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Venous thromboembolism prophylaxis in the pediatric trauma patient

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ABSTRACT

Although venous thromboembolism (VTE) occurs in less than 1% of hospitalized pediatric trauma patients, care providers must make decisions about VTE prophylaxis on a daily basis. The consequences of VTE are significant; the risks of developing VTE are variable; and the effectiveness of prophylaxis against VTE is not conclusive in children. While the value of VTE prophylaxis is well defined in adult trauma care, it is unclear how this translates to the care of injured children. This review evaluates the incidence and risks of VTE in pediatric trauma and assesses the merits of prophylaxis in children. Pharmacologic prophylaxis against VTE is a reasonable strategy in critically injured adolescent trauma patients. Further study is needed to establish the risks and benefits of VTE prophylaxis across the spectrum of injured children.

What is the risk of VTE?

Venous thromboembolism (VTE) is an uncommon consequence of injury in children. The clinical conditions of deep venous thrombosis (DVT) and pulmonary embolism (PE) are the primary components of this broader category of VTE. Classically, it has been thought that acute trauma contributes to hypercoagulability, endothelial injury, and vascular stasis to form a DVT, which can then propagate or embolize to the pulmonary circulation as a PE. Recent research suggests that blunt chest injury may cause primary pulmonary thrombus, independent of a predisposing DVT.[1–4]

Regardless of the underlying pathophysiology, VTE events are rare in pediatric trauma. Among hospitalized children, the pediatric trauma population is at higher risk for VTE than the uninjured hospitalized pediatric population. Estimates of incidence vary among published studies (Table 1). The sources of data for these studies cover a broad range, from single institution experience, to shared institutional experiences, to national trauma registries, and to large administrative hospital data sets. This makes valid direct comparisons between studies problematic. The described incidence ranges from 0.0001% to 2.1% among injured children.[5,6] McBride et al.[5] identified this low-end estimate when evaluating the specific condition of pulmonary embolism in children, while O'Brien et al.[6] identified this high-end estimate in a population heavily weighted toward patients of age 17–21 who received care at adult centers. Without these 2 extremes, the incidence estimates fall into a fairly narrow range, from 0.1% to 1.2% among the general pediatric trauma population.[7–26] Among the general pediatric trauma population, it is reasonable to conclude that the incidence of VTE is less than 1%.

This incidence is much lower than the estimate of 3–5% noted in the general adult trauma population and the 8–10% incidence in the adult neurotrauma population.[27] Clearly, one of the central challenges regarding prophylaxis against VTE in pediatric trauma is to identify the subgroup within the larger population that is at sufficiently high risk to benefit from prophylaxis.

Though they are rare, VTE are potentially serious events. In the acute setting, VTE may manifest as DVT, nonfatal PE, or stroke from paradoxical embolus. Death occurs in 2.2% of pediatric cases.[28] Long-term consequences of VTE may include postthrombotic syndrome, bleeding risk from long-term anticoagulation, and recurrent VTE. Postthrombotic syndrome may occur in almost 50% of children who develop DVT, and these symptoms can continue with varying severity for years.[29] It has not been well described if such symptoms in childhood continue into adulthood. Between potential years of life lost and potential years of life with chronic morbidity, the stakes are high for preventing VTE in children.

VTE in children are expensive conditions. Costs of diagnostic testing, pharmacotherapy, monitoring, and extended hospital stay can be significant. Recent data estimate this cost to be over $27,000 per VTE event in pediatric patients.[17,30] These financial costs must be weighed against potential costs of screening and prophylaxis. Such expenses could be minimized by limiting pharmacologic prophylaxis to only the children who are at highest risk for developing VTE.

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Table 1
Summary of evidence on the incidence and risk of VTE in pediatric trauma.

				Risk Factor								
Study	Population	VTE incidence (%)	Age risk (y)	CVC	Major surgery	Vascular injury	High ISS (> 25)	Low GCS (< 8)	Transfusion	Intubation	PICU admission	Other
Allen et al.[7]	Single center 0–17 y	22/1934 (1.2)	≥ 13	Yes	Yes	Yes						
Yen et al.[8]	Single center 0–21 y	49/17,366 (0.28)	≥ 13				Yes	Yes	Yes	Yes		
Connelly[9]	NTDB 0–17 y	1141/536,423 (0.21)	≥ 10	Yes	Yes			Yes	Yes	Yes	Yes	Female, pelvic fracture, lower extremity fracture
Harris and Lam[10]	Kids inpatient database, TBI patients 0–20 y	267/58,529 (0.46)	≥ 15	Yes	Yes					Yes		Tracheostomy, nonaccidental mechanism, long LOS
Van Arendonk et al.[11]	NTDB 0–21 y	1655/402,324 (0.41)	≥ 13	Yes	Yes		Yes	Yes	Yes	Yes		Obesity, long LOS
Askegard-Giesmann et al.[12]	PHIS 0–18 y	671/260,078 (0.26)	N/A	Yes							Yes	Pelvic fracture
Greenwald et al.[13]	Single center 0–17 y	3/1782 (0.17)	N/A									
Hanson et al.[14]	Single center PICU patients 0–17 y	11/375 (2.9)	≥ 13									Spinal cord injury
O'Brien et al.[6]	4 centers 0–21 y	15/706 (2.1)	N/A	Yes	Yes					Yes	Yes	Male
O'Brien et al.[15]	NTDB PICU patients 0–21 y	826/135,032 (0.61)	≥ 13	Yes	Yes	Yes	Yes	Yes	Yes		Yes	PICU, pelvic fracture, lower extremity fracture
Hanson et al.[16]	Single center PICU patients 0–17 y	9/144 (6.2)	N/A	Yes								TPN, sedation, NM blockade, inotropes, fVIIa
Candrilli et al.[17]	Kids inpatient database 0–20 y	648/240,387 (0.3)	N/A	Yes	Yes	Yes	Yes	Yes				Spine injury, pelvic fracture, lower extremity fracture
Rana et al.[18]	Single institution 6–20 y	2/1314 (0.2)	N/A									Obesity
Cyr et al.[19]	2 trauma center 0–17 y	11/3291 (0.3)	≥ 15	Yes	Yes		Yes					Thoracic and abdominal injuries, spine injury
Azu et al.[20]	Single institution 0–17 y	2/3345 (0.1)	N/A									
Cook et al.[21]	NTDB 0–17 y	91/116,357 (0.1)	N/A									
Jones et al.[22]	California patient discharge dataset, patients with SCI 0–19 y	70/1585 (4)	N/A									Spinal cord injury
Truitt et al.[23]	Single institution 0–16 y	3/3637 (0.1)	≥ 9				Yes	Yes				
Vavilala et al.[24]	19 hospital discharge database 0–15 y	45/58,716 (0.1)	≥ 10	Yes	Yes	Yes	Yes	Yes				
Grandas et al.[25]	Single institution 0–15 y	3/2746 (0.1)	N/A	Yes								
McBride et al.[5]	NPTR 0–19 y	6/28,692 (0.0)	N/A									Spinal cord injury