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Risk Factors for Venous Thromboembolism in Pediatric Trauma Patients and Validation of a Novel Scoring System: The Risk of Clots in Kids with Trauma (ROCKIT score)

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Abstract

OBJECTIVES—Identify risk factors for venous thromboembolism (VTE) and develop a VTE risk assessment model for pediatric trauma patients.

DESIGN, SETTING, AND PATIENTS—We performed a retrospective review of patients 21 years and younger who were hospitalized following traumatic injuries at the John Hopkins level 1 adult and pediatric trauma center (1987-2011). The clinical characteristics of patients with and without VTE were compared, and multivariable logistic regression analysis was used to identify independent risk factors for VTE. Weighted risk assessment scoring systems were developed based on these and previously identified factors from patients in the National Trauma Data Bank (NTDB 2008-2010); the scoring systems were validated in this cohort from Johns Hopkins as well as a cohort of pediatric admissions from the NTDB (2011-2012).

MAIN RESULTS—Forty-nine of 17,366 pediatric trauma patients (0.28%) were diagnosed with VTE after admission to our trauma center. After adjusting for potential confounders, VTE was

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independently associated with older age, surgery, blood transfusion, higher Injury Severity Score (ISS), and lower Glasgow Coma Scale (GCS) score. These and additional factors were identified in 402,329 pediatric patients from the NTDB from 2008-2010; independent risk factors from the logistic regression analysis of this NTDB cohort were selected and incorporated into weighted risk assessment scoring systems. Two models were developed and were cross-validated in 2 separate pediatric trauma cohorts: 1) 282,535 patients in the NTDB from 2011 to 2012 2) 17,366 patients from Johns Hopkins. The receiver operator curve using these models in the validation cohorts had area under the curves that ranged 90% to 94%.

CONCLUSIONS—VTE is infrequent after trauma in pediatric patients. We developed weighted scoring systems to stratify pediatric trauma patients at risk for VTE. These systems may have potential to guide risk-appropriate VTE prophylaxis in children after trauma.

Keywords

pediatric; trauma; venous thromboembolism; thromboprophylaxis

INTRODUCTION

Trauma is an independent risk factor for VTE in adults, with a reported incidence from less than 1% to 7.6%(1, 2). In trauma patients 21 years and younger, the incidence is considerably lower, in the range of 0.1% to 0.6%(3-5). While VTE is much less common in children compared to adults, the overall incidence of hospitalized pediatric patients diagnosed with VTE has increased by 70% in the past decade(6). In the subset of pediatric patients with hospital-associated VTE, trauma is one of the most frequent diagnoses(4). While evidence-based guidelines are available to guide VTE thromboprophylaxis in adults with trauma(7), no consensus recommendations are available for children.

In adults, the use of pharmacologic prophylaxis with low molecular weight and unfractionated heparin is a well-established practice after major trauma in the absence of contraindications. However, the widespread use of pharmacologic prophylaxis in children may be inappropriate due to the relatively low incidence of VTE and potential bleeding risk. On the other hand, failure to implement VTE prophylaxis in the subset of the pediatric patients at high risk may result in significant VTE-related morbidity. Several studies have found that older age, central venous catheters (CVCs), and increased ISS were risk factors for VTE(3, 5, 8-10). In addition, the presence of multiple simultaneous risk factors has been demonstrated to increase the odds of VTE in trauma patients(2, 8) as well as in medical patients(4, 11, 12). Based on the patient's age and the presence of multiple risk factors, Hanson and colleagues developed a local, hospital-based guideline for the use of VTE prophylaxis in pediatric trauma patients. The incidence of VTE decreased after implementation of this guideline(13). Risk assessment models that incorporate multiple weighted risks have been used to stratify adult patients into high risk groups who may benefit most from VTE prophylaxis and identify low risk groups in whom the risks of prophylaxis may not be warranted. Several of these models have been developed for adult trauma(14), medical(15-17), and surgical patients(18, 19). However, few have been validated, and none had existed for pediatric trauma patients until a recent publication of a clinical prediction tool by Connelly and colleagues (20).

The aim of this study were 1) to identify risk factors for VTE in a large population of pediatric and young adult trauma patients at a level 1 trauma center and 2) based on upon risks identified in this cohort and from the previously published NTDB (2008-2010)(3), to develop a weighted risk assessment model for VTE after pediatric trauma. We validated models in a cohort from the NTDB (2011-2012) and the Johns Hopkins Trauma Registry to assess its potential to capture pediatric trauma patients at risk for VTE.

METHODS

The Johns Hopkins Hospital and Johns Hopkins Children's Center adult and pediatric trauma registries include all patients who are evaluated after presentation with traumatic injury. Patient demographics, admission and discharge dates, VTE diagnoses (including deep vein thrombosis [DVT] and pulmonary embolism [PE]), injury type and ISS, operations, blood transfusions administered, and complications during hospitalization, and other clinical characteristics are recorded in the registry. Dedicated full time registrars enter data into the clinical trauma registry as required by the state of Maryland. Johns Hopkins University is a verified level 1 adult and pediatric trauma center, we are required submit these data to the state. The data entry registrar have specific training in medical coding with a trauma focus. We reviewed records from the adult registry from 1987 to 2011 and we reviewed records from the pediatric registry from 1990 to 2011. The total number of patients 21 years old or younger in the registries was 17,366. Major surgery was defined as having operations on the nervous system (ICD-9 codes 01.xx to 05.xx), respiratory system (30.xx to 34.xx), cardiovascular system (35.xx to 39.xx), hematopoietic and lymphatic system (i.e., spleen operations) (40.xx to 41.xx), digestive system (42.xx to 54.xx), urinary system (55.xx to 59.xx), or musculoskeletal system (77.xx to 78.xx, 79.20 to 79.39, 79.50 to 79.69, 79.80 to 79.99, 81.xx, and 83.xx to 84.xx) as previously described(3).

Patients 21 years old or younger in the adult and pediatric registries were included in the study if they were admitted to the hospital following trauma evaluation. Clinical data was extracted from the registry, and additional data were gathered through detailed chart review for only patients diagnosed with VTE. All VTE diagnoses were confirmed by review of radiology reports and deemed line-associated if a central line was located in the same anatomic location as the VTE.

Patients diagnosed with VTE were compared to patients without VTE in the Johns Hopkins registries using Wilcoxon rank-sum tests for continuous variables and Chi-squared tests for categorical variables. We then examined 402,329 patients registered in the NTDB from 2008 to 2010(3). Initially, univariate logistic regression models were created to determine which variables were statistically associated with the outcome of VTE in the NTDB. Those variables that were found to be statistically associated with VTE in the NTDB and in the Johns Hopkins registries were then chosen to be incorporated into a multivariable logistic regression model. A severity scoring system was then created based on the coefficient estimates of multivariable model, normalized by the lowest coefficient and rounded to the nearest whole number. We considered two systems of scores, one that included and one that excluded intubation. The fit of this scoring system to the data was determined by the area under the curve from an AUC analyses, the Hosmer-Lemeshow goodness of fit test, and

cross validation of the score using data from a separate cohort of 282,535 patients in the NTDB from 2011 to 2012, and the Johns Hopkins trauma cohort. A receiver operating characteristic (ROC) curve was generated using the GraphPad Prism statistical software. Other analyses were performed using STATA 12.1/SE (College Station, Texas). The study was approved by the Johns Hopkins IRB.

RESULTS

Study population

A total of 17,366 patients 21 years or younger were admitted to the Johns Hopkins Pediatric and Adult trauma centers with traumatic injury during the study period. VTE was diagnosed in 49 patients for an incidence of 0.28%. Twelve of the 49 were from the pediatric database, and 37 from the adult database. Forty-two patients had DVT, 11 had PE, and 4 had both. The majority of patients were African American males in both groups. The median age of patients with VTE was significantly older than those without VTE (18 years versus 11 years, $p<0.001$). As patient age increased the frequency of VTE also increased, especially after the age of 15 years. The frequency of VTE per for ages 0-12 years was 9 per 10,000, compared to 27 and 73 per 10,000 for ages 13-15 and 16-21 years respectively.

Clinical Characteristics

The clinical characteristics of the patients with VTE are outlined in Table 1. Seventy-one percent of patients underwent surgery that lasted over two hours and 67% were intubated for over 72 hours. Seventy-one percent of patients with VTE were intubated with an average number of 9.5 days (± 8.0 SD). The most common body regions injured were abdomen and head injuries, followed by chest, long bone and vascular injuries. Eight percent of patients with VTE suffered other orthopedic injuries and one patient experienced a burn injury. Many patients were injured in more than one body region. The majority of patients with VTE (62%) had a central line during some point of their hospitalization.. Thirty-seven percent did not have a CVC placed; of those, the most common site of DVT was the lower extremity. Five had PE and only 2 had upper extremity DVT. Of the 31 patients with CVCs, 65% were diagnosed with lower extremity DVT, 23% had upper extremity DVT and a total of 12% had PE. The majority of DVTs in patients with CVCs were in the same vessel as the catheter, or line-associated (64%, 20 of 31). Most of the upper extremity DVTs were CVC-associated (67%, 6 of 9 total upper extremity DVTs); in contrast most lower extremity DVTs were not CVC-associated (58%, 19 of 33 total lower extremity DVTs).

VTE Prophylaxis Use

Of patients diagnosed with VTE, 21 (43%) received either prophylactic unfractionated heparin or low molecular weight heparin. Ten patients were prescribed unfractionated heparin and 7 patients were prescribed low molecular weight heparin; 4 patients received both treatments during their hospitalization. Seventeen (35%) received only mechanical prophylaxis (i.e. sequential compression devices and/or TED[®] compression stockings), and 11 (22%) received neither mechanical nor pharmacologic prophylaxis (Table 1). Among those who did receive pharmacologic prophylaxis, all were 11 years old or older; 18 were from the adult registry and only three were from the pediatric registry.

Risk Factor Analysis and Risk Assessment Model

We examined factors associated with VTE in the 17,366 patients entered in the Johns Hopkins Trauma Registry. Undergoing an operation and receiving a blood transfusion were identified as risk factors for VTE. In addition, patients assessed to be more severely injured (with an ISS ≥ 9 and/or GCS ≤ 8), as well as those with longer hospital stay were at increased odds for developing a VTE (unadjusted odds ratios, Table 2). After adjustment by multivariable logistic regression, each of these remained statistically significant, independent risk factors for the development of VTE with trauma (adjusted odds ratios, Table 2). Race and penetrating trauma were not independent risks by multivariable logistic regression analysis. A risk assessment model was developed based upon independent risk factors identified in this study and in the study by Van Arendonk and colleagues from 402,329 patients 21 years and younger in the NTDB from 2008-2010(3). In both the Johns Hopkins trauma registry and the 2008-2010 NTDB, increasing age, higher ISS, lower GCS, blood transfusions and surgery were found to be independent risk factors for VTE. Non-white and non-black race was found to be a significant risk in the NTDB cohort, but not in the Johns Hopkins trauma registry and was not used for modeling. Complete data on intubation was not available from the Johns Hopkins trauma registry, but intubation was identified as an independent risk for VTE in the 2008-2010 NTDB study and was incorporated in a separate model. In addition, increased length of stay was identified as a significant predictor of VTE in both the Johns Hopkins registry and the 2008-2010 NTDB, however, since length of stay could not be determined until hospital discharge, it was not in this predictive model.

The 2008-2010 NTDB was used as a derivation cohort to develop VTE risk assessment model. In model 1, weighted scores were assigned based on the normalized beta coefficients for 6 individual risk factors (age, ISS, GCS, intubation, blood transfusion, and major surgery) obtained from logistic regression analysis of these factors (Table 3). Model 2 was developed using this set of factors without intubation. Three possible scores were assigned for ISS and for age and 2 possible scores for GCS, with higher scores given for older age, increasing ISS and decreasing GCS. Patients receiving a blood transfusion or undergoing intubation or major surgery received a single weighted score. Using this scoring system a total score (0 to 23 in model 1 and 0 to 19 in model 2) was derived for individual patients by summing the individual weighted scores.

In order to determine if the risk assessment scoring system identified patients at risk for VTE, we applied the two models to an independent cohort of 282,535 patients 21 years and younger in the NTDB over a one year period from 2011 to 2012. The demographics of this group is shown in Table 4; similar to the Johns Hopkins Registry, patients with VTE in the 2011-2012 NTDB were older than those without VTE. Males represented the majority of patients in both the Johns Hopkins Registry and 2011-2012 NTDB; however, black race was most common in the Johns Hopkins Registry compared to white race in the 2011-2012 NTDB. The overall incidence of VTE in this 2011-2012 NTDB cohort was 0.41%, compared to 0.28% from the Johns Hopkins Trauma registry. Patients with VTE had significantly higher scores than those without VTE using both models (17.3 versus 7.2 for model 1, $p<0.0001$; 13.7 versus 5.8 for model 2, $p<0.0001$). For both models, increasing score was associated with higher frequency of VTE (figure 1). In model 1, the maximum

frequency of VTE was 9% in patients with a score of 22 out of 23. In model 2 the maximum frequency of VTE was 6% with the highest score of 19 of 19. Based on the ROC analysis, the best performing score which maximized the sum of sensitivity and specificity was 13 for model 1, with a sensitivity of 87% and a specificity of 81%. The area under the ROC curve for this model was 91% (0.911, 95%CI: 0.905-0.917, Figure 2). For model 2, the best performing score was 11, with a sensitivity of 86% and specificity of 80%. The area under the ROC curve for model 2 was 90% (0.901, 95%CI: 0.894-0.907, Figure 2). While the AUC was high for the derivation cohort, the p-values for the Hosmer-Lemeshow test rejected the null hypothesis for goodness of fit ($p=0.0040$ for model 1, $p=0.0007$ for model 2). However, when the risk assessment models were cross-validated on the 2008-2010 NTDB, the area under the ROC curve remained high (Figure 2). For model 1 the AUC was 91% (0.908, 95%CI: 0.900-0.916) and for model 2 it was 90% (0.897, 95%CI: 0.889-0.905). As the Johns Hopkins registry did not have intubation data, we validated model 2 on this cohort. The area under the ROC curve was 93% (0.935, 95%CI: 0.906-0.963).

DISCUSSION

We identified older age, very severe ISS score, low GCS, surgery, and blood transfusion as independent risk factors for VTE from the Johns Hopkins Trauma Registry. These factors, in addition to intubation, were identified previously from the 2008-2010 NTDB(3); we incorporated these factors into a novel weighted risk assessment model. Using a score of 17 or above for model 1 and 13 or above for model 2, the incidence of VTE was over 2%; this is a cutoff that has been suggested as threshold for implementation of VTE prophylaxis(16). These models performed well when it was validated in 2 independent cohorts: 1) the NTDB 2011-2012 with an AUC of 90%-91% 2) the Johns Hopkins registry with an AUC of 93%. Although the AUC and cross-validation showed a good fit of these scores to the modeling and cross-validation data sets, the Hosmer-Lemeshow test, a test of goodness of fit, rejected the null hypotheses of the model fitting the data well. This may be mostly due to the fact that the large number of data points ($> 36,000$) were sensitive to small deviations of the data from the model, and hence this test was overpowered. Net reclassification indices may provide additional measures of the models performance that can be considered in future studies.

The incidence of VTE in trauma patients 21 years of age and younger in this study was 0.28%. The incidence of VTE in the derivation cohort was 0.41%; these frequencies are in the range of what has been reported in other studies(3, 5, 8-10, 13, 20-25). Many of the identified risk factors from our study have also been identified in other studies(5, 8-10, 20, 22, 25-27). In particular, older age, higher ISS, lower GCS, surgery and blood transfusion has been reported as VTE risk factors in children and adults(2, 3, 5, 8-10, 20, 28). Hanson and colleagues have implemented clinical guidelines that used some of the risk factors identified in this study to classify high risk patients; these included older age (over 13 years) and GCS less than 9. However, their guideline incorporated other risks that were not included in this model (12). These other risks (such as immobility and spinal cord injury) may also be important, but this data was not captured in the NTDB. Implementation of this guideline has decreased VTE incidence in children with trauma at their institution, suggesting the benefit of risk stratification.

Connelly and colleagues have recently published a clinical prediction tool that was developed similarly by identification of risk factors from the NTDB; a weighted risk assessment model was developed based on these factors(20). Their analysis focused on younger patients (0-17 years), but used all the factors that we used in our model 1 (age, GCS, ISS, intubation, blood transfusion, and surgery). Their best performing models incorporated an additional 5 to 8 factors for assessment. The AUCs for their ROC curves ranged from 0.873-0.946, similar to that of our models. Their study, together with ours, confirm the clinical utility of the 6 core factors in a VTE risk assessment, and provides compelling evidence to proceed with prospective trials incorporating these and other factors in assessment of risk for the development of VTE in pediatric patients after trauma.

A limitation is that the timing of blood transfusion and surgery in relation to the timing of VTE diagnosis were not available in the NTDB; thus we could not assess if these were risks present prior to development of VTE. We chose to keep it in this predictive model since there are patients who will undergo surgeries or blood transfusions within the first day of admission, a window when the decision to implement VTE prophylaxis is made. CVCs have been associated with VTE in several studies(5, 8, 9, 20, 26); however, we found that the majority of trauma patients with VTE did not have CVC associated VTEs. However, we did not have complete data for CVCs on all patients in our registry, so we were not able to assess it as a risk factor. It is also worth noting, that while pelvic and femur fractures in adults are recognized as a risk factor for VTE, in our study we found that orthopedic injuries or blunt trauma were not independent risks for VTE in pediatric patients. Similarly, other studies in children with trauma did not demonstrate that pelvic and femoral fractures were significant risk factors for VTE(8, 29).

This study has additional limitations. Because the frequency of VTE is low in this population, we identified only 49 patients with VTE in our trauma registry. We found variable prescribing practices of pharmacologic and mechanical prophylaxis in patients with VTE in our registry. Standardized VTE prophylaxis protocols are used by the adult trauma service(14, 30, 31); however, no formal guidelines were followed by the pediatric trauma service, contributing to the variable practice. In addition, the use of VTE prophylaxis was not routinely recorded in the Johns Hopkins trauma registries nor in the NTDB; thus, the development of VTE may be confounded by the use of VTE prophylaxis in this population. In our study, the majority of patients who developed VTE did not receive heparin prophylaxis, but data is not available for the entire cohort; thus we could not analyze it a risk factor and we cannot make any conclusions about the effectiveness of measures to prevent VTE after trauma in this cohort. The issue of surveillance bias must also be considered. It is well known that DVT events in trauma patients are often identified during screening duplex ultrasound in asymptomatic patients(2, 32-34). The adult trauma service has adopted institutional guidelines that suggest screening for VTE, while the pediatric trauma service does not, potentially leading to more events being identified on the adult service. The implementation of surveillance screening likely increased the rate of VTE diagnoses during the 24 of this study. Other changes in practice with unclear impact on VTE rate during the study period is the shift from use of UFH to LMWH for prophylaxis. Additional limitations were that patients who experienced VTE complications shortly after discharge might not have been documented in the registries either because the admission was not identified as

being trauma related or the patient was readmitted to a different institution. Complete data on other putative risks such as CVCs, medications, infection, inflammatory conditions, or other medical conditions was also not available for all patients in the registries. However, despite these limitations, the study has a number of strengths. The risk factors identified for the scoring system are standardized. The dataset is large and robust, and common risk factors identified in both the Johns Hopkins registry and the NTDB increased the strength of the associations.

CONCLUSIONS

The risk of VTE after pediatric trauma is generally low but older age, intubation, high ISS, low GCS, surgery and blood transfusion increase risk. We have developed a weighted risk assessment scoring system called Risk of Clots in Kids in Trauma, or ROCKIT. The scores were validated in 2 large independent cohorts and demonstrated an increased incidence of VTE with higher scores; it was sensitive and specific for the diagnosis of VTE. The model may be useful to identify patients at high risk of VTE who may benefit from VTE prophylaxis. However additional prospective trials are needed to determine the efficacy and safety of risk model-guided VTE prophylaxis in this patient population.

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Low molecular weight heparin is not approved by the FDA for use in pediatrics

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VTE frequency increases with higher score **Figure 1.**

The frequency of VTE in pediatric patients with risk scores derived from the 2 risk assessment models. Model 1 incorporates 6 factors (age, GCS, ISS, intubation, blood transfusion, and major surgery). Model 2 uses 5 factors from model one and does not incorporate intubation. Scores from the 2 models were applied to 402,329 pediatric patients less than or equal to 21 years of age from the NTDB from 2008-2010.

Figure 2.

Receiver Operator Curves for risk assessment score. The 2 risk assessment models were developed by assigning weighted scores to independent risk factors for VTE. The factors were identified from a derivation cohort of 402,329 patients in the NTDB from 2008 to 2010. The score was cross-validated by assessing the area under the curve of receiver operator curves for the 2 models on an independent cohort of 282,535 patients from the NTDB from 2011-2012 and 17,366 pediatric trauma patients from Johns Hopkins.

Table 1**Clinical Characteristics of Pediatric Trauma patients with VTE**

	Patients (n)	%
Surgery >2 hours	35	71
Immobilized >72 hours	33	67
Intubated	35	71
Days intubated (mean, SD)	9.5, 8.0	
Site of Injury		
Abdomen	22	45
Head	22	45
Chest	14	29
Long bone	14	29
Vascular	11	22
Other orthopedic	4	8
Burn	1	2
Central Lines	31	63 (% of total with lines)
LE DVT	20	65
UE DVT	7	23
PE	2	6
LE DVT + PE	2	6
No Central Line	18	37 (% of total without lines)
LE DVT	11	61
UE DVT	2	11
PE	5	28
Prophylaxis		
Pharmacologic	21	43 (% of total pharmacologic)
UFH	10	48
LMWH	7	29
UFH + LMWH	4	19
Mechanical	33	67 (% of total mechanical)
TEDs	31	94
SCDs	33	100
No prophylaxis	11	22

LE: lower extremity; UE: upper extremity; DVT: deep venous thrombosis; PE: pulmonary embolus; UFH: unfractionated heparin; LMWH: low molecular weight heparin; SCD: sequential compression device

Table 2

Unadjusted and adjusted Odds Ratios for VTE risk in Johns Hopkins Registry Trauma patients 21 years old

	Unadjusted Odds Ratio (95% CI)	P-value
Female Gender (vs. Male)	0.76 (0.39-1.45)	0.4
Race (vs. White)		
Black	2.13 (1.11-4.11)	0.02
Other/Unknown	1.72 (0.38-7.69)	0.5
Operation (vs. None)	26.08 (10.34-65.82)	<0.001
Penetrating Trauma (vs. Non-Penetrating Trauma)	3.63 (2.05-6.44)	<0.001
ISS (vs. Mild, 0-8)		
Moderate (9-15)	12.02 (2.60-55.67)	0.001
Severe (16-24)	39.46 (8.96-173.78)	<0.001
Very Severe (25-75)	129.50 (30.40-551.64)	<0.001
GCS (vs. Mild, 13-15)		
Moderate (9-12)	5.58 (2.12-14.74)	0.001
Severe (3-8)	9.04 (4.64-17.62)	<0.001
Blood Transfusion (vs. None)	26.90 (15.21-47.58)	<0.001
Length of Stay (per 1 day increase)	1.02 (1.01-1.02)	<0.001
Age (vs. 0-12)		
13-15	3.06 (1.14-8.21)	0.03
16	8.32 (3.98-17.40)	<0.001

	Adjusted Odds Ratio*(95% CI)	P-value
Operation (vs. None)	8.03 (2.64-24.40)	<0.001
Penetrating Trauma (vs. Non-Penetrating Trauma)	0.66 (0.31-1.40)	0.3
ISS (vs. Mild, 0-8)		
Moderate (9-15)	4.15 (0.85-20.33)	0.08
Severe (16-24)	10.78 (2.26-51.33)	0.003
Very Severe (25-75)	15.67 (3.26-75.39)	0.001
GCS (vs. Mild, 13-15)		
Moderate (9-12)	2.82 (0.98-8.08)	0.05
Severe (3-8)	2.37 (1.08-5.21)	0.03
Blood Transfusion (vs. None)	2.79 (1.36-5.74)	0.005
Length of Stay (per 1 day increase)	1.01 (1.00-1.02)	0.005
Age (vs. 0-12)		
13-15	3.81 (1.37-10.56)	0.01
16	5.22 (2.15-12.69)	<0.001

The regression equation is: log-odds of VTE = $-9.93 + 2.08*(\text{operation}) - 0.41*(\text{penetrating trauma}) + 1.42*(\text{moderate ISS}) + 2.38*(\text{severe ISS}) + 2.75*(\text{very severe ISS}) + 1.04*(\text{moderate GCS}) + 0.86*(\text{severe GCS}) + 1.03*(\text{blood transfusion}) + 0.01*(\text{length of stay}) + 1.34*(\text{age } 13-15) + 1.65*(\text{age } \geq 16)$. The Hosmer-Lemeshow chi-squared statistic for multivariable model is 1.51 (p=0.98).

Table 3

Weighted Scoring for VTE after Trauma

Clinical Factor	Adjusted Odd Ratios for VTE		Beta coefficient ***		Weighted score (rounded to nearest integer)	
	NTDB (2008-2010) *	JHU Trauma Registry	Model 1	Model 2	Model 1	Model 2
Age (years)	0-12	**	**	**	0	0
	13-15	2.0	0.65	0.64	2	1
	16-21	3.8	1.31	1.36	4	2
ISS	0-8	**	**	**	0	0
	9-15	4.0	1.59	1.71	5	5
	16-24	5.9	10.8			
	25-75	7.2	15.7	2.21	7	7
GCS	13-15	**	**	**	0	0
	9-12	1.3	2.8			
	3-8	1.3	2.4	0.31	1	3
Blood Transfusion	No	**	**	**	0	0
	Yes	1.5	2.8	0.51	2	1
Intubation	No	**	**	**	0	--
	Yes	2.5	NA	1.25	4	
Major surgery	No	**	**	**	0	0
	Yes	3.8	8.0	1.55	5	5

Odds Ratios rounded to nearest tenth of a decimal.

NA: not available. Regression equation for Model 1: $\log\text{-odds of VTE} = -9.39 + 0.646(\text{age } 13-15) + 1.31(\text{age } 16-21) + 0.308(\text{GCS}) + 1.59(\text{ISS } 9-24) + 2.21(\text{ISS } 25-75) + 0.51(\text{blood transfusion}) + 1.55(\text{surgery}) + 1.25(\text{intubation})$; The p-value for the Hosmer-Lemeshow for this multivariable model is $p=0.0040$. Regression equation: Model 2: $\log\text{-odds of VTE} = -9.42 + 0.636(\text{age } 13-15) + 1.36(\text{age } 16-21) + 0.9(\text{GCS}) + 1.71(\text{ISS } 9-24) + 2.59(\text{ISS } 25-75) + 0.61(\text{blood transfusion}) + 1.71(\text{surgery})$; The p-value for the Hosmer-Lemeshow for this multivariable model is $p=0.0007$

* reported from reference (3).

** Reference for Odds Ratios.

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From the regression equation for models with and without intubation.

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Table 4

Demographics of Johns Hopkins Trauma Registry and NTDB (2011-2012) patients ≥ 21 years old

	Johns Hopkins Registry		NTDB (2011-2012)	
	VTE (n = 49)	No VTE (n = 17,366)	VTE (n = 1168)	No VTE (n = 281,248)
Age (median years, SD)	18 (5.7)	11 (7)	19 (5)	14 (7)
Gender:				
Males (%)	76	70	76	68
Race:				
Black (%)	71	55	22	18
White (%)	24	41	56	57
Other/Unknown (%)	4	4	21	25