How long should we fear? Long-term risk of venous thromboembolism in patients with traumatic brain injury

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The reviewers have nothing to disclose.

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BACKGROUND: Although patients with traumatic brain injury (TBI) are known to be at high risk for venous thromboembolism (VTE), it is not clear how long this risk persists after injury. We aimed to determine the risk of VTE in patients with TBI during one year after injury and to identify associated factors.

METHODS: Patients 18 years and older with *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnoses of isolated TBI (head Abbreviated Injury Scale [AIS] ≥3 and AIS <3 for all other body regions) were identified in the California State Inpatient Database (2007–2011). Patient and admission (injury severity score, length of stay, and discharge disposition) characteristics were assessed. Hospital factors (teaching status, trauma center verification, and bed size) were extracted from the American Hospital Association database. Patients who developed VTE during the index admission and at different time points after discharge were determined. Multivariate logistic regression models were used to assess the associated risk factors for VTE after discharge.

RESULTS: There were 38,984 patients with isolated TBI identified. The incidence of VTE was 1.31% during the index admission and the cumulative incidence of VTE involving hospitalization within one year of injury was 2.83%. The major risk factors for VTE one year after injury (not including the index admission) were discharge to extended care facilities versus home [adjusted odds ratio, 2.69 (95% confidence interval, 2.14–3.37)], age older than 64 years versus 18 to 44 years [2.62 (1.80–3.81)], having an operation during the index admission [1.65 (1.36–2.01)], and hospital length of stay of more than 7 days versus 3 days or less [1.64 (1.27–2.11)].

CONCLUSION: The risk of VTE persists long after discharge in a significant proportion of patients with TBI. Demographic and admission characteristics of patients play significant roles in the risk of VTE after discharge. These results highlight the need for sustained surveillance and preventive measures among patients with TBI at increased risk for long-term VTE. (*J Trauma Acute Care Surg.* 2016;81: 71–78. Copyright © 2016 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Epidemiologic study, level III.

KEY WORDS: Incidence; long term; trauma; traumatic brain injury; venous thromboembolism.

Venous thromboembolism (VTE) constitutes an undesirable outcome in the care of patients with trauma. In the United States, the annual health care costs associated with VTE is estimated at $1.5 billion,[1] and close to 100,000 people die from VTE yearly.[2] Among patients with trauma who develop pulmonary embolism (PE), mortality is as high as 19%.[3] These data highlight the significant health burden that VTE exerts on the health care system. It is therefore important to identify patients who are at higher risk of developing these complications and institute measures to prevent the occurrence of VTE among them.

Compared to the general trauma population, patients with traumatic brain injury (TBI) are at increased risk for VTE.[3,4] Studies that have prospectively screened for VTE among hospitalized patients with TBI have found rates ranging from 20% to 32%.[5–7] Collectively, these studies have shown that older age, longer hospital stays, higher injury severity, and concomitant moderate-to-severe injuries in other body regions were independently associated with the higher VTE rates among this population. However, most of these studies included patients who have concomitant high-risk injuries, which may obscure the true patterns of VTE among patients with TBI. With the growing evidence that the risk of VTE among patients with trauma may persist for months after the traumatic events,[8] there is increasing interest in long-term preventive strategies for VTE. However, it is not clear how long active prevention for VTE should last among patients with TBI. Furthermore, there are no studies to show the long-term incidence of VTE among patients with TBI.

Therefore, the objective of this study was to examine the long-term incidence of VTE among patients with isolated TBI. We hypothesized that patients with isolated TBI will remain at increased risk for VTE for up to one year after hospital discharge.

METHODS

Data Source and Study Sample

We analyzed patient discharge data from the California State Inpatient Database, Healthcare Cost and Utilization Project, 2007 to 2011, which contains records from up to 98% of the hospitals in the state.[9] A unique feature of the database includes the ability to link records of care received at multiple hospitals, thereby evaluating long-term outcomes of various conditions.[10] Patients were assigned unique identifiers, which were verified in 88.2% of patients 18 to 64 years old and 97.5% of patients 65 years and older.[11] Only patients with verified patient identifiers were included in our analyses.

Using *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) diagnosis codes, we identified TBI admissions for patients 18 years and older between 2007 and 2010. To ensure at least one year of follow-up for every case of TBI, we did not include index cases of TBI that occurred during the last year of the available data (2011) in our analyses. Traumatic brain injury admissions were defined as admissions with *ICD-9-CM* diagnosis codes of 800.xx, 801.xx, 803.xx, 804.xx, and 850.xx to 854.xx. To restrict analyses to

Submitted: December 1, 2015, Revised: February 17, 2016, Accepted: February 19, 2016, Published online: March 25, 2016.
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This study was presented at the 29th annual scientific assembly of the Eastern Association for Surgery of Trauma, San Antonio, Texas, January 12–16, 2016.
Supplemental digital content is available for this article. Direct URL citations appear in the printed text, and links to the digital files are provided in the HTML text of this article on the journal's Web site (www.jtrauma.com).
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DOI: 10.1097/TA.0000000000001046

patients deemed to have isolated moderate to severe head injuries, we included patients who had head Abbreviated Injury Scale (AIS) scores of 3 or higher and had AIS scores of less than 3 in all other body regions. The AIS scores for each body region were derived using a validated method with the ICDPIC module in Stata.[12,13] Patients with AIS scores of 6 (nonsurvivable) were excluded from the analysis.

Demographic details of the patients were extracted from the database. Because several studies have shown that patients older than 65 years have significantly different responses to injury[14–16] and most studies on VTE use age cutoffs between 40 and 55 years,[3,7] we categorized our cohort as 18 to 44 years, 45 to 64 years, and 65 years or older. We also included details on sex, race/ethnicity (white, Hispanic, black, others), and insurance type (public, private, self-pay, other). "Others" insurance types included worker's compensation, county indigent programs, other government aids and other indigent funds.[10] We calculated the Charlson Comorbidity Index (CCI) using the CHARLSON command in Stata.[17] The CCI is a validated score that uses 19 possible diagnoses to predict mortality and perioperative complications in longitudinal data.[18–20] The CCI was classified as less than 2 and 2 or higher (higher being worse) based on previously published classifications.[21,22]

To account for injuries in other body regions, we calculated Injury Severity Scores (ISS) from *ICD-9-CM* diagnosis codes using the ICDPIC module in Stata.[12,23,24] Injury Severity Scores range from 0 to 75 (higher being more severe), and it is generally accepted that scores higher than 15 indicate more severe injuries.[25,26] We categorized scores into commonly used categories: 9 to 15, 16 to 24, 25 and higher.[27,28] We categorized the hospital length of stay (LOS) as 0 to 3, 4 to 7, and more than seven days based on the distribution of the sample (50th percentile corresponds to three days, and 75th percentile corresponds to seven days) to ensure a reasonable spread of the patients. We classified patients as having an operation if they had any of the *ICD-9-CM* procedure codes described by Haut et al.[29] as representing major surgery. Patients' discharge dispositions were categorized as home, home health care, other hospitals, skilled nursing facility (SNF)/intermediate care facility/other facilities, and against medical advice.

We linked patients' records in the database to hospital information in the American Hospital Association database. We identified characteristics of the hospitals included in our study and extracted data on the trauma center status, teaching status, and bed sizes of the hospitals.

Assessment of Outcomes

The primary outcome was a diagnosis of VTE, which comprises deep venous thrombosis (DVT) and PE. Deep venous thrombosis was defined by *ICD-9-CM* diagnosis codes corresponding to 451.1x, 451.81, 451.83, 453.2x, and 453.4x; and PE was defined by *ICD-9-CM* diagnosis codes corresponding to 415.1x. Venous thromboembolism was assessed at different time points: during the index admission, 30 days, 60 days, 90 days, 180 days, and 1 year after injury. Hospital mortality was also calculated as the proportion of hospital deaths among patients with TBI during the index admissions.

Statistical Analyses

The demographic, injury, and hospital characteristics of the patients were evaluated using descriptive statistics. We calculated the cumulative incidence of VTE as the number of VTE cases at a certain time point divided by the number of cases of TBI at the beginning of the study. The cumulative incidence of VTE was assessed at the earlier described time points. Estimates were calculated for the overall cohort and for patient groups stratified by head AIS scores.

Factors associated with VTE during the index admission and at one year after injury were identified using univariate logistic regression models built separately for each variable. Factors that were marginally significantly associated with VTE on the univariate analysis ($p < 0.1$) were included in further multivariate analyses. Multivariate logistic regression models were fitted to identify independent associations with VTE during the index admissions and at one year after injury. To ensure we were assessing postdischarge VTE, analyses of VTE at one year were restricted to patients who were discharged from the index admissions (not including transfers) and did not include VTEs that occurred during the index admission. All models were built with robust standard errors clustered on the individual hospitals to account for the nonindependence of patients treated at the same facilities.

To evaluate the impact of other patient factors that may influence long-term VTE risk, we performed sensitivity analyses by imposing stricter restrictions on our cohort. For these analyses, we excluded patients that had any operations, as previously described, at any point after discharge. Patients who had any *ICD-9-CM* diagnosis codes corresponding to traumatic injuries (800.xx–904.xx, 910.xx–929.xx, and 950.xx–959.xx) at least 30 days after the index event were also excluded. We used a cutoff of 30 days to ensure that we were more likely identifying new trauma diagnoses and not previously made diagnoses that had not resolved. We also excluded patients who had a diagnosis of primary hypercoagulable states (*ICD-9-CM* diagnosis code: 289.81). All analyses were done using Stata statistical software: Release 13 (StataCorp LP, College Station, TX), and the significance level was set as $p < 0.05$.

RESULTS

There were 38,984 cases of isolated TBI included in our analyses, and the incidence of VTE during the index admission was 1.31%. Of these patients, 389 (1.00%) had DVT and 176 (0.45%) had PE. Most patients were 65 years and older (55%), male (60%), and white (65%) (Table 1). The median hospital LOS was 3 days. However, 22% of patients were on admission for more than seven days. Up to 98% of patients had head AIS scores of 3 or 4. About 30% of the cohort had operations during the index admission. Of these, 66% had neurological operations, whereas most of the others had cardiovascular procedures and procedures in the digestive system. Only 49% of patients were discharged directly home. A large proportion of our cohort were treated at hospitals with at least 300 beds (65%).

The cumulative incidence of VTE continued to rise after the initial hospitalization. At one month after injury, the cumulative incidence of VTE rose to 1.87% and by one year, it was 2.83% (Table 2). Stratification by AIS scores showed that the rise in VTE cumulative incidence was most steep for patients with head AIS scores of 4. Abbreviated Injury Scale scores of 5 were associated with the least drastic increase in cumulative

TABLE 1. Demographic Characteristics of Patients With Isolated TBI; California State Inpatient Database, 2007–2010

Characteristics	No. of Patients	Proportion of Population, %
Overall	38,984	100.00
Age, years		
18–44	8,487	21.77
45–64	9,168	23.52
≥65	21,329	54.71
Sex		
Male	23,205	60.45
Female	15,185	39.55
Race		
White	23,573	64.52
Black	1,886	5.16
Hispanic	6,990	19.13
Others	4,085	11.18
Insurance type		
Public	24,063	61.73
Private	8,563	21.97
Self-pay	2,845	7.30
Other	3,509	9.00
Charlson Comorbidity Index (CCI)		
<2	30,353	77.86
≥2	8,631	22.14
Operation during admission		
No	27,488	70.51
Yes	11,496	29.49
Length of stay, days		
≤3	20,081	51.52
4–7	10,498	26.93
>7	8,398	21.55
Injury Severity Score		
9–15	18,305	46.96
16–24	19,839	50.89
≥25	840	2.15
Head AIS		
3	19,281	49.46
4	18,863	48.39
5	840	2.15
Discharge disposition		
Home	19,086	48.96
Home health care	3,451	8.85
SNF, ICF, others	10,273	26.35
Other hospital	1,921	4.93
AMA	654	1.68
Teaching status		
Nonteaching	22,241	57.05
Teaching	16,743	42.95
Trauma center status		
Nontrauma center	18,174	46.62
Trauma center	20,810	53.38
Hospital bed size		
<300	13,743	35.25
≥300	25,241	64.75

AMA, against medical advice; ICF, intermediate care facilities.

TABLE 2. Cumulative Incidence of VTE in Patients With TBI

Time Period	Overall Population	AIS = 3	AIS = 4	AIS = 5
Cumulative incidence of VTE, %				
During index admission	1.31	1.22	1.39	1.31
30 days after injury	1.87	1.65	2.12	1.43
60 days after injury	2.20	1.87	2.56	1.79
90 days after injury	2.31	1.94	2.71	1.79
180 days after injury	2.53	2.08	3.03	1.79
360 days after injury	2.83	2.31	3.41	1.79
In-hospital mortality, %				
During index admission	8.51	5.96	8.16	74.88

incidence over time and began to plateau at 60 days. Hospital mortality during the index admission was 8.51% in the overall cohort but was as high as 74.88% when patients with head AIS scores of 5 were examined in isolation.

The major risk factors associated with VTE during the index admission were having operations (adjusted odds ratio, 5.59; 95% confidence interval, 4.28–7.29) and longer hospital LOS (Table 3). Compared to patients who stayed for three days or less in the hospital, LOS of four to seven days (1.74; 1.23–2.47) and LOS of more than seven days (5.25; 3.84–7.19) were associated with higher odds of VTE.

When risk factors for VTE at one year were examined (excluding VTE that occurred during the index admissions), older age was associated with increased risk of long-term VTE. Compared to age younger than 45 years, being 45 to 64 years old (1.80; 1.25–2.61) and being older than 64 years (2.62; 1.80–3.81) were associated with higher VTE risk at one year (Table 4). Discharge to extended care facilities versus discharge home (2.69; 2.14–3.37), hospital LOS of more than seven days versus three days or less (1.64; 1.27–2.11), and having operations during the index admissions (1.65; 1.36–2.01) were associated with higher one-year VTE. Other factors associated with higher one-year VTE were being black, CCI 2 or higher, and discharge to home health care.

Sensitivity analyses excluding patients who had operations (n = 8,326) or traumatic injuries (n = 551) after discharge and those with primary hypercoagulable states (n = 42) showed a consistent, although slower, rise in VTE over time. Between the index admissions and one year after injury, the cumulative incidence of VTE rose from 1.14% to 1.72%. In the multivariate analyses of one-year postdischarge VTE risk, some of the risk factors earlier identified such as black race and higher CCI lost statistical significance (see Table, Supplemental Digital Content 1, http://links.lww.com/TA/A752). However, discharge to extended care facilities, older age, longer hospital LOS, and having operations during the index admissions were still associated with VTE at one year.

DISCUSSION

Venous thromboembolism among hospitalized patients with TBI has been extensively studied over the past few decades. Reports that TBI independently increases the risk of VTE in patients with TBI have triggered efforts toward preventing this feared complication.[3,4,8] Until recently, only nonpharmacologic

TABLE 3. Multivariate Analysis of Factors Associated With VTE During Index Admission

Characteristics	Proportion of VTE During Index Admission, %	Adjusted Odds Ratio* (95% Confidence Interval)
Age, years		
18–44	0.90	Ref
45–64	1.47	1.27 (0.94–1.72)
≥65	1.40	1.43 (1.04–1.97)
Sex		
Female	1.15	Ref
Male	1.44	1.05 (0.86–1.28)
Race		
White	1.46	Ref
Black	1.96	1.12 (0.79–1.60)
Hispanic	1.07	0.65 (0.50–0.85)
Others	0.83	0.47 (0.33–0.67)
Insurance type		
Public	1.44	Ref
Private	1.26	1.22 (0.94–1.58)
Self-pay	0.70	0.93 (0.57–1.52)
Other	1.00	0.91 (0.61–1.36)
CCI		
<2	1.07	Ref
≥2	2.12	1.29 (1.06–1.57)
Operation during admission		
No	0.32	Ref
Yes	3.67	5.59 (4.28–7.29)
Length of stay, days		
≤3	0.29	Ref
4–7	0.86	1.74 (1.23–2.47)
>7	4.30	5.25 (3.84–7.19)
Head AIS		
3	1.22	Ref
4	1.39	1.43 (0.77–2.66)
5	1.31	1.14 (0.61–2.12)

*Adjusted for all variables in the table and for hospital teaching status, trauma center status, and hospital bed size.

methods of VTE prophylaxis were recommended for patients with TBI owing to the increased risk of intracranial hemorrhage associated with TBI. However, recent studies have provided evidence to support early initiation of chemical VTE prophylaxis in patients that have no radiological signs of intracranial bleeding within 24 hours of injury.[4,30,31] Whereas most guidelines recommend initiating VTE prophylaxis during inpatient care,[4] there are few data to show how long the actual risk of VTE persists among patients with TBI. Our study showed that a significant proportion of patients with TBI are at continued risk for VTE up to one year after their injuries. Although the incidence of VTE in our study sample was 1.26% during the index hospitalization, the cumulative incidence rose to 2.76% by one year after the injury. It is unlikely that these new incidences of VTE were due to secular trends in VTE over time, since the annual hospitalization rate for VTE in the US general population is as low as 0.2%.[32] Our findings imply that the changes that may be responsible for the development of VTE in acute TBI may persist longer than previously thought. Identifying the mediators of this prolonged risk for TBI is necessary to formulate guidelines for the appropriate care of patients with TBI outside the hospital setting.

In agreement with the findings of previous studies, our study showed that longer hospital stay was a strong risk factor for VTE during the index admissions.[6,7,33] This relationship remained significant when we evaluated VTE at one year. Major operations during the index admissions were also strongly associated with VTE at one year. However, injury severity did not show a linear relationship with the risk of long-term VTE. The higher hospital mortality rates we observed to be associated with more severe injuries likely explain the slower rise in the cumulative incidence of VTE in severely injured patients. Although it seemed that the incidence of VTE was associated with increased

TABLE 4. Multivariate Analysis of Factors Associated With One–Year VTE After Discharge from Index Admission

Characteristics	Proportion of Postdischarge VTE After Index Admission, %	Adjusted Odds Ratio* (95% Confidence Interval)
Age, years		
18–44	0.54	Ref
45–64	1.39	1.80 (1.25–2.61)
≥65	2.73	2.62 (1.80–3.81)
Sex		
Female	2.08	Ref
Male	1.83	1.06 (0.89–1.25)
Race		
White	2.01	Ref
Black	2.56	1.49 (1.07–2.09)
Hispanic	1.83	1.12 (0.90–1.39)
Others	1.59	0.67 (0.50–0.89)
Insurance type		
Public	2.48	Ref
Private	1.38	1.21 (0.95–1.56)
Self-pay	0.37	0.54 (0.28–1.04)
Other	0.79	0.93 (0.60–1.44)
CCI		
<2	1.51	Ref
≥2	3.42	1.33 (1.12–1.58)
Operation during admission		
No	1.30	Ref
Yes	3.56	1.65 (1.36–2.01)
Length of stay, days		
≤3	0.95	Ref
4–7	2.24	1.32 (1.06–1.66)
>7	3.77	1.64 (1.27–2.11)
Head AIS		
3	1.33	Ref
4	2.50	0.83 (0.33–2.08)
5	2.81	1.01 (0.41–2.50)
Discharge disposition		
Home	0.79	Ref
Home health care	2.09	1.59 (1.17–2.16)
SNF, ICF, others	3.99	2.69 (2.14–3.37)
AMA	0.76	1.30 (0.53–3.20)

*Adjusted for all variables in the table and for hospital bed size.

injury severity among patients who were discharged from TBI admissions, this relationship did not persist when other associated factors were accounted for. Patients with greater comorbidity burdens were found to have higher risks for VTE at one year after their injuries. Because several diseases that comprise the CCI including diabetes and congestive heart failure are independently associated with increased long-term risk of VTE,[34,35] the higher odds of VTE in patients with higher CCI is not surprising. These findings, however, underscore the importance of having a holistic approach to the planning of postdischarge care for patients with TBI. Multidisciplinary care and early involvement of rehabilitation professionals in planning long-term care are strategies that have been suggested to improve postdischarge outcomes among patients with TBI.[36,37]

Previous studies have shown inconsistent associations between VTE and age among patients with TBI.[6,7] Our study showed that older age was an independent risk factor for TBI at one year. National trends show consistent increases in rates of VTE hospitalizations with 10-year increments in age for individuals older than 40 years.[32] This increased risk of VTE with age indicates the need for a higher degree of proactive VTE prevention measures among older patients with TBI. This may include closer surveillance for VTE, regular physical therapy, and frequent review of medications.

Discharge to extended care facilities such as SNFs and intermediate care facilities was one of the strongest risk factors for developing VTE at one year. Patients discharged to these facilities would more likely be those who had more severe long-term disability after their injuries. They are also more likely to have had risk factors previously associated with VTE such as more severe injury and higher comorbidity. After accounting for measured patient factors associated with VTE, these patients still had increased risk of VTE. Our findings have been replicated in other studies and may be a reflection of the pattern of care received at such facilities.[38] We could not tease out the effect of the different types of extended care facilities on VTE rates. However, compared to discharge to rehabilitation facilities, discharge to SNFs has been associated with higher mortality rates among trauma patients after adjusting for patient case mix.[39] Owing to the perceived benefits of rehabilitation facilities on functional outcomes of patients with neurological diseases, there have been increased efforts in the United States to ensure these patients have access to rehabilitation facilities after discharge.[40] Between 2004 and 2012, the percentage of patients with brain injury in rehabilitation facilities increased from 3.9% to 7.9%.[40] Expanding the eligibility criteria for discharge to rehabilitation facilities and promoting preferential discharge to rehabilitation facilities among patients that may require long-term specialized care may help to reduce the long-term risk of VTE among patients with TBI.

Despite the fact that our study shows that the risk of VTE doubles by one year after injury, the initial incidence of VTE we found during admission was lower than what was reported in prior studies. This may be because most studies involved active screening for VTE with duplex ultrasound or other screening methods.[5–7] Median hospital duplex ultrasound rates are known to be less than 2 per 100 trauma admissions,[41] and it is less likely that the VTE diagnoses we recorded were based solely on radiological findings. In addition, because most prior studies examined VTE rates in patients who had other injuries known to be associated with VTE risk, the rates reported were likely due to contributions from various injuries. By excluding patients with major injuries in other body regions, we were able to identify VTE risks attributable to TBI. Although the risk of VTE in patients with isolated TBI may not be as high as previously thought, a significant proportion of patients still stand at risk of VTE. Therefore, early identification of those patients coupled with interventions to prevent VTE both in hospital and after discharge will be important steps to reducing VTE among patients with TBI.

This study is not without limitations. We were not able to ascertain the practices of the hospitals regarding screening for VTE in patients with TBI. With the large variations that exist between individual hospitals' approaches to screening for VTE, we cannot clearly distinguish clinically significant VTE from VTE diagnoses that were made solely based on radiological findings. In addition, because our diagnosis of VTE was based on *ICD-9-CM* codes recorded by registrars with potential coding limitations, we may not be accurately capturing the risk of VTE in this population. However, previous research assessing the predictive value of VTE diagnoses extracted from discharge records show values ranging from 75% to 95%.[42] In addition, we were not able to determine deaths or VTE events that occurred outside the hospital and could not accurately estimate the population at risk at every time point. Lastly, we were not able to assess if patients were on VTE prophylaxis before or after their injuries and if inferior vena cava filters were placed before or after the development of VTE. Venous thromboembolism prophylaxis will likely modify the incidence of VTE in this population.[43] However, our goal was to evaluate the long-term incidence of VTE in the general TBI population regardless of treatment status, and this study serves as a reference for future assessments of the success of VTE prevention among patients with TBI.

In conclusion, patients with isolated moderate to severe head injuries have a sustained risk of VTE beyond the period of hospitalization. Older patients with high comorbidity burdens who have major operations and are discharged to extended care facilities are more likely to develop VTE after discharge. Better understanding of the factors associated with long-term VTE risk among patients with TBI would be necessary to formulate strategies directed toward ensuring patients with TBI are discharged with minimal risk of VTE.

AUTHORSHIP

O.A.O., B.K.Y., Z.R.C., A.R., D.M., J.M.H., E.K., A.H.H., J.D.G., and A. S. participated in developing the study concept, hypothesis, and design. O.A.O. and A.R. participated in literature review. O.A.O., Z.R. C., and A.S. performed data analysis. O.A.O., B.K.Y., Z.R.C., A.R., D. M., J.M.H., E.K., A.H.H., J.D.G., and A.S. participated in the interpretation of the results of data analysis. O.A.O., A.R., Z.R.C., J.M.H., and A.S. participated in manuscript writing. O.A.O., B.K.Y., Z.R.C., A.R., D.M., J.M.H., E.K., A.H.H., J.D.G, and A.S. critically reviewed the manuscript for content. All authors reviewed and approved the final version of the manuscript.

DISCLOSURE

The authors declare no conflicts of interest. No funding was received for this study. Dr. Haider is the cofounder of and an equity holder in Patient Doctor Technologies Inc., which owns and operates the Web site www.doctella.com.

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EDITORIAL CRITIQUE

I would like to commend Dr. Olufajo and his group for their investigation into an issue that has been overlooked in our evidence based guidelines. The increased incidence of VTE in severe TBI is well described, and the safety profile of early chemical prophylaxis has been validated. Yet, there remains a paucity of literature to support how long we should continue prophylaxis in this population.

The retrospective databank utilized in this study has multiple limitations, including variations in screening, prophylaxis, and diagnosis. The level of functional recovery (Rancho Score, GCS, etc) is also unfortunately not taken into account. An AIS score of anywhere from three to five encompasses a wide variety of diagnoses and functional recovery. As immobility contributes significantly to the risk of VTE, these patients may have considerably different risk profiles. Yet, a sample size of nearly 40,000 patients is hard to ignore and denotes, at the very least, an impressive trend. The risk of VTE nearly doubled within the first year in association with several major risk factors. It's possible that the risk factors that were identified correlate with immobility and therefore act as surrogate variables for functional recovery. However, further investigation needs to be done prior to making these assumptions. Our physiatry colleagues recommend chemical prophylaxis for up to three months in immobile patients, including those with spinal cord injury. In 2014, Dr. Coimbra's group from San Diego presented a review of over 250,000 trauma patients with injuries that affect mobility. Their findings suggest that the highest risk of VTE is within the first three months, yet the risk doesn't return to that of the general population until twelve to fifteen months. Taking both of these investigations into consideration, we as a trauma community may not be adequately addressing the prevention of VTE in patients with severe TBI and chronic immobility. At minimal, these results hint to the need for long term surveillance and or VTE prophylaxis in this population. Further investigation and prospectively designed risk assessment of severe TBI patients is warranted, and I look forward to seeing the follow up recommendations from this group.

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