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Multicenter Review of Current Practices Associated with Venous Thromboembolism Prophylaxis in Pediatric Patients after Trauma

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Abstract

Objective—Incidence of venous thromboembolism (VTE) in pediatric trauma patients admitted to pediatric intensive care units (PICUs) is not insignificant, ranging up to 6%. Risk factors have been identified in this population. However, there is little consensus of actual VTE prophylaxis practice. We examined factors associated with VTE prophylaxis in PICUs.

Design—A retrospective study evaluating associations with mechanical (MPx), pharmacologic (PPx) or dual therapy (DUAL) prophylaxis compared to no VTE prophylaxis. Multivariable logistic regression explored the relationship between prophylaxis type and selected covariates with stepwise selection method to identify the independent predictors of VTE prophylaxis utilization.

Setting—Five Level I/II pediatric trauma centers in the United States.

Patients—Children <18 years from January 1–December 31, 2013 admitted to the PICU after a trauma, identified through combined Trauma Registry and Virtual Pediatric Systems (VPS) database.

Interventions—None

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Drs. Bigelow, Flynn-O'Brien and Hanson designed the study, reviewed results, synthesized analysis, drafted the initial manuscript and approved the final manuscript as submitted.

Dr. Simpson and Mahua Dasgupta performed the statistical analysis, reviewed and revised the manuscript and approved the final manuscript as submitted.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of work.

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Main Results—692 patients were included in the database, with 55 excluded for missing data. Of the remaining 637 patients, 538 (84.5%) had no VTE prophylaxis by 48 hours, 77(12.1%) had only MPx, 11(1.7%) had DUAL, and 11(1.7%) had PPx alone. Multivariable analysis showed increased age and orthopedic procedure was associated with all forms of prophylaxis. Orthopedic procedures were associated with higher utilization of dual prophylaxis use (OR 5.2, 95% CI 1.2–21.8), PPx (OR 8.5, 95% CI 2.3–31.7) and MPx (OR 2.2, 95% CI 1.1–4.2) alone. Brain/spinal cord procedures (OR 3.7, 95% CI 1.9–7.3) and abdominal procedures (OR 6.6, 95% CI 2.5–17.1) were associated with MPx. Head injury was associated with a decreased use of any prophylaxis (OR 0.5, 95% CI: 0.3–0.9). Patient comorbidities were associated with decreased use of MPx (OR 0.5, 95% CI 0.3–1.0)

Conclusions—Pharmacologic prophylaxis for VTE is not common in critically ill children after trauma. Patient age, orthopedic and vascular procedures, and higher injury severity are associated with pharmacologic VTE prophylaxis.

Introduction

Hospital-acquired venous thromboembolism (VTE) in pediatrics is a major source of comorbidity causing increased length of stay and costs in excess of \$27,000 per VTE.¹ The incidence of VTE in children remains lower than adults, but is increasingly diagnosed in hospitalized pediatric patients, presumably from improvements in the care of critically ill children, increased awareness, and better detection methods.² With the increased incidence of VTE in hospitalized children, quality improvement initiatives have been set in place to prioritize VTE prevention as a national concern.³

The incidence of VTE in injured children is higher than in the general hospitalized pediatric population, ranging from 0.02% to 1% for children hospitalized after trauma,^{2,4–13} and as high as 3–6% in critically ill injured children.^{6,9,14} Risk factors associated with VTE in pediatric trauma patients have been identified and include older age, higher injury severity scores, major vascular injury, central venous catheter use, poor perfusion, inotropic support, immobility, and spinal cord injury.^{5,8,12–16} Despite the growing awareness of the risk for VTE in critically injured children, VTE prophylaxis in critically ill children is uncommonly and inconsistently used, even in high risk populations.¹⁷ In part, this is likely because there remains insufficient evidence to guide providers in the use of VTE prophylaxis. Recently published consensus guidelines for VTE prophylaxis after pediatric trauma were reliant on the Delphi method in light of the paucity of data.¹⁸

The purpose of our study was to identify factors associated with mechanical or pharmacologic VTE prophylaxis in pediatric trauma patients admitted to the pediatric intensive care unit (PICU) to better understand current VTE prophylaxis utilization patterns.

Materials and Methods

This was a retrospective, multicenter analysis of the existing de-identified Pediatric Trauma Assessment and Management (PTAM) database. The PTAM database was created by merging institutional trauma registry (TR) and PICU data from Virtual Pediatric Systems, LLC (VPS) at five Pediatric Trauma Centers (PTCs) for all children meeting the following

eligibility criteria: discharged from the PICU during calendar year 2013, less than 18 years of age at the time of discharge, and at least one documented International Classification of Disease 9-Clinical Modification (ICD 9) code 800–959.9, indicating a traumatic injury, and indication of traumatic injury in the VPS participant profile. The requested dataset had institutional review board approval from the sponsoring institutions and all data were de-identified from the patient and hospital. All five contributing sites were PTCs verified by either the American College of Surgeons and/or certified by the state, with four of the sites being level I and one site being level II.

Variables Collected

Factors hypothesized to be associated with initiation and choice of VTE prophylaxis were analyzed including patient demographics, time of initiation of any pharmacologic or mechanical prophylaxis, PICU admit date, PICU discharge date, hospital discharge date, hospital disposition, PICU length of stay (LOS), emergency department (ED) Glasgow Coma Scale (GCS), Injury Severity Score (ISS), Pediatric Risk of Mortality score (PRISM3), Pediatric Logistic Organ Dysfunction score (PELOD), and Paediatric Index of Mortality score (PIM2) upon PICU admission, mechanisms of injury, and ICD 9 diagnosis and procedure codes to evaluate injuries, interventions, and co-morbidities. The main outcome of this study was to determine the factors associated with the use of mechanical or pharmacologic prophylaxis within 48 hours of PICU admission. Forty-eight hours was chosen to capture early intervention efforts to mitigate development of VTE, as VTE risk is known to increase shortly after traumatic injury.¹⁴ Secondary outcomes included complications, length of stay, change in functional status from pre-injury to that at ICU discharge, and mortality.

Study definitions

Mechanical VTE prophylaxis (MPx) was defined as the use of sequential compression devices (SCDs) or any other form of intermittent pneumatic compression applied during the PICU stay to prevent VTE. Pharmacologic VTE prophylaxis (PPx) was defined as the use of medications including heparin, low-molecular weight heparin, direct thrombin inhibitor, oral Xa inhibitor, or warfarin with the intention to prevent VTE. If both mechanical VTE prophylaxis and pharmacologic VTE prophylaxis were used we defined it as DUAL therapy. When combining any form of prophylaxis (mechanical VTE, pharmacology VTE or DUAL therapy), we used the terminology ‘ANY’ to indicate use of one or both prophylactic therapies.

Patient characteristics included age, gender, body mass index (BMI), and comorbidities existing prior to injury. Comorbidities captured in the TR database included ascites, bleeding disorder, active chemotherapy, cancer, congenital heart disease, congestive heart failure, smoking status, chronic renal failure, acute kidney injury, history of cerebrovascular accident, diabetes mellitus, previous history of VTE, varices, hypertension, prematurity, obesity, steroid use, cirrhosis, psychiatric disorder, and drug dependence. BMI was calculated by height and weight data collected at PICU admission through VPS, and defined as weight (kg)/height(m)². Obesity and BMI were classified independently to optimize

capture of these important covariates. A binary comorbidity variable was created for obesity and analyzed as an aggregate (y/n) and for number of comorbidities.

ED disposition was classified as either direct admission to the PICU or operating room procedure then admission to the PICU. The highest reported GCS was from the first 24 hours of hospital arrival and was collected by the TR via the Trauma Quality Improvement Program (TQIP) guidelines¹⁹ ED GCS was the first GCS recorded upon ED/hospital arrival. Injury severity was characterized by mechanism of injury, ISS, and ED GCS. Mechanism of injury was defined by ICD-9 primary external cause of injury codes (E-codes) and grouped into the following categories: motor vehicle collision (MVC), falls, struck by/against, burns, cut/pierce (stab injury), firearm, bites/stings and all other injury. Injury severity was characterized by mechanism of injury, ISS, and ED GCS (Table 1).

Procedure diagnoses were determined from the primary ICD-9 procedure codes and grouped into categories: brain/spinal cord (01–03), cardiac/blood vessel (35–39), abdomen (42–54), respiratory (30–34), musculoskeletal (76–84), and any operative procedure (00–86). Similarly, injury diagnosis codes were determined from the primary ICD-9 diagnosis code and grouped into categories based on anatomic and physiologic injury patterns: intracranial head injury (850–854), thoracic injury (860–862), abdominal/pelvic injury (863–869), burn injury (940–949), blood vessel injury (900–904), lower extremity fracture (820–823, 827–828), upper extremity fracture (812, 819), crush injury (925–929), spinal cord injury (952), coagulation disorder (286), and hemorrhagic condition (287).

Statistical Analysis

All variables were compared across VTE prophylaxis types (mechanical or pharmacologic or dual or any, starting within 48 hours) vs the group with no prophylaxis starting within 48 hours using Mann-Whitney for continuous variables and, Chi-square or Fisher's Exact tests (as appropriate). Logistic regression was used for univariate analyses to explore the individual impact of each the variable (demographics and injury related) on each of the prophylaxes. Multivariable models were created for the outcome VTE Prophylaxis (DUAL (Model 1), Mechanical (Model 2), Pharmacologic (Model 3), Any combination (Model 4)) using logistic regression. A stepwise selection procedure with $\alpha = 0.10$ was applied to find the best set of predictors. The predictors considered were: demographics (age, weight, height, BMI), mechanism of injury, ED disposition, severity scores (ISS, PRISM3, PIM2, highest GCS), presence of comorbidity, injury diagnosis, procedures, head trauma and presence of hospital complications. Other outcomes for the study, including length of stay (LOS), change in pediatric overall performance category (POPC) from discharge to admission baseline, change in pediatric cerebral performance category (PCPC) from discharge to admission baseline, and mortality. The VTE prophylaxis vs. no prophylaxis groups were analyzed using generalized linear models (assuming gamma/negative binomial distribution with log link) for the outcome LOS, delta POPC/PCPC and using logistic model for mortality, and were adjusted for ISS. An unadjusted P value of 0.05 was used for significance. Software used was SAS version 9.4.

Results

A total of 692 patients were included in the database, with 55 excluded from analysis due to missing data. Demographic and injury characteristics of the cohort are shown in Table 1. Of the included 637 patients, 538 (84.5%) had no VTE prophylaxis by 48 hours, 11 (1.7%) had both PPx and MPx (DUAL), 77 (12.1%) had only MPx, and 11 (1.7%) had PPx alone. Increasing age was associated with all forms of VTE prophylaxis (DUAL, MPx, PPx) with the 13–17yo age group associated with DUAL and MPx. The median age of those receiving any form of prophylaxis was higher (14.0 years) than for those who did not receive any form of prophylaxis (4years). Patients receiving any prophylaxis versus none had similar demographics and injury characteristics. Higher age, BMI and ISS were associated with prophylaxis use (Table 1).

The relative associations between chosen variables and VTE prophylaxis are presented in Table 2. In univariate analysis, diagnosis of lower extremity long bone fractures was associated with higher utilization of dual prophylaxis use (OR 11.3, 95% CI 3.3–38.8.). Orthopedic procedures were associated with higher utilization of DUAL prophylaxis use (OR 9.2, 95% CI 2.7–31.1), PPx (OR 13.4, 95% CI 3.8–47.2) and MPx (OR 3.3, 95%CI 1.9–5.7). Brain/spinal cord procedures (OR 2.5, 95% CI 1.4–4.2) were associated with MPx. Procedures for head trauma and diagnosis of head injury were associated with a decreased use of all prophylaxis types. Abdominal procedures were associated with DUAL and MPx but not PPx. Admission to ICU post-operatively was associated with a higher rate of all forms of prophylaxis (DUAL, MPx, PPX and ANY). There was no significant association between study site with MPx alone (11.7% overall, range 0–19.1, $p=0.31$), though site was associated with PPx prophylaxis (6.3% overall, range 0–20.2, $p<0.0001$).

In multivariable analyses, older age and orthopedic procedures were associated with all methods of VTE prophylaxis (Table 3). Higher BMI, though significant in univariate analysis, was not associated with prophylaxis of any type after controlling for covariates. Brain/spinal cord procedures and abdominal procedures were associated with MPx, but not PPx, while cardiac/vascular procedures were associated with PPx. There was no significant association between injury diagnoses without the corresponding procedure, aside from head injury, which was inversely associated with ANY Px. Patient co-morbidities were inversely associated with MPx

In the outcomes analysis, patients who received any form of prophylaxis had longer physical and hospital length of stay and worsening change in POPC, even while controlling for ISS. There was no difference in mortality (Table 4).

Discussion

This is a multi-institutional study describing actual thromboprophylaxis practices being implemented in the PICU setting for pediatric trauma patients. Previous studies have identified the incidence and risk factors for VTE in critically injured children,^{6,9,14} but it is not known how providers are interpreting those data and implementing VTE prophylaxis in their management of pediatric trauma patients. We investigated the actual clinical practices

being implemented in the PICU setting. This is the first multicenter report describing actual VTE prophylaxis practices in the critically ill pediatric trauma population across centers.

The results of our univariate analysis showed that risk factors for VTE such as older patient age, increased BMI, neurosurgical, spine, abdominal, orthopedic, or vascular procedures, in addition to lower extremity long bone fractures and admission to the PICU post-operatively were associated with VTE prophylaxis in this patient population. Head injured patients were less likely to receive prophylaxis of any type. Interestingly, older age, and orthopedic procedures were the only factors associated with all forms of VTE prophylaxis in multivariate analyses. Age has been reported in several studies as a risk factor for VTE in the pediatric population^{4,7,15,20} and our study may imply that providers appropriately assess age as a strong risk factor for VTE.

Reporting actual VTE practices in the pediatric population is relevant to the clinician. The incidence of VTE in PICUs has dramatically increased but guidance for how to incorporate this evidence is lacking.^{21,22} The thromboprophylaxis practices observed in this study, with little prophylaxis use in those <12 years and decreased PPx and DUAL in patients with head injury, is consistent with a recent consensus statement on VTE prophylaxis in pediatric trauma patients, which states that most patients 12 years and younger do not need prophylaxis and that mechanical prophylaxis has a role in patients who cannot safely receive pharmacologic prophylaxis, such as in head trauma patients with risk of bleeding.¹⁸ The practices we observed, however, are inconsistent with the recommendations from the Pediatric Trauma Society (PTS) and the Eastern Association for the Surgery of Trauma (EAST) to use pharmacologic prophylaxis in spinal cord injuries, obesity and vascular injuries in pediatric trauma patients.^{21,23} However consistent with these recommendations, our study showed an increased ISS in patients receiving DUAL, but not MPx, PPx or ANY prophylactic therapy, compared to those who received none.

We also found that, among these high-level pediatric trauma centers, site variation exists for pharmacologic prophylaxis but is fairly uniform for mechanical prophylaxis. This is similar to the findings of the Protract (Prophylaxis Against Thrombosis Practice) Study, which identified site variation among global institutional participants, however they found variation for both mechanical and pharmacologic prophylaxis utilization in critically ill children.¹⁷ The authors theorized that the high variability in practice was related to the lack of evidence to guide practitioners.

In our study some high-risk populations were not associated with receiving VTE prophylaxis. As this was an observational study, the intent of providers could not be determined. For example, in these situations, it is unclear whether VTE prophylaxis was not given because of a lack of recognition of VTE risk or due to an assessment of an increased risk of bleeding that is not evident in the data available. This may indicate that institutions need to implement a formal screening tool to guide providers on appropriate patients in which to use VTE prophylaxis. Connelly et. al. recently developed an internally validated VTE screening tool from the National Trauma Database (NTDB) for pediatric trauma patients.¹¹ A screening tool such as this implemented on a larger scale may help providers in identifying high-risk populations and guide their decision on VTE prophylaxis.

This study has also identified patient factors associated with the decision to use prophylaxis. This is important information as we move to the next phase of studies in this area, beyond epidemiology and on to outcomes and effectiveness. Knowing physicians are comfortable with pharmacologic prophylaxis in older children, those with orthopedic or vascular procedures, will allow us to form cohorts from which to compare outcomes or design randomized controlled trials.

Limitations

There are some limitations to this retrospective study. We only looked at thromboprophylaxis in the first 48 hours after admission. The 2016 Pediatric Trauma Society (PTS) consensus guidelines endorse waiting 3–4 days for pharmacologic prophylaxis following neurosurgical procedures, intracranial hemorrhage and major solid organ injury,¹⁸ hence we may have missed a small population of patients who had prophylaxis appropriately initiated after 48 hours. Review of our data shows that six patients had some form of VTE prophylaxis started after 48 hours and all of them had a diagnosis of intracranial head injury or a brain/spinal cord procedure. The 2013 data in this study may not reflect recent practice changes since the 2016 PTS and EAST guidelines, however there is often a significant lag between guideline release and clinical practice implementation.^{24,25}

As with any established multi-center database there are inherent questions of accuracy related to the data captured. Though the five trauma centers included in this study have broad geographic distribution, generalizability of this study is limited by the sample size.

Conclusions

Pharmacologic prophylaxis for VTE is not common in critically ill children after trauma. Patient age, orthopedic and vascular procedures, and increased injury severity are associated with pharmacologic VTE prophylaxis. Higher BMI and other co-morbidities are not associated with the increased use of VTE prophylaxis.

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Abbreviations

VTE	Venous thromboembolism
PICU	Pediatric intensive care unit
PTAM	Pediatric Trauma Assessment and Management
TR	Trauma registry

VPS	Virtual Pediatric Systems
PTCs	Pediatric trauma centers
ICD-9	International Classification of Disease 9-Clinical Modification
ED	Emergency department
GCS	Glasgow coma scale
ISS	Injury severity score
PRISM3	Pediatric risk of mortality score
PIM2	Pediatric index of mortality score
PELOD	Pediatric logistic organ dysfunction
MPx	Mechanical venous thromboembolism prophylaxis
PPx	Pharmacologic venous thromboembolism prophylaxis
BMI	Body mass index
LOS	Length of stay
POPC	Pediatric Overall performance category
PCPC	Pediatric cerebral performance category
TQIP	Trauma Quality Improvement Program

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Table 1

Patient demographics and injury characteristics, N(%)

	None (N=538)	DUAL (N=11)	MPx (N=77)	PPx (N=11)	Any Px (N=99)
Age (years), median (IQR)	4.0 (0.8–11.0)	16.0 (14.9–16.0)*	14.0 (10.9–16.0)*	11.9 (7.0–16.5)*	14.0 (10.3–16.0)*
<1 year	139 (100.0)	0 (0.0)*	0 (0.0)*	0 (0.0)*	0 (0.0)*
1–4 years	149 (99.3)	0 (0.0)	1 (0.7)	0 (0.0)	1 (0.7)
5–12 years	148 (80.0)	1 (0.5)	29 (15.7)	7 (3.8)	37 (20.0)
13–17 years	102 (62.6)	10 (6.1)	47 (28.8)	4 (2.4)	61 (37.4)
Gender					
Female	180 (86.5)	1 (0.5)	23 (11.1)	4 (1.9)	28 (13.5)
Male	358 (83.4)	10 (2.3)	54 (12.6)	7 (1.6)	71 (16.6)
Race/Ethnicity[‡]					
White	282 (82.7)	3 (0.9)*	50 (14.7)*	6 (1.8)	59 (17.3)*
Black/African American	114 (82.6)	7 (5.1)	15 (10.9)	2 (1.4)	24 (17.4)
Hispanic/Latino	44 (93.6)	0 (0.0)	3 (6.4)	0 (0.0)	3 (6.4)
Asian	13 (86.7)	1 (6.7)	1 (6.7)	0 (0.0)	2 (13.3)
Other	71 (96.0)	0 (0.0)	1 (1.4)	2 (2.7)	3 (4.0)
Mechanism of Injury					
Motor Vehicle Collision	168 (75.3)	7 (3.1)*	45 (20.2)*	3 (1.4)*	55 (24.7)*
Bites/Stings	8 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Burn	16 (94.1)	0 (0.0)	1 (5.9)	0 (0.0)	1 (5.9)
Cut/Pierce	6 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Fall	193 (91.9)	1 (0.5)	15 (7.1)	1 (0.5)	17 (8.1)
Firearm	8 (40.0)	3 (15.0)	6 (30.0)	3 (15.0)	12 (60.0)
Struck by/Against	56 (84.8)	0 (0.0)	9 (13.6)	1 (1.5)	10 (15.2)
Height (cm) ϕ , median(IQR)	108.3 (73.0–147.0)	170.0 (160.0–178.0)*	154.0 (138.0–172.0)*	153.0 (123.2–173.0)*	159.0 (138.0–172.7)*
Weight (kg), median (IQR)	18.7 (9.5–40.0)	75.0 (56.5–81.4)*	54.4 (38.6–69.9)*	37.7 (26.0–75.0)*	54.8 (37.7–71.3)*
BMI ϕ , median (IQR)	17.6 (15.3–20.3)	24.5 (22.1–28.2)*	19.8 (17.6–22.9)*	19.4 (16.5–24.1)	20.1 (18.4–24.4)*

	None (N=538)	DUAL (N=11)	MPx (N=77)	PPx (N=11)	Any Px (N=99)
All Other	83 (95.4)	0 (0.0)	1 (1.2)	3 (3.4)	4 (4.6)
ISS ^{††} , median (IQR)	10.0 (9.0–17.0)	16.0 (9.0–26.0)	14.0 (9.0–24.0) [*]	13.0 (10.0–20.0)	14.0 (9.0–24.0) [*]
ED Glasgow Coma Scale^β					
<4	61 (79.2)	2 (2.6)	13 (16.9)	1 (1.3)	16 (20.8)
4–8	26 (74.3)	2 (5.7)	7 (20.0)	0 (0.0)	9 (25.7)
9–12	36 (92.3)	0 (0.0)	3 (7.7)	0 (0.0)	3 (7.7)
13–15	317 (83.0)	7 (1.8)	52 (13.6)	6 (1.6)	65 (17.0)

IQR = interquartile range, LOS = length of stay, DUAL = both mechanical and pharmacologic prophylaxis, MPx = mechanical prophylaxis, PPx = pharmacologic prophylaxis, Any Px = any form of prophylaxis to include MPx, PPx, and/or DUAL, BMI = body mass index, ED = emergency department

^β GCS (ED) was missing for 104 subjects,

^φ Height and BMI were missing for 231 subjects

^{††} ISS was missing for 8 subjects

[†] Race was missing for 22 subjects

^{*} Significantly different from “None.” (p<0.05)

Table 2

Univariate Analysis: Variables for VTE Prophylaxis

	Dual vs. None			MPx. vs. None			PPx. vs. None		
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
Age (yrs)	1.34	1.15–1.55	0.0002	1.27	1.20–1.34	<0.0001	1.16	1.05–1.29	0.004
Height (cm)	1.05	1.02–1.08	0.001	1.03	1.02–1.04	<0.0001	1.03	1.01–1.05	0.01
Weight (kg)	1.05	1.03–1.07	<0.0001	1.04	1.03–1.05	<0.0001	1.03	1.01–1.05	0.004
BMI	1.26	1.14–1.40	<0.0001	1.09	1.02–1.16	0.007	1.15	1.03–1.30	0.02
Mechanism (injury)									
Fall vs. MVC	0.12	0.02–1.02	0.05	0.29	0.16–0.54	<0.0001	0.29	0.03–2.82	0.28
Firearm vs. MVC	9.00	1.95–41.45	0.005	2.80	0.92–8.48	0.069			
Cyclist/Pedestrian vs. MVC	NA			0.60	0.28–1.30	0.20	1.00	0.10–9.81	>0.9
All Other vs. MVC	NA						2.02	0.40–10.25	0.39
ED disposition: OR vs. ICU	7.59	2.25–25.61	0.001	1.82	1.00–3.32	0.05	6.33	1.54–25.94	0.01
PIM2	1.23	0.93–1.64	0.15	0.98	0.82–1.18	0.86	1.24	0.94–1.62	0.12
ISS	1.04	0.99–1.10	0.10	1.02	0.99–1.05	0.08	1.03	0.98–1.09	0.22
PRISM3	1.07	1.02–1.12	0.01	0.99	0.96–1.04	0.93	1.06	1.01–1.11	0.02
PELOD Baseline	1.05	1.002–1.10	0.04	0.99	0.96–1.02	0.58	1.03	0.97–1.08	0.35
Highest GCS	0.83	0.69–1.00	0.05	0.93	0.86–0.99	0.03	0.87	0.75–1.01	0.07
Comorbidities(y/n)	0.25	0.03–2.00	0.19	0.83	0.48–1.44	0.52	0.56	0.12–2.64	0.47
Count of comorbidities									
1 vs None	NA			0.68	0.36–1.25	0.21	0.62	0.13–2.91	0.55
>1 vs None	2.76	0.33–23.05	0.35	2.38	0.82–6.85	0.11	NA		
Injury Diagnosis									

	Dual vs. None				MPx. vs. None				PPx. vs. None			
	OR	95% CI	p		OR	95% CI	p		OR	95% CI	p	
Head Injury	0.11	0.01–0.84	0.03		0.54	0.33–0.89	0.02		0.11	0.01–0.84	0.03	
Thoracic Injury	1.80	0.38–8.55	0.46		3.46	1.98–6.04	<0.0001		3.04	0.79–11.79	0.11	
Abdominal/Pelvic Injury	2.83	0.73–10.94	0.13		2.47	1.38–4.42	0.002		0.75	0.10–5.99	0.79	
Vascular	8.03	1.003–32.20	0.003		0.87	0.26–3.00	0.82		12.24	3.35–44.68	0.0002	
Lower Extremity Fracture	11.28	3.29–38.72	0.0001		1.79	0.83–3.88	0.14		1.35	0.17–10.87	0.78	
Upper Extremity Fracture	2.73	0.33–22.44	0.35		0.73	0.17–3.19	0.67		NA			
Procedure Diagnosis												
Brain/Spinal Cord	2.03	0.53–7.80	0.30		2.45	1.43–4.18	0.001		NA			
Cardiac/Vascular	14.71	3.14–68.99	0.0006		1.87	1.13–3.10	0.02		5.72	1.65–19.86	0.006	
Abdominal	8.80	2.18–35.45	0.002		5.21	2.54–10.7	<0.0001		NA			
Respiratory	3.76	0.78–18.19	0.10		3.44	1.71–6.93	0.0005		1.69	0.21–13.67	0.62	
Orthopedic	9.21	2.73–31.08	0.0003		3.27	1.88–5.70	<0.0001		13.44	3.82–47.21	<0.000	
Operative Procedures					2.90	1.72–4.89	<0.0001		11.61	1.48–91.30	0.02	
Head Trauma	0.12	0.03–0.48	0.002		0.47	0.28–0.79	0.005		0.12	0.03–0.48	0.002	

Bold text indicates significant variable with p <0.05

DUAL = both mechanical and pharmacologic prophylaxis, MPx = mechanical prophylaxis, PPx = pharmacologic prophylaxis, BMI = body mass index, MVC= motor vehicle collision, ED = emergency department, OR= operating room, ICU= intensive care unit, PIM2= pediatric index of mortality 2, PRISM3= pediatric logistic risk of mortality 3, PELOD=pediatric logistic organ dysfunction, GCS= Glasgow coma score,

Table 3

Multivariable Analysis: Demographic and injury variables independently associated with venous thromboembolism prophylaxis*

	DUAL vs. None		MPx. vs. None		PPx. vs. None		ANY Px vs. None	
	OR (95%CI)	p-value	OR (95%CI)	p-value	OR (95%CI)	p-value	OR (95%CI)	p-value
Age (yrs)	1.3 (1.1–1.6)	0.002	1.3 (1.2–1.4)	<0.0001	1.1 (1.0–1.2)	0.05	1.3 (1.2–1.4)	<0.0001
ISS	1.1 (1.0–1.1)	0.02						
Comorbidity (Y/N)			0.5 (0.3–1.0)	0.05			0.5 (0.3–1.0)	0.04
Brain/Spinal Cord procedure			3.7 (1.9–7.3)	0.0001			3.2 (1.7–6.1)	0.0005
Cardiac/Vascular procedure					4.2 (1.2–15.6)	0.03		
Abdominal procedure			6.6 (2.5–17.1)	0.0001				
Orthopedic procedure	5.2 (1.2–21.8)	0.02	2.2 (1.1–4.2)	0.02	8.5 (2.3–31.7)	0.002	2.8 (1.5–5.1)	0.0008
Head injury diagnosis	0.1 (0.03–0.74)	0.02					0.5 (0.3–0.9)	0.02

IQR = interquartile range, LOS = length of stay, DUAL = both mechanical and pharmacologic prophylaxis, MPx = mechanical prophylaxis, PPx = pharmacologic prophylaxis, ANY Px = any form of prophylaxis to include MPx, PPx, and/or DUAL, ISS= injury severity score

* Variables with p value <0.05 are displayed

Table 4

Outcomes associated with venous thromboembolism prophylaxis utilization, Median (IQR)

Outcome Measure	None (n=538)	DUAL (n=11)	MPx (n=77)	PPx (n=11)	Any Px (n=99)
Physical LOS	1.3 (0.7–2.7)	6.9 (1.3–11.6) *	1.7 (0.9–5.0) *	3.3 (1.6–3.8)	1.7 (1.0–5.9) *
Hospital LOS	3.0 (2.0–6.0)	14.0 (8.0–28.0) *	7.0 (3.0–13.0) *	6.0 (4.0–24.0) *	7.0 (4.0–16.0) *
Mean delta POPC ^a	1.0 (0.0–1.0)	2.0 (1.0–2.0)	1.0 (1.0–2.0) *	1.0 (1.0–2.0)	1.0 (1.0–2.0) *
Mean delta PCPC ^a	0.0 (0.0–0.0)	0.0 (0.0–2.0)	0.0 (0.0–1.0)	0.0 (0.0–0.0)	0.0 (0.0–1.0)
Mortality, n(%)	24 (85.7)	1 (4.0)	1 (4)	2 (7.7)	4 (14.3)

IQR = interquartile range, LOS = length of stay, DUAL = both mechanical and pharmacologic prophylaxis, MPx = mechanical prophylaxis, PPx = pharmacologic prophylaxis, Any Px = any form of prophylaxis to include MPx, PPx, and/or DUAL, POPC = pediatric overall performance category, PCPC = pediatric cerebral performance category

^aDelta POPC/PCPC is the change from pre-injury functional status to functional status at the time of ICU discharge

* significantly different from “None”, (p<0.05)