 (0.7%)	3 (1.1%)	
No response	8 (2.0%)	1 (0.7%)	7 (2.7%)	

Neurosurgeon Coverage, n (%):				
Yes	259 (65.2%)	114 (83.8%)	145 (55.6%)	χ^2 30.9
No	137 (34.5%)	22 (16.2%)	115 (44.0%)	
No response	1 (0.3%)	0	1 (0.4%)	$p \leq 0.001$
Endovascular Coverage, n (%):				
Yes	178 (44.8%)	92 (67.6%)	86 (33.0%)	χ^2 47.6
No	214 (53.9%)	40 (29.4%)	174 (66.6%)	
No response	5 (1.3%)	4 (2.9%)	1 (0.4%)	$p \leq 0.001$
Neurocritical Critical Care Unit, n (%):				
Yes	110 (27.7%)	68 (50.0%)	42 (16.1%)	χ^2 50.6
No	286 (72%)	68 (50.0%)	218 (83.5)	
No response	1 (0.3%)	0	1 (0.4%)	$p \leq 0.001$
Telemedicine Use, n (%):				
Always	112 (28.2%)	26 (19.1%)	86 (33.0%)	χ^2 22.6
Sometimes	90 (22.7%)	29 (21.3%)	61 (23.4%)	
Never	131 (33.0%)	44 (32.4%)	87 (33.3%)	
Never; comprehensive center	61 (15.4%)	36 (26.5%)	25 (9.5%)	$p \leq 0.001$
No response	3 (0.8%)	1 (0.7%)	2 (0.8%)	

Note: sd = standard deviation; IQR = interquartile range. χ^2 = Chi Square test statistic. MMT χ^2 = Mood's Median Test Chi Square test statistic.

responders admitted to often having a problem procuring a bed for a stroke patient on the unit with a median of 5% (IQR 1, 10) of acute stroke patients at any given time not able to be admitted to the SU.

Only 18.4% of SUs admitted tPA treated patients directly from the emergency department (ED), and only 11.8% of SUs admitted endovascular thrombectomy patients directly from the catheterization lab. However, 51.5% of SUs admitted intracerebral hemorrhage (ICH) patients directly from the ED and 10.3% of SUs admitted stable, slow to wean mechanically ventilated patients with a stroke diagnosis. Capabilities for 24/7 neuroimaging with computed tomography and magnetic resonance imaging were 97.1% and 80.9% respectively, with 75% having access to continuous EEG monitoring. Interestingly, 67.6% of SUs were able to administer bolus

or continuous infusion dihydropyridine calcium channel blocker infusions for hypertension management; similarly, 67.6% could also administer continuous insulin infusions. Clinical research was conducted in 58.8% of SUs (Table 3).

Table 4 presents personnel characteristics of SUs. Only 39% of hospitals with SUs had a neurology physician in house 24/7, with 25.7% having a stroke advanced practice provider (APP) in house 24/7. Only 41.9% of SUs were staffed with nurses similarly to a cardiac or coronary care unit, and 89.7% of SUs expected their nursing staff to care for patients with a variety of medical diagnoses, not solely acute stroke patients. The nurse to patient ratio for staffing on SUs was 1 nurse to a median 4 patients on both the day and night shifts, with this decreasing to 2 when nurses are caring for an acute tPA treated or endovascular thrombectomy patient.

Table 3: Characteristics of USA Stroke Units

Characteristic	Response
Is the Stroke Unit a “closed unit” that only admits stroke patients? n (%)	
Yes	10 (7.4%)
No	123 (90.4%)
No response	3 (2.2%)
How many licensed/operational patient beds are on the Stroke Unit? median (IQR)	24 (15,25)
Is Stroke Unit bed assignment controlled by the Stroke Medical Director and/or Stroke Nurse Manager? n (%)	
Yes	20 (14.7%)
No	112 (82.4%)
No response	4 (2.9%)
How often is it difficult to obtain a bed for a stroke patient on the Stroke Unit? n (%)	
Never	20 (14.7%)
Rarely (~ once a month)	44 (32.4%)
Sometimes (~ 2-3 times per month)	37 (27.2%)
Often (~ once a week)	23 (16.9%)
Always (several times a week)	9 (6.6%)
No response	3 (2.2%)
Approximately what % of stroke patients never are placed in a Stroke Unit bed? median (IQR)	5 (1, 10)
Does the Stroke Unit admit patients acutely treated with a tissue plasminogen activator drug (alteplase or tenecteplase) directly from the Emergency Department? n (%)	
Yes	25 (18.4%)
No	108 (79.4%)
No response	3 (2.2%)
Does the Stroke Unit admit acute mechanical thrombectomy patients directly from the Catheterization Lab? n (%)	
Yes	16 (11.8%)
No	110 (80.9%)
No response	10 (7.3%)
Does the Stroke Unit admit patients with acute intracerebral hemorrhage directly from the Emergency Department? n (%)	
Yes	70 (51.5%)
No	63 (46.3%)
No response	3 (2.2%)
Does the Stroke Unit admit stable (e.g. non-critical, slow to wean) intubated patients? n (%)	
Yes	14 (10.3%)
No	119 (87.5%)
No response	3 (2.2%)
Does the Stroke Unit participate in clinical research? n (%)	
Yes	80 (58.8%)
No	53 (39%)
No response	3 (2.2%)

Our Stroke Unit patients have access to STAT computed tomography (CT) scanning 24 hours a day, 7 days a week. n (%) True False No response	132 (97.1) 0 4 (2.9%)
Our Stroke Unit patients have access to STAT magnetic resonance imaging (MRI) 24 hours a day, 7 days a week. n (%) True False No response	110 (80.9%) 22 (16.2%) 4 (2.9%)
Our Stroke Unit patients have access to electroencephalogram (EEG) 24 hours a day, 7 days a week. n (%) True False No response	102 (75.0%) 29 (21.3%) 5 (3.7%)
Our Stroke Unit patients have access to ongoing vital sign monitoring 24 hours a day, 7 days a week. n (%) True False No response	127 (93.4%) 5 (3.7%) 4 (2.9%)
Our Stroke Unit patients have access to continuous electrocardiogram (ECG) monitoring (hard wired or telemetry) 24 hours a day, 7 days a week. n (%) True False No response	123 (90.4%) 9 (6.6%) 4 (2.9%)
Our Stroke Unit patients have access to intravenous bolus (i.e. labetalol) and/or continuous infusion antihypertensive (i.e. nicardipine or clevidipine) medication delivery 24 hours a day, 7 days a week. n (%) True for both True only for labetalol bolus; not true for continuous infusion medications False, not true for either No response	92 (67.6%) 30 (22.1%) 10 (7.4%) 4 (2.9%)
Our Stroke Unit patients have access to continuous insulin infusions if indicated for glucose control 24 hours a day, 7 days a week. n (%) True False No response	92 (67.6%) 40 (29.4%) 4 (2.9%)
Our Stroke Unit patients have access to advanced neurological assessment (i.e. National Institutes of Health Stroke Scale) performed by the RN staff 24 hours a day, 7 days a week. n (%) True False No response	119 (87.5%) 13 (9.6%) 4 (2.9%)
Our Stroke Unit patients have access to bedside swallow screening using an evidence based tool, performed by the RN staff 24 hours a day, 7 days a week. n (%) True False No response	129 (94.9%) 3 (2.2%) 4 (2.9%)

Note: Hospitals with dedicated Stroke Units, n=136; IQR = interquartile range.

Table 4: Personnel Characteristics of USA Stroke Units

Characteristic	Response
Does the Stroke Unit have a stroke physician (e.g. attending vascular neurologist, general neurologist or junior/in-training neurologist) in-house 24/7? n (%)	
Yes	53 (39.0%)
No	80 (58.8%)
No response	3 (2.2%)
Does the Stroke Unit have an advanced practice provider with prescriptive authority (e.g. nurse practitioner, clinical nurse specialist, physician assistant) in-house 24/7? n (%)	
Yes	35 (25.7%)
No	98 (72.1%)
No response	3 (2.2%)
Is the Stroke Unit staffed with nurses similarly to a Coronary or Cardiac Care Unit? n (%)	
Yes	57 (41.9%)
No	74 (54.4%)
No response	5 (3.7%)
Do Stroke Unit registered nurses only take care of stroke patients? n (%)	
Yes	10 (7.4%)
No	122 (89.7%)
No response	4 (2.9%)
On average, how many patients does a single RN on the Stroke Unit care for on the day shift? median (IQR)	4 (3, 4.25)
On average, how many patients does a single RN on the Stroke Unit care for on the night shift? median (IQR)	4 (3, 5)
On average, how many patients does a single RN on the Stroke Unit care for while managing an acute tissue plasminogen activator (tPA; alteplase or tenecteplase) treated patient admitted directly from the Emergency Department? median (IQR)	*n = 24 SUs that admit tPA 2 (2, 2.125)
On average, how many patients does a single RN on the Stroke Unit care for while managing an acute mechanical thrombectomy (MT) patient admitted directly from the Catheterization Lab? median (IQR)	*n = 13 SUs that admit MT 2 (2, 2)
All of our Stroke Unit RNs are <u>NOT</u> considered members of our acute stroke team. n (%)	
True	83 (61.0%)
False	49 (36.0%)
No response	4 (2.9%)
Our most experienced Stroke Unit RNs respond to Code Strokes called in our hospital. n (%)	
True	42 (30.9%)
False	90 (66.2%)
No response	4 (2.9%)
Our Stroke Unit RNs are certified in the National Institutes of Health Stroke Scale. n (%)	
True	120 (88.2%)
False	13 (9.6%)
No response	3 (2.2%)

Our Stroke Unit RNs are certified in the modified Rankin Score. n (%)	
True	13 (9.6%)
False	119 (87.5%)
No response	4 (2.9%)
The highest degree earned by our Stroke Unit <i>nurse expert</i> : n (%)	
Diploma RN	4 (2.9%)
BSN	37 (27.2%)
Other bachelor's degree	3 (2.2%)
MSN or MS	71 (52.2%)
DNP	12 (8.8%)
PhD or DNSc	2 (1.5%)
No response	7 (5.1%)
The Stroke Unit <i>nurse expert</i> is certified as a Critical Care Registered Nurse (CCRN). n (%)	
True	34 (25.0%)
False	98 (72.1%)
No response	4 (2.9%)
The Stroke Unit <i>nurse expert</i> is certified as a Neurovascular Registered Nurse-Board Certified (NVRN-BC). n (%)	
True	6 (4.4%)
False	126 (92.6%)
No response	4 (2.9%)
The Stroke Unit <i>nurse expert</i> is certified as a Stroke Certified Registered Nurse (SCRN). n (%)	
True	60 (44.1%)
False	71 (52.2%)
No response	5 (3.7%)
The Stroke Unit <i>nurse expert</i> is certified as a Certified Neuroscience Registered Nurse (CNRN). n (%)	
True	32 (23.5%)
False	100 (73.5%)
No response	4 (2.9%)
The Stroke Unit <i>nurse expert</i> is certified as a Certified Emergency Nurse (CEN). n (%)	
True	6 (4.4%)
False	126 (92.6%)
No response	4 (2.9%)
The Stroke Unit <i>nurse expert</i> is certified as an Adult/Gerontology Acute Care Nurse Practitioner-Board Certified (AGACNP-BC or ACNP). n (%)	
True	20 (14.7%)
False	112 (82.4%)
No response	4 (2.9%)
The Stroke Unit <i>nurse expert</i> is certified as a Clinical Nurse Specialist (CNS). n (%)	
True	28 (20.6%)
False	104 (76.5%)
No response	4 (2.9%)
The Stroke Unit <i>nurse expert</i> is certified as a Family Nurse Practitioner (FNP). n (%)	
True	11 (8.1%)
False	121 (89%)
No response	4 (2.9%)



The Stroke Unit <i>nurse expert</i> is certified as a Adult/Gerontology Nurse Practitioner (ANP or AGPCNP-BC). n (%)	
True	9 (6.6%)
False	123 (90.4%)
No response	4 (2.9%)
The Stroke Unit <i>nurse expert</i> is certified as a Advanced Neurovascular Practitioner-Board Certified (ANVP-BC). n (%)	
True	7 (5.1%)
False	125 (91.9%)
No response	4 (2.9%)
Approximate percent of <i>Stroke Unit registered nurses (RN)</i> that are certified as either a SCRNP or NVRNP-BC, median (IQR)	2 (0, 10)
All RNs working on our Stroke Unit have received <i>formal educational orientation</i> (e.g. classroom taught content) to care of the acute stroke patient, developed and overseen by an expert acute stroke nurse. n (%)	
True	121 (89.0%)
False	12 (8.8%)
No response	3 (2.2%)
All RNs working on our Stroke Unit have received <i>formal supervised clinical training</i> (e.g. supervised by an expert clinical preceptor) in care of the acute stroke patient, overseen by an expert acute stroke nurse. n (%)	
True	109 (80.1%)
False	23 (16.9%)
No response	4 (2.9%)
Approximate hours of <i>ongoing formal acute stroke education</i> (e.g. classroom, conference) annually received by <i>Stroke Unit RNs</i> , median (IQR)	8 (8, 8)
Which of the following best describes the stroke physician leader's involvement with the coordination and management of the Stroke Unit? n (%)	
The stroke physician leader serves as the Stroke Unit Medical Director, overseeing all aspects of interdisciplinary care delivery and unit administration	37 (27.2%)
The stroke physician leader oversees some aspects of interdisciplinary care delivery and unit administration	41 (30.1%)
The stroke physician leader oversees only medical care delivery for physicians caring for stroke	28 (20.5%)
The stroke physician leader oversees only his/her own medical care delivery	27 (19.9%)
No response	3 (2.2%)
How often does the multidisciplinary team meet to discuss the plan of care for patients on the Stroke Unit? n (%)	
Never	12 (8.8%)
At least once a week	13 (9.6%)
Twice weekly	9 (6.6%)
3 to 4 times weekly	10 (7.4%)
Daily	89 (65.4%)
No response	3 (2.2%)
The Stroke Unit uses the same physiotherapist(s) each day dedicated to the care of stroke patients; about 90% of physical therapy care is provided by the same physiotherapist(s). n (%)	
True	100 (73.5%)
False	33 (24.3%)
No response	3 (2.2%)



The Stroke Unit uses the same occupational therapist(s) each day dedicated to the care of stroke patients; about 90% of occupational therapy care is provided by the same occupational therapist(s). n (%) True False No response	101 (74.3%) 32 (23.5%) 3 (2.2%)
The Stroke Unit uses the same speech and language pathologist(s) (SLP) each day dedicated to the care of stroke patients; about 90% of language and swallow assessment and care is provided by the same SLP(s). n (%) True False No response	102 (75.0%) 31 (22.8%) 3 (2.2%)
The Stroke Unit has a dedicated case manager; about 90% of case management services are provided by the same case manager. n (%) True False No response	123 (90.4%) 10 (7.4%) 3 (2.2%)
The Stroke Unit has a dedicated social worker; about 90% of social work care is provided by the same social worker. n (%) True False No response	119 (87.5%) 14 (10.3%) 3 (2.2%)
The Stroke Unit has a dedicated neuropsychologist; about 90% of neuropsychologic testing and care is provided by the same neuropsychologist. n (%) True False No response	25 (18.4%) 107 (78.7%) 4 (2.9%)
Approximate hours of <i>ongoing formal acute stroke education</i> (e.g. classroom, conference) annually received by <i>therapist staff</i> , median (IQR)	2 (2, 4)
Approximate hours of <i>ongoing formal acute stroke education</i> (e.g. classroom, conference) annually received by <i>stroke physicians</i> , median (IQR)	8 (8, 8)

Note: Hospitals with dedicated Stroke Units, n=136; IQR = interquartile range; SU = stroke unit.

Only 36% of SUs considered their registered nurse (RN) staff to all be members of their stroke team and only 30.9% used their most experienced RNs as code stroke responders. Despite this, 88.2% of SU RNs were certified in use of the National Institutes of Health Stroke Scale (NIHSS), but only 9.6% were certified in use of the modified Rankin Scale (mRS). Nursing experts serving SUs most commonly (52.2%) held a master's degree, with stroke certification held by 48.5%, however few were board certified advanced neurovascular practitioners (ANVP-BC). Overall, SUs reported that only a median of

2% (IQR 0, 10%) of their nursing staff hold a stroke-specific professional certification. The majority of SUs utilized the same therapy staff each day to ensure continuity of care; similarly, the same case managers and social workers were consistently assigned to most SUs. Not surprisingly, few (18.4%) SUs have access to neuropsychologists to support their patients (Table 4).

Discussion

Our study shows that unlike other English-speaking countries of similar socioeconomic status, the majority of USA certified stroke

centers lack SUs. It remains unclear exactly what has contributed to this radical disregard for SU care, although heightened interest in emergent reperfusion treatment, and the more lenient former USA stroke guidelines³⁴ allowing “dedicated beds” as a SU substitute, may have contributed to a belief that SU care is not essential to improve patient outcomes. Despite this, SUs remain the very first intervention shown to improve stroke patient outcomes⁵⁻⁸ with evidence emerging well before the approval of intravenous tPA reperfusion treatment, and substantially benefitting recovery for even ICH patients.²⁷

Ironically, a 1977 USA publication¹⁵ was among the first to provide guidance on development and implementation of SUs, and the USA saw early adopters of SUs in a few hospitals in the 1960s-1970s.¹⁻⁴ However, the length of time these original USA SUs operated, whether they continue to operate in their affiliated hospitals, and/or factors associated with unit closure remains unknown at this time. Clinical trials of SU care have exclusively been performed outside the USA,^{5-14,20,21} suggesting either a disinterest in studying hospital care delivery models as a factor influencing patient outcomes, or an inability to study SU performance due to a lack of units from which to sample. Fortunately, numerous systematic reviews and meta-analyses of clinical trials from a variety of settings have confirmed the mortality, morbidity, and functional improvement benefits of SUs, forming the basis for the current USA 2026 SU guidelines revisions³⁰ finally bringing them in line with those of other English-speaking countries.³¹⁻³³

Surprisingly, only 18.4% of SUs admitted intravenous thrombolysis patients directly from the ED, suggesting that the majority of USA SUs overuse critical care units to manage post-thrombolysis monitoring. Interestingly, unlike other English-speaking countries of similar socioeconomic status and most European and Asian countries, the USA remains the only country to overuse critical care services for 24-hours of post-thrombolysis monitoring, and this use contributes to critical care bed shortages and substantially increases hospital costs. Our team has previously shown that SU management of acute thrombolysis is safe and results in significant cost savings that ultimately financially benefits hospitals.³⁵ This finding suggests that hospital administrators should adopt a flexible approach to nurse staffing that allows nurse to patient ratios to shift to 1 RN to 2 patients on a SU to support thrombolysis monitoring needs, with the ability to flex back to 1 RN to 3 or 4 patients once patients are beyond the 24 hour period. Of note, the 18.4% of SUs admitting thrombolysis patients in our study have adopted this innovative staffing approach as reflected in their reported nurse to patient ratios, and also administer vasoactive continuous antihypertensive infusions in their SUs to ensure blood pressure control.

Discrete hospital units that segregate interdisciplinary stroke clinicians together with stroke patients have been shown to provide the strongest evidence of benefit compared to stroke care provided on general or mixed units with peripatetic/traveling stroke teams.^{20,21,28} Importantly, the benefits of SU care appear to be independent of stroke



subtype, severity, age and sex. Collectively, these findings suggest that acutely hospitalized stroke patients in the USA could likely benefit from adoption of a SU paradigm.

Key findings from the Stroke Unit Trialists' Collaboration have demonstrated several important characteristics that affect SU patient outcomes through complex ongoing patient interactions, specifically: 1) Interdisciplinary stroke specialist clinicians; 2) well-coordinated interdisciplinary treatment plans; 3) ongoing specialist interdisciplinary clinical education and skills training; 4) stroke patient segregation with specialized and consistent interdisciplinary clinician oversight; and, 5) delivery of evidence-based standardized patient management.³⁶ In contrast, our findings suggest that acute stroke patients in the USA are most commonly cared for by a stroke physician who travels to different generalist units, and nurses that care for a variety of patient diagnoses and lack specialty stroke certification. While it remains unknown whether use of a SU approach supported by all the characteristics identified by the Stroke Unit Trialists' Collaboration³⁶ could further improve USA acute stroke patient outcomes, it is difficult to argue against such a comprehensive high-quality approach.

Our study has limitations that must be acknowledged. First, our methods are limited by those tied to survey research, including the assumption of response truthfulness without an independent audit to confirm results; however, this approach was pragmatic and is

used to support numerous registries, including the American Heart Association's Get with the Guidelines,³⁷ making our findings of similar importance to registry reports. Second, our study return was limited to 27.6% of the certified USA stroke center hospitals with validated mailing addresses. It is unclear what contributed to this limited return, and whether not having a SU may have reduced willingness to self-report this in our study. Despite this, our methods produced returns from 47 out of 50 states, the District of Columbia, and Puerto Rico. Additionally, our findings span all levels of certified stroke centers in the USA, representing locations ranging from highly rural areas, to suburban, and urban locations. Future study of how SUs evolve in response to the 2026 guidelines³⁰ will be important to better understand implementation barriers, organizational approaches, and the potential impact of the SU model in the USA.

Conclusions

Unlike English-speaking countries of similar socioeconomic stature, few certified stroke center hospitals in the USA are supported by dedicated SUs, with many patients admitted to general care, multi-purpose hospital units. Whether stroke patient outcomes can be further improved by specialist SU care in the USA remains unknown and warrants study.



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Conflicts of Interest

The authors declare no conflicts of interest.

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References

1. Haerer AF, Smith RR, Currier RD. UMC Stroke Unit: review of the first 100 cases. J Miss State Med Assoc. 1969 Jun;10(6):237-41. PMID: 5783907.
2. Haerer AF, Smith RR, Currier RD. The Mississippi Regional Medical Program Stroke Unit. Critique and follow-up of the first 200 patients admitted. South Med J. 1971 Aug;64(8):951-5. doi: 10.1097/00007611-197108000-00011. PMID: 5565334.
3. McCann BC, Culbertson RA. Comparison of two systems for stroke rehabilitation in a general hospital. J Am Geriatr Soc. 1976 May;24(5):211-6. doi: 10.1111/j.1532-5415.1976.tb06781.x. PMID: 1262676.
4. Kong BW, Saunders E, Shafi J, Wheeler BA. The stroke area: feasibility of adoption in community hospitals. J Natl Med Assoc. 1978 Sep;70(9):637-9. PMID: 702596; PMCID: PMC2537150.
5. Smith ME, Garraway WM, Smith DL, Akhtar AJ. Therapy impact on functional outcome in a controlled trial of stroke rehabilitation. Arch Phys Med Rehabil. 1982 Jan;63(1):21-4. PMID: 7034669.
6. Strand T, Asplund K, Eriksson S, Hägg E, Lithner F, Wester PO. A non-intensive stroke unit reduces functional disability and the need for long-term hospitalization. Stroke. 1985 Jan-Feb;16(1):29-34. doi: 10.1161/01.str.16.1.29. PMID: 3917584.
7. Strand T, Asplund K, Eriksson S, Hägg E, Lithner F, Wester PO. Stroke unit care--who benefits? Comparisons with general medical care in relation to prognostic indicators on admission. Stroke. 1986 May-Jun;17(3):377-81. doi:

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- 10.1161/01.str.17.3.377. PMID: 3715931.
8. Indredavik B, Bakke F, Solberg R, Rokseth R, Haaheim LL, Holme I. Benefit of a stroke unit: a randomized controlled trial. *Stroke*. 1991 Aug;22(8):1026-31. doi: 10.1161/01.str.22.8.1026. PMID: 1866749.
 9. Kalra L, Dale P, Crome P. Improving stroke rehabilitation. A controlled study. *Stroke*. 1993 Oct;24(10):1462-7. doi: 10.1161/01.str.24.10.1462. PMID: 8378947.
 10. Kalra L. The influence of stroke unit rehabilitation on functional recovery from stroke. *Stroke*. 1994 Apr;25(4):821-5. doi: 10.1161/01.str.25.4.821. PMID: 8160227.
 11. Kalra L, Eade J. Role of stroke rehabilitation units in managing severe disability after stroke. *Stroke*. 1995 Nov;26(11):2031-4. doi: 10.1161/01.str.26.11.2031. PMID: 7482644.
 12. Indredavik B, Slørdahl SA, Bakke F, Rokseth R, Håheim LL. Stroke unit treatment. Long-term effects. *Stroke*. 1997 Oct;28(10):1861-6. doi: 10.1161/01.str.28.10.1861. PMID: 9341685.
 13. Indredavik B, Bakke F, Slørdahl SA, Rokseth R, Håheim LL. Stroke unit treatment improves long-term quality of life: a randomized controlled trial. *Stroke*. 1998 May;29(5):895-9. doi: 10.1161/01.str.29.5.895. PMID: 9596231.
 14. Rønning OM, Guldvog B. Stroke units versus general medical wards, I: twelve- and eighteen-month survival: a randomized, controlled trial. *Stroke*. 1998 Jan;29(1):58-62. doi: 10.1161/01.str.29.1.58. PMID: 9445329.
 15. Feigensohn JS, McCarthy ML. Stroke rehabilitation. II. Guidelines for establishing a stroke rehabilitation unit. *N Y State J Med*. 1977 Aug;77(9):1430-4. PMID: 267836.
 16. Langhorne P, Williams BO, Gilchrist W, Howie K. Do stroke units save lives? *Lancet*. 1993 Aug 14;342(8868):395-8. doi: 10.1016/0140-6736(93)92813-9. PMID: 8101901.
 17. Langhorne P, Williams BO, Gilchrist W, Dennis MS, Slattery J. A formal overview of stroke unit trials. *Rev Neurol*. 1995 Mar-Apr;23(120):394-8. PMID: 7497198.
 18. How do stroke units improve patient outcomes? A collaborative systematic review of the randomized trials. *Stroke Unit Trialists Collaboration*. *Stroke*. 1997 Nov;28(11):2139-44. doi: 10.1161/01.str.28.11.2139. PMID: 9368554.
 19. Stegmayr B, Asplund K, Hulter-Asberg K, Norrving B, Peltonen M, Terént A, Wester PO. Stroke units in their natural habitat: can results of randomized trials be reproduced in routine clinical practice? *Riks-Stroke Collaboration*. *Stroke*. 1999 Apr;30(4):709-14. doi:



- 10.1161/01.str.30.4.709. PMID: 10187866.
20. Evans A, Perez I, Harraf F, Melbourn A, Steadman J, Donaldson N, Kalra L. Can differences in management processes explain different outcomes between stroke unit and stroke-team care? *Lancet*. 2001 Nov 10;358(9293):1586-92. doi: 10.1016/S0140-6736(01)06652-1. PMID: 11716885.
 21. Evans A, Harraf F, Donaldson N, Kalra L. Randomized controlled study of stroke unit care versus stroke team care in different stroke subtypes. *Stroke*. 2002 Feb;33(2):449-55. doi: 10.1161/hs0202.102364. PMID: 11823651.
 22. Langhorne P, Dey P, Woodman M, Kalra L, Wood-Dauphinee S, Patel N, Hamrin E. Is stroke unit care portable? A systematic review of the clinical trials. *Age Ageing*. 2005 Jul;34(4):324-30. doi: 10.1093/ageing/afi038. PMID: 15955755.
 23. Foley N, Salter K, Teasell R. Specialized stroke services: a meta-analysis comparing three models of care. *Cerebrovasc Dis*. 2007;23(2-3):194-202. doi: 10.1159/000097641. Epub 2006 Dec 1. PMID: 17143003.
 24. Seenan P, Long M, Langhorne P. Stroke units in their natural habitat: systematic review of observational studies. *Stroke*. 2007 Jun;38(6):1886-92. doi: 10.1161/STROKEAHA.106.480871. Epub 2007 Apr 26. PMID: 17463308.
 25. Govan L, Langhorne P, Weir CJ; Stroke Unit Trialists Collaboration. Does the prevention of complications explain the survival benefit of organized inpatient (stroke unit) care?: further analysis of a systematic review. *Stroke*. 2007 Sep;38(9):2536-40. doi: 10.1161/STROKEAHA.106.478842. Epub 2007 Aug 9. PMID: 17690313.
 26. O'Rourke K, Walsh C. Impact of stroke units on mortality: a Bayesian analysis. *Eur J Neurol*. 2010 Feb;17(2):247-51. doi: 10.1111/j.1468-1331.2009.02782.x. Epub 2009 Sep 23. PMID: 19780805.
 27. Langhorne P, Fearon P, Ronning OM, Kaste M, Palomaki H, Vemmos K, Kalra L, Indredavik B, Blomstrand C, Rodgers H, Dennis MS, Al-Shahi Salman R; Stroke Unit Trialists' Collaboration. Stroke unit care benefits patients with intracerebral hemorrhage: systematic review and meta-analysis. *Stroke*. 2013 Nov;44(11):3044-9. doi: 10.1161/STROKEAHA.113.001564. Epub 2013 Sep 24. PMID: 24065713.
 28. Stroke Unit Trialists' Collaboration. Organised inpatient (stroke unit) care for stroke. *Cochrane Database Syst Rev*. 2020 Apr 23;4:CD000197. doi: 10.1002/14651858.CD000197.pub4. PMID: 24026639; PMCID: PMC6474318.

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29. Anåker A, Kevdzija M, Elf M. Enriched Environments in Stroke Units: Defining Characteristics and Limitations. *HERD*. 2024 Apr;17(2):344-359. doi: 10.1177/19375867231224972. Epub 2024 Mar 18. PMID: 38494920; PMCID: PMC11080395.
30. Prabhakaran S, Gonzalez NR, Zachrison KS, Adeoye O, Alexandrov AW, Ansari SA, Chapman S, Czap AL, Dumitrascu OM, Ishida K, Jadhav AP, Johnson B, Johnston KC, Khatri P, Kimberly WT, Lee VH, Leslie-Mazwi TM, Mac Grory B, Madsen TE, Menon B, Mistry EA, Park S, Parker S, Pérez de la Ossa N, Reeves M, Saiz T, Scott PA, Schwartzberg D, Sheth SA, Sporns PB, Times S, Tjoumakaris S, Wolfe SQ, Yaghi S; Peer Review Committee. 2026 Guideline for the Early Management of Patients With Acute Ischemic Stroke: A Guideline From the American Heart Association/American Stroke Association. *Stroke*. 2026 Jan 26. doi: 10.1161/STR.0000000000000513. Epub ahead of print. PMID: 41582814.
31. Stroke Foundation of Australia. [Living Clinical Guidelines for Stroke... | InformMe - Stroke Foundation](#); accessed January 9, 2026.
32. National Clinical Guideline for Stroke for the UK and Ireland. [National Clinical Guideline for Stroke](#); accessed January 9, 2026.
33. Canadian Stroke Best Practices. [8. Acute Stroke Unit Care | Canadian Stroke Best Practices](#); accessed January 9, 2026.
34. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, Biller J, Brown M, Demaerschalk BM, Hoh B, Jauch EC, Kidwell CS, Leslie-Mazwi TM, Ovbiagele B, Scott PA, Sheth KN, Southerland AM, Summers DV, Tirschwell DL. Guidelines for the Early Management of Patients With Acute Ischemic Stroke: 2019 Update to the 2018 Guidelines for the Early Management of Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke*. 2019 Dec;50(12):e344-e418. doi: 10.1161/STR.0000000000000211. Epub 2019 Oct 30. Erratum in: *Stroke*. 2019 Dec;50(12):e440-e441. doi: 10.1161/STR.0000000000000215. PMID: 31662037.
35. Alexandrov AW, Coleman KC, Palazzo P, Shahripour RB, Alexandrov AV. Direct stroke unit admission of intravenous tissue plasminogen activator: safety, clinical outcome, and hospital cost savings. *Ther Adv Neurol Disord*. 2016 Jul;9(4):304-9. doi: 10.1177/1756285616648061. Epub



2016 May 15. PMID: 27366237;
PMCID: PMC4916527.

36. Langhorne P. The Stroke Unit Story:
Where Have We Been and Where
Are We Going? Cerebrovasc Dis.
2021;50(6):636-643. doi:
10.1159/000518934. Epub 2021 Sep
21. PMID: 34547746.
37. American Heart Association. [Get
With The Guidelines | American
Heart Association](#); accessed January
9, 2026.

