SUPPLEMENTAL MATERIAL

Access to Mechanical Thrombectomy for Ischemic Stroke in the United States

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Table I. Codes Used to Define Major Variables in Analysis of Access to Thrombectomy for Ischemic Stroke.

Service	Procedure Code
Ischemic stroke	*ICD-10-CM* code I63
Mechanical thrombectomy for ischemic stroke	*ICD-10-CM* code 03CG3 *ICD-10-CM* code 03CH3 *ICD-10-CM* code 03CI3 *ICD-10-CM* code 03CJ3 *ICD-10-CM* code 03CK3 *ICD-10-CM* code 03CL3 *ICD-10-CM* code 03CP3 *ICD-10-CM* code 03CQ3
Expanded definition of endovascular therapy for ischemic stroke	*ICD-10-CM* code 03CG3 *ICD-10-CM* code 03CH3 *ICD-10-CM* code 03CI3 *ICD-10-CM* code 03CJ3 *ICD-10-CM* code 03CK3 *ICD-10-CM* code 03CL3 *ICD-10-CM* code 03CP3 *ICD-10-CM* code 03CQ3 *ICD-10-CM* code 3E06317 *ICD-10-CM* code 037G3-037G4
Intravenous thrombolysis for ischemic stroke	*ICD-10-CM* code 3E03017 *ICD-10-CM* code 3E03317 *CPT* code 37195
Mechanical ventilation	*ICD-10-CM* code 5A093 *ICD-10-CM* code 5A095 *ICD-10-CM* codes 5A193-5A195
Any neurosurgical intervention	*ICD-10-CM* code 00
Any cardiac intervention	*ICD-10-CM* code 02
Any vascular intervention	*ICD-10-CM* codes 03-07

Abbreviations: *CPT*, *Current Procedural Terminology*; *ICD-10-CM*, *International Classification of Diseases*, *10th Revision*, *Clinical Modification*.

Table II. Urban-Rural Classification Scheme* Used in Analysis of Access to Thrombectomy for Ischemic Stroke.

Category	Description
1	"Central" counties of metro area of >=1 million population
2	"Fringe" counties of metro area of >=1 million population
3	Counties in metro area of 250,000-999,999 population
4	Counties in metro area of 50,000-249,999 population
5	Micropolitan counties
6	Noncore counties

*This urban-rural classification scheme was developed for healthcare research by the National Center for Health Statistics.[9]

Table III. Sensitivity Analyses of Initial Presentation with Ischemic Stroke to Thrombectomy Hubs versus Gateways versus Gaps[*].

Facility Type[†]	All Ischemic Stroke	Probable LVO[‡]	Received IV Thrombolysis	Presented to High-Volume Center[§]	Expanded Endovascular Therapy Definition[‖]
Hub	48.7%	61.7%	59.6%	49.5%	52.9%
Gateway	35.3%	31.3%	30.5%	35.5%	31.8%
Gap	16.1%	7.0%	9.9%	15.0%	15.3%

Abbreviations: IV, intravenous; LVO, large-vessel occlusion.

[*]We classified a facility as a thrombectomy hub for ischemic stroke if it performed stroke thrombectomy in at least one stroke patient during the study period, a thrombectomy gateway if it did not perform any stroke thrombectomies but transferred out at least one stroke patient who received stroke thrombectomy at the receiving hospital, and a thrombectomy gap otherwise.

[†]Data are presented as number (%).

[‡]Defined as a National Institutes of Health Stroke Scale (NIHSS) score ≥12 among patients with documented NIHSS data. Data available for 22,188 patients.

[§]Defined as a facility that cared for at least 30 strokes during the study period.

[‖]Endovascular stroke therapy included intra-arterial thrombolysis and intracranial angioplasty/stenting in addition to mechanical thrombectomy.

[#]Hubs with <10 endovascular procedures during the study period were excluded.

Table IV. Temporal Trends in Initial Presentation with Ischemic Stroke to Thrombectomy Hubs versus Gateways versus Gaps[*].

Facility Type[†]	2016	2017-2018[‡]
Hub	48.0%	49.9%
Gateway	33.2%	38.7%
Gap	18.8%	11.4%

[*]We classified a facility as a thrombectomy hub if it performed thrombectomy in at least one stroke patient during the study period, a thrombectomy gateway if it did not perform any stroke thrombectomies but transferred out at least one stroke patient who received stroke thrombectomy at the receiving hospital, and a thrombectomy gap otherwise.

[†]Data are presented as number (%).[‡]Data for calendar years 2017 and 2018 were collapsed into one category given relatively smaller numbers in 2018.

Table V. Sensitivity Analyses of Association between Initial Presentation to Thrombectomy Gateway (versus Hub) and Likelihood of Ultimately Undergoing Thrombectomy. [*]

Facility Type[†]	All Ischemic Stroke Patients	Adjusted for Estimated Stroke Severity	Probable LVO[‡]	Received IV Thrombolysis	Presented to High-Volume Center[§]	Stricter Definition of Endovascular Hub[||]	Expanded Endovascular Therapy Definition[#]
Hub	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Gateway	0.27 (0.25-0.29)	0.28 (0.26-0.30)	0.36 (0.30-0.42)	0.13 (0.11-0.16)	0.25 (0.24-0.27)	0.22 (0.21-0.24)	0.29 (0.27-0.31)

Abbreviations: IV, intravenous; LVO, large-vessel occlusion.

[*]We classified a facility as a thrombectomy hub for ischemic stroke if it performed stroke thrombectomy in at least one stroke patient during the study period, a thrombectomy gateway if it did not perform any stroke thrombectomies but transferred out at least one stroke patient who received stroke thrombectomy at the receiving hospital, and a thrombectomy gap otherwise.

[†]Reported data represent odds ratios and 95% confidence intervals for the association between presentation to a thrombectomy gateway (as opposed to a hub) and receipt of thrombectomy.

[‡]Defined as a National Institutes of Health Stroke Scale (NIHSS) score ≥12 among patients with documented NIHSS data. Data available for 22,188 patients.

[§]Defined as a facility that cared for at least 30 strokes during the study period.

[||]Hubs with <10 endovascular procedures during the study period were excluded.

[#]Endovascular stroke therapy included intra-arterial thrombolysis and intracranial angioplasty/stenting in addition to mechanical thrombectomy.

Table VI. Characteristics of Patients with Ischemic Stroke, Stratified by Thrombectomy Access[*] at Initial Healthcare Facility.

Patient Characteristic[†]	Thrombectomy Hub (N = 100,139)	Thrombectomy Gateway (N = 72,534)	Thrombectomy Gap (N = 33,008)
Age, mean (SD), y	70 (15)	71 (14)	71 (14)
Female	49,927 (49.9)	36,761 (50.7)	17,154 (52.0)
Race[‡]			
White	61,476 (61.4)	51,113 (70.5)	22,741 (68.9)
Black	22,773 (22.7)	13,824 (19.1)	7,022 (21.3)
Hispanic	10,121 (10.1)	3,777 (5.2)	1,947 (5.9)
Asian	1,505 (1.5)	1,522 (2.1)	384 (1.2)
Other	4,264 (4.3)	2,298 (3.2)	914 (2.8)
Payment source			
Medicare	66,622 (66.5)	50,601 (69.8)	22,888 (69.3)
Medicaid	9,740 (9.7)	5,140 (7.1)	2,804 (8.5)
Private insurance	16,831 (16.8)	11,084 (15.3)	5,094 (15.4)
Other	6,946 (6.9)	5,709 (7.9)	2,222 (6.7)
Rural location of residence[§]	9,721 (9.7)	8,813 (12.2)	13,487 (40.9)
Socioeconomic advantage score, mean (SD) [‖]	4.6 (4.4)	4.3 (4.6)	3.6 (5.8)
Charlson comorbidity index, mean (SD)	2.8 (1.4)	2.7 (1.4)	2.6 (1.3)
NIHSS score, median (IQR) [#]	5 (2-11)	4 (2-8)	4 (2-8)

Abbreviations: IQR, interquartile range; NIHSS, National Institutes of Health Stroke Scale; SD, standard deviation.

[*]We classified a facility as a thrombectomy hub for ischemic stroke if it performed stroke thrombectomy in at least one stroke patient during the study period, a thrombectomy gateway if it did not perform any stroke thrombectomies but transferred out at least one stroke patient who received stroke thrombectomy at the receiving hospital, and a thrombectomy gap otherwise.

[†]Data are presented as number (%) unless otherwise specified.

[‡]Self-reported by patients or their surrogates.

[§]Defined as nonmetropolitan location according to the urban-rural classification scheme developed by the National Center for Health Statistics.[9]

[‖]Aggregate zip-code level socioeconomic advantage score calculated from American Community Survey data using previously published methods.[10]

[#]National Institutes of Health Stroke Scale (NIHSS) scores encoded in *ICD-10-CM* discharge codes.[15] Data available for 22,188 patients.

Table VII. Adjusted Probabilities of Relevant Clinical Services Available to Ischemic Stroke Patients at Initial Facility[*].

Clinical Service[†]	Thrombectomy Gateway (N = 72,534)	Thrombectomy Gap (N = 33,008)
Intravenous thrombolysis	94.7%	80.9%
Mechanical ventilation[‡]	99.6%	98.5%
Any neurosurgical intervention	99.4%	97.6%
Any cardiac intervention	99.7%	98.2%
Any vascular intervention	99.8%	98.7%

[*]We classified a facility as a thrombectomy hub if it performed stroke thrombectomy in at least one stroke patient during the study period, a thrombectomy gateway if it did not perform any stroke thrombectomies but transferred out at least one stroke patient who received stroke thrombectomy at the receiving hospital, and a thrombectomy gap otherwise.

[†]A clinical service was considered to be available if any procedure within that broad category was performed at a site at least once during the study period. Reported percentages reflect probabilities of each service after adjustment for age, sex, race, insurance, socioeconomic status, urban-rural location of residence, and Charlson comorbidity index.

[‡]For patients admitted to the hospital, not patients in the emergency department.

Figure I

Title: Flow Diagram of Patients Included in Analysis of Access to Thrombectomy for Ischemic Stroke.

Caption: Mimics were defined as patients with a stroke diagnosis at the initial facility but no such diagnosis at the receiving facility. Cross-border transfers were defined as patients transferred to a hospital for which we had no linked records.

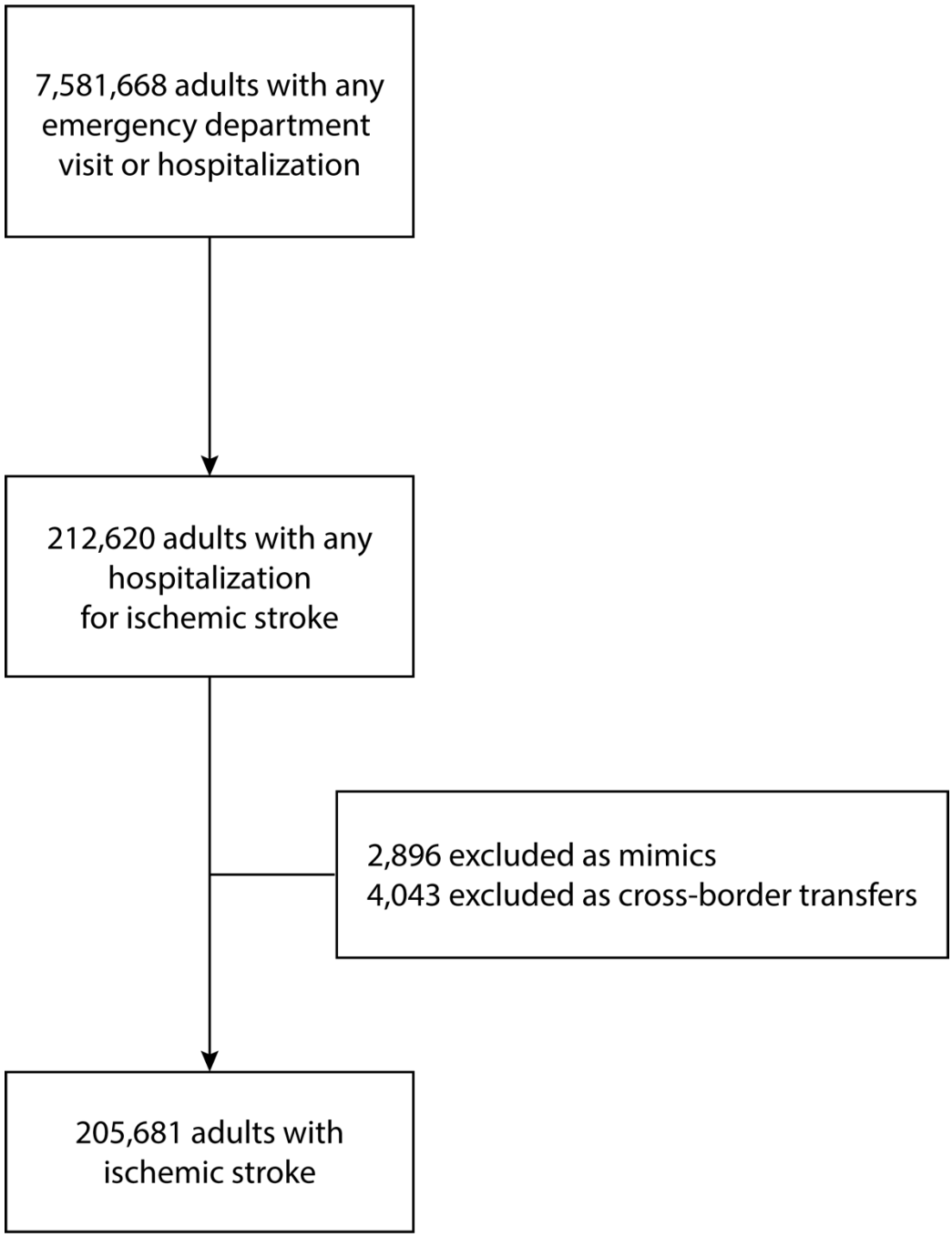

Figure II

Title. Demographic Characteristics of Ischemic Stroke Patients and Probability of Presenting to Stroke Thrombectomy Hub versus Gateway versus Gap.

Caption. All probabilities were adjusted for age, sex, race, insurance, socioeconomic status, urban-rural location of residence, and Charlson comorbidity index.

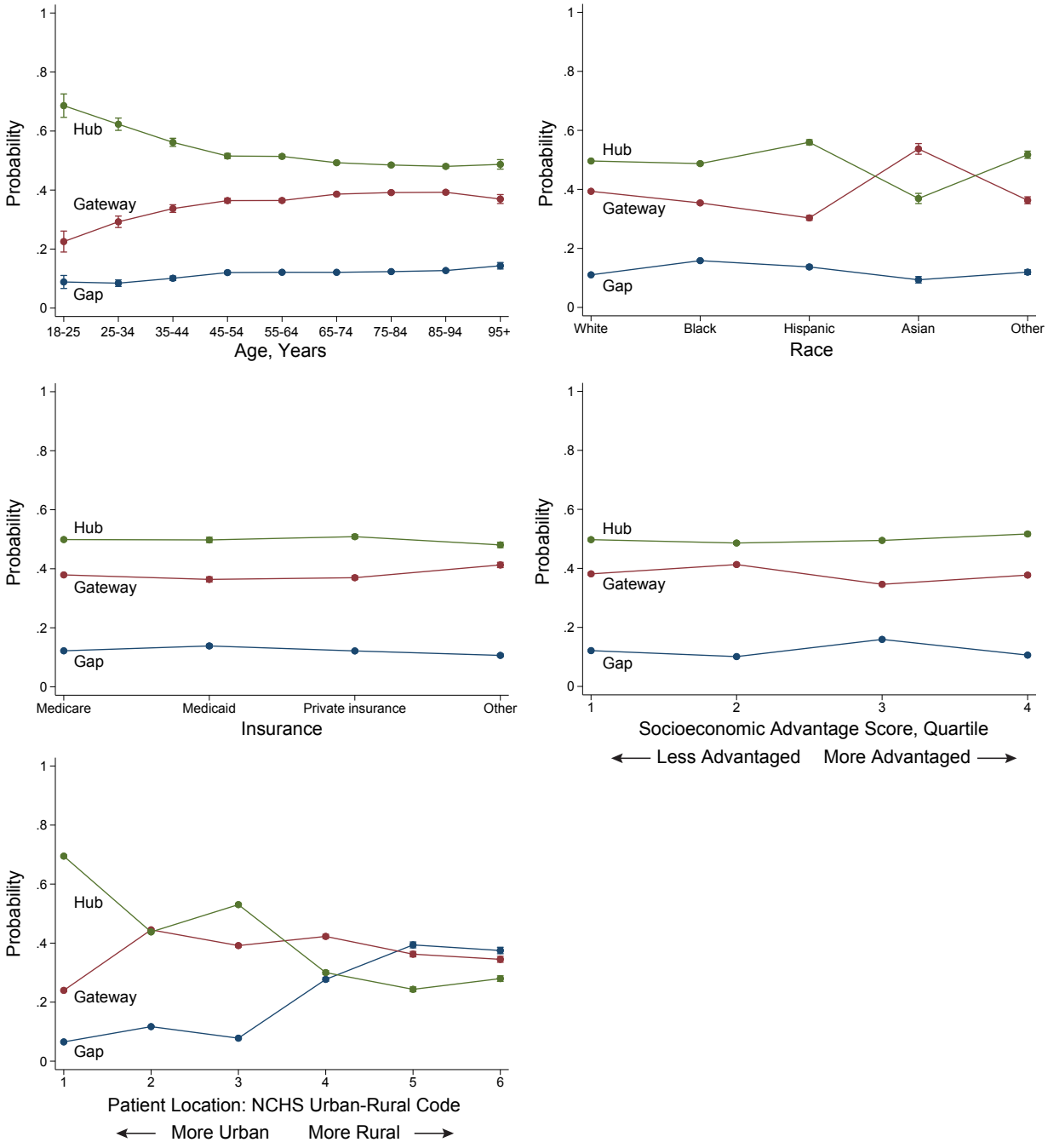

Figure III. Sensitivity Analyses of Ischemic Stroke Patients' Urban-Rural Location of Residence and Presentation to Stroke Thrombectomy Hub versus Gateway versus Gap.

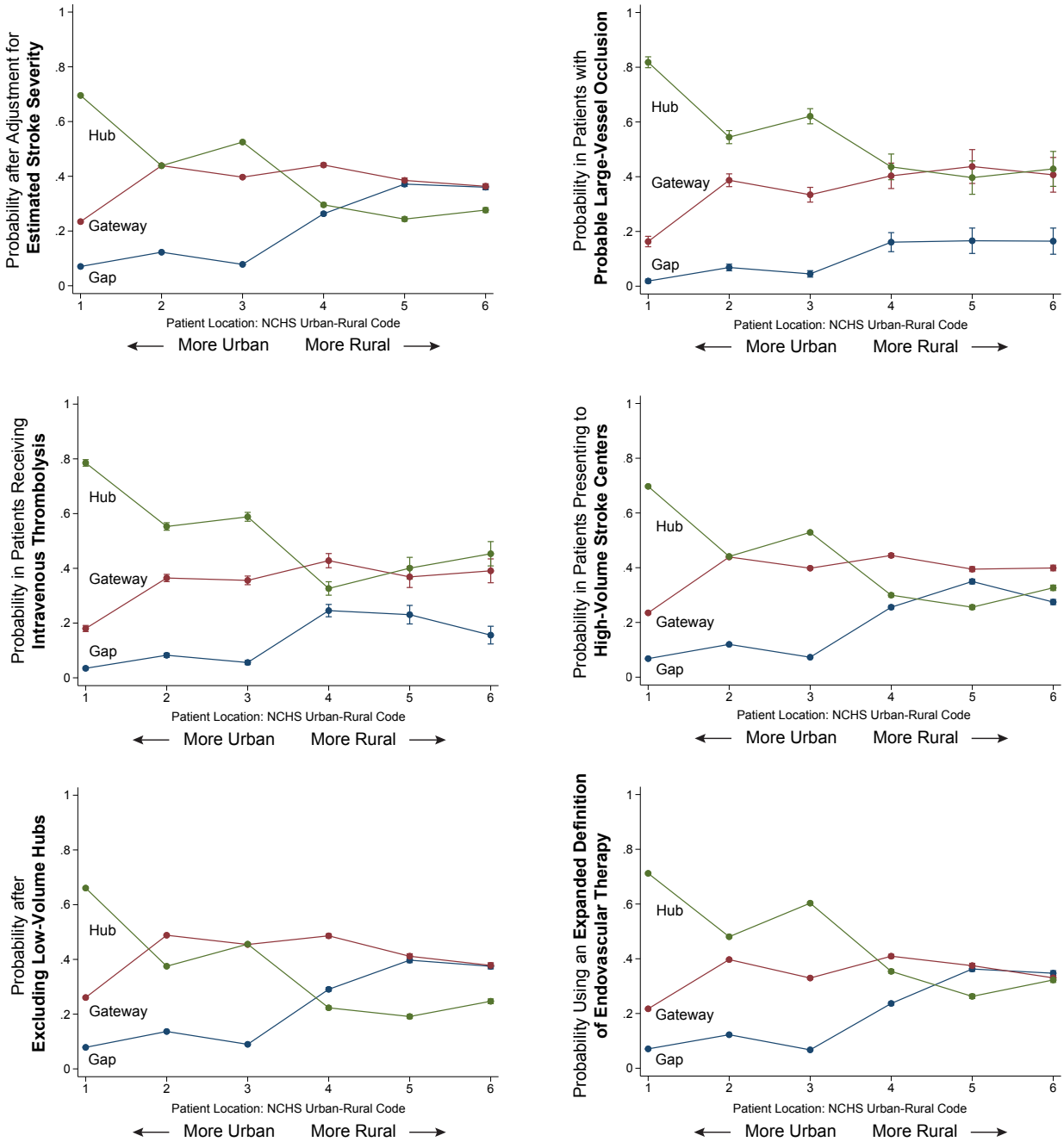

Figure IV.

Title: Proportion of Patients with Ischemic Stroke and Myocardial Infarction Presenting to an Endovascular Treatment Hub, by ZIP Code.

Caption: Maps from New York, Vermont, and Florida are shown in Figure 2 in the main manuscript. Maps from Iowa, Maryland, and Massachusetts could not be created because ZIP-code data were not available. Proportions are mapped according to the color scheme below:

- 81% - 100%
- 61% - 80%
- 41% - 60%
- 21% - 40%
- 0% - 20%

Figure IVa. Arkansas.

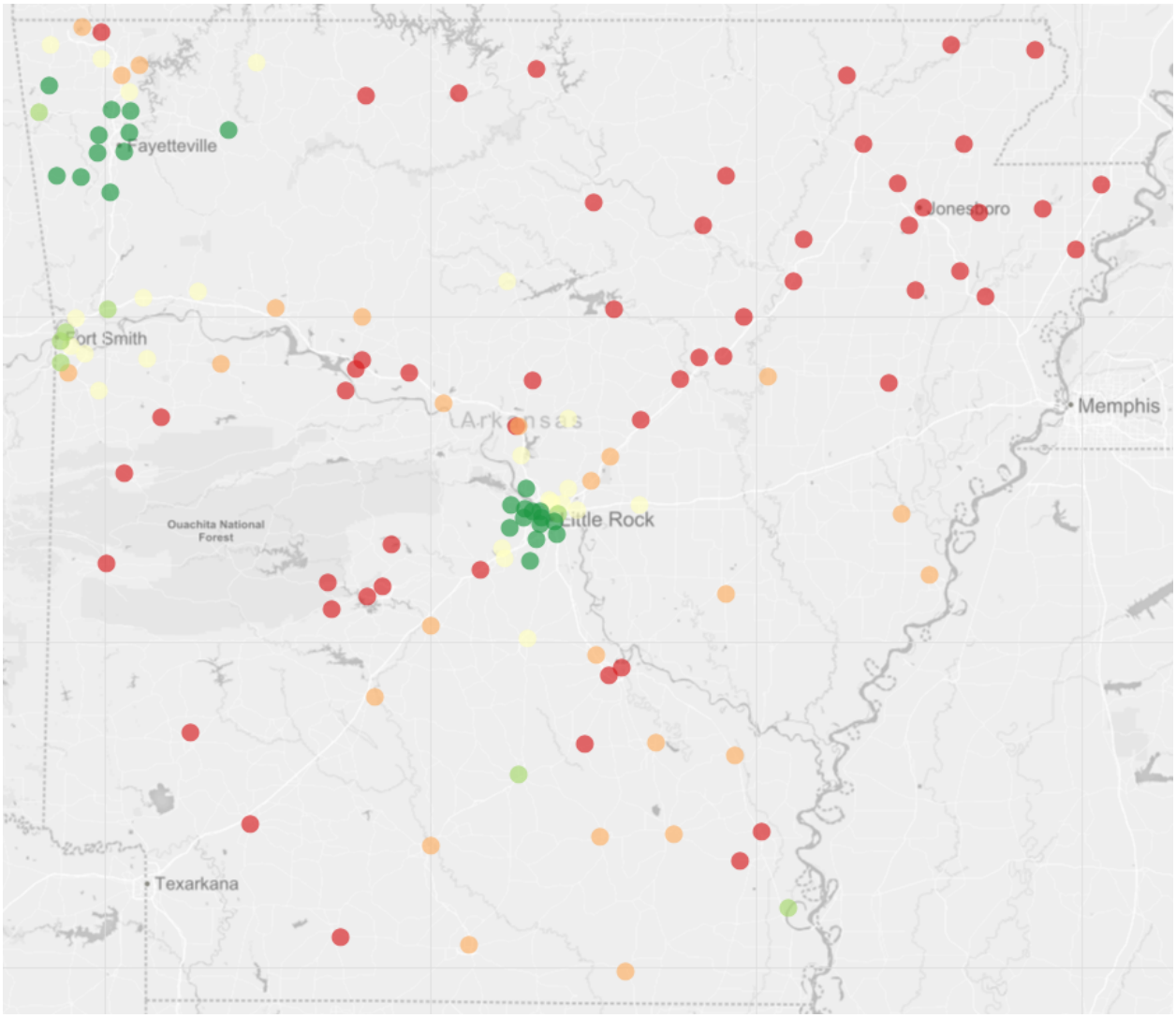

Figure IVb. Georgia.

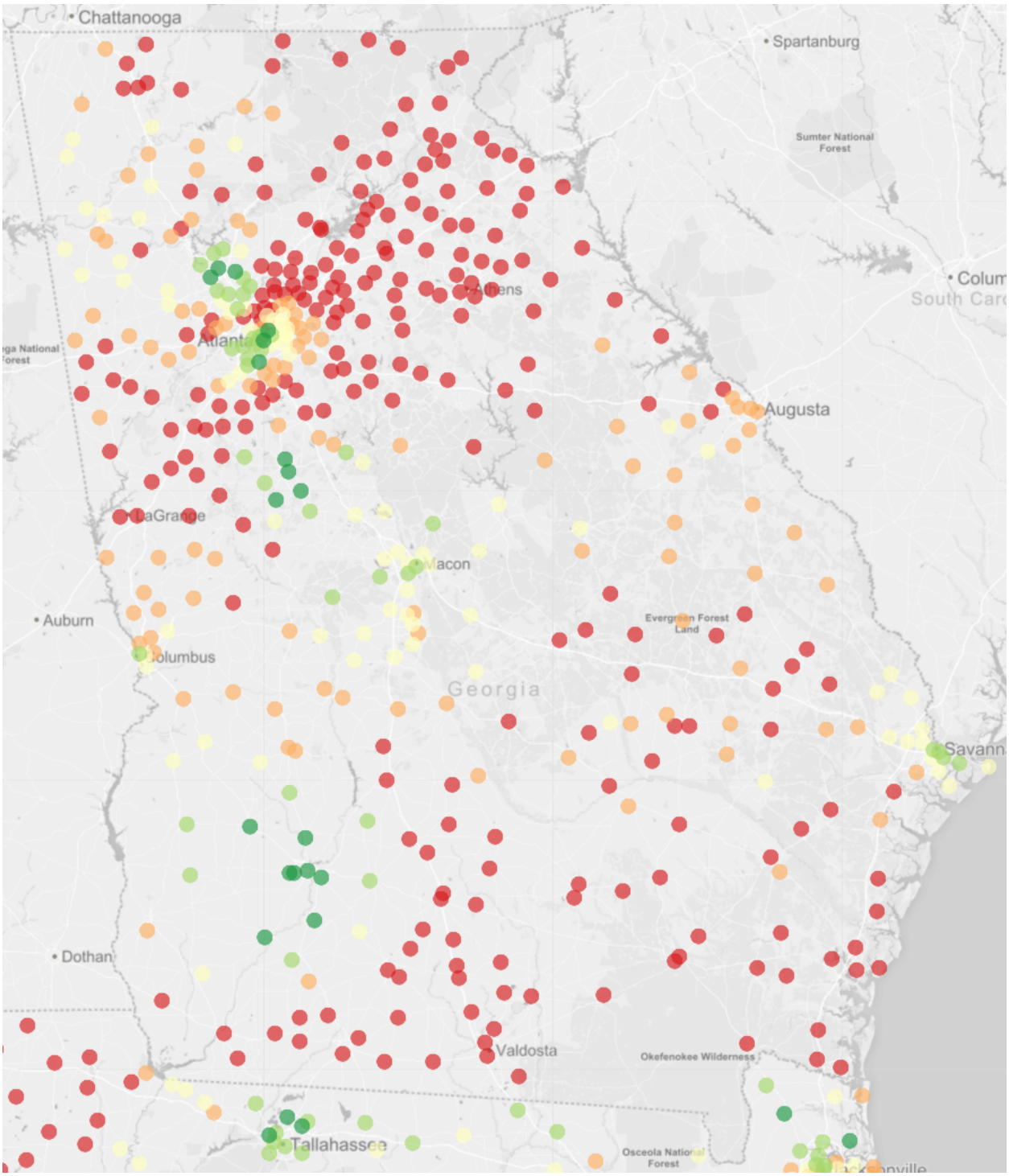

Figure IVc. Nebraska.

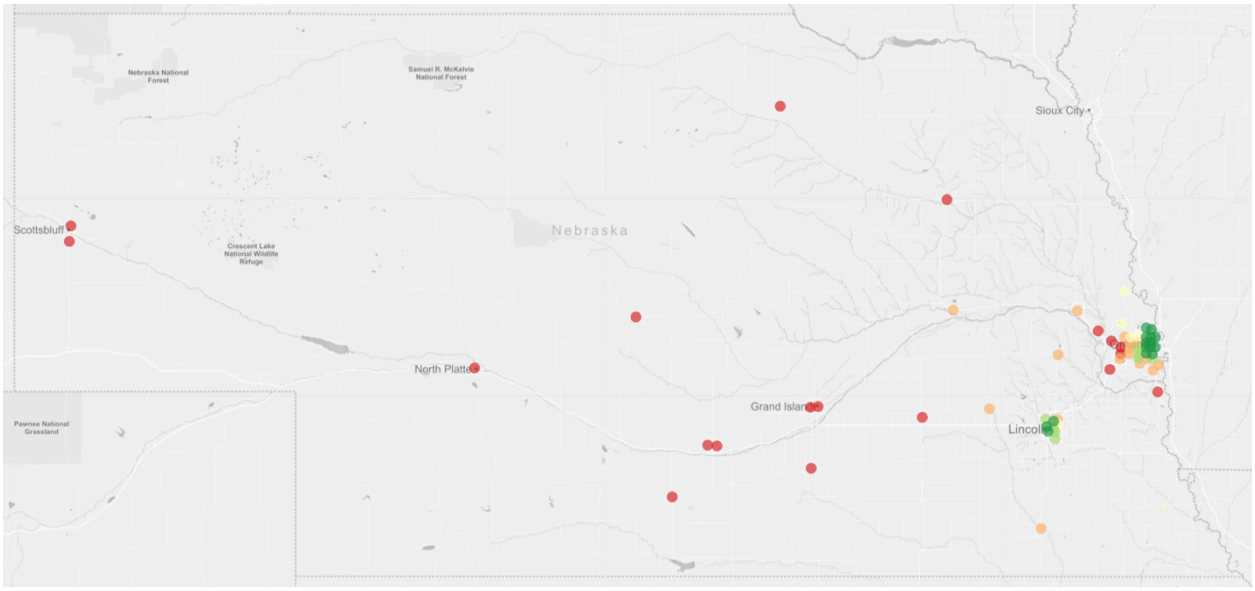

Figure IVd. Utah.

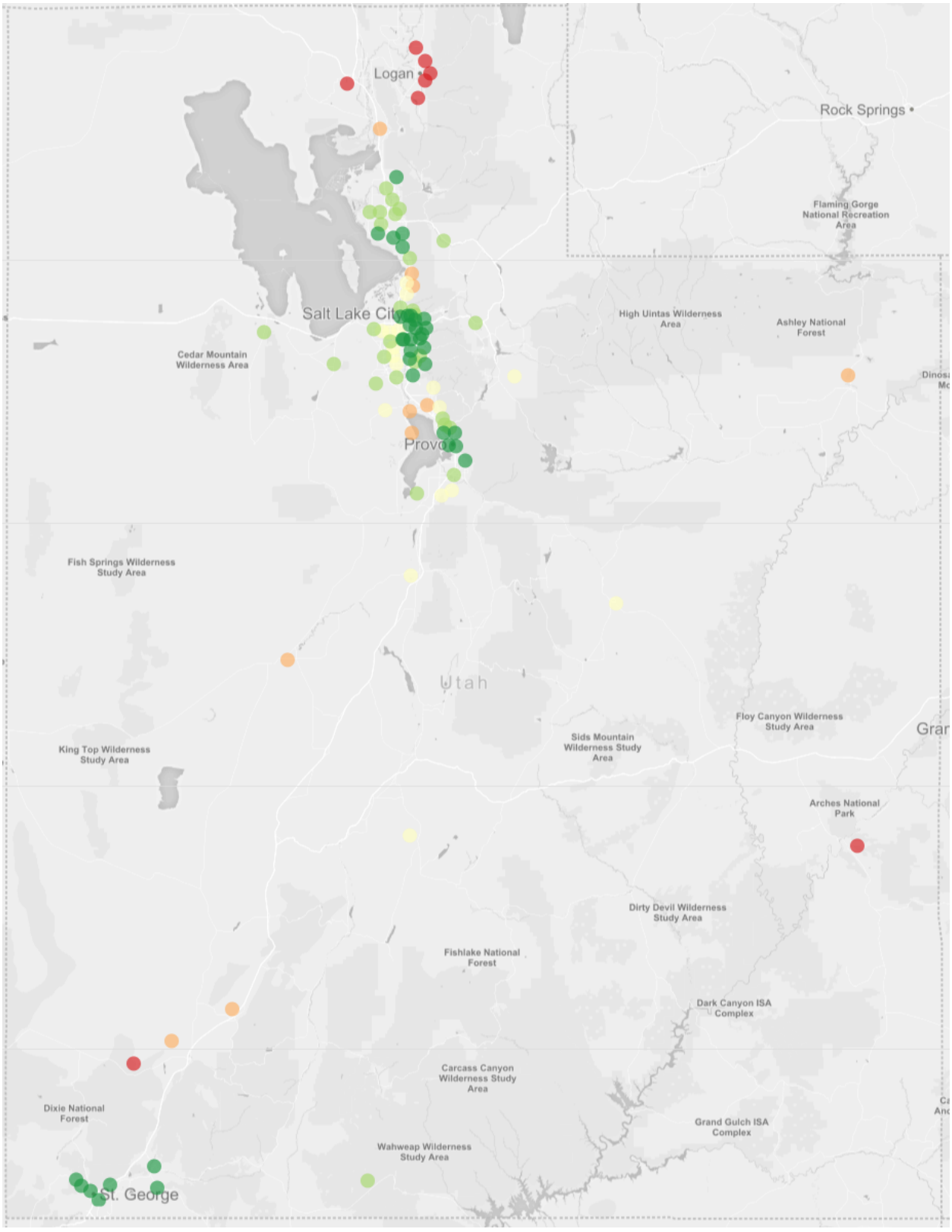

Figure IVe. Wisconsin.