

## SUPPLEMENTARY MATERIAL

### **Misdiagnosis of Cerebral Vein Thrombosis in the Emergency Department**

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#### Table of Contents

Supplemental Methods	Page 1-2
Supplemental Tables	Pages 3-4
Supplemental References	Page 5

## Supplemental Methods

### *Design*

We used administrative claims data collected by the California Office of Statewide Health Planning and Development, the New York Statewide Planning and Research Cooperative System, and the Florida Agency for Health Care Administration. These agencies all provide data to the Agency for Healthcare Research and Quality for its Healthcare Cost and Utilization Project (HCUP).<sup>1</sup> Each patient included in the HCUP database is assigned a personal linkage number that allows for anonymous tracking through all subsequent hospitalizations.<sup>2</sup>

We performed our retrospective cohort study using data from all emergency department (ED) visits and nonfederal hospitalizations in New York from 2006-2013, California from 2005-2011, and Florida from 2005-2013. These three states contain a demographically and geographically-diverse cohort of patients as reflected by the payer and race/ethnic breakdown of the study cohort (Supplemental Table, Page 3). The data and analytic methods of this study are available upon request from the corresponding author.

### *Subjects*

To identify the study cohort, cerebral vein thrombosis (CVT) was defined using *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes 325.0, 437.6, and 671.5 in any discharge diagnosis code position. These codes have been previously validated via detailed medical record review and found to have a positive predictive value of 76%, sensitivity of 78%, and specificity of 93%.<sup>3</sup>

To capture relevant ED treat-and-release visits for probable CVT misdiagnosis, headache was defined using *ICD-9-CM* codes 339, 784.0x, 346, and 307.81 in the primary discharge diagnosis position.<sup>4</sup> Seizure was defined using *ICD-9-CM* code 345 in the primary position; this approach that has previously been shown to have a positive predictive value ranging of 84%-98% in adult patients.<sup>5-7</sup> Back pain was defined using *ICD-9-CM* codes 721, 723, and 724 in the primary discharge diagnosis position.

### *Ascertainment of Covariates*

We identified relevant comorbidities recorded at index CVT hospitalization using *ICD-9-CM* codes. Traumatic brain injury was defined using *ICD-9-CM* codes 800.0–801.9, 803.0–804.9, 850.0–854.1, or 959.01.<sup>8</sup> Primary hypercoagulable state was defined using the standard *ICD-9-CM* code 289.81. Polycythemia vera was defined using the standard *ICD-9-CM* code 238.4. Any cancer was broadly defined using *ICD-9-CM* codes 140-172 or 174-208.

We considered mastoiditis, otitis, meningitis, and encephalitis as central nervous system infections. We defined mastoiditis using *ICD-9-CM* codes 383.00, 383.02, 383.1, and 383.9. We defined otitis using *ICD-9-CM* codes 053.71, 054.73, 055.1, 112.82, 380.10, 380.11, 380.12, 380.14, 380.15, 380.16, 380.22, 380.23, 381.0-381.0x, 381.29, 381.3, 381.4, 382.01, 382.02, 382.1, 382.2, 382.3, 382.9, or 383.00. For meningitis and encephalitis, we used *ICD-9-CM* codes 003.21, 036.0, 036.1, 046.2, 047, 049.0, 049.1, 049.8, 049.9, 052.0, 053.0, 054.3, 054.72, 055.0, 058.21, 058.29, 062-64, 066.2, 066.41, 072.1, 072.2, 100.81, 112.83, 115, 130.0, 139.0, 320-322.9, 323-323.9, and 341.2x in keeping with prior research.<sup>9</sup>

Pregnancy was defined using *ICD-9-CM* codes for vaginal delivery (72, 73, 75, V27, or 650–659) or cesarean delivery (74).<sup>10</sup> To define the puerperium, we identified cases where the codes for pregnancy were used within 98 days of CVT hospitalization.

#### *Exploratory Analysis*

We defined a history of a primary headache using *ICD-9-CM* codes 339, 784.0x, 346, or 307.81 in any discharge diagnosis position between 14 days and 379 days prior to CVT hospitalization.<sup>4</sup>

#### *Outcomes*

To identify the adverse in-hospital outcome of ICH we use a previously validated algorithm using *ICD-9-CM* codes that has been found to be 82% sensitive and 93% specific.<sup>11</sup>

**Supplemental Table I.** Patient Characteristics, Stratified by Probable Misdiagnosis of Cerebral Vein Thrombosis

Characteristic *	No Misdiagnosis (N = 5,750)	Probable Misdiagnosis (N = 216)
Age, mean (SD), years	44.4 (18.5)	38.5 (15.4)
Female	4,111 (71.5)	165 (76.4)
Race <sup>†</sup>		
White	3,110 (55.3)	119 (55.4)
Black	896 (16.0)	49 (22.8)
Hispanic	1,046 (18.6)	31 (14.4)
Other	576 (10.1)	16 (7.4)
Payment source <sup>‡</sup>		
Medicare	1,133 (19.7)	19 (8.8)
Medicaid	1,325 (23.1)	55 (25.5)
Private	2,701 (47.0)	118 (54.6)
Self-pay/Other	590 (10.2)	24 (11.1)
Central Nervous System Infections	414 (7.2)	18 (8.3)
Primary Hypercoagulable State	437 (7.6)	27 (12.5)
Elixhauser Comorbidities <sup>§</sup> , mean (SD)	1.8 (1.7)	1.5 (1.6)

Abbreviations: SD, standard deviation; y, years.

\*Data are presented as number (%) unless otherwise specified.

<sup>†</sup>Self-reported by patients or their surrogates. Numbers do not sum to group totals because of missing race/ethnicity data in 2.1 % of patients.

<sup>‡</sup>Numbers do not sum to group totals because of missing payment-source data in <0.01% of patients.

<sup>§</sup>Numbers represent the number of Elixhauser comorbid conditions, which includes 28 comorbidity measures used to evaluate disease severity in large administrative dataset studies.

**Supplemental Table II. Patient Outcomes, Stratified by Probable Misdiagnosis of Cerebral Vein Thrombosis**

<b>Characteristic*</b>	<b>No Misdiagnosis (N = 5,750)</b>	<b>Probable Misdiagnosis (N = 216)</b>
Length of Stay, mean (SD), days	8.8 (11.5)	9.1 (11.9)
Intracerebral Hemorrhage	378 (6.6)	16 (7.4)
Unfavorable Discharge Disposition	1,633 (30.8)	48 (25.8)

Abbreviations: SD, standard deviation; d, days.

\*Data are presented as number (%) unless otherwise specified.

## Supplemental References

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