Venous Thromboembolism in Upper Extremity Fractures

Suresh K. Nayar*, Anne M. Kuwabara*, José M. Flores†, Greg M. Osgood*, Dawn M. LaPorte*, Babar Shafiq*

*Department of Orthopaedic Surgery and †Bloomberg School of Public Health, The Johns Hopkins University, School of Medicine, Baltimore, MD, USA

Background: Venous thromboembolism (VTE) has been studied in lower extremity fractures but little is known of its relation with upper extremity (UE) fractures. As an often overlooked but serious complication, VTE may compromise patient outcomes.

Methods: Using data on inpatients (aged ≥ 18 years) at a level-I trauma center and patients in the National Surgical Quality Improvement Program database who sustained UE fractures (clavicle, humerus, or radius/ulna) and VTE in the same hospitalization between 2007 and 2014, the authors analyzed data on demographic characteristics, fracture type, VTE location (pulmonary embolism, lower extremity, or UE), VTE onset, polytrauma, operative or nonoperative management, comorbidities, and mortality.

Results: Of 1984 inpatients with UE fractures at 1 instution, 9 experienced VTE on admission, and 17 (15 received thromboprophylaxis) experienced VTE during hospitalization, for an overall VTE rate of 1.3%. VTE occurred most often in patients with fractures of the proximal humerus (3.0%) followed by the clavicle (2.0%), midshaft humerus (1.9%), distal radius/ulna (0.95%), and distal humerus/elbow (0.36%) (p = 0.0035). There were no significant trends in the incidence of PE (p = 0.33) over the study period, but there was a sharp rise since 2011. In the national database, 42 of 11570 (0.36%) patients with UE fracture had VTE, with incidence by fracture location ranging from 0.14% (radius/ulna) to 0.98% (proximal humerus) (p = 0.00001). Predictors were chronic steroid use (odds ratio [OR] = 6.22, p = .030), inpatient status (OR = 4.09, p = .002), and totally disabled functional status (OR = 3.31, p = .021).

Conclusions: VTE incidence was highest following proximal humerus or clavicle fractures and are rarely associated with radius/ulna fractures. There may have been a rise in the incidence of PE since 2007, warranting further investigation.

Keywords: *Deep vein thrombosis, National Surgical Quality Improvement Program, Pulmonary embolism, Upper extremity fracture, Venous thromboembolism*

INTRODUCTION

Venous thromboembolism (VTE) consists of pulmonary embolism (PE) and deep vein thrombosis (DVT), which can occur in the upper and lower extremities. Untreated PE is associated with a mortality rate as high as 30% and accounts for 5% to 10% of inpatient hospital deaths in the United States.[1] Studies[2,3] have shown the value of chemoprophylaxis VTE prophylaxis in patients with lower extremity (LE) fractures, and prevention in these patients is routine.[4] In contrast, the literature on VTE prophylaxis for patients with upper extremity (UE) fractures is scarce, perhaps because of the perception of low incidence relative to LE fractures or a lack of available data with appropriate sample size and power. However, case reports[5-8] and a large retrospective study[9] show that VTE occurs in patients with UE fractures and might be inadequately managed by current practice.

Case reports have documented VTE in fractures of the distal radius,[6] clavicle,[7] and humerus,[8] as well as for ulnar pseudarthrosis.[5] In a retrospective study, Prensky et al[9] reported 6 patients with VTE in a cohort of 479 patients after low-energy isolated UE fractures, yielding

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Correspondence to: Suresh K. Nayar
Department of Orthopaedic Surgery, The Johns Hopkins University School of Medicine, 601 N. Caroline St., Fl. 5, Baltimore, MD 21231, USA
Tel: +1-641-821-9089, Fax: +
E-mail: snayar2@jhmi.edu

an estimated incidence of 1.25%. The authors found only body mass index (BMI) and female sex to be significant predictors of VTE.

As hospitals face increased pressure to contain costs and improve patient outcomes, better characterization of VTE in patients with UE fractures is needed to help establish prophylaxis guidelines. This study aims to estimate the incidence of and characterize risk factors for VTE following UE fracture at a single institution and within the National Surgical Quality Improvement Program (NSQIP) database.

METHODS

Single-Institution Sample

The authors used a database of patients at their institution (a level-I trauma center and major tertiary care facility) to identify by *International Classification of Diseases, 9th edition*, coding (Appendix table) and manually review the records of all inpatients ≥ 18 years old hospitalized for UE fracture, including those who arrived with or later sustained VTE in the same visit (Table 1) from January 2008 through December 2014. Those with missing data, inaccurate diagnoses, or evidence of preexisting chronic VTE were excluded. Demographic characteristics were age (continuous variable in years), sex, and race/ethnicity (African American, white, Hispanic, or other). VTE characteristics were VTE location, day of hospitalization on which VTE occurred (herein, "day of event"), and type of prophylaxis (mechanical, chemical (subcutaneous heparin, enoxaparin, or warfarin), or none). Other variables were polytrauma (dichotomous variable), operative vs nonoperative treatment, inferior vena cava filter placement (dichotomous variable), length of stay (LOS) (continuous variable in days), and number of imaging studies. The authors assessed inpatient mortality rates, as well as 90-day mortality rates and recurrence of VTE after discharge. Incidence of VTE was analyzed by fracture location (clavicle, proximal humerus, midshaft humerus, distal humerus/elbow, or mid- and/or distal ulna/radius).

Table 1. Characteristics of 26 Patients Who Experienced VTE after Upper Extremity Fracture at a Single Institution, 2008–2014

Parameter	No. (%)
Age (y)	54 (18–87)[a]
Sex	
Female	8 (31)
Male	18 (69)
Race	
White	11 (42)
Black	14 (54)
Asian	1 (4)
VTE present on admission	
Yes	9 (35)
No	17 (65)
Days to event	8 (1–24)[b]
Received thromboprophylaxis[c]	15 (88)
VTE location[d]	
PE	9 (35)
Lower extremity	10 (38)
Upper extremity[e]	7 (27)
Polytrauma	
Yes	16 (62)
Operative treatment	11 (69)
Orthopedic polytrauma[f]	12 (46)
No	10 (38)
Operative treatment	3 (30)
Inferior vena cava filter placed	
Prophylactically	2 (8)
After VTE	9 (34)
New VTE in 90 days	2 (9)[g]

PE: pulmonary embolism, VTE: venous thromboembolism.

[a]Expressed as mean (range). [b]Expressed as median (range). [c]Thromboprophylaxis consisted of mechanical (sequential compression devices and compression stockings) and/or chemical (unfractionated heparin or low-molecular-weight heparin) prophylaxis. [d]p = .68 by chi-square analysis. [e]Upper extremity includes vasculature, subclavian vein, and internal jugular vein. [f]Orthopedic polytrauma involving femoral, pelvic, or spinal fractures. [g]Only 22 patients with available records.

NSQIP Sample

Because large proportions of patients at their institution sustained polytrauma, the authors used the NSQIP database to find a larger sample of patients with isolated UE fractures. The NSQIP database provides comprehensive clinical data on surgical patients treated at more than 400 hospitals across the United States, including community and academic centers. These data are nationally validated, regularly audited, and gathered by NSQIP-trained staff members. Using this database, the authors queried all records of patients from 2007 to 2013 who sustained UE fractures. Patient characteristics were age (continuous variable in years), sex, race (white, black, Asian, other, unknown/not reported), BMI (continuous variable), smoking history (current, former, never smoker), and comorbidities (history of diabetes, chronic obstructive pulmonary disease, or bleeding disorder). All patients in this dataset had operative treatment. Other variables were polytrauma (dichotomous variable), LOS (continuous variable in days), day of event, and 30-day mortality. Significant differences between patients experiencing DVT and PE were assessed to evaluate comparability between groups.

Statistical Analysis

For the single-institution group, associations between VTE incidence and fracture location, day of event, age, number of imaging studies, operative management, and LOS were estimated. Statistical significance was tested

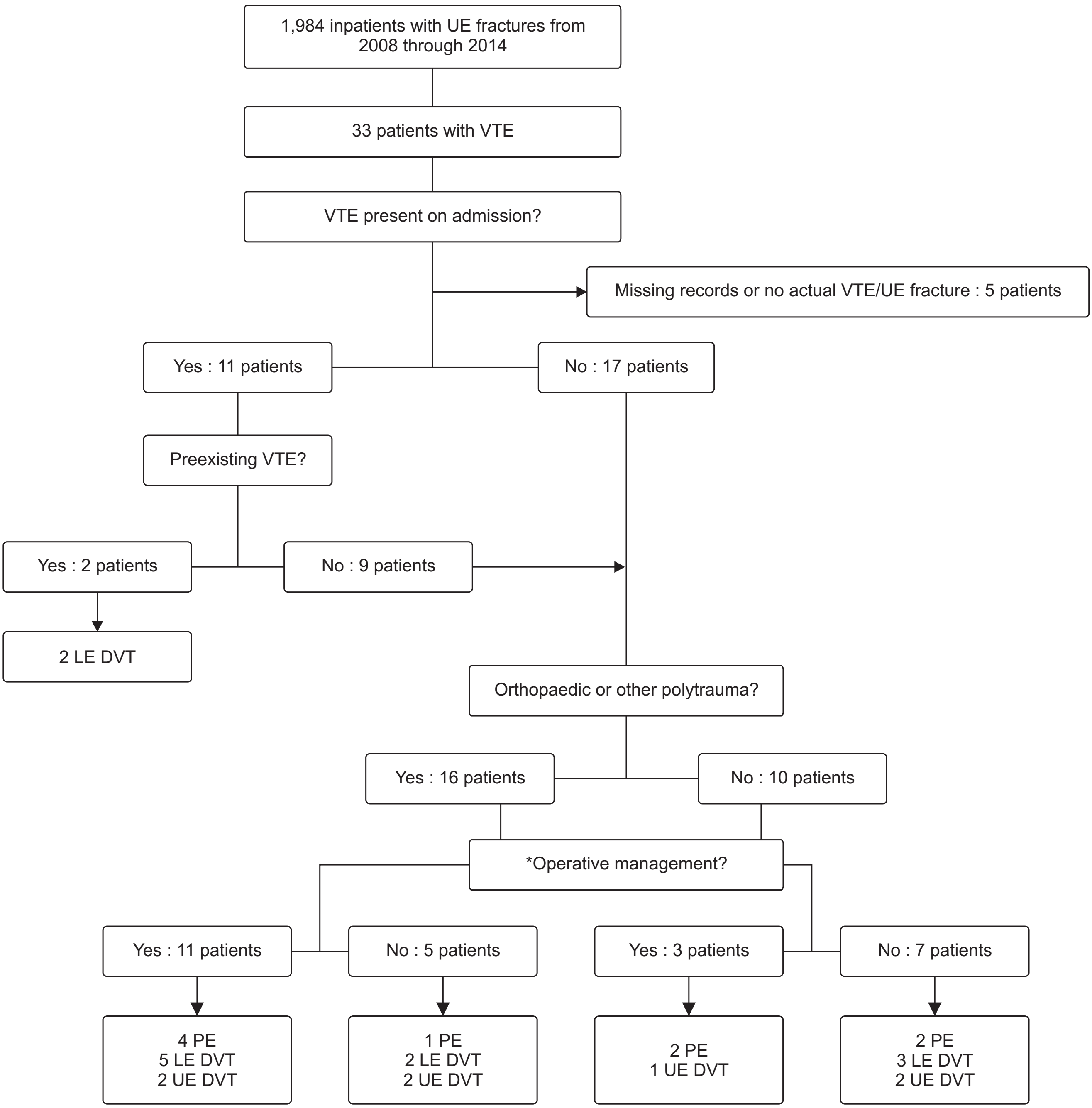

Fig. 1. Patient selection scheme for single-institution database query. Twelve of the 26 patients had orthopedic polytrauma (46%) involving femur, pelvis, or spine fractures. Four other patients without orthopedic polytrauma had additional trauma (15%) consisting of abdominal gunshot wounds (n = 2), intracranial hemorrhage (n = 1), or pneumothorax (n = 1). DVT, deep vein thrombosis; LE, lower extremity; PE, pulmonary embolism; UE, upper extremity; VTE, venous thromboembolism. *All patients received operative treatment for fractures. Only 1 patient with polytrauma received operative treatment for a nonorthopaedic injury and experienced PE.

using 2-way Student's t tests, analyses of variance, and chi-square tests with $\alpha = .05$. For the NSQIP sample, multivariable logistic regression was used to identify predictors for VTE, including age (continuous variable), BMI (continuous variable), sex, functional status (partially or totally disabled), American Society of Anesthesiologists physical status classification, chronic steroid use, diabetes, inpatient status, and history of chronic obstructive pulmonary disease, bleeding disorder, or cancer. To test whether there was a significant trend in the annual incidence of VTE over the analyzed period, the authors used the Mann-Kendall test, with $\alpha = .05$. Data were analyzed with Stata/SE, version 13, software (StataCorp LP, College Station, Texas). Kaplan-Meier curves were generated for both groups showing survival until VTE.

RESULTS

Single-Institution Sample

Of the 1984 inpatients with UE fractures, 33 had VTE. Seven patients were excluded because of missing data (n = 1), inaccurate diagnosis (n = 4), or preexisting VTE (n = 2) (Fig. 1), yielding an overall rate of 1.3%. Because the incidence of VTE was low among both outpatients and those admitted to the emergency department and later discharged (6 events in 15,660 documented visits of patients with UE fracture), the authors excluded these patients because they might differ in important unmeasured confounders. In the remaining 26 inpatients, VTE occurred at similar frequencies in the 3 locations (35% PE, 38% LE, and 27% UE) (Table 1). There were no deaths associated with VTE. Nine patients (35%) with no history of VTE were diagnosed with VTE during their initial admissions for their injuries (defined as present on admission). The other 17 patients (65%) developed VTE during their hospital stay. Polytrauma and operative details are shown in Fig. 1. There was no discernible trend between operative management and VTE location or LOS ($p = .96$). No significant correlation was observed between VTE location and age ($p = .27$), number of imaging studies (chest/neck computed tomography and extremity ultrasonography) ($p = .43$), or LOS ($p = .32$). The mean number of imaging studies was 3.6 (range, 1–9) for PE patients, 2.6 (range, 1–4) for LE DVT patients, and 3.14 (range, 2–4) for UE DVT patients. The mean LOS was 19 days (range, 1–75) for patients with PE, 26 days (range, 10–39) for patients with LE DVT, and 13 days (range, 6–32) for patients with UE DVT. Finally, proximal shoulder girdle injuries (clavicle and proximal or mid-humerus) were associated with the highest incidence of VTE (Table 2).

In the 17 patients who developed VTE during their hospital stays, 2 (12%) were not given chemical thromboprophylaxis (subcutaneous heparin or enoxaparin) despite having no contraindications. Of all 26 patients, 9 (34%) were given an inferior vena cava filter after VTE, and 2 (8%) were given a filter prophylactically. Neither of the 2 patients sustained a PE. Of the 17 patients who developed VTE during their hospital stays, 88% of PE and 25% of DVT occurred within the first week. In this group, the mean time to DVT and PE diagnosis was 10 days (range = 2–24) and 3.7 days (range = 1–10), respectively. No primary event occurred after hospital discharge. Kaplan-Meier curves showing survival until VTE are presented in Fig. 2. Although there was a sharp upward trend in PE incidence since 2011, the trend was not statistically significant during the period analyzed ($p = .33$) (Fig. 3).

NSQIP Sample

In the NSQIP sample, of the 11,570 patients from

Table 2. VTE Incidence by Fracture Type in 1,984 Adults Hospitalized for UE Fracture at a Single Institution, 2008–2014

Fracture Location	VTE Location			Orthopedic Polytrauma, No. (%)[a]	Operative Treatment, No. (%)[b]	Contro[illegible]	Incidence (%)[d]
	PE	LE	UE				
Clavicle	2	1	2	2 (40)	0 (0)	244	2.05
Proximal humerus	4	4	1	4 (44)	4 (44)	296	3.04
Midshaft humerus	1	0	1	1 (50)	2 (100)	104	1.92
Distal humerus/elbow	0	2	1	2 (66)	1 (33)	842	0.36
Mid- and/or distal ulna and/or radius	2	3	2	3 (43)	3 (43)	733	0.95
Totals	9	10	7	12 (46)	10 (38)	2219	1.17

LE: lower extremity, PE: pulmonary embolism, UE: upper extremity, VTE: venous thromboembolism.

[a]Involving femur, pelvis, or spine fractures. [b]Operative treatment for any fracture, (including UE and LE fractures). [d]$p = 0.0035$ by chi-square analysis.

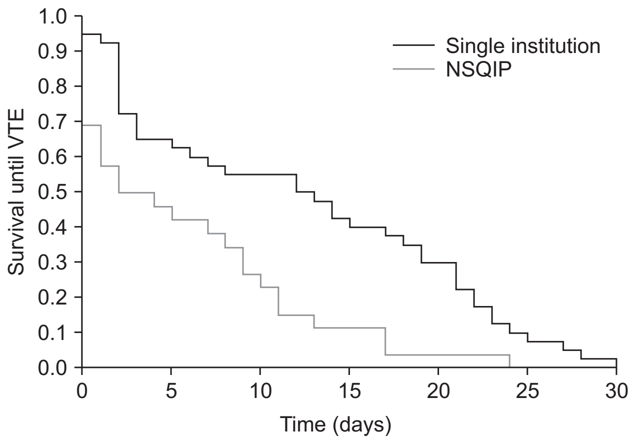

Fig. 2. Kaplan-Meier curves showing survival until venous thromboembolism (VTE) (pulmonary embolism and deep vein thrombosis) in adults who sustained upper extremity fractures in a single-institution database (2008–2014, n = 26) and the National Surgical Quality Improvement Program (NSQIP) database (2007–2013, n = 40).

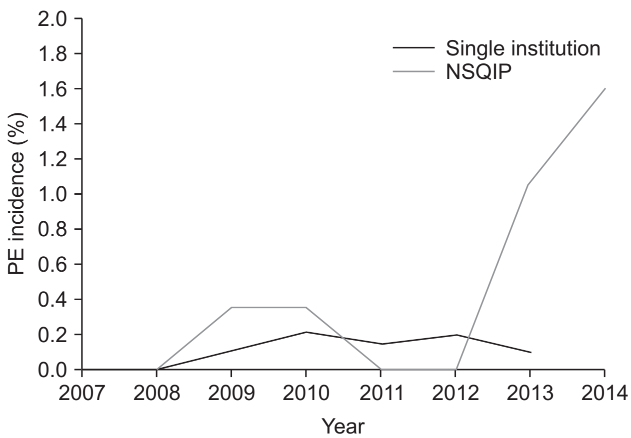

Fig. 3. Pulmonary embolism (PE) incidence by year in adults hospitalized for upper extremity fractures in a single institution database (2008–2014, n = 1,984) and the National Surgical Quality Improvement Program (NSQIP) database (2007–2013, n = 11,570).

2007 to 2013 with a primary diagnosis of UE fracture, 40 patients (0.36%) sustained VTE (25 DVT and 17 PE; 2 sustained both). Demographic and hospitalization characteristics are shown in Table 3. Thirty-eight percent of DVT and 50% of PE occurred within the first week of injury, whereas 75% of DVT and 50% of PE occurred after discharge. The mean time to DVT and PE diagnosis was 13.6 days (range = 2–30) and 10.7 days (range = 1–27), respectively. There was 1 death (6%) associated with PE. The median time to event was 14.5 and 7.5 days for DVT and PE, respectively. Kaplan-Meier curves showing survival until VTE are presented in Fig. 2. VTE

Table 3. Characteristics and Hospitalization Details for 40 Patients Hospitalized for Upper Extremity Fracture Who Experienced VTE in the National Surgical Quality Improvement Program Database, 2007–2013[a,d]

Parameter	No. (%) of DVT group (n=25)	% of PE group (n=17)	*p* value[c]
Age, (y)	66 (12)[b]	68 (13)[b]	.59
Female sex	18 (72)	11 (65)	.62
Race			
White	18 (72)	12 (71)	.92
Black	1 (4)	0 (0)	.40
Asian	0 (0)	1 (6)	.22
Other	1 (4)	1 (6)	.78
Unknown/not reported	5 (20)	3 (18)	.85
Body mass index (kg/m^2)	30.1 (8.73)[b]	30.9 (5.24)[b]	.78
Diabetic	7 (28)	4 (24)	.75
Smoker (in previous 12 months)	3 (12)	1 (6)	.51
Orthopedic polytrauma	0 (0)	0 (0)	.78
Length of hospital stay (days)	6 (0–33)[e]	6 (1–11)[e]	1.00
VTE present on admission	1 (4)	1 (6)	

DVT: deep vein thrombosis, LOS: length of stay, PE: pulmonary embolism, VTE: venous thromboembolism.

[a]All patients in this query received operative treatment. [b]Expressed as mean (standard deviation). [c]Statistical difference tested with 2-tailed Student's *t* test or chi-square analysis. [d]Two patients sustained both DVT and PE. [e]Expressed as mean (range).

incidence was highest in proximal shoulder girdle injuries and was rare in mid- and/or distal ulna and/or radius fractures (Table 4). There was no significant increase in PE incidence over the period analyzed (p = .38) and no discernible pattern for DVT (Fig. 3). Regression analysis showed that totally disabled functional status (odds ratio [OR] = 6.22 (95% confidence interval [CI], 1.31 to 29.4), p = .021), inpatient status (OR = 4.09 (95% CI, 1.69 to 9.87), p = .002), and chronic steroid use (OR = 3.31 (95% CI, 1.12 to 9.72), p = .030) were significant predictors of VTE (Table 5). This analysis could not be performed individually by fracture location due to inadequate effective sample sizes.

DISCUSSION

In this study of adults with UE fracture, VTE occurred in 1.3% of those at a single institution and 0.36% of those in the NSQIP sample, occurring most frequently in patients with upper shoulder girdle injuries, with rates ranging from 0.98% to 3.0% for proximal humerus fractures. Injuries of the radius and ulna were rarely associated with VTE in the NSQIP sample (incidence of

Table 4. Incidence of Venous Thromboembolism by Fracture Type in 11,570 Adults Hospitalized for UE Fracture in the National Surgical Quality Improvement Program Database, 2007–2013

Fracture type	No. of patients	No. of DVT cases	No. of PE cases	Incidence (%)		
				DVT	PE	Combined*
Clavicle	1,072	3	1	0.28	0.09	0.37
Proximal humerus	2,040	11	9	0.54	0.44	0.98
Midshaft humerus	656	3	2	0.46	0.30	0.76
Distal humerus/elbow	1,497	4	0	0.27	0	0.27
Mid- and/or distal ulna and/or radius	6,305	4	5	0.06	0.08	0.14
Total	11,570	25	17	0.22	0.15	0.36

DVT: deep vein thrombosis, PE: pulmonary embolism.

*p = .00001 by χ^2 analysis.

Table 5. Predictors of Venous Thromboembolism in Adults Hospitalized for Upper Extremity Fracture in the National Surgical Quality Improvement Program Database, 2007–2013

Variable	Odds ratio	95% CI	p value
Age (1-year increment)	1.02	0.99–1.04	.15
Body mass index (1 kg/m^2-unit increment)	1.03	0.99–1.07	.13
Male sex	1.36	0.65–2.86	.41
Functional status[a]			
Totally independent	Referent		
Partially disabled	1.75	0.69–4.41	.23
Totally disabled	6.22	1.31–29.45	.02
ASA physical status classification			
No disturbance	Referent		
Mild disturbance	1.65	0.35–7.78	.52
Severe disturbance	1.46	0.27–7.73	.66
Life threatening/moribund	1.67	0.21–13.09	.62
Chronic steroid use vs. no use	3.31	1.12–9.72	.03
Inpatient vs. outpatient status	4.09	1.69–9.87	.002
Comorbidities (presence vs. absence)			
Diabetes	1.56	0.71–3.44	.27
COPD	0.30	0.038–2.26	.24
Bleeding disorder	1.77	0.59–5.27	.31
Race[b]	---	---	.12

ASA: American Society of Anesthesiology, CI: confidence interval, COPD: chronic obstructive pulmonary disease.

[a]Determined using American Society of Anesthesiologists Physical Status Classification. [b]Race reported as white, black, Asian, or other. Eight of the 40 patients with VTE and 2,170 patients of the total sample had unknown/not reported race and were excluded from this analysis. This statistic was measured using categorical chi-square analysis, all other variables in this table were analyzed with regression analysis.

0.14%). Most VTE events occurred within the first week of injury and many occurred despite thromboprophylaxis. Death was rare, with an overall incidence of 1.5% in patients with VTE. Further, there is modest evidence that since 2007, the incidence of PE has steadily risen, which might reflect an increased use of imaging.

The American College of Chest Physicians published its latest guidelines on thromboprophylaxis for the orthopedic patient in 2012.[4)] However, these recommendations were only for those undergoing LE procedures, and there is no recommendation for patients with isolated UE fractures. Although VTE is thought to be rare in the setting of UE fractures, these incidence rates are comparable to those documented in other injuries in patients who received thromboprophylaxis, including those with isolated fractures of the UE (overall rate of 1.2%),[9)]

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proximal humerus (0.64%),[10] hip (2.2%–2.6%),[9,11] pelvis (0.7%–4.2%),[9,12] tibia (1.1%–6.9% with circular frame treatment),[13] ankle (0.22%, PE only),[14] and vertebra (3.6%).[12] Incidence rates at the authors' institution may be higher than those in the NSQIP database because this large tertiary center may treat patients with more comorbidities and more severe trauma.

Although there were variable incidence rates by fracture type between databases, proximal humerus injuries consistently had the greatest association with VTE. Further, VTE occurred more frequently in patients with clavicle and midshaft humerus injuries, suggesting that injuries of the proximal shoulder girdle may share a similar mechanism of VTE propagation to that of injuries of the pelvis and hip. Conversely, in the NSQIP data, distal humerus/elbow and radius/ulna fractures were associated with the lowest rates of VTE and are similar to the risk of VTE among the general population (0.1%–0.5%),[12,15] providing strong evidence that these fractures may not predispose individuals to VTE.

Although not significant, an interesting finding was the general rise in PE incidence during the past decade, both at the authors' institution and within the NSQIP group. In an epidemiologic study of VTE, Heit[16] showed a steady rise of PE incidence in the general population that increased nearly 3-fold from 1985 to 2009. Heit hypothesized that this may be attributed in part to increased use of imaging, namely CT pulmonary angiography and magnetic resonance imaging, as well as improved image resolution. Studies have indeed demonstrated an increase of CT imaging to diagnose PE and have also shown a substantial decrease in associated mortality.[17,18] PE occurred within the first week of hospitalization in 83% and 50% of patients in the single-institution and NSQIP groups, respectively, suggesting a timeframe for PE monitoring. In the NSQIP group, 75% of DVT and 50% of PE occurred after hospital discharge. This shows considerable risk even after the acute phase of treatment and highlights the importance of thromboprophylaxis on discharge.

In the single-institution group, nearly one-third of VTE cases occurred at initial patient presentation, reiterating the importance of proper screening on admission of trauma patients; however, evidence shows that even in high-risk orthopedic patients, aggressive screening and prophylactic inferior vena cava filters would not benefit up to 95% of patients nor prevent any deaths associated with PE.[19] In the single-institution group, nearly 90% of those who developed VTE during their hospital stays received thromboprophylaxis. This observation is corroborated by another study showing that DVT incidence may remain high despite aggressive chemical and mechanical prophylaxis.[20]

Although there is little research on VTE in patients with UE fractures, the more clinically relevant point might be that the vast majority of VTE may remain clinically indolent, asymptomatic, or non-fatal, as shown with VTE in the setting of LE fractures.[21] In the authors' study, death after VTE was rare (1.5%). Finally, within the NSQIP group, the only significant predictors of VTE were totally disabled functional status, inpatient status, and chronic steroid use. The authors found no correlation between VTE and other factors commonly associated with VTE, including age,[22] BMI,[9,23,24] and sex,[9] suggesting the possibility of alternate risk factors and/or mechanisms for the development of VTE after UE fractures. In addition, the authors found no association between diabetes and VTE, a controversial association recently dispelled by meta-analysis.[25]

The authors encourage the careful interpretation of the differences and variability in incidence estimates between the single-institution study and the NSQIP database because the reliability and accuracy of these predictions are limited by sample size and other features of the data and study design. In addition, the NSQIP database excludes patients admitted to the hospital for acute trauma, which likely underestimates the true rate of VTE following UE fracture. However, it was necessary to use this database to provide a clean sample of isolated UE fractures because trauma patients often present with multiple injuries associated with VTE.

There are limitations to this study. Data were limited to information present in medical records, which, at times, were found to be inaccurate or incomplete. For example, thromboprophylaxis data are not recorded in NSQIP. Although this information was available for the single institution, sample sizes were small with heterogeneous data, and associations could not be estimated, necessitating future prospective studies. Nearly half of the authors' single-institution population sustained polytrauma, which might confound the association between VTE and UE fractures. However, this association was observed in isolated UE fractures in the NSQIP population, demonstrating consistency and evidence for an actual association. Complete demographic data was not available for the single institution to perform a regression analysis on this population; however, the heterogeneity of the group and important confounders, such as polytrauma, makes this analysis less meaningful. Some traditional risk factors associated with VTE risk (smoking, cancer, and a hypercoagulable state) could not be determined in the NSQIP group because of incomplete data. Further, the NSQIP database includes records only of patients receiving operative treatment; however, in the authors' single-institution study, VTE was also a risk in patients who received nonoperative treatment.

In summary, the authors found that patients with UE fractures, even those receiving thromboprophylaxis, have a small but clinically important risk of VTE. Given these findings and the currently mixed thromboprophylaxis practice for UE fractures,[26] effective guidelines should be developed through future prospective studies.

CONFLICT OF INTEREST AND FUNDING STATEMENT

The authors have no relevant financial relationships to disclose.

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The Journal of Hand Surgery (Asian-Pacific Volume) • Vol. 23, No. 3, 2018 • www.jhs-ap.org

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Appendix. ICD-9 Codes for Upper Extremity Fracture and Venous Thromboembolism

ICD-9 code	Description	ICD-9 code	Description	ICD-9 code	Description
810.00	Clavicle (unspecified), closed	812.49	Humerus capitellum, closed	813.21	Radius shaft, closed
810.01	Clavicle sternal end, closed	812.49	Humerus (other, trochlea), closed	813.22	Ulna shaft, closed
810.02	Clavicle shaft, closed	812.50	Humerus (lower, unspecified), open	813.23	Radius shaft with ulna, closed
810.03	Clavicle acromial end, closed	812.51	Humerus supracondylar, open	813.30	Radius or ulna, shaft unspecified, open
810.10	Clavicle unspecified, open	812.52	Humerus lateral condyle, open	813.31	Radius shaft, open
810.11	Clavicle sternal end, open	812.53	Humerus medial condyle, open	813.32	Ulna shaft, open
810.12	Clavicle shaft, open	812.54	Humerus condyle unspecified, open	813.33	Radius shaft with ulna, open
810.13	Clavicle acromial end, open	812.59	Humerus (other), open	813.40	Forearm lower unspecified, closed
812.00	Humerus (upper, unspecified), closed	813.00	Forearm upper unspecified, closed	813.41	Colles, distal radius, closed
812.01	Humerus surgical neck, closed	813.01	Ulna, olecranon process, closed	813.42	Galeazzi radius, closed
812.01	Humerus surgical neck, closed	813.01	Ulna, olecranon, closed	813.43	Ulna (alone) distal end, closed
812.02	Humerus anatomical neck, closed	813.02	Ulna, coranoid, closed	813.44	Radius with ulna, lower, closed
812.03	Humerus greater tuberosity, closed	813.03	Monteggia, ulna proximal, closed	813.45	Radius torus (alone)
812.09	Humerus head, lesser tuberosity, or upper epiphysis, closed	813.04	Ulna (other or unspecified), closed	813.46	Ulna torus (alone)
812.10	Humerus (upper, unspecified), closed	813.05	Radius head, closed	813.47	Radius and ulna, torus
812.11	Humerus surgical neck, open	813.06	Radius neck -closed	813.50	Forearm, lower unspecified, open
812.12	Humerus anatomical neck, open	813.07	Radius (other or unspecified), closed	813.51	Colles, distal radius, open
812.13	Humerus greater tuberosity, closed	813.08	Radius with ulna, upper end, closed	813.52	Galeazzi radius, open
812.19	Humerus (other), closed	813.10	Forearm upper unspecified, open	813.53	Ulna, distal, open
812.20	Humerus (shaft unspecified), closed	813.11	Ulna, olecranon process, open	813.54	Radius with ulna, lower, open
812.21	Humerus shaft, closed	813.12	Radius and ulna coronoid, closed	813.80	Forearm, unspecified, closed
812.30	Humerus (shaft unspecified)	813.13	Monteggia, ulna proximal, open	813.81	Radius (alone), unspecified, closed
812.31	Humerus shaft, open	813.14	Ulna (other or unspecified), open	813.82	Ulna (alone), unspecified, closed
812.40	Humerus (lower, unspecified), closed	813.15	Radius, head, open	813.83	Radius with ulna, unspecified, closed
812.41	Humerus supracondylar, closed	813.16	Radius, neck, open	813.90	Forearm, unspecified, open
812.42	Humerus lateral condyle, closed	813.17	Radius, proximal (other or unspecified), open	813.91	Radius (alone), unspecified, open
812.43	Humerus medial condyle, closed	813.18	Radius with ulna, upper end, open	813.92	Ulna (alone), unspecified, open
812.44	Humerus condyles unspecified, closed	813.20	Radius or ulna, shaft unspecified, closed	813.93	Radius with ulna, unspecified, open

VTE codes: 415.11, 415.12, 415.13, 415.19, 453.9, 453.81, 453.82, 453.83, 453.84, 453.85, 453.86, 453.87, 453.88, 453.89, 453.2, 453.40, 453.41, 453.42.