Does Adding Thrombectomy-Capable Stroke Centers in a Regional Stroke Care System Affect Procedural Volume?

Juliana Tolles, MD, MHS;[1,2] Jake Toy, DO, MS;[1,2,3] Patrick Lyden, MD;[4] Marianne Gausche-Hill, MD;[1,2] Nichole Bosson, MD, MPH[1,2,3]

1. Department of Emergency Medicine, Harbor-UCLA Medical Center & The Lundquist Institute, Torrance, California USA
2. David Geffen School of Medicine at UCLA, Los Angeles, California USA
3. Los Angeles Emergency Medical Services Agency, Santa Fe Springs, California USA
4. Zilkha Neurogenetic Institute of the Keck University School of Medicine at USC, Los Angeles, California USA

Correspondence:
Juliana Tolles, MD, MHS
Department of Emergency Medicine
Harbor-UCLA Medical Center & The Lundquist Institute
1000 W Carson St.
Torrance, California USA 90502
E-mail: jtolles@dhs.lacounty.gov

Conflicts of interest: The authors have no conflicts of interest to declare.

Keywords: large vessel occlusion; regional care; stroke; thrombectomy; tPA

Abbreviations:
CSC: comprehensive stroke center
EMS: Emergency Medical Services
IA: intra-arterial
IV: intravenous
LA: Los Angeles
LVO: large vessel occlusion
PSC: primary stroke center
SPA: service planning area
tPA: tissue plasminogen activator
TSC: thrombectomy-capable stroke center

Received: May 14, 2024
Revised: January 23, 2025
Accepted: February 18, 2025

Abstract

Background: To maintain procedural proficiency and certification according to the standards set by The Joint Commission—which accredits health care centers in the United States—thrombectomy-capable stroke centers (TSCs) must achieve a minimum annual procedural volume. The addition of thrombectomy-capable centers in a regional stroke care system has the potential to increase access but also to decrease patient presentations and procedural volume at nearby centers. This study sought to characterize the impact of certifying additional thrombectomy-capable centers on procedural volume by center in a large, urban Emergency Medical Services (EMS) system.

Methods: Data were collected from each designated thrombectomy-capable center in Los Angeles (LA) County from January 1, 2018 through June 30, 2022, during which a net total of five thrombectomy-capable centers were newly designated in the County. Per center volume for ischemic stroke presentations, intravenous (IV) thrombolysis administrations (IV tissue plasminogen activator [tPA]), and thrombectomy were tabulated by six-month interval. Median last-known-well-to-procedure times by LA County Public Health service planning area (SPA) were calculated. The effect of the number of designated centers on procedural volumes per center and median last-known-well-to-procedure times were analyzed via a linear mixed effects model with a log link function.

Results: Procedural volume, ischemic stroke presentation volume, and last-known-well-to-procedure times had high variability over the time period studied. Nonetheless, the median values for each metric in this EMS system remained largely stable over the study period. There was no statistically significant association between the number of thrombectomy-capable centers and per center procedural volumes or times-to-procedure.

Conclusion: The designation of additional thrombectomy-capable centers in a regional stroke care system was not significantly associated with the volume of procedures by center or times-to-procedure, suggesting that additional centers may increase patient access to time-sensitive interventions without diluting patient presentations at existing centers.

Tolles J, Toy J, Lyden P, Gausche-Hill M, Bosson N. Does adding thrombectomy-capable stroke centers in a regional stroke care system affect procedural volume? *Prehosp Disaster Med.* 2025;40(2):119–123.

Introduction

Thrombectomy for patients with acute ischemic strokes due to large vessel occlusion (LVO) has demonstrated benefit in multiple clinical trials.[1] Stroke thrombectomy for LVO is associated with improved 90-day modified Rankin Scale outcomes, and a shorter time from symptom onset to thrombectomy is associated with a larger treatment effect. It is therefore imperative to provide access to this critical therapy to as many people as possible, without compromising the proficiency of neuro-interventionalists or the quality of care at the level of the stroke center.

Prior studies have shown that higher stroke center volume was associated with fewer delays to thrombectomy[2,3] and improved patient outcomes.[4,5] While geographical access to

doi:10.1017/S1049023X25000275
© The Author(s), 2025. Published by Cambridge University Press on behalf of World Association for Disaster and Emergency Medicine.

https://doi.org/10.1017/S1049023X25000275 Published online by Cambridge University Press

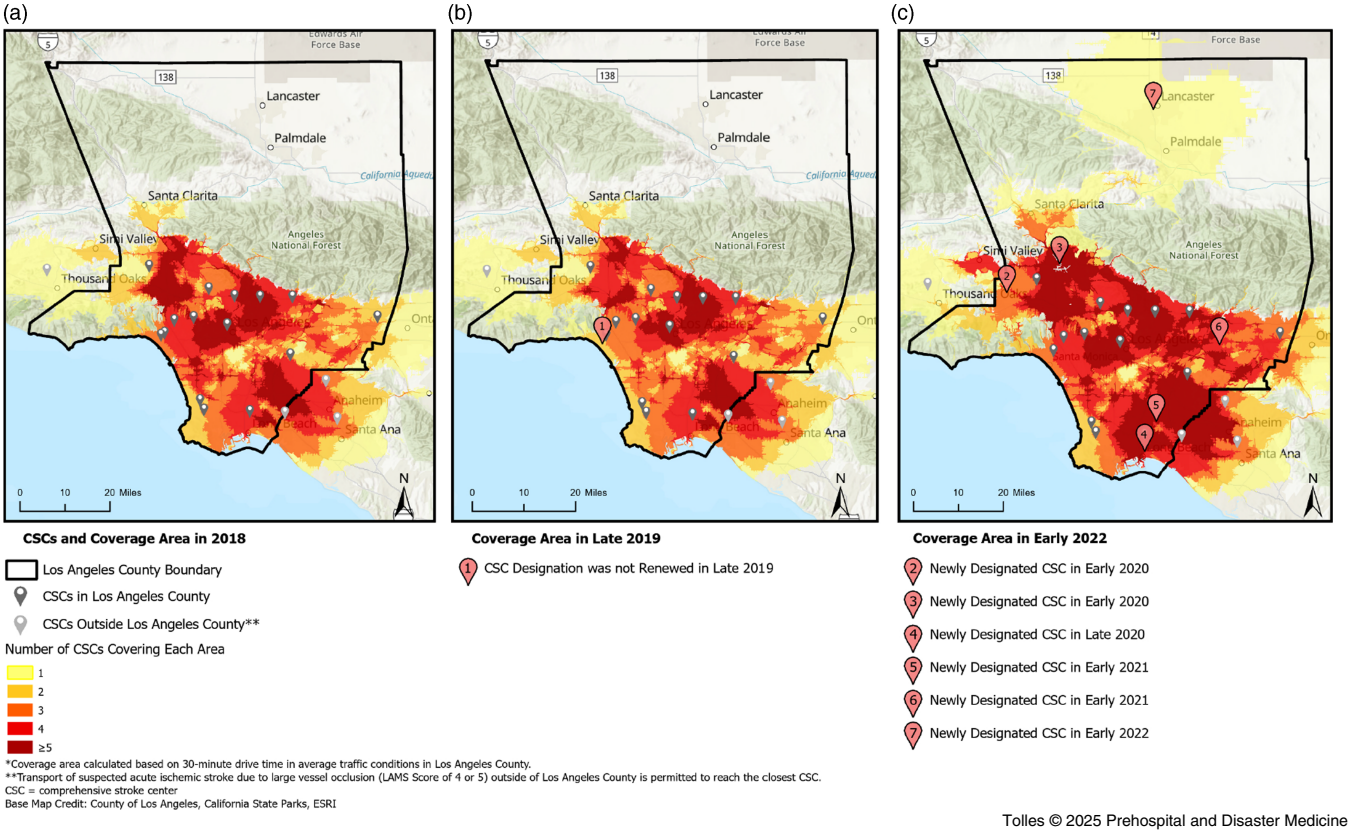


Figure 1. Comprehensive Stroke Centers and Coverage Area in Los Angeles County.
Abbreviation: CSC, comprehensive stroke center.

thrombectomy-capable centers is not uniform in the United States, with limited care access particularly in rural regions, there is a clustering of such centers in large urban areas.[6] Concerns have been raised regarding the ability of neuro-interventionalists and facility staff to maintain the procedural competency due to the potential for insufficient case volume in areas where clustered thrombectomy-capable stroke centers (TSCs) have significant overlap in catchment areas.[7–9] This investigation describes the impact of adding thrombectomy-capable centers in a large, urban, regional stroke care system on per center procedural volume and time-to-procedure.

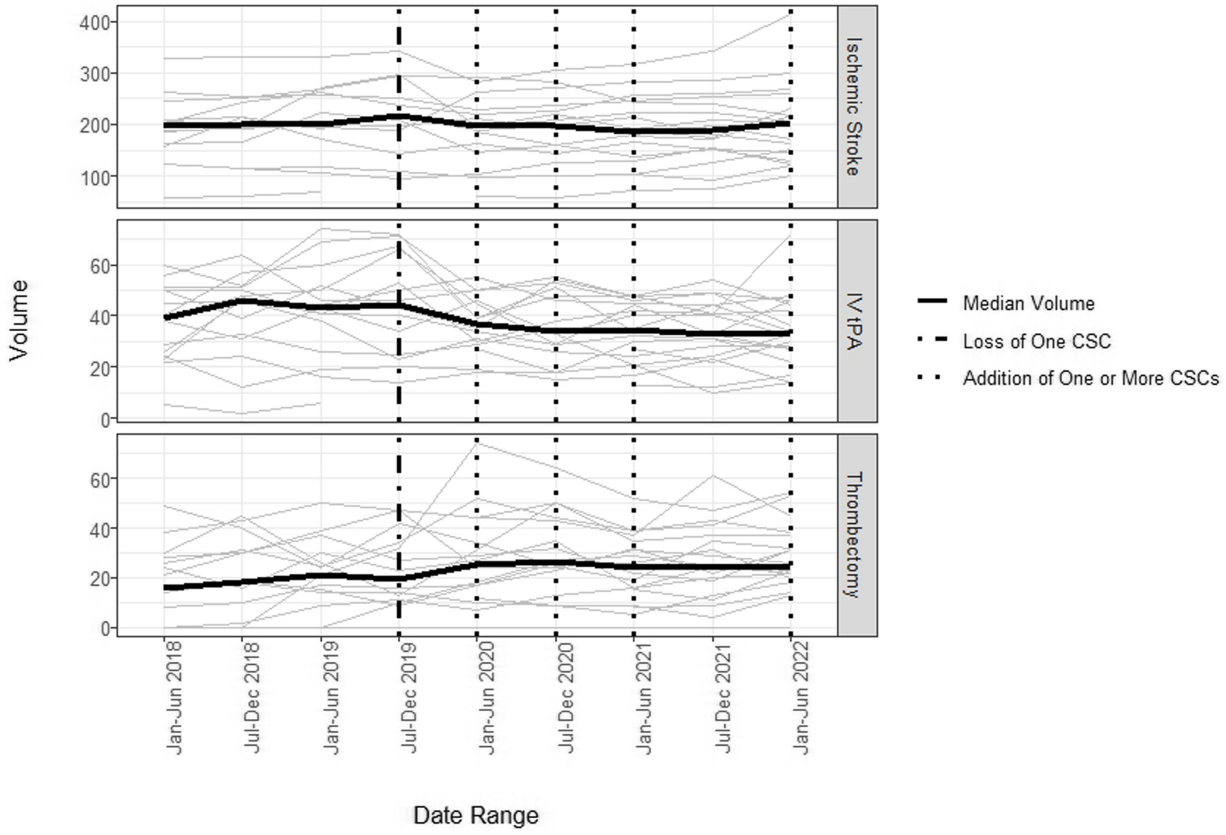
Methods

This was a retrospective analysis of registry data from the Los Angeles (LA) County (California USA) Emergency Medical Services (EMS) system. The study was approved by Harbor-UCLA Medical Center and The Lundquist Institute Institutional Review Board (Torrance, California USA; 18CR-31909-01).

Los Angeles County spans over 4,000 square miles and is home to a population of nearly ten million. The County is divided into eight geographic areas, known as service planning areas (SPAs). The two-tiered regionalized stroke system in LA County has been previously described.[10] The LA County EMS Agency designates primary stroke centers (PSCs) and comprehensive stroke centers (CSCs); designated CSCs are required to have 24/7 thrombectomy capability whereas PSCs are not required to offer this intervention.[11] Treatment protocols in LA County direct all patients with a last-known well time of <24 hours and LA Motor Scale (LAMS) score of four or five to be transported directly to a CSC if the estimated transport time is <30 minutes.[12] In 2018, there were 15 designated CSCs in LA County. By early 2022, six additional CSCs had been designated and one previously designated CSC had decided not to maintain its CSC designation, resulting in a net gain of five LA County CSCs. All LA County CSCs participate in a system quality improvement program and submit data on patient treatments and outcomes to the Get With The Guidelines–Stroke Registry (American Heart Association; Dallas, Texas USA).[11]

Data elements were abstracted from Get With The Guidelines–Stroke for all LA County CSCs for the time period from January 1, 2018 through June 30, 2022. Patients with an acute stroke who were transported from the field via EMS, transferred between facilities via EMS, and who self-presented to CSCs were included—as the total volume of procedures is the most relevant metric to skill proficiency maintenance. The number of ischemic stroke presentations, intravenous (IV) tissue plasminogen activator (tPA) administrations, and thrombectomies per CSC per six-month period were tabulated. As this was an exploratory analysis, no *a priori* sample size calculation was performed. A generalized Poisson regression model was fit to the procedural volume data for each procedure type in order to determine if there was a relationship between the procedural volume by center and the number of CSCs; fixed effects for the number of active CSCs and year (as a categorical variable), as well as a random effect for center were included. The percentage of CSCs meeting the minimum case volume of thrombectomies as recommended by The Joint Commission (Oakbrook Terrace, Illinois USA) – 15 per facility over the last 12 months or 30 over the last 24 months – was calculated.[13,14] The time between last-known well time and thrombectomy, IV tPA, or intra-arterial (IA) tPA as indicated

https://doi.org/10.1017/S1049023X25000275 Published online by Cambridge University Press



Tolles © 2025 Prehospital and Disaster Medicine

Figure 2. Volume for Ischemic Stroke Presentations, IV tPA Administrations, and Thrombectomies, as well as Median CSC Volume.
Abbreviations: CSC, comprehensive stroke center; IV tPA, intravenous tissue plasminogen activator.

per six-month period by SPA was also calculated. A generalized linear model was fit to log-transformed times-to-procedure with fixed effects for year and number of CSCs, as well as random effect for SPA. Statistical analyses were conducted in R software (packages: ggplot2, dplyr; R Foundation for Statistical Computing; Vienna, Austria).

To determine population access to CSCs, coverage area was calculated in ArcGIS Online (ESRI; Redlands, California USA) and ArcGIS Pro (Version 3.1; ESRI). Population access and coverage area were calculated in ArcGIS Online with the *Generate Travel Areas* tool and was defined by a 30-minute drive time toward each CSC during a typical Thursday at 5:00PM as this is the heaviest traffic time in LA County. Further analysis and visualization were conducted in ArcGIS Pro.

Results

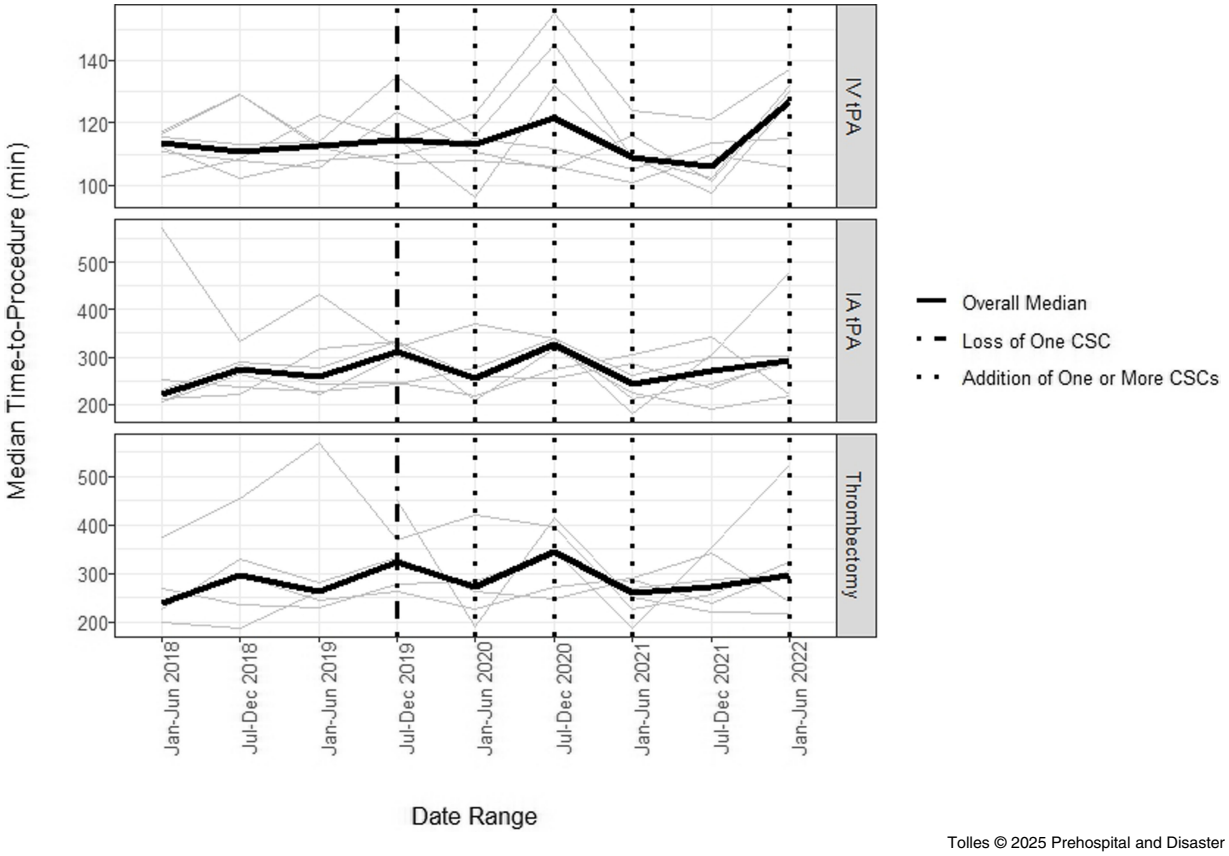
A total of 86,861 stroke presentations were included in the analysis, of which 51% were transported via EMS directly to the CSC, 32% self-transported directly to the CSC, and eight percent were transferred from another acute care facility. Mode of arrival data were missing for nine percent of cases. The median patient age was 71 (IQR 60-82) years and 50% were male. Population access based on CSC coverage area increased during the study period (Figure 1).

The volume for each CSC per six-month period for ischemic stroke presentations, IV tPA administrations, and thrombectomies, as well as the median CSC volume, is shown in Figure 2. The fraction of CSCs meeting the minimum recommended annual volume for thrombectomy procedures increased over time – 66% of CSCs met the minimum in 2018; 86% in 2019; 94% in 2020; 89% in 2021; and 95% were on track to meet it in 2022 based on volume in the first six months of 2022. The results of the regression analysis did not demonstrate a statistically significant association between the number of designated CSCs and the semiannual volume of ischemic stroke presentations (one percent decrease in ischemic stroke presentations per additional CSC; 95%CI, -3% to 4%), IV tPA administration (one percent decrease in administrations per additional CSC; 95%CI, -9% to 7%), or thrombectomies per center (two percent increase in thrombectomies per additional CSC, 95%CI, -74% to 299%). Median last-known-well-to-procedure time by SPA for IV tPA administration, IA tPA, and thrombectomy are shown in Figure 3. The results of the regression analysis did not demonstrate a statistically significant association between the number of designated CSCs and last-known-well-to-procedure times for IV tPA (0.2% increase in time-to-IV tPA per additional CSC; 95%CI, -3% to 4%), IA tPA (0.1% decrease in time-to-IA tPA per additional CSC; 95%CI, -9% to 10%), or thrombectomy (two percent increase in time-to-thrombectomy per additional CSC; 95%CI, -8% to 13%).

Discussion

In this descriptive study evaluating procedural volumes at TSCs in this large, regionalized stroke care system, there was no significant association between procedural volumes by center with designation additional thrombectomy-capable centers. This was despite

https://doi.org/10.1017/S1049023X25000275 Published online by Cambridge University Press



Tolles © 2025 Prehospital and Disaster Medicine

Figure 3. Median Last-Known-Well-to-Procedure Time by SPA for IV tPA Administration, IA tPA, and Thrombectomy.
Abbreviations: SPA, service planning area; CSC, comprehensive stroke center; IV tPA, intravenous tissue plasminogen activator; IA tPA, intra-arterial tissue plasminogen activator.

significant overlap in the geographic coverage area served by newly designated center and existing centers. Further, the fraction of centers meeting the minimum recommended thrombectomy procedural volume to maintain competency by The Joint Commission increased year over year despite an increase in the number of designated TSCs in this regional stroke care system.

While no previous studies have evaluated the real-world impact of adding stroke centers to existing regional stroke care systems, prior work has modeled patient volumes and outcomes after the addition of stroke centers within a simulated regional hospital network. Zhou, et al employed Monte Carlo simulation to determine the impact adding thrombectomy capability to an existing stroke center when a thrombectomy-capable center already existed nearby.[9] The authors found that adding additional centers within their simulated hospital network increased stroke patient volume to the newly designated thrombectomy-capable center by >40% and procedural volume by >30% but decreased volumes at the existing thrombectomy-capable center. While these findings seem intuitive in a simulated setting, they are not consistent with the findings in the LA County system.

One possible explanation for the differing findings is that new centers in LA County were able to serve patients who would previously not have been able to access specialized stroke care, instead of simply drawing patients away from existing centers. Though coverage areas of the newly designated CSCs in LA County largely overlap (based on 30-minute transport times), this did not account for increased walk-in patients to new CSCs, logistical considerations surrounding air transport (ie, helipad access), and the development of transfer agreements between new CSCs and existing hospitals. Although it is likely that there is a TSC density which would result in decreased volumes per center within a regional stroke care system, to date, this threshold is unknown and likely varies by system.

Importantly, there was also no trend observed in the time-to-procedures over the six-year time period of the study as the two-tiered regional stroke system matured. A primary objective of regional systems is to concentrate resources and volume in order to improve treatment efficiency and reduce variation. It is not feasible to further explore this within the limitations of these data, but it is possible that, despite TSCs meeting the minimum number of procedures required for certification, the current procedural volumes are insufficient to drive process improvement.

Limitations

The following limitations should be considered when interpreting these results. The analysis does not account for other concurrent system-levels interventions that may have impacted procedural volumes. Neither could changes in the indication for thrombectomy as recommended by national guidelines during the study period be accounted for. Additionally, these findings were also from a single urban-suburban EMS system and may not be generalizable to all stroke care systems, particularly those in rural regions or developing countries.

https://doi.org/10.1017/S1049023X25000275 Published online by Cambridge University Press

While there is evidence that a higher volume of stroke thrombectomy procedures both per center and per proceduralist improves outcomes,[2–5] evidence to support the specific threshold of 15 procedures per 12 months (or 30 procedures per 24 months) for United States Joint Commission TSC certification is lacking. Indeed, the studies cited above showed a continuous positive association between procedural volumes and outcomes rather than a threshold effect. More work is required to define the precise threshold at which the benefit from increased access to this therapy is balanced with the risk associated with decreased center and provider proficiency. However, this analysis showed no association between the number of designated thrombectomy-capable centers and the number of stroke thrombectomy procedures, measured either as a continuous and dichotomized outcome.

Conclusions

In this descriptive study, the designation of additional thrombectomy-capable centers in a regional stroke care system was not associated with a change in the volume of procedures by center, suggesting that additional centers may increase patient access to time-sensitive interventions without diluting patient presentations at existing centers. Median last-known-well-to-procedure times were also not significantly associated with the number of designated centers.

References

1. Powers WJ, Rabinstein AA, Ackerson T, et al. 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;50(12):e344–e418.
2. Gupta R, Horev A, Nguyen T, et al. Higher volume endovascular stroke centers have faster times to treatment, higher reperfusion rates and higher rates of good clinical outcomes. *J Neurointerv Surg.* 2013;5(4):294–297.
3. Rinaldo L, Brinjikji W, Rabinstein AA. Transfer to high-volume centers associated with reduced mortality after endovascular treatment of acute stroke. *Stroke.* 2017;48(5):1316–1321.
4. Waqas M, Tutino VM, Cappuzzo JM, et al. Stroke thrombectomy volume, rather than stroke center accreditation status of hospitals, is associated with mortality and discharge disposition. *J NeuroInterv Surg.* 2023;15(3):209–213.
5. Stein LK, Mocco J, Fifi J, Jette N, Tuhrim S, Dhamoon MS. Correlations between physician and hospital stroke thrombectomy volumes and outcomes: a nationwide analysis. *Stroke.* 2021;52(9):2858–2865.
6. Aldstadt J, Waqas M, Yasumiishi M, et al. Mapping access to endovascular stroke care in the USA and implications for transport models. *J Neurointerv Surg.* 2022;14(1): neurintsurg-2020-016942.
7. Linfante I, Nogueira RG, Zaidat OO, et al. A joint statement from the Neurointerventional Societies: our position on operator experience and training for stroke thrombectomy. *J Neurointerv Surg.* 2019;11(6):533–534.
8. Mack WJ, Mocco J, Hirsch JA, et al. Thrombectomy stroke centers: the current threat to regionalizing stroke care. *J NeuroInterv Surg.* 2018;10(2):99–101.
9. Zhou MH, Kansagra AP. Changes in patient volumes and outcomes after adding thrombectomy capability. *Stroke.* 2021;52(6):2143–2149.
10. Bosson N, Gausche-Hill M, Saver JL, et al. Increased access to and use of endovascular therapy following implementation of a 2-tiered regional stroke system. *Stroke.* 2020;51(3):908–913.
11. Stroke Receiving Center Standards Reference No. 322. https://file.lacounty.gov/SDSInter/dhs/1016600_322-StrokeStandards20170109-signed.pdf. Accessed November 6, 2023.
12. Stroke Patient Destination Reference No. 521. https://file.lacounty.gov/SDSInter/dhs/238671_521-7-1-16.pdf. Accessed November 6, 2023.
13. Joint Commission reinstates individual physician mechanical thrombectomy volume eligibility requirement. *The Bulletin*. https://bulletin.facs.org/2019/04/joint-commission-reinstates-individual-physician-mechanical-thrombectomy-volume-eligibility-requirement/. Accessed November 6, 2023.
14. Quick Guide: Thrombectomy-Capable Stroke Certification (TSC). https://www.jointcommission.org/-/media/tjc/documents/accred-and-cert/certification/certification-by-setting/stroke/dsc-quick-guide—thrombectomy-2019.pdf. Accessed November 6, 2023.

https://doi.org/10.1017/S1049023X25000275 Published online by Cambridge University Press