BRIEF COMMUNICATION

Validity of ICD-10 Codes for Cerebral Venous Thrombosis Depends on Clinical Context

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ABSTRACT: We examined the accuracy of International Classification of Disease 10th iteration (ICD-10) diagnosis codes within Canadian administrative data in identifying cerebral venous thrombosis (CVT). Of 289 confirmed cases of CVT admitted to our comprehensive stroke center between 2008 and 2018, 239/289 were new diagnoses and 204/239 were acute events with only 75/204 representing symptomatic CVTs not provoked by trauma or structural processes. Using ICD-10 codes in any position, sensitivity was 39.1% and positive predictive value was 94.2% for patients with a current or history of CVT and 84.0% and 52.5% for acute and symptomatic CVTs not provoked by trauma or structural processes.

RÉSUMÉ : La validité des codes de la CIM-10 dans des cas de thrombose veineuse cérébrale dépend du contexte clinique. En nous basant sur des données administratives canadiennes, nous avons voulu analyser l'exactitude des codes diagnostics de la dixième version de la Classification internationales des maladies (CIM-10) dans l'identification de cas de thrombose veineuse cérébrale (TVC). Sur un total de 289 cas confirmés de TVC au sein de notre établissement de soins complets de l'AVC de 2008 à 2018, 239 ont représenté de nouveaux cas diagnostiqués et 204 ont été considérés comme des événements de nature aiguë. Sur ces 204 cas, précisons que seulement 75 d'entre eux ont été identifiés comme des cas de TVC symptomatique n'ayant pas été causés par un traumatisme ou par des processus de nature structurelle. C'est en recourant aux codes de la CIM-10, et ce, pour n'importe quelle position, qu'on a obtenu une sensibilité de 39,1 % et une valeur prédictive positive (VPP) de 94,2 % pour des patients affectés à l'heure actuelle ou dans le passé par une TVC. Dans le cas de TVC aiguës symptomatiques non provoquées par un traumatisme ou par des processus structurels, ces résultats ont été respectivement de 84,0 % et de 52,5 %.

Keywords: Cerebral venous thrombosis, Neuroepidemiology, International Classification of Disease, Validity, ICD-10, Sensitivity, Positive predictive value

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Ascertainment of baseline rates of cerebral venous thrombosis (CVT) has taken on significant recent importance in evaluating frequency of CVT as a complication of both COVID-19 and COVID-19 vaccination, particularly in the context of vaccine-induced thrombosis with thrombocytopenia.[1] Previous estimates of the incidence of CVT vary widely, ranging from 3[2] to 20[3] per million person-years, with more recent studies reporting a higher incidence than previous.

Factors that may account for discrepancies in estimates include 1) increased use of routine neurovascular imaging,[3] 2) case ascertainment method for CVT[4] (e.g. using administrative data, prospective reporting, use of other EMR free text), and 3) inconsistent exclusion of CVT secondary to another condition (e.g. trauma).[5]

International Classification of Disease (ICD) diagnosis coding is commonly used for case ascertainment in administrative data. Because administrative data are generated during routine clinical care and not for research purposes, it provides a wealth of data for identifying trends and patterns in large sets of real-world patient data. However, there can be many potential sources of error when ICD codes are used to capture diagnosis and treatment, ranging from errors of transcription to those from coder inattention or inexperience.[6] Therefore, determining the validity of specific ICD diagnosis codes allows interpretation of analysis of administrative data within its limitations. For example, while previous studies have shown good evidence of validity for both ICD-9 and 10 codes in identifying patients with ischemic stroke in administrative data,[7] procedural codes used for the use of thrombolytics in stroke are likely less reliable.[8] Here we examined the accuracy of administrative codes for CVT.

Cases of CVT admitted to a large Canadian tertiary stroke center (catchment of approximately 1.25 million) between 2008 and 2018 were identified using two case identification strategies: 1) free text search through all hospital electronic radiology reports using Boolean logic regardless of modality and body part and then subsequently confirming cases on manual reading of the full

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radiology report; 2) searching for ICD 10th Canadian iteration (ICD-10-CA) CVT diagnostic codes in all hospitalizations between 2008 and 2018 (see Table 1). Electronic medical records were reviewed to verify diagnoses of CVT identified using either strategy and the clinical context of the CVT diagnosis (Figure 1) to calculate positive predictive value (PPV) of ICD-10 codes. Sensitivities of ICD-10 codes were calculated against all identified cases of CVT identified using either strategy and were subsequently verified by chart review as the gold standard. Statistical analysis was performed using STATA/IC 15.1 (StataCorp LLC, College Station, TX). Approval was obtained from the Clinical Research Ethics Board at the University of British Columbia.

Through our search of radiology reports, 2530 radiology reports from 1775 patients were flagged. All reports were read in full and 282 patients with a current or prior history of CVT by radiology report were identified. We excluded cases with isolated thrombosis of the internal jugular vein, superior or inferior ophthalmic veins, or venous thrombosis associated with concurrent dural arteriovenous fistulas. Administrative data ICD-10-CA codes identified 120 patients.

After a full electronic chart review, 4/282 patients identified using radiology reports were false positives and confirmed not to have CVT on subsequent confirmatory imaging and chart review. Of patients identified using ICD codes, 7/120 were determined to

Table 1: CVT case identification method

Case identification using radiology reports	"thrombosis" AND [specific dural sinuses or superficial or deep cerebral veins: "Sagittal Sinus" OR "Transverse Sinus" OR "Sigmoid Sinus" OR "Cavernous Sinus" OR "Marginal Sinus" OR "Occipital Sinus" OR "Straight Sinus" OR "Vein of Galen" OR "Rosenthal" OR "Labbe" OR "Trolard"] OR
	"thrombosis" AND "venous infarct" OR
	"thrombosis" AND "venous hemorrhage"
	And subsequently full radiology reports manually review
Administrative data ICD-10 codes	G08.X (intracranial and intraspinal phlebitis and thrombophlebitis)
	I67.6 (non-pyogenic thrombosis of intracranial venous system)
	I63.6 (cerebral infarction due to cerebral venous thrombosis, non-pyogenic)
	O22.5 (cerebral venous thrombosis in pregnancy)
	O87.3 (cerebral venous thrombosis in the puerperium)

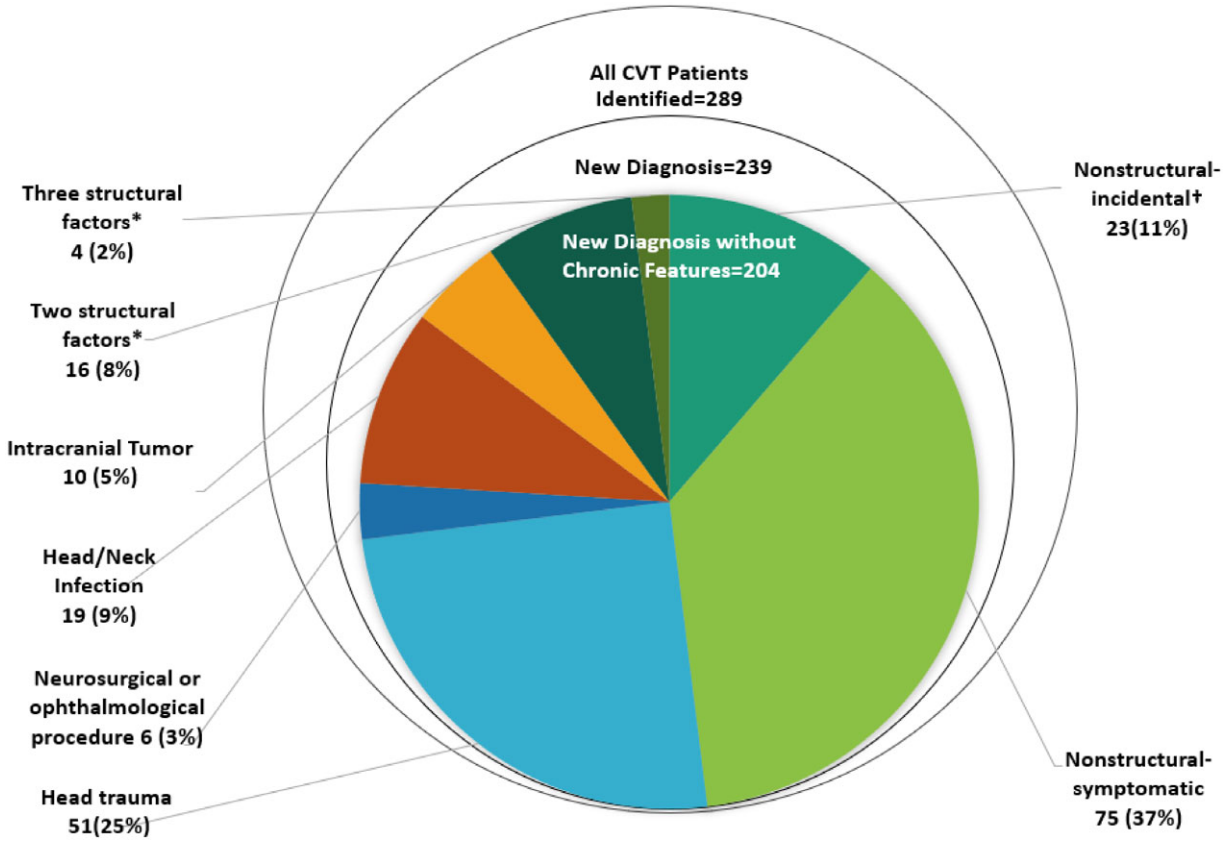

Figure 1: Cases identified using combined method of ICD-10 discharge codes and radiology database search. *Structural defined as associated with 1) head/neck Infection, 2) neurosurgical/ophthalmological procedures, 3) intracranial tumor, or 4) head trauma. †Cases deemed incidental if found on neuroimaging for an indication not attributable to the CVT (e.g. ischemic stroke).

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Table 2: PPV and sensitivity of ICD-10 CVT codes

	Current or history of CVT	New CVT diagnosis	New symptomatic nonstructural CVT
CVT cases according to reference standard	***n* = 289**	***n* = 239**	***n* = 75**
CVT code in any position	***n* = 113**	***n* = 101**	***n* = 63**
PPV	94.2%	84.2%	52.5%
Sensitivity	39.1%	42.3%	84.0%
CVT code in first three positions	***n* = 83**	***n* = 72**	***n* = 58**
PPV	95.4%	82.8%	66.7%
Sensitivity	28.7%	30.1%	77.3%
CVT code in first position	***n* = 65**	***n* = 58**	***n* = 52**
PPV	97.0%	86.6%	77.6%
Sensitivity	22.5%	24.3%	69.3%

have a diagnosis miscoded as CVT after chart review (Supplementary Table 1).

Using radiology reports and ICD codes for case ascertainment, 289 CVT cases were confirmed after chart review: 176 were identified only through radiology search, 11 were identified only through administrative data, and 102 were identified on both. Of these 289 cases, there were 239 new diagnoses, 204 of which were acute events without chronic features on imaging. Only 75 cases (37%) were new, symptomatic CVTs not provoked by trauma or structural processes (Figure 1). Sensitivity and PPV for ICD-10 codes depending on clinical context are reported in Table 2 and for individual ICD-10 codes in Supplementary Table 2.

Within our study, the combination of all CVT codes has a high PPV of 94.2% for identifying patients with either a current or history of CVT. This is similar to another previous study of ICD-10 codes (PPV of 92.3%)[9] and higher than one older study reporting a PPV of 75.7% for ICD-9 codes (325.0, 437.6, and 671.5) in any position for CVT.[10] The sensitivity of a ICD-10 CVT code in any position within our study is lower than previously reported for ICD-9 CVT codes (39.1 vs. 77.8%[10]) which may be a result of our more inclusive search strategy for identifying cases in radiology reports. Notably, within our study, 4/282 patients identified using radiology reports were found to not have a true diagnosis of CVT upon further chart review suggesting additional confirmation of diagnosis beyond radiology reports is useful to exclude imaging artifact and CVT mimics.

The majority of CVT identified were incidentally diagnosed in the context of intracranial processes such as trauma, surgery, infection, or masses. Only 37% were symptomatic, nonstructural incident diagnoses. As the management and prognosis of incidental versus symptomatic CVT may differ, this information has implications in the interpretation of CVT rates identified through administrative data. This is especially relevant when these codes are used to establish baseline incidence and to examine risks associated with population-based interventions such as COVID-19 vaccination.

Our study has limitations. First, data for this validation analysis come from a single urban tertiary hospital which does not have an obstetrical service; thus, the accuracy of these codes could not be assessed. Additionally, there may also be reduced generalizability to non-teaching rural hospitals with fewer cases of trauma and complicated head and neck infections. Second, our data are based on ICD-10-CA. Within Canadian administrative coding standard, the first diagnosis code reflects the most responsible diagnosis contributing to longest length of stay, as opposed to the diagnosis at admission to hospital, which is the coding practice in the United States. This may alter the generalizability of our findings when only the code within the first position is used. Finally, more detailed clinical information was not available for analysis, which limits our fuller understanding of the clinical context for individual cases.

In conclusion, administrative data have high PPV but low sensitivity for CVT (39.1%). Sensitivity was higher (84.0%), when cases of interest were limited to those with new symptomatic CVT without an obvious provoking structural cause. Our findings suggest that relying solely on CVT ICD codes for identifying CVT cases within administrative data may result in underestimation of overall CVT burden, and that reported rates of CVT may include incidentally diagnosed cases and cases secondary to structural processes.

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Disclosures

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Statement of Authorship

TSF, MH, and LZ were responsible for constructing the research and analysis plan. WH and LZ carried out data extraction. LZ and TSF carried out data analyses and preparation of figures. LZ and AY carried out preparation of tables and supplemental tables. The first draft was prepared by LZ and TSF and revised for intellectual content by all authors.

Supplementary Material

To view supplementary material for this article, please visit https://doi.org/10.1017/cjn.2021.235.

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