

ORIGINAL RESEARCH

Incidence of Hospital-Acquired Venous Thromboembolic Codes in Medical Patients Hospitalized in Academic Medical Centers

Raman Khanna, MD^{1*}, Gregory Maynard, MD, MS², Banafsheh Sadeghi, MD, PhD³, Laurie Hensley, MHA⁴, Sofia Medvedev, PhD⁴, Beate Danielsen, PhD⁵, Richard H. White, MD³

¹Department of Medicine, University of California San Francisco, San Francisco, California; ²Department of Medicine, University of California San Diego, San Diego, California; ³Department of Medicine, University of California Davis School of Medicine, Sacramento, California; ⁴University HealthSystem Consortium, Chicago, Illinois; ⁵Health-Information-Solutions, Rocklin, California.

BACKGROUND: Hospital-acquired venous thromboembolism (HA-VTE, VTE occurring during a hospitalization) codes in hospital billing data are often used as a surrogate for hospital-associated VTE events occurring during or up to 30 days after a hospitalization, which are more difficult to measure.

OBJECTIVE: Establish the incidence and composition of HA-VTE/superficial venous thrombosis (SVT) coded in a large cohort of medical patients.

DESIGN: Retrospective analysis of discharges.

SETTING: Eighty-three academic medical centers in UHC (formerly University HealthSystem Consortium).

PATIENTS: Patients with medical diagnoses hospitalized >2 days between October 1, 2009, and March 31, 2011.

MEASUREMENTS: Incidence and anatomic location of HA-VTE codes, defined as *International Classification of Diseases, Ninth Revision, Clinical Modification* codes for VTE coupled to a present-on-admission indicator flag set to "No."

RESULTS: Among 2,525,068 medical hospitalizations, 12,847 (0.51%) cases had ≥ 1 thrombotic code; 2449 (19.1%) with pulmonary embolism (PE), and 3848 (30%) with lower-extremity deep venous thrombosis (LE-DVT) without PE. Upper-extremity DVT (2893; 22.5%) and SVT (3248; 25.3%) comprised the bulk of remaining cases. Among cases with HA-PE/LE-DVT, 34.3% had cancer, 47.8% received care in an intensive care unit, 78% had severe or extreme severity of illness, and 16.5% died in the hospital. Overall, 54.9% of the patients who developed a HA-PE/LE-DVT had been started on VTE pharmacoprophylaxis on hospital day 1 or 2.

CONCLUSION: At academic centers, HA-VTE/SVT is coded in 0.51% of medical inpatients, and HA-PE/LE-DVT is coded in half of those. Most patients with HA-PE/LE-DVT are severely ill and develop VTE despite receiving prophylaxis. *Journal of Hospital Medicine* 2014;9:221–225. © 2014 Society of Hospital Medicine

Pulmonary embolism (PE) and deep venous thrombosis (DVT), historically referred to together as venous thromboembolism (VTE), are common, treatable, sometimes fatal, and potentially preventable medical problems.¹ Such thromboses can both precipitate a hospitalization as well as complicate it (either during or soon after discharge). Preventing such thrombosis as a complication of medical care has become a national imperative. Landmark studies such as Prophylaxis in Medical Patients With Enoxaparin (MEDENOX)² and Prospective Evaluation of Dalteparin Efficacy for Prevention of VTE in Immobilized Patients Trial (PREVENT)³ demonstrated both a high incidence of thrombosis in a hospitalized high-risk medical population (15% and 5% in the 2 trials' placebo arms, respectively) as well as significant relative

risk reduction through venous thromboembolism pharmacoprophylaxis (VTEP)—63% and 45%, respectively. The Joint Commission,⁴ the Society of Hospital Medicine,⁵ and the American College of Chest Physicians^{6,7} have thus all strived to ensure the appropriate provision of VTEP in order to reduce the morbidity and mortality associated with thrombosis in hospitalized patients, including those on medical services.

Ideally, the global success of these efforts would be assessed by measuring the rate of hospital-associated VTE (potentially including superficial venous thrombosis [SVT], which, like upper-extremity deep venous thrombosis [UE-DVT], is commonly a central venous catheter [CVC]-associated, or peripherally inserted central catheter [PICC]-associated, complication)—thrombosis acquired and diagnosed during either the index hospitalization (hospital-acquired, or HA-VTE/SVT) or up to 30 days postdischarge. Unfortunately, postdischarge VTE/SVT is difficult to measure because patients developing it may not present to the original hospital, or at all (eg, if they do not seek care, are treated as outpatients, or, in the most extreme case, die at home). In this context, despite being far less comprehensive, HA-VTE/SVT is a useful subset of hospital-associated VTE/SVT, for several reasons. First, the Centers for Medicare & Medicaid Services

*Address for correspondence and reprint requests: Raman Khanna, MD, MAS, Assistant Clinical Professor of Medicine, University of California San Francisco, Department of Medicine, Division of Hospital Medicine, 533 Parnassus, U136, San Francisco, CA; Telephone: 415-476-4806; Fax: 415-514-2094; E-mail: rkhanna@medicine.ucsf.edu.

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(CMS) have mandated hospitals to qualify all medical diagnoses as “present-on-admission” (POA = Y) or not (POA = N) since 2008, such that all medical diagnoses coded POA = N can be considered hospital acquired.⁸ Second, refinements made to the International Classification of Diseases, 9th Revision (ICD-9) codes now allow differentiation of UE-DVT and SVT from lower-extremity (LE) DVT/PE, whereas the former were sometimes obscured by nonspecific coding.⁹ Third, recent studies have shown that medical diagnoses administratively coded as HA-VTE/SVT correlated well with HA-VTE/SVT ascertained through chart review.^{9,10} Finally, previous work has estimated that approximately half of all hospital-associated VTE are HA-VTE and the other half are postdischarge VTE.¹¹ Thus, HA-VTE, though comprising only approximately half of all hospital-associated VTE, is often used as a surrogate for measuring the success of ongoing VTE prevention programs.¹²

Our study aimed to assess the incidence of HA-VTE plus HA-SVT in the era of mandatory POA coding and newer ICD-9 codes for VTE.

METHODS

Setting and Cases

We conducted a retrospective analysis of discharges from the 83 academic medical centers belonging to the UHC (formerly, the University HealthSystem Consortium, <https://www.uhc.edu>)¹³ between October 1, 2009 and March 31, 2011. UHC collects demographic, clinical, and billing data from these centers including medical diagnoses and procedures coded using the ICD-9-Clinical Modification (ICD-9-CM), a POA indicator for each diagnosis; UHC also collects data on medication use. This study was approved by the institutional review board at the University of California Davis.

Patients in our analysis were age ≥ 18 years and discharged with a “medical” medical severity diagnostic-related group (MS-DRG) code, hospitalized for ≥ 48 hours, and did not have a surgical or obstetric MS-DRG code (except when assigned a surgical MS-DRG code solely due to insertion of an inferior vena cava filter, with no other major procedures performed). Cases excluded discharges with a principal diagnosis of acute VTE/SVT (defined here as including PE, LE-DVT, UE-DVT, SVT, chronic VTE, and thrombosis not otherwise specified), as coding guidelines prohibit assigning a HA-VTE as the principal diagnosis for the index hospitalization.¹⁴

Hospital-Acquired Venous Thromboembolism or Superficial Venous Thrombosis

Cases were classified as having a HA-VTE/SVT if there was ≥ 1 VTE/SVT coded in a secondary diagnosis position (“other diagnosis”) with a corresponding POA indicator equal to either “N” (not POA) or “U” (documentation insufficient to clarify whether VTE

was POA or not). This usage corresponds to CMS guidelines and reimbursement policies for hospital-acquired conditions.¹⁵ Among cases with ≥ 1 HA-VTE (or SVT), we assigned 1 HA-VTE diagnosis using a hierarchy based on the highest level of clinical importance: first, PE; then LE-DVT; then UE-DVT; then SVT; then chronic VTE; then, finally, unspecified VTE. We subsequently excluded cases with primarily chronic VTE from our analysis because these were likely miscodes (ie, it is unclear how a chronic VTE could not be POA) and there were only 30 such cases. Cases with HA-PE or HA-LE DVT were analyzed separately as an important subset of HA-VTE (plus SVT), because HA-PE/LE-DVT is both life-threatening and theoretically preventable with VTEP.

Severity of Illness and Other Measures of Comorbidity

For each case we used proprietary software (3M Health Information Systems, Murray UT) to classify severity of illness (SOI). The SOI scale, based on physiologic derangement and organ system loss of function,¹⁶ has 4 levels: minor, major, severe, and extreme. Defined within specific disease groups (All Patient Refined DRGs), it is often compared across diseases as well.¹⁷ We also assessed whether patients had a cancer diagnosis, spent time in the intensive care unit (ICU), and died in the hospital.

Central Venous Catheter Use in Patients With Upper-Extremity Deep Venous Thrombosis or Superficial Venous Thrombosis

Because UE-DVT and SVT are frequently associated with a CVC or PICC, we assessed central venous catheterization among patients with an UE-DVT or SVT of the cephalic, basilic, or antecubital veins using diagnosis codes for complications related to dialysis devices, implants, and grafts.

Pharmacologic Thromboprophylaxis

Pharmacy records of the subset of HA-VTE/SVT cases with PE or LE-DVT were analyzed to determine if VTEP was administered on hospital day 1 or 2, as per Joint Commission performance requirements.⁴ Medications that met criteria as VTEP included unfractionated heparin, 5000 IU, given 2 \times or 3 \times a day; enoxaparin, 40 mg, given daily; dalteparin, 2500 or 5000 IU, given daily; fondaparinux, 2.5 mg, given daily; and warfarin. We could not reliably determine if VTEP was used throughout the entire hospitalization, or whether mechanical prophylaxis was used at all.

Statistical Analysis

This was a descriptive analysis to determine the incidence of HA-VTE/SVT and describe the demographic and clinical characteristics of this population. We calculated means and standard deviations (SD) for continuous variables and proportions for binary variables (including HA-VTE/SVT incidence). All comparisons

TABLE 1. Patients With No HA-VTE Code and Patients With a HA-PE/LE-DVT Code (ICD-9-CM)

Characteristic	No HA-VTE, n = 2,512,221	HA-PE/LE DVT, n = 6,297*	P Value [†]
Proportion of hospitalizations, %	99.49	0.25	
Age, y	48.2 ± 27.1	62.5 ± 20.0	<0.001
Female sex	1,347,219 (53.6)	3,104 (49.3)	<0.001
Race			<0.001
Caucasian	1,455,215 (57.9)	3,963 (64.7)	
Black	600,991 (23.9)	1,425 (23.3)	
Hispanic	206,553 (8.2)	263 (4.3)	
API	59,560 (2.4)	88 (1.4)	
Other	189,902 (7.6)	389 (6.4)	
Admission SOI			<0.001
Minor	461,411 (18.4)	181 (2.9)	
Major	922,734 (36.7)	1,081 (17.2)	
Severe	880,542 (35.1)	2,975 (47.2)	
Extreme	247,244 (9.8)	2,060 (32.7)	
Unknown	290 (0.01)	0 (0.0)	
Had an active diagnosis of cancer	331,705 (13.2)	2,162 (34.3)	<0.001
Length of stay, d	7.31 ± 9.31	18.7 ± 19.5	<0.001
Spent time in the ICU	441,412 (17.6)	3,011 (47.8)	<0.001
Died in hospital	57,954 (2.3)	1,036 (16.5)	<0.001
Received prophylaxis [‡]	†	3,454 (54.9)	†

NOTE: Data are presented as n (%) or mean ± SD. Abbreviations: API, Asian or Pacific Islander; HA-PE/LE DVT, hospital-acquired pulmonary embolism or lower-extremity deep venous thrombosis; HA-VTE, hospital-acquired venous thromboembolism; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; ICU, intensive care unit; LMWH, low-molecular-weight heparin; SD, standard deviation; SOI, severity of illness.

*The first 2 columns, no HA-VTE and HA-PE/LE DVT, were compared as noted in the third column. Data on upper-extremity or superficial thrombosis are not shown in this table.

[†]For all variables except age and length of stay, P values are calculated by χ^2 ; for age and length of stay, P value is calculated by rank-sum test.

[‡]Prophylaxis with LMWH, fondaparinux, unfractionated heparin, or warfarin on the first or second day of hospitalization. Prophylaxis was not estimated in the population that did not develop a HA-VTE.

between populations were performed as either 2-tailed *t* tests or χ^2 analyses. All analysis was conducted using SAS software, version 9.2 (SAS Institute, Inc., Cary, NC).

RESULTS

For the 18-month period between October 1, 2009, and March 31, 2011, across 83 UHC hospitals, there were 2,525,068 cases. Among these, 12,847 (0.51%) had ≥ 1 HA-VTE/SVT coded. As per the clinical importance hierarchy described above, 2449 (19.1%) cases had at least a PE coded; 3848 (30%) had at least a LE-DVT (but not a PE) coded; 2893 (22.5%) had at least an UE-DVT coded; 3248 (25.3%) had at least an SVT coded; 30 had at least a chronic VTE coded; and 379 had at least a VTE coded with no specified location. Of those with SVT, 192 (5.8%) were LE-SVT codes, whereas the rest were SVT/thrombophlebitis of the upper extremities or not otherwise specified. There were 11,882 (92.5%) hospitalizations with a single HA-VTE/SVT code and an additional 965 (7.5%) with multiple codes, for a total of 13,749 HA-VTE/SVT events (see Supporting Information, Table S1, in the online version of this article for more specific data for the individual ICD-9 codes used to specify HA-VTE events).

Compared with those who did not develop any HA-VTE/SVT, patients with HA-PE/LE-DVT were more likely to be Caucasian (65% vs 58%, $P < 0.001$) and were older (age 62 vs 48 years, $P < 0.001$) and sicker (79.9% vs 44.9% with a severe or extreme SOI, $P < 0.001$). They also were more likely to have cancer, have longer lengths of stay, be more likely to stay in the ICU, and die in the hospital ($P < 0.001$ for all comparisons; Table 1).

Among cases with a code for UE-DVT (22.5% of all patients with HA-VTE), 74% were noted to also have a code for a CVC, as did 60% of cases with a HA-SVT of the antecubital, basilic, or cephalic veins (71% of SVT events; see Supporting Information, Table S1, in the online version of this article).

Of those with HA-PE/LE-DVT, 54.9% received pharmacologic prophylaxis on hospital day 1 or 2 (mostly with low-molecular-weight heparin or unfractionated heparin).

DISCUSSION

In this study of medical patients admitted to academic medical centers throughout the United States, we found that HA-VTE/SVT was coded in approximately 0.51% of discharges, and the incidence of HA-PE/LE-DVT was 0.25%. Patients with a HA-PE/LE-DVT code were, in general, older and sicker than those who did not develop VTE. We further found that close to half of all HA-VTE/SVT occurred in the upper extremity, with the majority of these occurring in patients who had CVCs. Finally, the majority of patients diagnosed with HA-PE/LE-DVT were started on VTEP on the first or second hospital day.

The overall incidence of HA-VTE/SVT we discovered corresponds well to other studies, even those with disparate populations. A single-institution study found a HA-VTE/SVT incidence of approximately 0.6% among hospitalized patients on medical and nonmedical services.¹² The study by Barba found a rate of 0.93%,¹⁸ whereas the study by Lederle found a rate of approximately 1%.¹⁹ Spyropolous found an HA-VTE incidence of 0.55%.¹¹ Rothberg found a lower rate of 0.25% in his risk-stratification study, though in the pre-POA and pre-updated code era.²⁰ Our findings extend and provide context for, in a much larger population, the results of these prior studies, and represent the first national examination of HA-VTE/SVT in the setting of numerous quality-improvement and other efforts to reduce hospital-associated VTE.

The incidence of HA-VTE/SVT codes we observed likely underestimates the incidence of hospital-associated VTE/SVT by a factor of approximately 4, for 2 reasons. First, although VTE/SVT codes with a POA flag set to “No” are truly hospital-acquired events on chart review approximately 75% of the time, and thus overestimate HA-VTE/SVT, 25% of POA = Yes codes are actually HA-VTE/SVT events

on chart review, and therefore lead to underestimation of HA-VTE/SVT.⁹ Because VTE/SVT codes with a POA flag set to “Yes” outnumber those flagged “No” by 3 or 4 to 1, events mis-flagged “Yes” contribute a much greater number of undercounted HA-VTE/SVT, elevating the actual HA-VTE/SVT event rate by a factor of approximately 2. Second, HA-VTE events do not include hospital-associated VTE events that are diagnosed after the index hospitalization. In the Spyropolous study, 45% of hospital-associated VTE events occurred after discharge, so translating HA-VTE/SVT events to hospital-associated VTE/SVT events would again involve multiplying by a factor of 2.¹¹ Thus, the overall incidence of hospital-associated VTE/SVT events in our sample may have been approximately 2% ($0.51\% \times 4$), and the overall incidence of hospital-associated PE or LE-DVT events may have been approximately 1%, though there may be significant variation around these estimates given that individual institutions were themselves quite variable in their POA flag accuracy in our study.⁹ There is additionally the possibility that hospitals may have deliberately left some VTE/SVT uncoded, but in the absence of financial incentives to do so for anything other than postsurgical VTE, and in the presence of penalties from CMS for undercoding, we believe this to be unlikely, at least at present.

Despite these upward extrapolations, the estimated incidence of hospital-associated VTE/SVT in our study may seem low compared with that reported in the MEDENOX² and PREVENT studies.³ Much of this discrepancy vanishes on closer examination. In the large randomized trials, patients were uniformly and routinely assessed for LE-DVT using vascular ultrasound; in contrast, in our population of hospitalizations patients may have only had diagnostic studies done for signs or symptoms. Clinically apparent hospital-associated VTE is less common than all hospital-associated VTE, as it was even in PREVENT,³ and increased surveillance may even be partially driving increased hospital-associated VTE/SVT at some hospitals.²¹ Our findings suggest that success or failure in preventing administratively coded, clinically apparent HA LE-VTE/PE should be judged, broadly, against numbers in the range established in our study (eg, 0.25%), not the 5% or 15% of chart-abstracted, aggressively ascertained (and sometimes clinically silent) hospital-associated VTE in the large randomized controlled trials. That is, 0.25% is not an achievement, but rather the average, expected value.

Almost 25% of the observed HA-VTE/SVTs coded were UE-DVT, with roughly 75% of these being likely related to central venous catheterization (including those peripherally inserted). An additional $\sim 1/5$ were upper-extremity SVT of the antecubital, cephalic, and basilic veins, with the majority of these (60%) also listed as catheter-related. Such thrombosis is best prevented by decreased use of central catheters or

perhaps by using smaller-caliber catheters.²² It is unclear if VTEP can prevent such clots, though in cancer patients at least one recent trial seems promising.²³

We found that patients with a coded HA-PE/LE-DVT were remarkably different from those not developing HA-VTE/SVT. Patients with HA-PE or HA-LE-DVT were older, sicker, more likely to have cancer, significantly more likely to spend time in the ICU, and much more likely to die in the hospital; risk factors for HA-VTE overlap significantly with risk factors for death in the hospital. A small majority (55%) of patients in the HA-PE/LE-DVT group had actually received VTEP on at least day 1 or 2 of hospitalization. It may be the case that the dose of VTEP was insufficient to suppress clot formation in these patients, or that HA-PE/LE-DVT in patients with this degree of comorbidity is difficult to prevent.

There are a number of limitations to our study. We analyzed administrative codes, which underestimate hospital-associated VTE/SVT events as noted above. This was a descriptive study, cross-sectional across each hospitalization, and we were unable to draw any causal inference for differences in HA-VTE/SVT incidence that might exist between subpopulations. We estimated VTEP from medication usage in just the first 2 days of hospitalization; we could not assess mechanical prophylaxis in this dataset; and we did not have any VTEP data for the first 2 days of hospitalization on the patients who did not develop a HA-VTE/SVT, which made it impossible to compare the 2 populations on this measure. For those who did not receive VTEP, we were unable to obtain data regarding possible contraindications to VTEP, such as ongoing gastrointestinal or intracerebral hemorrhage. Additionally, our data are based on academic hospitals only and may not generalize to nonacademic settings. Extrapolating from HA-VTE/SVT to hospital-associated VTE/SVT may not be possible due to heterogeneity of clotting events and perhaps variability in whether patients would return to the hospital for all of them (eg, superficial or UE VTE may not result in readmission). Finally, it is unclear whether a switch to ICD Tenth Revision (ICD-10) codes will impact our measured baseline in the coming year. The strengths of our analysis included stratification by type of HA-VTE/SVT and our ability to assess the incidence of HA-VTE/SVT in a large national population, and the provision of a baseline for VTE incidence—easily usable by any individual hospital, network, or researcher with access to administrative data—going forward.

In conclusion, among patients hospitalized in academic medical centers, HA-VTE/SVT was coded in approximately 0.51% of patients with a medical illness staying >2 days, with approximately half of the events due to HA-PE/LE-DVT. Patients who developed HA-PE/LE-DVT were more acutely ill than those who did not, and VTE developed despite 55% of these patients receiving VTEP on day 1 or 2.

Hospitals can reasonably treat the 0.25% figure as the baseline around which to assess their own performance in preventing HA-PE/LE-DVT, and can measure their own performance using administrative data. Further research is needed to determine how best to achieve further reductions in HA-VTE/SVT through risk stratification and/or through other interventions.

Disclosures: Nothing to report.

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