Original Research

Description of Venous Thromboembolism in Hospitalized Patients With Metastatic Cancer: A National Sample

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Abstract

Background: This study aimed to determine patient-, tumor-, and hospital-level characteristics associated with venous thromboembolism (VTE), and to assess the impact of VTE on in-hospital mortality and length of hospital stay in hospitalized patients with metastatic cancer. **Methods:** Using the Nationwide Inpatient Sample database, a cross-sectional analysis was performed of patients aged ≥18 years with at least 1 diagnosis of primary solid tumor and subsequent secondary or metastatic tumor between 2008 and 2013. **Results:** Among 850,570 patients with metastatic cancer, 6.6% were diagnosed with VTE. A significant trend for increasing VTE rates were observed from 2008 to 2013 (5.7%–7.2%; *P*<.0001). Using an adjusted multilevel hierarchical regression model, higher odds of VTE were seen among women (odds ratio [OR], 1.04; 95% CI, 1.02–1.06), black versus white patients (OR, 1.14; 95% CI, 1.11–1.18), and those with an Elixhauser comorbidity index score of ≥3 (OR, 2.50; 95% CI, 2.38–2.63). Hospital-level correlates of VTE included treatment in a teaching hospital (OR, 1.05; 95% CI, 1.01–1.11) and an urban location (OR, 1.18; 95% CI, 1.09–1.27), and admission to hospitals in the Northeast (OR, 1.16; 95% CI, 1.08–1.24) and West (OR, 1.09; 95% CI, 1.03–1.16) versus the South. Patients with metastasis to the liver, brain, or respiratory organs and those with multiple (≥2) metastatic sites had higher odds of VTE, whereas those with metastasis to lymph nodes and genital organs had lower odds. Patients diagnosed with versus without VTE had higher odds of in-hospital mortality (OR, 1.50; 95% CI, 1.38–1.63) and prolonged hospital stay (OR, 1.65; 95% CI, 1.57–1.73). **Conclusions:** The frequency of VTE in patients with metastatic cancer is increasing. Patient characteristics, hospital factors, and site of metastasis independently predict the occurrence of VTE and allow for better stratification of patients with cancer according to their VTE risk.

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Venous thromboembolism (VTE) is a leading cause of morbidity and mortality in patients with cancer.[1,2] Patients with cancer and VTE have a lower survival rate; Sorensen et al[1] reported a 1-year survival rate of 12% in patients with VTE compared with 36% of those without. Additionally, patients with cancer and VTE are at a 4- to 8-fold higher risk of death relative to those without cancer.[3,4] During hospitalization, patients with VTE have higher rates of in-hospital mortality and a prolonged hospital stay compared with those without VTE.[5,6] The economic burden of VTE in United States is enormous, with an estimated annual cost of $7 to $10 billion USD each year in medical care.[7] Previous studies have reported varied incidence of VTE in hospitalized patients with cancer, ranging from 0.6% to 7.8%.[5,8,9] This inconsistency is likely due to heterogeneity of the

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cancer, sampling variability, and variation in VTE surveillance and outcome measures.[10–13] Major risk factors for the development of VTE include advanced age, major surgery, obesity, medical comorbidities, and immobilization.[14,15] Risk factors for VTE in patients with cancer include the primary tumor site, receipt of chemotherapy, and presence of metastatic disease.[8,9,16,17]

Patients with metastatic cancer are now living longer. However, factors such as increased hypercoagulability, larger tumor burden, and impaired physical activity place these patients at increased risk of preventable disease, such as VTE.[18,19] The distribution, correlates, and short-term outcomes associated with VTE in hospitalized patients with metastatic cancer are not well-defined. This study aimed to (1) describe the prevalence of VTE among hospitalized patients with metastatic cancer; (2) examine the association between patient-, tumor-, and hospital-level characteristics and the occurrence of VTE; and (3) assess the impact of VTE on in-hospital mortality and hospital length of stay (LOS) among patients with metastatic cancer.

Methods

Data Source

This study involved cross-sectional analysis of hospital discharge data from the Nationwide Inpatient Sample (NIS) database between 2008 and 2013. The NIS data are obtained from the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ).[20] It is the largest publically available all-payer inpatient care database in the United States containing data on >7 million hospital stays each year (estimating >30 million weighted hospitalizations nationally), representing 20% of a stratified random sample of all hospital discharges from approximately 1,050 hospitals across 44 states. Detailed information on the NIS design and sampling methods are described elsewhere.[20] NIS is a publically available database containing deidentified patient information and was reviewed as an exempt project by the Saint Louis University Institutional Review Board.

Patient Population

Patients aged ≥18 years with at least 1 diagnosis of a primary solid tumor were identified using ICD-9-CM diagnostic codes (supplemental eTable 1, available with this article at JNCCN.org). Using secondary diagnostic codes, only patients with metastasis were included in the study.

Outcome Variables

The primary outcome of interest was the presence of VTE among hospitalized patients diagnosed with metastatic cancer. VTE was defined as pulmonary embolism (PE) and/or deep vein thrombosis using relevant ICD-9 diagnosis codes as described by AHRQ Patient Safety Indicators (supplemental eTable 1).[21] These codes have been validated to be appropriate for the identification of VTE using administrative data.[22] Patients with superficial thrombophlebitis and thrombosis were excluded, as were those with chronic VTE.

Secondary outcome measures were in-hospital mortality and hospital LOS. In-hospital mortality was defined as death that occurred during hospitalization, as coded from the discharge disposition of the patient. Hospital LOS was dichotomized into prolonged hospital stay (yes/no) if the LOS was ≥75th percentile based on the presence or absence of a major operating room procedure related to the same admission for each patient.[23] These adverse outcomes were selected based on their previously described association with VTE.[6]

Patient and Hospital Characteristics

Sociodemographic variables examined included sex, age, race/ethnicity (white, black, Hispanic, other), and health insurance status. These variables were selected based on their association with VTE, as documented in previous studies.[5,6,11] Comorbidities were classified using the Elixhauser comorbidity index[24] and the final variable was a summation of the number of comorbid conditions defined by the index. Because previous studies have indicated that patients with cancer undergoing major surgery or an oncologic procedure are at increased risk for VTE,[25,26] we assessed a major operating room procedure (yes/no) related to the same admission. This variable was predefined in the NIS database using ICD-9-CM procedure code for any major diagnostic or therapeutic operating room procedure. Hospital-level characteristics included in this analysis were hospital location (rural vs urban), hospital teaching status (nonteaching vs teaching), hospital size (small, medium, large),

and geographic location of the hospital (Northeast, Midwest, South, West).

Statistical Analysis

Available patient sociodemographic, clinical, and hospital-level characteristics were compared between patients with and without VTE using χ^2 or *t* test, as appropriate. Trends in the prevalence of VTE and in-hospital mortality rates in patients with and without VTE were assessed using the Cochran-Armitage test. Multilevel hierarchical logistic regression using generalized linear mixed models with generalized estimated equations were used to examine the association between patient, tumor, and hospital characteristics and study outcomes. Variables that were significant on univariate regression were included in the multivariable models. We required hospitals have at least 10 patients diagnosed with metastatic cancer for inclusion in the analysis to appropriately measure hospital-level variability. Data distribution and analyses were weighted according to the standard NIS approach to account for the complex sampling design and provide nationally representative estimates. All tests were 2-sided with an a priori α of 0.05. All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, North Carolina).

Results

Baseline Characteristics

Characteristics of 850,570 patients aged ≥18 years with a diagnosis of metastatic cancer stratified by the presence or absence of VTE are described in Table 1. Approximately 6.6% of patients had a diagnosis of VTE (n=56,302). Most of the patients were women (51.3%), were ≥65 years of age (53.0%), were white (72.1%), had health insurance (94.0%), had a major operating room procedure related to the same admission (30.0%), were admitted to a teaching hospital (53.4%), and were admitted to an urban hospital (90.0%).

Weighted distribution of primary and metastatic tumor sites in the study sample is depicted in Table 2. Most of the patients had lung cancer (29.2%) as the primary tumor site, followed by colorectal (16.2%), breast (11.8%), prostate (7.8%), and pancreatic (7.1%) cancers. Approximately 2.3% had multiple primary cancers. The most common sites of metastasis were liver (28.4%), bone and bone marrow (26.9%), lymph nodes (23.0%), respiratory organs (19.5%), and other gastrointestinal organs (13.3%). Approximately 35.6% of the patients had multiple metastatic sites.

Table 1. Weighted Characteristics of Patients With Metastatic Tumors

Characteristics	% Overhall	% Without VTE	% With VTE	*P* Value[a]
Patients, N (weighted %)	850,570	794,143 (93.4%)	56,302 (6.6%)	
Sex				
Male	48.7	48.8	47.4	<.001
Female	51.3	51.2	52.6	
Age, y				
18–44	6.7	6.8	5.5	<.001
45–64	40.3	40.2	41.2	
≥65	53.0	53.0	53.2	
Race/Ethnicity				
White	72.1	72.1	71.2	<.001
Black	14.2	14.0	16.6	
Hispanic	7.6	7.7	7.1	
Other	6.1	6.2	5.1	
Insurance status				
Uninsured	6.0	6.0	5.7	.003
Insured	94.0	94.0	94.3	
Hospital teaching status				
Teaching	53.4	53.3	55.3	<.001
Nonteaching	46.6	46.7	44.5	
Hospital location				
Urban	90.0	89.9	91.7	<.001
Rural	10.0	10.1	8.3	
Hospital size				
Small	11.7	11.7	10.9	<.001
Medium	22.5	22.5	22.0	
Large	65.8	65.8	67.1	
Hospital region				
Northeast	21.3	21.2	21.8	<.001
Midwest	23.5	23.5	24.4	
West	17.8	17.8	17.6	
South	37.4	37.5	36.1	
Major operating room procedure	30.0	29.8	32.0	<.001
Chemotherapy	6.3	6.2	6.3	.74
Elixhauser comorbidity index				
0	12.7	13.1	6.6	<.001
1	20.4	20.7	16.6	
2	22.8	22.9	22.1	
≥3	44.0	43.2	54.7	

Abbreviation: VTE, venous thromboembolism.
[a]*P* value from χ^2 test for categorical variables.

Rates and Temporal Trends of VTE

The overall prevalence of VTE was 6.6%. VTE rates were not uniformly distributed across all subgroups of patients with metastatic cancer (Table 3). Primary cancer sites with the highest VTE rates included pancreas, uterus, cervix, ovary, lung, and stomach. The sites of tumor metastasis with the highest VTE rates included adrenal glands, liver, brain and spinal cord, and other gastrointestinal organs. A statistically significant trend for increasing VTE rates was

Table 2. Distribution of Tumor Sites, VTE Rates, and Multilevel Regression Predicting Occurrence of VTE

Tumor Characteristics	Overall %	VTE %	OR (95% CI)[a]	*P* Value
Primary tumor site[b]				
Pancreas	7.1	11.2	1.83 (1.71–1.96)	<.001
Uterus	2.3	9.4	1.44 (1.33–1.57)	<.001
Cervix	1.3	8.9	1.47 (1.33–1.62)	<.001
Ovary	5.0	7.7	1.25 (1.16–1.35)	<.001
Lung & bronchus	29.2	7.5	1.14 (1.07–1.22)	<.001
Stomach	3.1	7.4	1.21 (1.12–1.32)	<.001
Bladder	2.7	7.2	1.12 (1.03–1.21)	.005
Gallbladder & biliary tract	1.2	7.0	1.07 (0.96–1.19)	.21
Testis	0.6	6.9	1.29 (1.07–1.55)	.008
Brain	0.3	6.7	1.05 (0.88–1.26)	.58
Esophagus	2.1	6.5	1.01 (0.92–1.10)	.85
Kidney & renal pelvis	3.9	5.8	0.77 (0.71–0.84)	<.001
Liver	2.1	5.6	0.83 (0.76–0.91)	<.001
Colon/Rectum	16.2	5.3	0.81 (0.76–0.87)	<.001
Prostate	7.8	5.3	0.82 (0.76–0.88)	<.001
Bone	0.7	5.2	0.91 (0.78–1.06)	.23
Breast	11.8	4.8	0.74 (0.69–0.79)	<.001
Head & neck	3.5	2.8	0.44 (0.40–0.49)	<.001
Thyroid	1.3	2.4	0.41 (0.35–0.48)	<.001
Metastatic site[b]				
Adrenal glands	3.8	8.6	1.18 (1.12–1.23)	<.001
Liver	28.4	7.8	1.16 (1.13–1.20)	<.001
Respiratory organs	19.5	7.7	1.29 (1.25–1.33)	<.001
Gastrointestinal organs (other than liver)	13.3	7.5	1.03 (0.99–1.07)	.113
Brain & spinal cord	14.8	7.4	1.14 (1.10–1.18)	<.001
Other organs	9.4	7.0	1.11 (1.07–1.15)	<.001
Bone & bone marrow	26.9	7.0	1.18 (1.15–1.22)	<.001
Unspecified site	7.4	6.7	1.23 (1.18–1.29)	<.001
Urinary organs	2.4	6.6	0.97 (0.90–1.04)	.36
Genital organs	2.1	5.8	0.78 (0.72–0.84)	<.001
Lymph nodes	23.0	5.5	0.89 (0.86–0.92)	<.001
Number of metastatic sites				
Single	64.4	6.0	1.00 [Ref]	
Multiple (≥2)	35.6	7.7	1.09 (1.05–1.13)	<.001

Abbreviations: OR, odds ratio; VTE, venous thromboembolism.
[a]Model was weighted and adjusted for patients' clinical and sociodemographic characteristics, tumor characteristics, and hospital-level factors.
[b]Compared with all other cancers.

observed from 2008 to 2013 (5.7%–7.2%; *P*<.001) (Figure 1).

Patient- and Hospital-Level Correlates of VTE

Table 3 presents findings from the weighted adjusted multilevel analysis of patient- and hospital-level factors associated with the development of VTE in hospitalized patients with metastatic cancer. Higher odds of VTE were associated with female sex (odds ratio [OR], 1.04; 95% CI, 1.02–1.06), black race (vs white; OR, 1.14; 95% CI, 1.11–1.18), having a major operating room procedure (OR, 1.42; 95% CI, 1.37–1.48), receipt of chemotherapy (OR, 1.08; 95% CI, 1.03–1.14), and Elixhauser comorbidity index score of ≥3 (OR, 2.50; 95% CI, 2.38–2.63). Hospital-level factors associated with higher odds of VTE were admission to a teaching hospital (OR, 1.05; 95% CI, 1.01–1.11), urban location (OR, 1.18; 95% CI, 1.09–1.27), and hospitals located in the Northeast (OR, 1.16; 95% CI, 1.08–1.24) and West (OR, 1.09; 95% CI, 1.03–1.16) compared with patients admitted to southern hospitals.

Association of Primary and Secondary Tumor Site With VTE

Table 2 presents the results of weighted adjusted multilevel regression analysis examining the association between primary and secondary site of the tumor and VTE. After controlling for the effect of patient- and hospital-level factors, patients with metastatic cancer with primary tumors in the pancreas, uterus, cervix, ovary, lung, stomach, bladder, and testis had higher odds of VTE, whereas those with primary tumors in the breast, liver, prostate, kidney, colon/rectum, head and neck, and thyroid had lower odds of VTE. Similarly, patients with tumor metastases to the adrenal glands, liver, brain and spinal cord, respiratory organs, and bone and bone marrow had higher odds of VTE whereas those with metastasis to lymph nodes and genital organs had lower odds of VTE. Having multiple (≥2) metastatic sites increased the odds of VTE by 9% (OR, 1.09; 95% CI, 1.05–1.13) compared with a single metastatic tumor.

Mortality and Hospital LOS After VTE

Across all years in the study, the overall in-hospital mortality rate in patients with VTE was 12.4% compared with only 8.6% in patients without VTE (Table 4). In contrast to trends in VTE rates, a declining annual rate of in-hospital mortality was observed regardless of VTE diagnosis (*P*<.001) (Figure 1). After adjusting for covariates in the multilevel regression analysis (Table 4), hospitalized patients with metastatic cancer diagnosed with VTE had 50% (OR, 1.50; 95% CI, 1.38–1.63) higher odds of in-hospital mortality relative to patients without VTE (*P*<.001). Similarly, those with VTE had 65% (OR, 1.65; 95% CI, 1.57–1.73) higher odds of experiencing longer hospital stays relative to those without VTE (*P*<.001).

Table 3. VTE Rates and Weighted Multilevel Logistic Regression Predicting Occurrence of VTE in Patients With Metastatic Cancer

Characteristics	VTE %	OR (95% CI)[a]	*P* Value
Overall	6.6	–	–
Sex			
Female	6.8	1.04 (1.02–1.06)	<.001
Male	6.4	1.00 [Ref]	
Age, y			
18–44	5.4	1.04 (0.96–1.10)	0.093
45–64	6.4	1.06 (0.99–1.12)	0.072
≥65	6.8	1.00 [Ref]	
Race/Ethnicity			
Black	7.8	1.14 (1.11–1.18)	<.001
Hispanic	6.2	0.91 (0.87–0.95)	<.001
Other	5.5	0.83 (0.79–0.87)	<.001
White	6.6	1.00 [Ref]	
Insurance status			
Uninsured	6.3	0.97 (0.93–1.02)	.21
Insured	6.6	1.00 [Ref]	
Hospital teaching status			
Teaching	6.9	1.05 (1.01–1.11)	.04
Nonteaching	6.3	1.00 [Ref]	
Hospital location			
Urban	6.7	1.18 (1.09–1.27)	<.001
Rural	5.4	1.00 [Ref]	
Hospital bed size			
Small	6.2	0.94 (0.88–1.01)	.09
Medium	6.5	0.94 (0.90–1.00)	.04
Large	6.7	1.00 [Ref]	
Hospital region			
Northeast	6.8	1.16 (1.08–1.24)	<.001
Midwest	6.9	1.08 (0.99–1.17)	.07
West	6.6	1.09 (1.03–1.16)	.002
South	6.8	1.00 [Ref]	
Major operating room procedure	7.1	1.42 (1.37–1.48)	<.001
Chemotherapy	6.6	1.08 (1.03–1.14)	<.001
Elixhauser comorbidity index			
0	3.4	1.00 [Ref]	
1	5.4	1.59 (1.52–1.67)	<.001
2	6.4	1.89 (1.81–1.98)	<.001
≥3	8.2	2.50 (2.38–2.63)	<.001

Abbreviations: OR, odds ratio; VTE, venous thromboembolism.
[a]Model was weighted and adjusted for patients' clinical and sociodemographic characteristics, tumor characteristics, and hospital-level factors. Model was also adjusted for site of primary tumor, site of metastatic tumor, and receipt of chemotherapy.

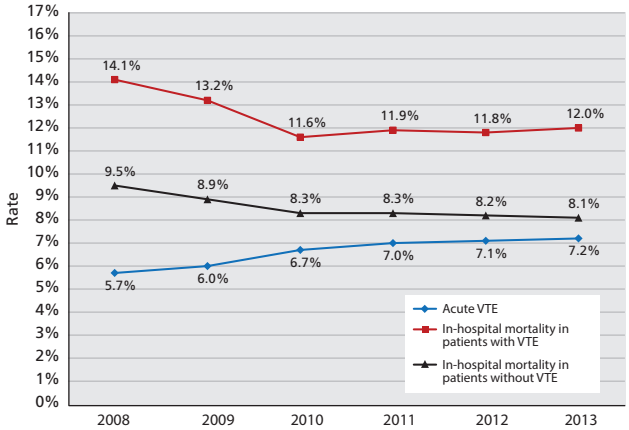

Figure 1. Rates of venous thromboembolism (VTE) among patients with metastatic cancer and overall in-hospital mortality among those with and without VTE between 2008 and 2013.

Discussion

This study, involving 56,302 patients with VTE, is the largest study to date to determine the rates, correlates, and trends for VTE in hospitalized patients with metastatic cancer. Approximately, 6.6% of patients with metastatic cancer in our analysis experienced VTE during hospitalization. This is higher than the rates reported by previous studies of hospitalized patients with cancer irrespective of their metastatic status; the previously reported range was 2.0% to 4.1%,[5,17] indicating the greater vulnerability of patients with metastatic cancer to the development of VTE compared with those without metastasis.

Our analysis indicates a significant increase in VTE rates over the study period, which is consistent with previous studies.[5,17] On the contrary, in-hospital mortality decreased in our study, despite the known association of inpatient mortality with VTE, which was previously estimated to increase mortality 2.5 times.[5] It is possible that the increasing rate of VTE may be attributable to improvements in survival that result in more hospitalizations of patients with cancer. The trend of increased VTE incidence in hospitalized patients may also be the result of improved detection and increased surveillance. The phenomenon of surveillance bias in VTE is well described in trauma[27] and surgical patients.[10,12] Another reason for the increasing VTE trend among patients with cancer is the incidental finding of asymptomatic PE identified during CT scanning performed for other reasons, such as staging.[28] Increased use of ultrasonography[29] and CT[30] over time confounds temporal analysis of VTE incidence and mortality.[31] Increased surveillance and improved sensitivity of methods to detect VTE may lead to the diagnosis of VTE at an earlier stage, introducing both lead time and length bias in the assessment of mortality from VTE. Additionally, these findings reiterate the perception regarding greater clinician awareness of the association between VTE and cancer, and the increasing adoption of guidelines and evidence-based treatment and prophylaxis.[32]

Table 4. Association Between VTE and In-Hospital Mortality and Prolonged Hospitalization

Outcome Variable	No VTE, %	VTE, %	OR (95% CI)[b]	*P* Value
In-hospital mortality	8.6	12.4	1.50 (1.38–1.63)	<.001
Prolonged hospital stay	27.0	40.7	1.65 (1.57–1.73)	<.001

Abbreviations: OR, odds ratio; VTE, venous thromboembolism.
[a]Weighted rate.
[b]Models were weighted and adjusted for patients' clinical and sociodemographic characteristics, tumor characteristics, hospital-level factors, and data collection year.

There were several notable patient-level characteristics associated with VTE in those with metastatic cancer. Consistent with findings of previous studies,[5,6] higher odds of VTE were observed in women and patients with more comorbidities. In contrast to findings of previous studies, age was not a significant predictor for VTE in patients with metastatic cancer.[5,6] A possible explanation could be that the biological aggressiveness of cancer metastasis predisposes all adult inpatients to VTE regardless of their age, especially after holding the effect of comorbidities constant. A significant increase in the odds of VTE was noted among black patients relative to white patients. Black patients have consistently been shown to be at increased risk of VTE,[33] which has been attributed to the genetic variability in coagulation factors, particularly elevated factor VIII levels.[34,35] Other studies have reported a lower use of thromboprophylaxis in black patients.[36]

Several hospital-level characteristics were found to be associated with VTE in patients with metastatic cancer. Admission to a teaching and an urban hospital significantly predicted the occurrence of VTE relative to nonteaching and rural hospitals. A possible explanation could be that cancer care centers are mostly based in urban and teaching hospitals, and that more complex patients are consistently referred to specialized centers for more advanced care.[37] Furthermore, regional variation in the occurrence of VTE was evident in this analysis. Compared with the South, patients admitted to hospitals in Northeast and West had increased odds of developing VTE. This might suggest the difference in the implementation of thromboprophylaxis guidelines across the hospitals in different regions or differences in surveillance.

Consistent with previous studies, primary tumor sites associated with higher odds of VTE included pancreas, ovary, uterine, cervix, lung, stomach, and bladder.[2,5,17] Moreover, patients with metastasis to liver, adrenal gland, brain, bone, and respiratory organs had higher odds of developing VTE, whereas those with metastasis to lymph nodes and genital organs had lower odds, even after controlling for the number of metastatic sites. Previous studies have documented the strong association between metastatic or regional-stage cancer and the development of VTE, specifically, in the first few months after diagnosis.[2] To our knowledge, the current study is the first to report the independent association between specific metastatic sites of the tumor and VTE while adjusting for the effect of primary tumor type, patient sociodemographic variables, hospital characteristics, comorbidities, and other relevant covariates. It is possible that, in addition to primary tumor-specific prothrombotic mechanisms, cancer metastasis to certain organs, such as liver, lung, and adrenal glands, may be biologically more aggressive, resulting in increased hypercoagulability and a higher rate of VTE.

Patients with metastatic cancer with VTE had 48% higher odds of in-hospital mortality compared with those without VTE, which is consistent with findings of previous studies, but lower than previously reported.[5] Furthermore, patients with VTE had 63% higher odds of prolonged hospital stay relative to those without VTE, which is significantly longer than the hospitalization duration reported in previous studies, regardless of cancer stage and metastatic status.[6] These findings might indicate the greater vulnerability of patients with metastatic cancer to the complications associated with VTE, and subsequently the negative impact VTE exerts on short-term hospitalization outcomes. However, severity of illness and duration of hospitalization are associated with VTE,[38,39] which confounds assessment of VTE complication. Given that some VTEs are preventable, there may be a need for stricter compliance with available prevention methods, such as thromboprophylaxis in high-risk patient populations, including those with metastatic cancer.

The strengths of this analyses include the large sample size used for powered analysis; the use of multilevel hierarchical regression to account for the patient-, tumor-, and hospital-level variation in the development of VTE; and the focus on patients with metastatic cancer, minimizing the need to account for the stage and grade of tumor, which the NIS data does not provide.

This study has several limitations. First, our cross-sectional study design does not allow for evaluation of the directionality of the association to make any causal inference. Therefore, it is not possible to determine whether VTE occurred before admission or during hospitalization. Second, the NIS does not distinguish patients with multiple admissions, because it is based on unique admission rather than unique patient. Therefore, it is possible that repeated admissions of the same patients were included, and thereby VTE rates were underestimated or overestimated. Third, NIS data lacks information regarding medications; hence, we could not account for the use of VTE prophylaxis and treatment that might have influenced mortality rates and hospital LOS across different hospital settings. Third, administrative data have the potential to both overdiagnose and underdiagnose VTE cases, and are subject to coding errors.[40,41] Furthermore, use of ICD-9 codes to identify the site of metastatic cancer for research purposes remains a challenge and a limitation associated with the use of NIS data, because studies have indicated that claims data might miss a significant percentage of cases based on the site of metastasis.[42,43] Future studies should ascertain metastatic status through access to individual medical records or other confirmatory methods. Finally, the generalizability of these findings are confined to hospitalized patients with metastatic cancer in the United States.

Conclusions

This study highlights significant patient-, tumor-, and hospital-level attributes that are associated with the occurrence of VTE in patients with metastatic cancer. We found that VTE was strongly associated with in-hospital mortality and longer hospital stays. Although our study prevents providing clear guidelines on inpatient VTE, our findings corroborate those of previous studies aimed at identifying potential subgroups of patients who might be considered for thromboprophylaxis based on their tumor, sociodemographic, and other clinical characteristics. Particular attention can be given to patients with a primary tumor of lung and pancreas given the elevated risk and frequency of hospitalizations observed.

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