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# *International Classification of Diseases, Ninth Revision (ICD-9)* Diagnosis Codes Can Identify Cerebral Venous Thrombosis in Hospitalized Adults

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**Abstract**

**Background:** Cerebral venous thrombosis (CVT) is a relatively rare and understudied disease. We sought to determine the accuracy of *International Classification of Diseases, Ninth Revision* (*ICD-9*) diagnosis codes to identify CVT. **Methods:** Retrospective chart review using the electronic medical record (EMR) to identify all patients discharged with CVT following admission or emergency department visit from May 1, 2010 to May 1, 2015 at our center. **Results:** We identified 111 patients with an *ICD-9* discharge diagnosis code of 325.0 (cerebral sinovenous thrombosis, excluding nonpyogenic cases and cases associated with pregnancy and the puerperium), 437.6 (CVT of nonpyogenic origin), or 671.5 (CVT complicating pregnancy, childbirth, or the puerperium) in any position. Of these 111 patients, 84 (75.7%) had confirmed CVT after EMR review. Searching outpatient and radiology records, we found an additional 24 patients with CVT who were not identified via query of *ICD-9* discharge diagnosis codes. The *ICD-9* codes 325.0, 437.6, or 671.5 in any position had a combined sensitivity of 77.8% and specificity of 92.7%; in the primary position, they had a sensitivity of 28.7% and specificity of 98.3%. **Conclusion:** The *ICD-9* codes 325.0, 437.6, and 671.5 can be used to identify CVT with acceptable sensitivity and specificity.

**Keywords**

cerebral venous thrombosis, sinovenous thrombosis, *ICD*-9 codes, accuracy

## Background and Purpose

Cerebral venous thrombosis (CVT), clot within the intracranial veins and/or sinuses, has an estimated annual incidence of 3 to 4 cases per million in adults.[1] Due to its rarity, little high-quality data exist on CVT aside from the observational International Study on Cerebral Vein and Dural Sinus Thrombosis (ISCVT).[2] In ISCVT, 13.4% of patients had significant morbidity or mortality at long-term follow-up, demonstrating the clinical impact of CVT.[3] Administrative claims data may prove useful in studying CVT as a way to access large numbers of cases with consistency across patients.[4] However, inaccurate coding of some cerebrovascular diseases has been shown.[5,6] The *International Classification of Diseases, Ninth Revision* (*ICD-9*) codes for CVT have only been evaluated in a pediatric cohort.[7] The accuracy of *ICD-9* codes for CVT has not been studied in adults though the codes have been used by some researchers.[8,9]

## Methods

We performed a cross-sectional retrospective study at the 3 centers of our academic health system. We sought to include all patients discharged with CVT following inpatient admission or emergency department (ED) visit from May 1, 2010 to May 1, 2015.

We queried the electronic medical record (EMR) for all patients with a discharge *ICD-9* code of 325.0 (cerebral sinovenous thrombosis, excluding nonpyogenic cases and cases associated with pregnancy and the puerperium), 437.6 (CVT of nonpyogenic origin), or 671.5 (CVT complicating pregnancy, childbirth, or the puerperium) in any position.

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**Table 1.** Code Validation for Cerebral Venous Thrombosis.

| | Total number of Patients | CVT | No CVT | Positive Predictive Value (95% CI) | Sensitivity (95% CI) | Specificity (95% CI) |
|---|---|---|---|---|---|---|
| *ICD-9* codes 325.0, 437.6, and 671.5 in any position | 111 | 84 | 27 | 75.7 (66.9-82.8) | 77.8 (69.0-84.6) | 92.7 (89.5-94.9) |
| *ICD-9* codes 325.0, 437.6, and 671.5 in primary position | 37 | 31 | 6 | 83.8 (68.5-92.7) | 28.7 (21.0-37.9) | 98.3 (96.2-99.3) |
| *ICD-9* code 325.0 in any position | 87 | 76 | 11 | 87.4 (78.6-93.0) | 70.4 (66.7-83.4) | 96.9 (94.4-98.3) |
| *ICD-9* code 325.0 in primary position | 30 | 28 | 2 | 93.3 (77.6-99.2) | 25.9 (18.6-35.0) | 99.4 (97.8-100.0) |
| *ICD-9* code 437.6 in any position | 24 | 8 | 16 | 33.3 (17.8-53.4) | 7.4 (3.6-14.1) | 95.5 (92.8-97.3) |
| *ICD-9* code 437.6 in primary position | 7 | 3 | 4 | 42.9 (15.8-75.0) | 2.8 (0.6-8.2) | 98.8 (97.0-99.7) |

Abbreviations: CI, confidence interval; CVT, cerebral venous thrombosis; *ICD-9*, *International Classification of Diseases, Ninth Revision*.

To identify patients discharged with a diagnosis of CVT who were not detected via *ICD-9* code, we searched the EMR in 2 other ways. First, we searched institutional outpatient records for any encounters with the *ICD-9* diagnosis codes 325.0, 437.6, or 671.5. We then reviewed each chart to determine whether any of the identified outpatients were diagnosed with CVT during an inpatient or ED visit at our institution. Second, we performed an electronic free-text search of all neuroradiology records for the terms "sinus vein thrombosis" OR "cerebral vein thrombosis" OR "cortical vein thrombosis" OR "sinus venous thrombosis" OR "cerebral venous thrombosis" OR "cortical venous thrombosis" OR "venous sinus thrombosis" OR "dural vein thrombosis" in the report or study indication fields. We reviewed each case identified via neuroradiology records to detect patients with CVT who were discharged following an admission or ED visit from May 1, 2010, to May 1, 2015.

All cases were adjudicated by review of the EMR by a single investigator (A.L.L.) who was blinded to the primary *ICD-9* code diagnosis. Baseline demographics, CVT type, length of stay (LOS), mortality, and imaging modalities used were abstracted from the EMR for all patients with CVT. We defined true negative cases as those initially identified via our free-text search of neuroradiology records, as these cases presumably had clinical concern for CVT but lacked CVT upon report review and did not have *ICD-9* codes 325.0, 437.6, or 671.5 as a discharge diagnosis. We calculated *ICD-9* code sensitivity, specificity, and positive predictive value (PPV). The Wald method was used to estimate 95% confidence intervals (CIs). Patients with CVT who had *ICD-9* discharge diagnosis codes of 325.0, 437.6, or 671.5 were compared to those who lacked these codes. Two-sided Fisher exact tests were used for dichotomized variables and Mann-Whitney *U* for continuous variables aside from age which was compared via student *t* test. We considered $P < .05$ to be statistically significant. SPSS was used for all calculations (v24; IBM, Armonk, New York). Institutional review board (IRB) approval was obtained for this study. A waiver of informed consent was granted by the IRB.

## Results

We identified 111 patients with an ED or inpatient discharge diagnosis *ICD-9* code of 325.0, 437.6, or 671.5 in any position. The code 325.0 in any position identified 87 patients, 437.6 in any position identified 24 patients, and 671.5 identified none. In primary position, 325.0 identified 30 patients and 437.6 identified 7 patients. A total of 84 (75.7%) patients identified via *ICD-9* code had confirmed CVT after EMR review (Table 1).

We found an additional 24 patients with CVT who met inclusion criteria but were not identified via query of *ICD-9* discharge diagnosis codes. Outpatient records identified 9 patients and radiology records identified an additional 15 patients (Table 2). A total of 341 cases identified via free-text search of radiology records did not have evidence of CVT.

The *ICD-9* diagnosis codes 325.0, 437.6, or 671.5 combined in any position were 77.8% (CI: 69.0%-84.6%) sensitive and 92.7% (CI: 89.5%-94.9%) specific for CVT. The PPV of all 3 codes combined in any position was 75.7% (CI: 66.9%-82.8%). A query for all 3 codes in the primary position identified 37 patients of whom 31 (83.8%) had CVT. The combination of all 3 codes in primary position was 28.7% (CI: 21.0%-37.9%) sensitive and 98.3% (CI: 96.2%-99.3%) specific for CVT, with PPV of 83.8% (CI: 68.5%-92.7%; Table 1).

Comparing the 24 patients with CVT who were not detected via *ICD-9* code to patients with CVT who were identified via *ICD-9* code, we found that those without the codes of interest were older (58.1 vs 45.8 years, $P = .007$) and more likely to have isolated cortical vein thrombosis (1.2% vs 41.7%, $P < .001$). The few patients in our study who were pregnant or postpartum ($n = 5$) were more likely to lack the correct *ICD-9* code than those who were not pregnant or postpartum (16.7% vs 1.2%, $P = .001$). There were no significant differences in medical center, advanced imaging modalities used, LOS, or in-hospital mortality between the 2 groups (Table 2). The 24 patients with CVT who did not have the *ICD-9* codes 325.0, 437.6, or 671.5 were assigned a variety of

**Table 2.** Baseline Demographic, Clinical, and Outcome Factors of Study Participants.

| | Total With CVT (n = 108) | True Positive CVT (n = 84) | False Negatives CVT (n = 24) | *P* Value |
|---|---|---|---|---|
| Demographic factors | | | | |
| Mean age (SD) | 48.5 (20.0) | 45.8 (18.64) | 58.13 (21.8) | 0.007 |
| Sex, women (%) | 56 (51.9%) | 40 (47.6%) | 16 (66.7%) | 0.08 |
| Pregnant or postpartum (%) | 5 (4.6%) | 1 (1.2%) | 4 (16.7%) | 0.001 |
| Medical center | | | | |
| Hospital of the University of Pennsylvania (%) | 80 (74.1%) | 63 (75.0%) | 17 (70.8%) | 0.79 |
| CVT type | | | | |
| Isolated cortical vein (%) | 11 (10.2%) | 1 (1.2%) | 10 (41.7%) | *P* < .001 |
| Single dural sinus (%) | 47 (43.5%) | 43 (51.2%) | 4 (16.7%) | 0.003 |
| Multiple dural sinuses (%) | 48 (44.4%) | 40 (47.6%) | 8 (33.3%) | 0.25 |
| Isolated deep cerebral vein (%) | 2 (1.9%) | 0 | 2 (8.3%) | 0.05 |
| Imaging modality | | | | |
| MRI (%) | 80 (74.1%) | 61 (72.6%) | 19 (79.2%) | 0.61 |
| MRV (%) | 44 (40.7%) | 31 (36.9%) | 13 (54.2%) | 0.16 |
| CTV (%) | 32 (29.6%) | 24 (28.6%) | 8 (33.3%) | 0.80 |
| Either CTV or MRV (%) | 71 (65.7%) | 54 (64.3%) | 17 (70.8%) | 0.63 |
| Hospital outcome | | | | |
| In-hospital death (%) | 8 (6.5%) | 6 (7.1%) | 2 (8.3%) | 0.57 |
| Median LOS, days [IQR] | 6.5 [3-15] | 7 [3-16] | 6 [3.3-10.8] | 0.82 |

Abbreviations: CTV, computed tomography venography; CVT, cerebral venous thrombosis; IQR, interquartile range; LOS, length of stay; MRI, magnetic resonance imaging; MRV, magnetic resonance venography; SD, standard deviation.

different primary *ICD-9* diagnosis codes. The most commonly used *ICD-9* diagnosis code among this group, 434.01 (cerebral thrombosis with cerebral infarction), was used in only 3 (12.5%) patients.

## Discussion

Our study demonstrates that the *ICD-9* codes 325.0, 437.6, and 671.5 in combination identify cases of CVT with moderate sensitivity, excellent specificity, and good PPV. While a number of patients with CVT lacked the codes of interest, we saw no differences in in-hospital mortality and LOS between patients who had the appropriate *ICD-9* codes and those who did not. We did note that patients lacking a documented CVT code were more likely to have a small burden of venous thrombosis.

The percentage (75.7%) of patients identified via *ICD-9* codes, who had confirmed CVT after EMR review in our study is similar to that reported in a retrospective single-center study in hospitalized pediatric patients. The pediatric study identified a total of 57 patients with the code 325.0, 437.6, or 671.5 in any position; code 671.5 did not identify any patients. After chart review, 71.9% had ''probable or definite'' thrombosis. No other searches to detect inaccurately coded or misdiagnosed cases of CVT were performed, and therefore sensitivity and specificity were not reported.[7] The accuracy of code 671.5 for CVT identification requires further study as neither the pediatric study nor our current study identified any patients with this *ICD-9* code.

The accuracy of the combined *ICD-9* diagnosis codes for CVT in any position is consistent with the findings from other validation studies of hospitalized patients diagnosed with other cerebrovascular diseases. Although values vary greatly depending on the method of validation and the specific codes and algorithms used, a systematic review of 35 articles concluded that algorithms to detect the presence of stroke and intracranial bleeds had PPVs of 80% or greater and those to detect Transient Ischemic Attack (TIA) generally had PPVs of 70% or greater.[10] Our results are also similar to the accuracy of *ICD-9* codes for identifying transient global amnesia, another rare neurologic condition with an acute presentation.[11]

Strengths of this study include our relatively large sample size as well as our thorough use of the EMR to detect patients with CVT who lacked the *ICD-9* codes of interest.

This study has several limitations. It is conceivable that some individuals with no clinical concern for CVT were captured by our free-text search of radiology reports and thus included in our study. It is also possible that our free-text search may have missed cases where there was clinical concern for CVT. However, since CVT is exclusively confirmed via brain imaging,[2] we thought it prudent to rely primarily on radiographic records to identify relevant cases in addition to those identified via *ICD-9* code. A second important limitation is that all cases were adjudicated by a single reviewer in this study which may have led to patient misclassification. Unlike prior work,[7] blinding to primary *ICD-9* diagnosis code was maintained during case adjudication, which should prevent bias. It is also possible that there were patients at our institution who were never correctly diagnosed with CVT and thus did not receive appropriate neuroimaging or *ICD-9* codes, but no retrospective study can capture these individuals. Finally, our study is limited by the use of data exclusively

from a single health system that includes a tertiary referral center, making regional CVT incidence difficult to determine as well as potentially biasing our sample with the inclusion of more cases requiring high-level care.

It is important to note that the *International Statistical Classification of Diseases and Related Health Problems, 10th revision* (*ICD-10*) codes came into use in World Health Organization member states in 1994. In the United States, however, the National Center for Health Statistics developed a *clinical modification* (*CM*) of the *ICD-10* code set that was not mandated for use until October 2015.[12] Our center did not adopt *ICD-10-CM* for hospitalized patients during the study epoch; our study findings pertain only to *ICD-9* codes. Only a few studies have validated *ICD-10* codes in cerebrovascular diseases, despite mandated *ICD-10-CM* use and the new system's potential for improved diagnostic specificity.[10] The sensitivity, specificity, and PPV of the *ICD-10* codes for CVT may differ from the *ICD-9* codes, despite guidance from the Centers for Medicare and Medicaid Services in mapping from one code set to the other. Future research is needed to determine whether *ICD-10* diagnosis codes can identify CVT in hospitalized patients.

In conclusion, the *ICD-9* diagnosis codes 325.0, 437.6, and 671.5 can be used in combination to reliably identify cases of CVT with good PPV. This finding should pave the way for future work using administrative data sets to study conditions associated with CVT, short- and long-term outcomes, as well as various treatment modalities for CVT.

## Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## References

1. Agnelli G, Verso M. Epidemiology of cerebral vein and sinus thrombosis. *Front Neurol Neurosci*. 2008;23:16-22.
2. Saposnik G, Barinagarrementeria F, Brown RD Jr, et al; American Heart Association Stroke Council and the Council on Epidemiology and Prevention. Diagnosis and management of cerebral venous thrombosis: a statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2011;42(4):1158-1192.
3. Ferro JM, Canhao P, Stam J, Bousser MG, Barinagarrementeria F, Investigators I; ISCVT Investigators. Prognosis of cerebral vein and dural sinus thrombosis: results of the International Study on Cerebral Vein and Dural Sinus Thrombosis (ISCVT). *Stroke*. 2004;35(3):664-670.
4. Tirschwell DL, Longstreth WT Jr. Validating administrative data in stroke research. *Stroke*. 2002;33(10):2465-2470.
5. Benesch C, Witter DM Jr, Wilder AL, Duncan PW, Samsa GP, Matchar DB. Inaccuracy of the International Classification of Diseases (ICD-9-CM) in identifying the diagnosis of ischemic cerebrovascular disease. *Neurology*. 1997;49(3):660-664.
6. Mullen MT, Moomaw CJ, Alwell K, et al. ICD9 codes cannot reliably identify hemorrhagic transformation of ischemic stroke. *Circ Cardiovasc Qual Outcomes*. 2013;6(4):505-506.
7. Golomb MR, Garg BP, Williams LS. Accuracy of ICD-9 codes for identifying children with cerebral sinovenous thrombosis. *J Child Neurol*. 2007;22(1):45-48.
8. Wasay M, Bakshi R, Bobustuc G, et al. Cerebral venous thrombosis: analysis of a multicenter cohort from the United States. *J Stroke Cerebrovasc Dis*. 2008;17(2):49-54.
9. Kamel H, Navi BB, Sriram N, Hovsepian DA, Devereux RB, Elkind MS. Risk of a thrombotic event after the 6-week postpartum period. *N Engl J Med*. 2014;370(14):1307-1315.
10. Andrade SE, Harrold LR, Tjia J, et al. A systematic review of validated methods for identifying cerebrovascular accident or transient ischemic attack using administrative data. *Pharmacoepidemiol Drug Saf*. 2012;21(suppl 1):100-128.
11. Mangla A, Navi BB, Layton K, Kamel H. Transient global amnesia and the risk of ischemic stroke. *Stroke*. 2014;45(2):389-393.
12. Prevention CfDCa. Centers for Disease Control and Prevention. Web site. http://www.cdc.gov/nchs/icd/icd10cm.htm. Updated March 31, 2016. Accessed April 27, 2016.