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Sensibilité des codes diagnostiques saisis dans le cadre du programme de médicalisation des systèmes d'information pour l'identification des cas de maladie thrombo-embolique veineuse

Pierre Casez

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UNIVERSITE JOSEPH FOURIER
FACULTE DE MEDECINE DE GRENOBLE

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**SENSIBILITÉ DES CODES DIAGNOSTIQUES SAISIS DANS LE CADRE DU PROGRAMME DE
MÉDICALISATION DES SYSTÈMES D'INFORMATION POUR L'IDENTIFICATION DES CAS DE MALADIE
THROMBO-EMBOLIQUE VEINEUSE**

THESE
PRESENTEE POUR L'OBTENTION DU DOCTORAT EN MEDECINE
DIPLOME D'ETAT

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PREAMBULE

La maladie thromboembolique veineuse (MTEV), regroupant la thrombose veineuse profonde (TVP) et l'embolie pulmonaire (EP), est une pathologie fréquente avec une incidence annuelle estimée entre 128 et 243 cas pour 100'000 patients. Si elle est un motif fréquent d'admission à l'hôpital, la MTEV est dans un quart des cas « acquise » au cours du séjour hospitalier, devenant alors une cause majeure de morbi-mortalité potentiellement évitable chez les patients hospitalisés.

La collecte de données sur une pathologie cible à l'aide des bases de données médico-administratives est une alternative pratique et bien moins chère à la revue de dossier. Au cours de ces 10 dernières années, les codes de la MTEV de la Neuvième Classification Internationale des Maladies (CIM-9) et ceux de la Dixième (CIM-10), ont été utilisés en épidémiologie et dans le monitoring de la qualité des soins.

Cependant, la validité de ces bases de données médico-administratives en recherche ou dans la construction d'indicateurs reste discutée. En effet, certaines études utilisant la revue de dossier comme référence suggèrent que la précision des codes CIM-9 dans l'identification de la TVP est faible à modérée. A notre connaissance, très peu d'études ont estimé la valeur prédictive positive et aucune la sensibilité des codes CIM-10 de MTEV issus des bases médico-administratives, en dépit du fait que la CIM-10 ait été adoptée par un grand nombre de pays depuis son introduction en 1992.

Dans ces études, la revue rétrospective de dossier a le plus souvent été utilisée comme référence dans l'évaluation des bases médico-administratives. Cependant, l'exhaustivité et la validité des dossiers médicaux font débat depuis des années. La revue de dossier ne pouvant reconnaître les erreurs qui peuvent être faites par les médecins lors de la documentation du dossier médical, celle-ci ne reflète que partiellement la validité des données médico-administratives. De plus, il est fréquent que les médecins documentent des pathologies en rapport avec leur spécialité d'où le risque de voir disparaître les autres du dossier médical. C'est pourquoi, les données récoltées de manière

prospective sont actuellement considérées comme étant une meilleure référence que celles obtenues par revue de dossier rétrospective dans l'évaluation de la validité des bases médico-administratives.

En France, c'est dans le cadre du Programme de Médicalisation du Système d'Information (PMSI), que ces codes CIM-10 sont saisis dans ces bases de données.

Dans cette étude, nous avons évalué la sensibilité des codes CIM-10 issus du PMSI dans la détection des TVP et EP, confirmée par des stratégies diagnostiques validées. Dans cet objectif, nous avons utilisé comme référence des données originales issues d'une étude prospective multicentrique.

ARTICLE

ICD-10 hospital discharge diagnosis codes were sensitive for identifying pulmonary embolism but not deep vein thrombosis.

RESUME DE L'ARTICLE

Objectif

Evaluer la sensibilité des codes CIM-10 (dixième Classification Internationale des Maladies) issus des bases de données médico-administratives hospitalières dans la détection de la thrombose veineuse profonde (TVP) et de l'embolie pulmonaire (EP).

Protocole de l'étude

Nous avons comparé les codes CIM-10 issus des bases de données médico-administratives hospitalières avec les diagnostics issus d'une étude de cohorte prospective établis selon une stratégie diagnostique validée. La sensibilité a été définie comme étant le pourcentage de patients atteints de TVP et/ou d'EP identifiés par les codes CIM-10 de ces bases de données hospitalières.

Effectifs

1375 patients suspects de TVP et/ou d'EP inclus sur 25 hôpitaux en France.

Résultats

La sensibilité des codes CIM-10 est de 58.0% (159/274; Intervalle de confiance 95% [IC 95%], 51.9-64.1) concernant les TVP et de 88.9% (297/334; [IC 95%], 85.6-92.2) pour l'EP.

Selon les hôpitaux, la valeur médiane de la sensibilité pour la TVP est de 57.7% (Interquartile, 48.6-66.7; coefficient de corrélation intergroupe, 0.02; $p=0.31$), et de 88.9% pour l'EP (interquartile, 83.3-96.3; coefficient de corrélation intergroupe, 0.11; $p=0.03$). La sensibilité des codes CIM-10 est plus basse pour les patients ayant bénéficié d'une intervention chirurgicale et pour les TVP ou les EP déclarées au cours du séjour hospitalier.

Conclusion

Les codes CIM-10 des bases de données médico-administratives sont suffisamment sensibles pour détecter les patients atteints d'EP. Un nombre important de patients avec TVP ne sont pas identifiés lors de l'utilisation de ces mêmes bases de données à des fins de surveillance ou de recherche.

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ABSTRACT

Objective

To estimate the sensitivity of ICD-10 hospital discharge diagnosis codes for identifying deep vein thrombosis (DVT) and pulmonary embolism (PE).

Study design and Setting

We compared predefined ICD-10 discharge diagnosis codes with the diagnoses that were prospectively recorded for 1375 patients with suspected DVT or PE who were enrolled at 25 hospitals in France. Sensitivity was calculated as the percentage of patients identified by predefined ICD-10 codes among positive cases of acute symptomatic DVT or PE confirmed by objective testing.

Results

The sensitivity of ICD-10 codes was 58.0% (159/274; 95% confidence interval [95% CI], 51.9–64.1) for isolated DVT and 88.9% (297/334; 95% CI, 85.6–92.2) for PE. Depending on the hospital, the median values for sensitivity were 57.7% for DVT (interquartile range, 48.6–66.7; intraclass correlation coefficient, 0.02; $P=0.31$) and 88.9% for PE (interquartile range, 83.3–96.3; intraclass correlation coefficient, 0.11; $P=0.03$). The sensitivity of ICD-10 codes was lower for surgical patients and for patients who developed PE or DVT while hospitalized.

Conclusions

ICD-10 discharge diagnosis codes yield satisfactory sensitivity for identifying objectively confirmed PE. A substantial proportion of DVT cases are missed when using hospital discharge data for complication screening or research purposes.

INTRODUCTION

Venous thromboembolism (VTE), consisting of deep vein thrombosis (DVT) and pulmonary embolism (PE), is a common cardiovascular disease, with an estimated annual incidence of 128–243 cases per 100,000 persons (1). Community-acquired VTE is a frequent reason for hospital admissions, while hospital-acquired VTE, which accounts for one-fourth of all cases (2), is a major and often preventable cause of mortality and morbidity among hospitalized patients (3, 4).

Using computerized administrative hospital discharge data is considered a convenient and inexpensive alternative to retrospective chart abstraction for collecting data on various conditions (5). Over the past decade, the International Classification of Diseases, Ninth revision, Clinical Modification (ICD-9-CM) and ICD-10 codes of DVT and PE have been used for elucidating VTE epidemiology (6, 7), conducting outcome research (8), and monitoring safety and quality of care (9, 10).

Concerns exist regarding the validity of routinely collected health administrative data for complication screening or research purposes (11, 12). Indeed, current evidence suggests that ICD-9-CM diagnosis codes have low to moderate accuracy for identifying DVT when using retrospective chart abstraction as the reference (13, 14). To our knowledge, very few studies have assessed the positive predictive value (15, 16) and none has assessed the sensitivity of ICD-10 hospital discharge diagnosis codes for VTE, even though the 10th revision of ICD has been adopted by many countries since its introduction in 1992 (5).

Retrospective chart review has been used as the reference method for assessing discharge diagnosis code validity by many authors. However, the completeness and validity of medical records

have raised questions for decades (17). Because chart review does not capture errors that could occur when clinicians record information on charts, it only reflects a part of the validity of administrative data (18). Physicians are more likely to record medical conditions that relate to their specialty and therefore a condition that is present in a patient may not be recorded in the chart (17, 18). Hence, prospectively collected information is now considered a “truer” reference method than retrospective chart review for assessing discharge diagnosis code validity (5).

In this study, we assessed the sensitivity of ICD-10 coding in routinely collected hospital discharge data for identifying acute DVT and PE confirmed by objective tests. For this purpose, we used the original data from a multicenter prospective cohort study as the reference.

METHODS

Study population

The OPTIMEV study is a prospective cohort study of consecutive patients referred for clinical suspicion of acute VTE to vascular medicine physicians practicing in hospitals or offices evenly distributed throughout France (ClinicalTrials.gov registration number: NCT00670540). Depending on the site, the enrollment period consisted of 1 to several predefined days distributed between November 2004 and January 2006. Suspicion of PE was defined as acute onset of new or worsening shortness of breath, chest pain, hemoptysis, or syncope without another obvious cause, while suspicion of DVT was defined as acute leg pain, swelling, redness, or warmth. Patients referred for screening of asymptomatic DVT were not eligible for this study.

The present analysis focused on the patients who were enrolled at 25 hospitals in metropolitan France, including 13 general hospitals, ten university-affiliated hospitals, and two private hospitals.

Patients were admitted to the hospital for clinical suspicion of VTE or developed clinical suspicion of VTE during their stay while hospitalized for surgical or medical conditions other than VTE.

Vascular medicine physicians prospectively collected baseline characteristics, clinical examination findings, pre-existing comorbidities (including prior history of VTE), relevant laboratory test results, and long-term ongoing or new anticoagulant treatments using standardized definitions. Vascular medicine specialists are board-certified physicians with knowledge and technical skills necessary for the evaluation and management of all peripheral vascular diseases. Vascular medicine physicians practicing in hospitals examine patients clinically, perform and interpret ultrasound vascular imaging, are skilled in the interpretation of other imaging modalities (computed tomographic angiography, conventional contrast angiography, etc.), and initiate medical treatments. Each patient underwent bilateral compression ultrasonography of both proximal and distal veins of the lower extremities using a standardized examination protocol (19, 20).

The diagnostic criterion for a patient's first episode of deep vein thrombosis was the incompressibility of the vein in the transverse plane. For gastrocnemius and soleal vein thrombosis only, the diagnostic criterion was incompressibility of the vein combined with the absence of venous flow after distal compression. The diagnostic criterion for recurrent deep vein thrombosis was the incompressibility of a previously normal venous segment in patients with a previous history of deep vein thrombosis. Clinical suspicion of PE was confirmed based on findings on computed tomographic angiography, ventilation–perfusion scanning, pulmonary angiography, or lower limb compression ultrasonography using validated criteria (21-23). Although superficial vein thrombophlebitis (i.e., thrombosis of the greater or lesser saphenous vein) was recorded in the OPTIMEV study, it was not considered venous thromboembolism in the present analysis. Patients with clinical suspicion of upper extremity deep vein thrombosis were excluded from the present study.

Hospital discharge abstract data

As part of the French diagnosis-related group (DRG)-based prospective payment system, hospital discharge abstract data include dates of hospital admission and discharge, procedure codes, and primary and secondary discharge diagnosis codes. The number of secondary discharge diagnosis codes is limited to 99. ICD-10 coding complies with national guidelines and is done by trained technicians or physicians, depending on the hospital. Coders generally abstract diagnoses from physician notes, although admission notes, daily progress notes, consultation reports, diagnostic imaging reports, and treatments are routinely recorded in the medical chart. However, the coders did not have access to the data prospectively collected in the OPTIMEV study. Discharge data are externally audited by reabstracting a random sample of hospital stays every year.

In this study, we used predefined ICD-10 discharge diagnosis codes that identified patients with VTE including I26.0–I26.9, O88.2 for PE and I80.1–I80.9, I82.1, I82.8, I82.9, O22.3, O22.9, and O87.1 for DVT. These codes had been determined by searching the ICD-10 and reviewing published literature (6, 15, 24). In accordance with previous studies (25), we allowed the VTE codes to be in any position (i.e., primary or secondary discharge diagnosis codes).

Analysis

Descriptive statistics were presented as numbers and percentages for categorical variables or median and interquartile range (IQR) for continuous variables. We compared predefined ICD-10 codes that were recorded in primary or secondary diagnostic positions with DVT and PE status prospectively recorded in the OPTIMEV study. We defined sensitivity as the percentage of patients who were identified by predefined ICD-10 codes among positive cases of DVT or PE confirmed by objective testing in the OPTIMEV study. Ninety-five percent confidence intervals were computed using bootstrap resampling with 1000 replications (26).

In order to assess the extent to which sensitivity of ICD-10 codes varied across hospitals for identifying DVT and PE, we calculated intraclass correlation coefficients (27). The intraclass

correlation, which measures the degree of correlation within a cluster, was calculated by the proportion of total variance of sensitivity that can be explained by the variation between clusters. The intraclass correlation coefficient ranges from 0 (reflecting statistical independence among observations within a cluster) to 1 (denoting that all observations within a cluster are identical) (28).

In prespecified exploratory univariable analyses, we assessed heterogeneity in the sensitivity of ICD-10 codes for identifying DVT or PE according to patient characteristics using the chi square test, replaced by the Fisher exact probability when appropriate. Statistical analysis was performed using Stata 9.0 (Stata Corporation, College Station, TX, USA).

This study was approved by the institutional review board of the Rhône-Alpes-Auvergne Clinical Investigation Centers (Comité d'Ethique des Centres d'Investigation Clinique de l'Inter-région Rhône-Alpes-Auvergne [IRB 5891]) and by the French Data Protection Agency (Commission Nationale de l'Informatique et des Libertés).

RESULTS

Our study sample consisted of 1375 patients, with a median of 40 patients (IQR, 22–64) enrolled per hospital. The median age for all patients was 71 years (IQR, 54–80), 625 (45%) were male, and the in-hospital mortality rate was 4% (Table 1).

Overall, 274 patients (20%) were diagnosed as having acute symptomatic DVT and 334 (24%) acute symptomatic PE (including 227 patients [17%] with both DVT and PE) (Figure). PE was confirmed based on a high-probability lung scan in 89 patients, an intermediate-probability lung scan combined with the detection of DVT on compression ultrasonography in eight patients, a positive multidetector computed tomography in 188 patients, the detection of proximal deep vein thrombosis

on compression ultrasonography in 48 patients, and a positive pulmonary angiography in one patient. All cases of deep vein thrombosis were confirmed by compression ultrasonography. Of the 608 patients with VTE, 595 (98%) received anticoagulant therapy, three (0.5%) inferior vena cava filter, and ten (1.5%) no treatment (including six patients with a contraindication to anticoagulant therapy, two patients receiving palliative care, one patient who died within 24 h of DVT diagnosis, and one patient for whom the reason was not specified). Overall, 357 patients were admitted to the hospital for acute VTE and 251 patients developed acute VTE while hospitalized for surgical or medical conditions other than VTE (Figure).

The median number of ICD-10 discharge diagnosis codes recorded per patient was 4 (IQR, 2–6). Using the predefined ICD-10 diagnosis codes, we identified 177 (13%) patients with DVT and 331 (24%) patients with PE (including 164 [12%] patients with both DVT and PE). A total of 159 cases of DVT and 297 cases of PE were identified by both methods. The sensitivity of ICD-10 hospital discharge diagnosis codes was 58% for DVT (95% CI, 52–64) and 89% for PE (95% CI, 86–92). Depending on the hospital, the median values for sensitivity were 57% for DVT (IQR, 49–67; intracluster correlation coefficient, 0.02; $P = 0.31$) and 89% for PE (IQR, 83–96; intracluster correlation coefficient, 0.11; $P = 0.03$).

The predefined ICD-10 codes did not contribute equally to accuracy in identifying PE or DVT (Table 2). I26.9 and I26.0 codes were used in 85% and 21%, respectively, of positive cases with any discharge diagnosis codes for PE. The most commonly used ICD-10 discharge diagnosis codes for positive cases of DVT included I80.2, I80.3, and I80.1. None of the three patients with PE and three of the eight patients with DVT during pregnancy or the postpartum period had appropriate pregnancy-specific VTE discharge diagnosis codes.

Compared to patients with PE or DVT present on admission, the sensitivity of ICD-10 codes was lower for patients who developed PE (75% v 94%, $P < 0.001$) and DVT (49% v 71%, $P < 0.001$) while hospitalized for medical or surgical conditions other than VTE (Table 3). Undergoing a surgical procedure during the hospital stay was associated with a lower sensitivity of ICD-10 codes for both PE and DVT, acute respiratory failure or exacerbation of chronic obstructive pulmonary disease (COPD) was associated with a lower sensitivity of ICD-10 codes for PE, while presenting with acute infectious disease was associated with a higher sensitivity of ICD-10 codes for DVT (Table 4). The sensitivity of ICD-10 codes for DVT was not affected by the location of DVT.

DISCUSSION

Using prospectively collected data as the reference, ICD-10 discharge diagnosis codes yield satisfactory sensitivity for identifying patients with PE (89%). Because of a much lower sensitivity (58%), a substantial proportion of DVT cases are missed when using hospital discharge data for identifying this condition. Although useful for validating DVT cases identified by ICD-10 discharge diagnosis codes, chart review cannot address the lack of sensitivity of routinely collected hospital discharge data.

An important finding of our study was the lower sensitivity of ICD-10 discharge diagnosis codes for patients developing DVT and, to a lesser extent, PE while hospitalized for medical or surgical conditions other than VTE. Coding discharge diagnosis is primarily intended for hospital reimbursement under the DRG-based prospective payment system. Guidelines require coding all clinical or psychosocial problems that coexist at the time of admission, develop subsequently, and

affect length of stay or impact patient care by requiring additional diagnostic or therapeutic procedures or increased nursing care. Hence, coding PE is often critical for DRG assignment, whereas adding a secondary diagnosis code of DVT does not change DRG assignment for most patients hospitalized with medical or surgical conditions other than venous thromboembolism (29). Consistently with previous studies (14, 30), our findings also suggest that clinicians may refrain from identifying postoperative VTE in hospital claims data.

Other potential reasons may explain undercoding DVT and PE in hospital databases. First, hospital discharge abstract information is retrospective and coders are dependent on the completeness and accuracy of the documentation in the discharge summary for determining diagnosis codes (11). In a recently published study, adequate documentation of postoperative venous thromboembolism existed in the chart for all false negative cases but the event was not captured by the discharge abstract process (31). Indeed, coders generally abstract diagnoses from physician notes rather than from diagnostic imaging test reports. Therefore a clot found on lower limb compression ultrasonography would not trigger coding of DVT unless this diagnosis is explicitly noted by the physician in the chart. This may also explain the lower sensitivity of discharge diagnosis codes for PE in patients with acute respiratory failure or exacerbation of COPD since clinical signs and symptoms of the two conditions frequently overlap. Second, clinicians may miss or even refute isolated calf DVT diagnosis, despite abnormal objective test findings. Indeed, the clinical significance and the appropriate treatment of isolated calf DVT are currently being debated. However, 150 out of 155 patients (97%) with isolated distal deep vein thrombosis received anticoagulant therapy as recommended by current guidelines (32). Finally, the hypothesis that isolated distal deep thrombosis is undercoded is not supported by our data, which did not show any significant association between DVT location and the sensitivity of ICD-10 discharge diagnosis codes.

Another noteworthy finding of our study was the moderate although statistically significant intraclass correlation coefficient (0.11, $P = 0.03$) for sensitivity of ICD-10 discharge diagnosis codes for PE. This finding may reflect variations in hospital coding practices or in PE diagnosis management or screening practices (33). As noted by others (34), these variations may introduce bias in comparison of hospital performance regarding VTE prevention.

Only a few studies have assessed the sensitivity of hospital discharge diagnosis codes for identifying VTE and all of them used ICD-9-CM codes. Differences in sensitivity across studies likely reflect heterogeneity in the study population, recruitment period, and reference method. As shown in our study, the postoperative nature of VTE may explain the lower sensitivity reported by Zahn et al (13, 14). Our sensitivity estimates are consistent with those reported by Birman-Deych et al (35) for DVT and even compare favorably with those reported by Heckbert et al (36) for PE. This extends the findings of previous studies which showed that coding sensitivity had been preserved in the transition from ICD-9-CM to ICD-10 for other conditions (37, 38).

Several limitations of our study deserve mention. First, the best denominator used to determine sensitivity would include only patients with symptomatic DVT and/or PE and who were treated with anticoagulant therapy. All cases of acute venous thromboembolism were symptomatic and the vast majority of them (98%) were treated with anticoagulant treatment or inferior vena cava filter, making coding failure the most likely cause for the absence of ICD-10 diagnosis codes in our study. Second, the validity of diagnosis codes encompasses important dimensions other than sensitivity (39). Estimating the specificity of ICD-10 discharge diagnosis codes for PE and DVT was not within the scope of the present study and the estimates of specificity for these conditions would have been pessimistic because our study population consisted of patients with suspected VTE. Third, our study was not powered to evidence statistically significant differences in the sensitivity of ICD-10 discharge

diagnosis codes according to patient characteristics and the results of our exploratory analyses should be considered to be only hypothesis-generating. Heterogeneity in sensitivity according to patient characteristics may also have occurred by chance and replication in independent studies is essential. Fourth, it would have been interesting to review medical charts and ask clinicians and coders for the reasons for omitting appropriate discharge diagnosis codes in patients with objectively confirmed DVT or PE. However, this could not be done because of the design of our study. Fifth, our study was conducted in 25 hospitals in France and we cannot exclude that the results would have been different in other countries or settings.

In summary, the sensitivity of ICD-10 discharge diagnosis codes for identifying objectively confirmed PE is 89% using prospectively collected data as the reference. In contrast, using ICD-10 codes recorded in the hospital discharge abstract for identifying DVT would miss approximately four out of ten acute episodes of VTE confirmed by compression ultrasonography. Improvements in consistency across hospitals would strengthen the validity of PE discharge diagnosis codes for research or comparative purposes.

CONCLUSION

THESE SOUTENUE PAR : Pierre CASEZ

TITRE: Sensibilité des codes diagnostiques saisis dans le cadre du programme de médicalisation des systèmes d'information pour l'identification des cas de maladie thrombo-embolique veineuse

CONCLUSION

Les codes diagnostiques de la 9^{ème} révision de la Classification Internationale des Maladies (CIM) saisis dans les bases de données médico-administratives nord-américaines sont utilisés à des fins épidémiologiques ou d'évaluation de la qualité des soins.

Cette étude, conduite dans 25 établissements de santé publics et privés, a permis de documenter la sensibilité des codes de la 10^{ème} révision de la CIM saisis en routine dans le cadre du programme de médicalisation des systèmes d'information (PMSI) en France pour identifier les cas de maladie thrombo-embolique veineuse. Son originalité réside dans la comparaison des codes saisis avec les diagnostics établis selon une stratégie validée et recueillis dans le cadre d'une étude de cohorte prospective.

La sensibilité des codes est de 58,0% (intervalle de confiance à 95% [IC_{95%}], 51,9 à 64,1) pour la thrombose veineuse profonde et de 88,9% (IC_{95%}, 85,6 à 92,2) pour l'embolie pulmonaire. La sensibilité est significativement inférieure pour les patients ayant bénéficié d'une intervention chirurgicale et pour ceux dont l'événement thrombo-embolique veineux est diagnostiqué en cours de séjour.

La sensibilité médiane par établissement est de 57,7% (intervalle interquartile, 48,6 à 66,7; coefficient de corrélation intraclasse, 0,02; p=0,31) pour la thrombose veineuse profonde, et de 88,9%


(intervalle interquartile, 83,3 à 96,3; coefficient de corrélation intraclasse, 0,11; $p=0,03$) pour l'embolie pulmonaire, suggérant une variabilité de la qualité du codage pour cette dernière pathologie.


La sensibilité des codes diagnostiques de la 10^{ème} révision de la CIM saisis dans le cadre du PMSI est satisfaisante pour l'identification des cas d'embolie pulmonaire. L'harmonisation des pratiques de codage entre les établissements permettrait leur utilisation en routine à des fins d'évaluation de la qualité de la prévention de cette pathologie. En revanche, l'utilisation des codes diagnostiques saisis dans le cadre du PMSI conduirait à omettre plus de quatre cas de thrombose veineuse profonde sur dix.

VU ET PERMIS D'IMPRIMER

Grenoble, le 26 août 2009

LE DOYEN


Professeur Bernard SELE



UNIVERSITE JOSEPH FOYER
U.F.R.
DE
MEDECINE
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LE PRESIDENT DE THESE


Professeur Jacques DEMONGEOT

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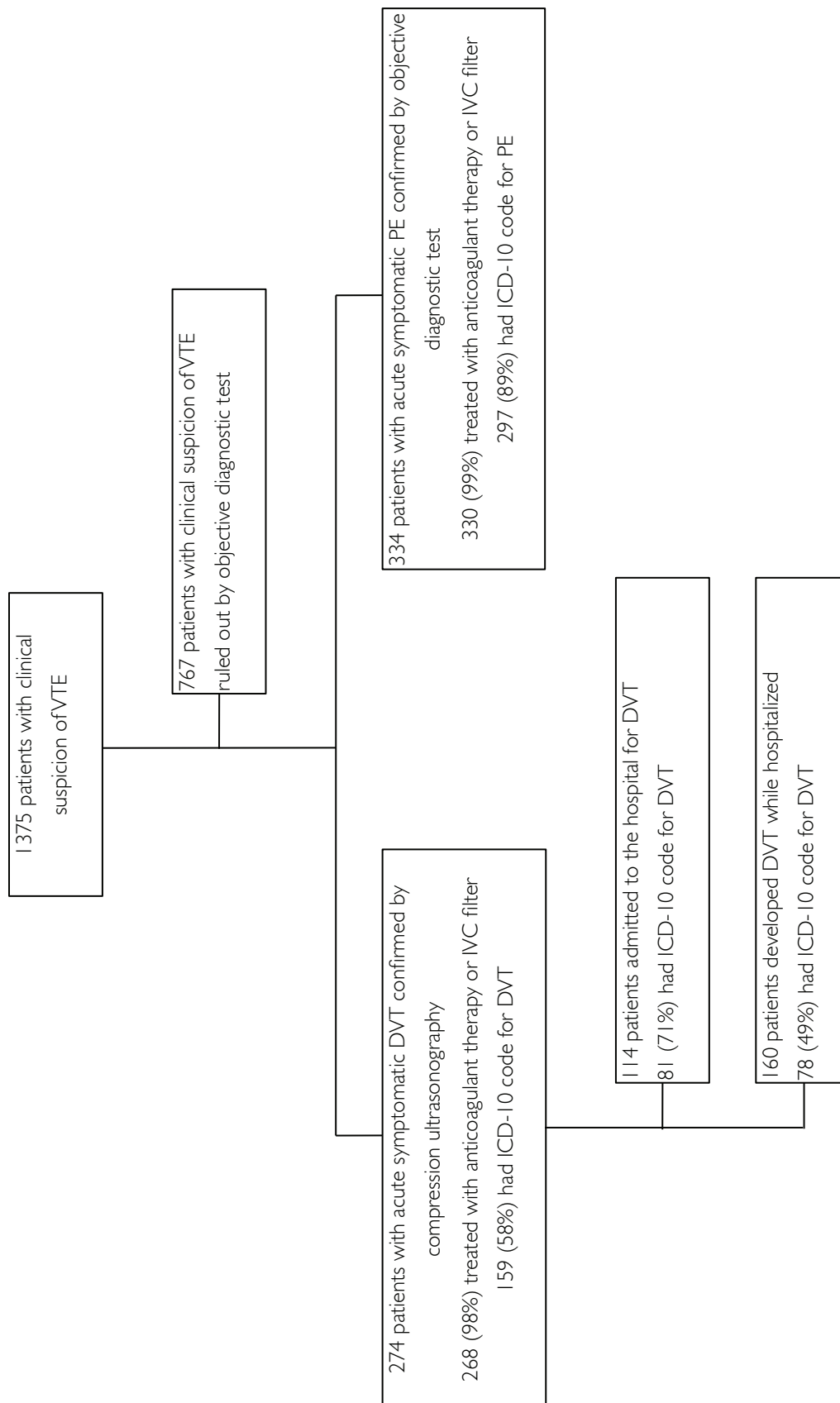
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FIGURE

Figure I: Patient enrollment flow-chart



TABLES

Table 1. Characteristics of Patients with Clinical Suspicion for Acute Pulmonary Embolism and/or Deep Vein Thrombosis (N= 1375).

Characteristics*

Age, y, median (IQR)	71 (54–80)
Female gender, n (%)	750 (54.5)
Risk factor for VTE, n (%)	
Cancer	327 (23.8)
Immobilization	455 (33.1)
Varicose veins	221 (16.1)
Acute infectious disease	171 (12.4)
NYHA class III or IV congestive heart failure	141 (10.3)
Acute respiratory failure or exacerbation of COPD	91 (6.6)
Stroke	10 (0.7)
Previous history of PE	86 (6.3)
Previous history of DVT	152 (11.1)
Pregnancy or postpartum period	39 (2.8)
Obesity (body mass index >30)	210 (15.3)
Surgical procedure	229 (16.7)
Venous thromboembolism confirmed by objective diagnostic test, n (%)	
Pulmonary embolism	334 (24.3)
Deep vein thrombosis	274 (19.9)
In-hospital mortality, n (%)	55 (4.0)

IQR indicates interquartile range; COPD, chronic obstructive pulmonary disease; NYHA, New York Heart Association.

* Patient baseline characteristics and follow-up data were prospectively collected in the OPTIMEV study.

Table 2. Distribution of ICD-10 Discharge Diagnosis Codes for Pulmonary Embolism and/or Deep Vein Thrombosis.

ICD-10 codes – Description*

Number of patients with acute symptomatic pulmonary embolism	334
Number (%) of patients with any ICD-10 code for pulmonary embolism	297 (88.9)
I26.9 Pulmonary embolism without mention of acute cor pulmonale	251
I26.0 Pulmonary embolism with mention of acute cor pulmonale	63
Number of patients with acute symptomatic deep vein thrombosis	274
Number (%) of patients with any ICD-10 code for deep vein thrombosis	159 (58.0)
I80.2 Phlebitis and thrombophlebitis of other deep vessels of lower extremities	80
I80.3 Phlebitis and thrombophlebitis of lower extremities, unspecified	62
I80.1 Phlebitis and thrombophlebitis of femoral vein	11
I82.8 Embolism and thrombosis of other specified veins	6
I80.9 Phlebitis and thrombophlebitis of unspecified site	5
I82.9 Embolism and thrombosis of unspecified vein	4
I80.8 Phlebitis and thrombophlebitis of other sites	3
O22.3 Phlebothrombosis profunda in graviditate	1
O22.9 Venous complication in pregnancy, unspecified	1
O87.1 Deep phlebothrombosis in the puerperium	1

ICD indicates International Classification of Diseases.

* Patients may have more than one ICD-10 discharge diagnosis code of DVT and/or PE.

Table 3. Sensitivity of ICD-10 Hospital Discharge Diagnosis Codes for Identifying Patients with Acute Symptomatic Pulmonary Embolism and/or Deep Vein Thrombosis.

	Acute PE	Acute DVT
All patients, n (%)	334 (100)	274 (100)
ICD-10 code absent, n (%)	37 (11.1)	115 (42.0)
ICD-10 code present, n (%)	297 (88.9)	159 (58.0)
Patients admitted to hospital for PE or DVT, n (%)	243 (100)	114 (100)
ICD-10 code absent, n (%)	14 (5.8)	33 (29.0)
ICD-10 code present, n (%)*	229 (94.2)	81 (71.0)
Primary diagnosis	204	56
Secondary diagnosis	35	35
Patients who developed PE or DVT while hospitalized, n (%)	91 (100)	160 (100)
ICD-10 code absent, n (%)	23 (25.3)	82 (51.2)
ICD-10 code present, n (%)*	68 (74.7)	78 (48.8)
Primary diagnosis	40	9
Secondary diagnosis	32	70

ICD indicates International Classification of Diseases; PE, pulmonary embolism; DVT, deep vein thrombosis.

* Three patients had two different secondary diagnosis codes of PE and four patients had two different secondary diagnosis codes of DVT.

Table 4. Univariable Analysis of Patient Characteristics Associated with Sensitivity of ICD-10 Hospital Discharge Diagnosis Codes for Pulmonary Embolism and Deep Vein Thrombosis.

		Acute pulmonary embolism (N=334)		P-value	Acute deep vein thrombosis (N=274)		P-value
		No. Patients	No. (%) patients with ICD-10 code		No. Patients	No. (%) patients with ICD-10 code	
Age	<70	157	142 (90.4)		125	69 (55.2)	
	≥70	177	155 (87.6)		149	90 (60.4)	
Gender	male	150	134 (89.3)		114	69 (60.5)	
	female	184	163 (88.6)		160	90 (56.3)	
Cancer	no	261	236 (90.4)		190	114 (60.0)	
	yes	73	61 (83.6)		84	45 (53.6)	
Immobilization	no	242	217 (89.7)		154	93 (60.4)	
	yes	92	80 (87.0)		120	66 (55.0)	
Varicose veins	no	266	236 (88.7)		232	136 (58.6)	
	yes	68	61 (89.7)		42	23 (54.8)	
Acute infectious disease	no	310	275 (88.7)		249	139 (55.8)	*
	yes	24	22 (91.7)		25	20 (80.0)	
NYHA class III or IV congestive heart failure	no	312	278 (89.1)		256	149 (58.2)	
	yes	22	19 (86.4)		18	10 (55.6)	
Acute respiratory failure or exacerbation of COPD	no	322	289 (89.7)	*	260	153 (58.8)	
	yes	12	8 (66.7)		14	6 (42.9)	
Stroke	no	330	294 (89.1)		272	159 (58.5)	
	yes	4	3 (75.0)		2	0 (0.0)	
Previous history of PE	no	298	265 (88.9)		257	146 (56.8)	
	yes	36	32 (88.9)		17	13 (76.5)	
Previous history of DVT	no	285	252 (88.4)		227	130 (57.3)	
	yes	49	45 (91.8)		47	29 (61.7)	
Surgical procedure	no	322	290 (90.1)	†	205	133 (64.9)	†
	yes	12	7 (58.3)		69	26 (37.7)	
Concurrent DVT	no	107	96 (89.7)		-	-	
	yes	227	201 (88.5)		-	-	
Isolated calf DVT	no	-	-		190	115 (60.5)	
	yes	-	-		84	44 (52.4)	
Time from diagnosis to discharge	<3 days	24	19 (79.2)		49	27 (55.1)	
	≥3 days	310	278 (89.7)		225	132 (58.7)	
Anticoagulant therapy or inferior vena cava filter	no	4	4 (100)		6	4 (66.7)	
	yes	330	293 (88.8)		268	155 (57.8)	
In-hospital death	no	315	282 (89.5)		263	153 (58.2)	
	yes	19	15 (78.9)		11	6 (54.5)	

PE indicates pulmonary embolism; COPD, chronic obstructive pulmonary disease; DVT, deep vein thrombosis.
* P <0.05; † P <0.01



Qui diasmemorem laudes, repetamque fideles
 Ingenij dotes, Hippocratisque decus.
 Democriti auditor. Phœbea, ô, Coë propago,
 Certius an quis te tradidit artis opes?

SERMENT D'HIPPOCRATE

*En présence des Maîtres de cette Faculté, de mes chers condisciples et devant
 l'effigie d'HIPPOCRATE,*

*je promets et je jure d'être fidèle aux lois de l'honneur et de la probité dans
 l'exercice de la Médecine.*

*Je donnerai mes soins gratuitement à l'indigent et n'exigerai jamais un salaire au
 dessus de mon travail. Je ne participerai à aucun partage clandestin d'honoraires.*

*Admis dans l'intimité des maisons, mes yeux n'y verront pas ce qui s'y passe ; ma
 langue taira les secrets qui me seront confiés et mon état ne servira pas à corrompre
 les mœurs, ni à favoriser le crime.*

*Je ne permettrai pas que des considérations de religion, de nation, de race, de parti
 ou de classe sociale viennent s'interposer entre mon devoir et mon patient.*

Je garderai le respect absolu de la vie humaine.

*Même sous la menace, je n'admettrai pas de faire usage de mes connaissances
 médicales contre les lois de l'humanité.*

*Respectueux et reconnaissant envers mes Maîtres, je rendrai à leurs enfants
 l'instruction que j'ai reçue de leurs pères.*

Que les hommes m'accordent leur estime si je suis fidèle à mes promesses.

Que je sois couvert d'opprobre et méprisé de mes confrères si j'y manque.