Supplementary Online Content

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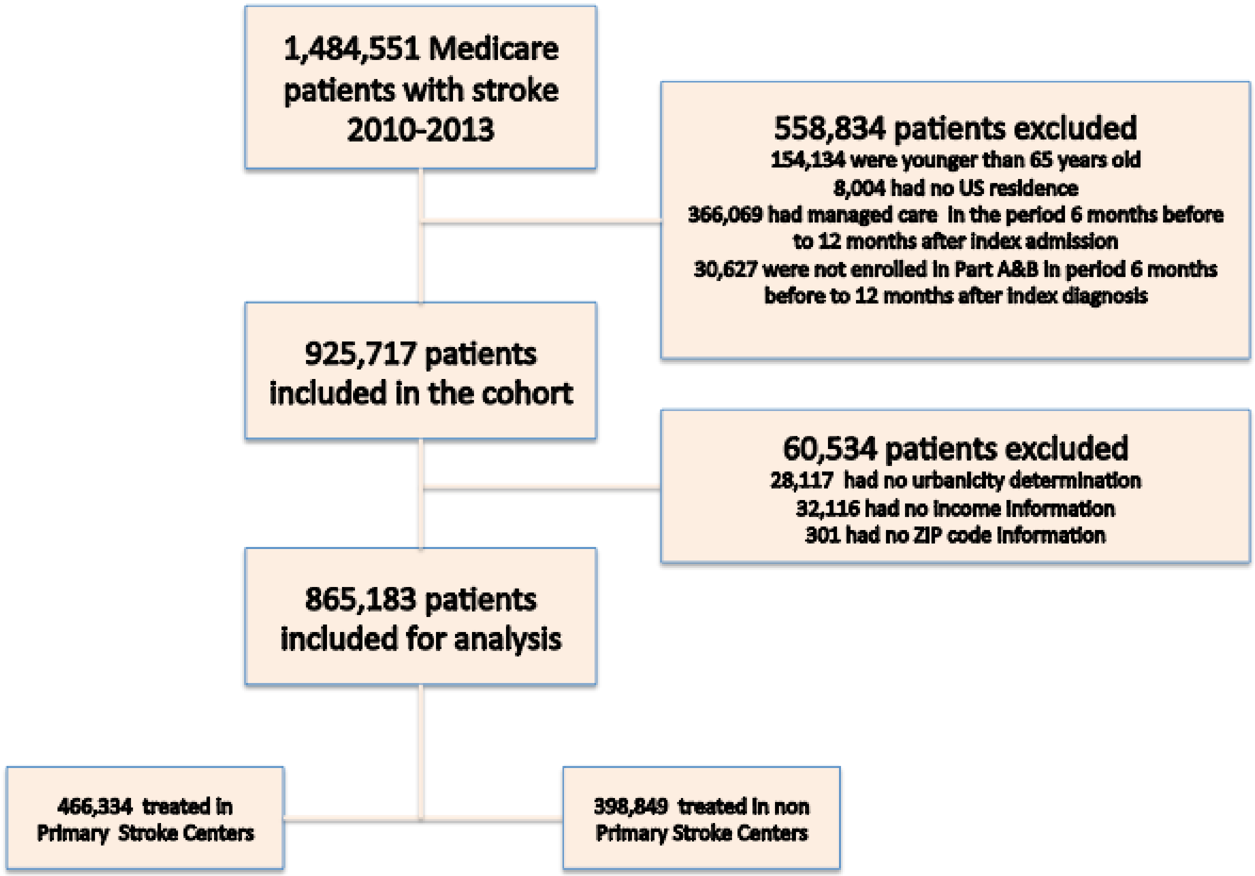
This supplementary material has been provided by the authors to give readers additional information about their work.

eFigure. Cohort Creation



eTable 1. Coding Definitions

GROUP	CATEGORY	ICD-9 Codes
Covariates	Myocardial infarction	**410, 410.0-410.9, 411, 411.1, 411.89, 412, 413, 413.1, 413.9, 414, 414.2, 414.3, 414.4, 414.8, 414.9**
	Cardiac arrhythmia	**426.10, 426.11, 426.13, 426.2-426.53, 426.6-426.89, 427.0, 427.2, 427.31, 427.60, 427.9, 785.0, v45.0, v53.3**
	Congestive Heart Failure	**398.91, 402.11, 402.91, 404.11, 404.13, 404.91, 404.93, 428.0-428.9**
	Diabetes Mellitus	**250.00-250.33, 250.40-250.73, 250.90-250.93**
	Coagulopathy	**286.0-286.9, 287.1, 287.3-287.5**
	Chronic Renal Failure	**403.11, 403.91, 404.12, 404.92, 585, 586, V42.0, V45.1, V56.0, V56.8**
	Hypertension	**401.0-405.99**
	Hyperlipidemia	**272, 272.0, 272.1, 272.2, 272.3, 272.4**
	Peripheral Vascular Disease	**440.00-440.9, 441.2, 441.4, 441.7, 441.9, 443.1-443.9, 447.1, 557.1, 557.9, V43.4**
	Tobacco use	**415.0, 416.8, 416.9, 491.0, 492.0, 494.0, 496.0 305.1, V15.82, 989.84**

eTable 2. Intervention and Hospitalization Characteristics Among Patients Admitted in PSC and Non-PSC Institutions

	PSC	**Non-PSC**
Thrombolytics	25,890 (6.0%)	11,031 (2.8%)
Mechanical thrombectomy	4,203 (1.0%)	865 (0.2%)
Median length of stay (IQR), days	8 (17)	8 (17)
Median length of ICU stay (IQR), days	1 (3)	0 (2)

PSC: Primary Stoke Center, IQR: Interquartile Range, ICU: Intensive Care Unit

eTable 3. Disposition of Stroke Patients in Our Cohort Who Were Alive at the Time of Discharge

Discharged to home or self care	302,763 (35.0%)
Discharged/transferred to skilled nursing facility (SNF)	180,957 (20.9%)
Discharged/transferred to another rehabilitation facility including rehabilitation distinct part units of a hospital Discharged/transferred to an inpatient rehabilitation facility including distinct part units of a hospital	137,017 (15.8%)
Discharged/transferred to home under care of organized home health service organization	92,494 (10.7%)
Discharged/transferred to Hospice – medical facility	32,116 (3.7%)
Transferred to a short term hospital for inpatient care	15,602 (1.8%)
Discharged/transferred to Hospice – home	13,388 (1.6%)
Discharged/transferred to long term care hospital	8,966 (1.0%)
Discharged/transferred to a hospital-based Medicare approved swing bed	8,769 (1.0%)
Discharged/transferred to a facility that provides custodial or supportive care	7,183 (0.83%)
Discharged/transferred to a psychiatric hospital	817 (0.09%)
Discharged/transferred to federal hospital	411 (0.05%)

eTable 4. Models of the Association of PSC Admission With 7- and 30-Day Case Fatality

	Probit regression with IV*		**Poisson regression with IV***	
	7-day Case-fatality	**30-day Case-fatality**	**7-day Case-fatality**	**30-day Case-fatality**
	Coefficient (95% CI)§	**Coefficient (95% CI) §**	**RR (95% CI)**	**RR (95% CI)**
PSC admission	-0.14 (-0.17 to -0.11)	-0.10 (-0.12 to -0.07)	0.70 (0.64 to 0.78)	0.82 (0.76 to 0.88)
Age				
65-69 years old	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
70-74 years old	0.02 (0.002 to 0.04)	0.03 (0.01 to 0.04)	0.89 (0.83 to 0.96)	0.93 (0.88 to 0.98)
75-79 years old	0.08 (0.07 to 0.10)	0.13 (0.12 to 0.15)	1.03 (0.97 to 1.12)	1.18 (1.13 to 1.24)
80-84 years old	0.19 (0.17 to 0.20)	0.29 (0.27 to 0.30)	1.30 (1.29 to 1.47)	1.65 (1.58 to 1.72)
Over 85 years old	0.40 (0.38 to 0.41)	0.60 (0.58 to 0.61)	2.30 (2.16 to 2.44)	2.87 (2.76 to 2.99)
Male gender	-0.09 (-0.10 to -0.08)	-0.09 (-0.10 to -0.09)	0.81 (0.78 to 0.84)	0.84 (0.82 to 0.86)
Poverty	-0.35 (-0.44 to -0.26)	-0.34 (-0.42 to -0.26)	0.56 (0.39 to 0.80)	0.58 (0.46 to 0.74)
Urban status				
Rural	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Suburban	-0.02 (-0.04 to -0.01)	-0.05 (-0.06 to -0.04)	0.95 (0.90 to 1.01)	0.91 (0.87 to 0.95)
Urban	-0.05 (-0.06 to -0.03)	-0.09 (-0.10 to -0.07)	0.94 (0.88 to 1.01)	0.86 (0.82 to 0.90)
Race				
White	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Black	-0.19 (-0.21 to -0.17)	-0.14 (-0.15 to -0.12)	0.71 (0.66 to 0.77)	0.88 (0.84 to 0.93)
Asian	-0.11 (-0.15 to -0.08)	-0.10 (-0.13 to -0.07)	0.90 (0.79 to 1.03)	0.92 (0.83 to 1.01)
Other	-0.11 (-0.14 to -0.08)	-0.09 (-0.12 to -0.07)	0.83 (0.74 to 0.94)	0.94 (0.87 to 1.02)
Income				
Category 1	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Category 2	-0.02 (-0.03 to -0.01)	-0.02 (-0.03 to -0.01)	0.93 (0.88 to 0.99)	0.93 (0.90 to 0.97)
Category 3	-0.03 (-0.05 to -0.02)	-0.04 (-0.05 to -0.03)	0.92 (0.86 to 0.98)	0.92 (0.88 to 0.96)
Category 4	-0.07 (-0.09 to -	-0.08 (-0.09 to	0.88 (0.82 to	0.86 (0.82 to

	0.05)	-0.06)	0.94)	0.90)
Category 5	-0.10 (-0.12 to -0.08)	-0.12 (-0.13 to -0.10)	0.76 (0.71 to 0.82)	0.78 (0.74 to 0.82)
HCC				
Category 1	1 (Reference)	1 (Reference)	1 (Reference)	1 (Reference)
Category 2	0.27 (0.25 to 0.29)	0.31 (0.30 to 0.33)	2.19 (2.04 to 2.35)	2.09 (1.99 to 2.19)
Category 3	0.52 (0.50 to 0.54)	0.58 (0.57 to 0.60)	4.33 (4.04 to 4.64)	3.65 (3.49 to 3.81)
Category 4	0.73 (0.71 to 0.75)	0.86 (0.84 to 0.87)	7.24 (6.77 to 7.75)	5.84 (5.59 to 6.09)
Category 5	0.90 (0.88 to 0.92)	1.17 (1.16 to 1.19)	10.88 (10.16 to 11.65)	9.57 (9.17 to 9.99)
Intracerebral hemorrhage	1.09 (1.08 to 1.10)	0.93 (0.92 to 0.94)	9.23 (8.93 to 9.54)	4.99 (4.87 to 5.10)
Subarachnoid hemorrhage	1.01 (0.99 to 1.03)	0.87 (0.84 to 0.89)	8.82 (8.32 to 9.36)	4.88 (4.66 to 5.10)
Myocardial Infarction	0.04 (0.03 to 0.05)	-0.06 (-0.07 to -0.05)	0.96 (0.92 to 0.99)	0.85 (0.83 to 0.87)
Arrhythmia	0.13 (0.12 to 0.13)	0.08 (0.07 to 0.09)	1.37 (1.33 to 1.41)	1.20 (1.18 to 1.22)
Congestive Heart Failure	-0.01 (-0.02 to 0.02)	-0.02 (-0.03 to -0.01)	1.03 (0.99 to 1.07)	1.02 (0.99 to 1.05)
Hyperlipidemia	-0.25 (-0.26 to -0.24)	-0.32 (-0.33 to -0.31)	0.48 (0.47 to 0.50)	0.52 (0.51 to 0.53)
Coagulopathy	-0.08 (-0.11 to -0.06)	-0.03 (-0.05 to -0.01)	1.10 (1.04 to 1.17)	0.99 (0.94 to 1.05)
Hypertension	-0.07 (-0.08 to -0.06)	-0.16 (-0.17 to -0.15)	0.89 (0.82 to 0.96)	0.75 (0.74 to 0.77)
Peripheral Vascular Disease	-0.19 (-0.21 to -0.17)	-0.26 (-0.28 to -0.25)	0.52 (0.50 to 0.57)	0.57 (0.54 to 0.60)
Tobacco use	-0.19 (-0.21 to -0.17)	-0.29 (-0.30 to -0.27)	0.55 (0.51 to 0.60)	0.54 (0.52 to 0.57)
Diabetes Mellitus	-0.13 (-0.14 to -0.12)	-0.19 (-0.20 to -0.18)	0.74 (0.71 to 0.77)	0.76 (0.74 to 0.78)
Chronic Renal Failure	-0.14 (-0.16 to -0.13)	-0.16 (-0.17 to -0.15)	0.73 (0.70 to 0.77)	0.81 (0.78 to 0.84)

IV: Instrumental Variable; RR: Risk Ratio
* Differential travel time to a PSC was used as an instrument for PSC admission.
§Coefficients of Probit regression are not readily interpretable (other than the direction and relative magnitude of the association). Numbers presented in the main text of the manuscript are the marginal effects of these regressions.

eTable 5. Post Hoc Analyses of the Association of PSC Admission With 7-Day Postadmission Mortality

Subgroups		
	Adjusted difference (95% CI) *	**P-value**
Ischemic stroke	-1.7% (-2.0% to -1.4%)	<0.01
Intracerebral hemorrhage	-2.8% (-9.5% to 3.9%)	0.35
Subarachnoid hemorrhage	-1.3% (-3.9% to 1.4%)	0.42
Transfers excluded	-2.1% (-2.6% to -1.7%)	0.10

*Numbers represent probability differences in a two-stage approach with a Probit function in the second stage, using differential travel time of the patient to a PSC versus a non-PSC hospital as an instrument.

eMethods. Supplemental Methods

Assessment of ground travel burden of regionalization

Street-level network data, from ESRI's StreetMap North America v10.2 (2009 data), were used to calculate the optimal travel time routes. Road segments of this dataset were previously categorized into road classes, with travel time and distance impedance already calculated for each segment. Travel time paths and their distances between origin and destination points were calculated to find the optimal routes using ESRI's ArcGIS software with the Network Analyst extension.

To minimize bias from patients who sought care when they were away from their primary residence (i.e. on a trip), patient origin-hospital/PSC destination pairs with greater than 8 hours ground drive time were excluded. Furthermore, due to the limited street network data in Alaska and Hawaii, ground drive time calculations were derived from geodesic distances between the origin and destination centroids. Geodesic distance is the shortest surface path between two points on a sphere.

The urban-rural character of the drive path was subsequently determined. Drive paths were classified as urban, suburban, or rural depending on the average population of the origin and the destination centroid pair taken together and then assigned a tertile category using the population averages of these pairs. Based on prior literature,[12] pre-hospital parameters were incorporated into the total drive times between patient origins and destinations. 1.4, 1.4, and 2.9 minutes in urban, suburban, and rural areas, respectively, were added to drive times to account for the time from the receipt of emergency call to ambulance departure time. In addition, drive times were multiplied by the constants 1.6, 1.5, and 1.4 for urban, suburban, and rural areas, respectively, to account for the time between ambulance dispatch and arrival on-scene. Moreover, 13.5, 13.5, and 15.1 minutes in urban, suburban, and rural areas, respectively, were added to account for the average time spent on the scene. The final total drive time used for access calculations was the sum of the road network drive time multiplied by the appropriate constant, plus call, plus on-scene time, respective to the urban, suburban, or rural tertile of the path. Shortest ground total drive times between patient origin and destination pairs were then identified. For the ground travel time calculations in AK and HI, drive times were derived by converting calculated geodesic distances to times using drive speeds of 20, 47.47, and 56.52 mph for urban, suburban, and rural areas, respectively, similar to prior studies.[12]

All access calculations were initially performed assuming that the emergency ground medical services could cross state lines to achieve the shortest time to a PSC. As part of a sensitivity analysis, these were repeated respecting the state boundaries.

Estimation Issues

There are a variety of approaches to estimating models with dichotomous endogenous variables. We used as our primary model the instrumental variable (IV) Probit model, but in sensitivity analysis not reported in the text, we also considered a variety of different approaches. For example, some economists are concerned about the IV Probit model because the second stage is nonlinear (e.g., Joshua Angrist and some economics (e.g., Angrist and Pischke, "Mostly Harmless Econometrics"). To address this issue, we also estimated the model using two-stage least squares linear probability approach, and the two-step IV Probit in STATA. The results were consistent across estimation methods.