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A simplified stratification system for venous thromboembolism risk in severely injured trauma patients

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ABSTRACT

Background: The objective of this study was to re-evaluate and simplify the Greenfield risk assessment profile (RAP) for venous thromboembolism (VTE) in trauma using information readily available at the bedside.

Methods: Retrospective review of 1233 consecutive admissions to the trauma intensive care unit from August 2011-January 2015. Univariate analyses were performed to determine which RAP risk factors were significant contributors to VTE. Multivariable logistic regression was used to develop models for risk stratification. All results were considered statistically significant at $P \leq 0.05$.

Results: The study population was as follows: age 44 ± 19, 75% male, 72% blunt, injury severity score 21 ± 13, RAP score 9 ± 5, and 8% mortality. Groups were separated into +VTE ($n = 104$) and −VTE ($n = 1129$). They were similar in age, gender, mechanism, and mortality, but injury severity and RAP scores were higher in the +VTE group (all $P < 0.0001$). The +VTE group had more transfusions and longer time to prophylaxis (all $P < 0.05$). Receiving four or more transfusions in the first 24 h (odds ratio [OR], 2.60; 95% confidence interval [CI], 1.64-4.13), Glasgow coma score <8 for >4 h (OR, 2.13; 95% CI, 1.28-3.54), pelvic fracture (OR, 2.26; 95% CI, 1.44-3.57), age 40-59 y (OR, 1.70; 95% CI, 1.10-2.63), and >2-h operation (OR, 1.80; 95% CI, 1.14-2.85) predicted VTE with an area under the receiver operator curve of 0.729, which was comparable with 0.740 for the RAP score alone.

Conclusions: VTE risk in trauma can be easily assessed using only five risk factors, which are all readily available at the bedside (transfusion, Glasgow coma scale, pelvic fracture, prolonged operation, and age). This simplified model provides similar predictive ability to the more complicated RAP score. Prospective validation of a simplified risk assessment score is warranted.

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Introduction

Despite "optimal" thromboprophylaxis and adherence to evidence-based guidelines in trauma and other surgical populations,[1,2] venous thromboembolism (VTE) remains a significant public health concern[3] with an incidence that ranges from 4%-90%.[4-11] This large variation in reported incidence underscores the shortcomings of VTE research, which are largely because of surveillance bias, but it also highlights the importance of this condition that carries significant morbidity and mortality.

Several risk factors contribute to VTE in trauma, including age, prolonged immobility, coma, spinal cord injury, pelvic fractures, transfusions, presence of central venous catheters, and prolonged operations.[1,6-9,12-23] Two risk-stratification scoring systems are useful to guide surveillance and prophylaxis specifically for trauma patients: the Greenfield risk assessment profile (RAP) and the trauma embolic scoring system.[15,19]

RAP is used most often at our trauma center for risk stratification. Although the original RAP identified a high incidence of VTE in a group of patients, the magnitude of RAP was not correlated with VTE.[15] This scoring system has been previously validated, but controversy still exists regarding its predictive ability and clinical utility.[24-26] For example, a significant fraction of trauma patients who develop VTE are classified as "low risk," suggesting that further refinement is necessary.[26] Furthermore, risk stratification should ideally be performed early in the hospital course, but RAP uses variables that are not routinely available until after discharge (Table 1). Rather than identifying new risk factors for VTE after trauma, the objective of this study was to re-evaluate the individual risk factors reported by Greenfield and to simplify the RAP score using information readily available at the bedside.

Table 1 – Greenfield risk assessment profile.[15]

	Points
Underlying conditions	
Obesity (BMI > 30 kg/m^2)	2
Malignancy	2
Abnormal coagulation factors at admission	2
History of thromboembolism	3
Iatrogenic factors	
Femoral central venous catheter >24 h	2
Four or more transfusions in 24 h	2
Surgical procedure >2 h	2
Repair or ligation of major vascular injury	3
Injury-related factors	
AIS chest >2	2
AIS abdomen >2	2
AIS head >2	2
GCS score <8 for >4 h	3
Complex lower extremity fracture	3
Pelvic fracture	4
Spinal cord injury with paraplegia or quadriplegia	4
Age	
40-59 y	2
60-74 y	3
≥75 y	4

AIS = abbreviated injury scale; BMI = body mass index.

Methods

This was a retrospective cohort study conducted at the Ryder Trauma Center in the University of Miami/Jackson Memorial Medical Center and was approved by the institutional review board. Adult patients sustaining blunt or penetrating trauma and admitted to the Ryder Trauma Center from August 2011-January 2015 were included. Deep venous thrombosis (DVT) was diagnosed with venous duplex ultrasonography (VDU). Pulmonary embolism (PE) was identified by computed tomography with angiography of the chest or postmortem analysis. All expired patients routinely undergo postmortem analysis unless refused by the patient's family.

Twenty percent of the data set included patients who were enrolled in a prospective observational trial evaluating hypercoagulability and VTE in trauma patients. This group had a RAP score ≥10 and was deemed "high risk" for VTE, based on our previous work.[7,27] All these high-risk patients received weekly surveillance VDU of the lower extremities. The VDU protocols at our institution have been previously reported.[28] Briefly, all VDUs were performed by certified ultrasound technologists and interpreted by an attending radiologist. The deep venous systems of both lower extremities are examined from the inguinal ligament to the ankles using B-mode compression, color augmentation, and spectral Doppler ultrasound. Studies were considered positive if venous abnormalities were detected at or below the inguinal ligaments. The remaining 80% of the study sample underwent VDU or computed tomography with angiography for symptomatic disease only.

The RAP score was calculated prospectively on patient arrival to the trauma intensive care unit. Obesity was defined as a body mass index >30 kg/m^2. History of malignancy was any known diagnosis of ongoing or previous cancer. Abnormal coagulation factors were prothrombin time, activated partial thromboplastin time, or international normalized ratio outside the reference range. History of VTE was defined as any current or previous diagnosis of DVT or PE. Four or more transfusions in 24 h was defined as transfusion of any blood product, including packed red blood cells, plasma, platelets, or cryoprecipitate. Major vascular injury was defined as damage to any named vessel requiring repair or ligation. Glasgow coma scale score was calculated with the patient off sedation. Complex lower extremity and pelvic fractures were defined as the presence or absence of fracture, but were not quantified based on severity. Several variables that are not readily available to the clinician, including abbreviated injury score (AIS) and injury severity score (ISS), were calculated by trained trauma research staff.

All statistical analyses were performed using SPSS Statistics, version 22.0 (IBM Corporation, Armonk, NY). Categorical