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ORIGINAL RESEARCH

Venous thromboembolism risk assessments on trauma patients has suboptimal interobserver reliability among inexperienced clinicians (fourth-year medical students)

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Akella Chendrasekhar[1,2]
Sireesha Aleti[2]

[1]State University of New York Downstate, Brooklyn, NY, USA; [2]Department of Surgery, Richmond University Medical Center, Staten Island, NY, USA

Background: Venous thromboembolic disease is a major cause of morbidity and mortality in hospitalized patients worldwide. The objective of this study is to compare interobserver reliability for qualitative and quantitative venous thromboembolism (VTE) risk assessments in hospitalized trauma patients.

Methods: We conducted a retrospective medical record review of 40 randomly selected trauma patients admitted to a 448-bed urban level-I trauma center from January 2013 to January 2014. Interclass correlation coefficient (ICC) was calculated based on a two-way mixed model. The sample was equally distributed between patients admitted to the floor and the intensive care unit (ICU). Eight fourth-year medical students performed the risk assessments by the medical record. Two forms for risk assessment were used: a qualitative screening and a quantitative screening. The composite of intraobserver and interobserver variabilities was determined.

Results: The ICC for qualitative VTE risk assessments was 0.845 and for quantitative VTE risk assessment was 0.628.

Conclusion: To optimize accuracy of VTE risk stratification and appropriate prophylaxis, medical students and first-year residents should be formally trained to perform quantitative assessments.

Keywords: venous thromboembolism, risk assessment, qualitative analysis, quantitative analysis, prophylaxis, interobserver reliability

Introduction

Venous thromboembolism (VTE) is a significant cause of mortality and morbidity in hospitalized patients worldwide. Fatal pulmonary embolism (PE) is the most common preventable cause of hospital death. The incidence of clinically symptomatic VTE in the USA is ~250,000–300,000 new cases each year.[1,2] PE occurs in 0.2%–0.4% of hospitalized patients and causes ~200,000 deaths annually.[3] It is estimated that the USA spends ~US$7–10 billion in direct medical costs on VTE each year.[4] Each hospital-acquired deep vein thrombosis (DVT) represents an incremental inpatient cost of US$10,000, while each PE represents ~US$20,000 in additional cost. Without prophylaxis, the incidence of DVT in general surgery patients is about 15%–40%, while it is 40%–80% in major trauma.[5] Despite guidelines being regularly published by the American College of Chest Physicians (ACCP), VTE prophylaxis remains underutilized. Current estimates suggest that only 30%–60% of patients at risk receive appropriate VTE prophylaxis.[6]

Correspondence: Akella Chendrasekhar
Department of Surgery, Richmond University Medical Center, 355 Bard Avenue, Staten Island, NY 10310, USA
Tel +1 718 818 2420
Fax +1 718 818 1252
Email achendrasekhar@rumcsi.org

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Established clinical risk factors include presence of inherited conditions, such as factor V Leiden mutation, prothrombin gene mutation, and protein S or C deficiency, or acquired risk factors, such as major surgery involving the abdomen, pelvis, and lower extremities; active malignancy and its treatment; immobilization; trauma, especially involving the spinal cord injuries or spinal fractures; fracture of pelvis, hip, and leg; presence of central venous catheter; pregnancy; drugs; congestive heart failure; chronic renal disease; the antiphospholipid syndrome; obesity; smoking; older age; and history of thromboembolism.

Trauma is the leading cause of death in people of age <40 years, and the care of patients with trauma accounts for more hospital days per year than the care of patients with heart disease or cancer. DVT and PE are common complications of major trauma.[7] The 2016 Annual Report of the National Trauma Data Bank (NTDB) reports DVT/thrombophlebitis as one of the top 10 posttrauma complications, with incidence of 0.60%. The incidence of PE is reported as 0.27% (NTDB).

The Eastern Association for the Surgery of Trauma has developed evidence-based practice management guidelines for the prevention of VTE in trauma patients.[8]

The process of providing VTE prophylaxis begins with assessment of each patient's VTE risk. Assessment forms are often completed by first-year residents on admission or arrival to the floor; based on the relative inexperience of the interns, we hypothesize that these VTE risk assessments may be inconsistent. The objective of this study is to compare interobserver reliability for qualitative and quantitative VTE risk assessments in hospitalized trauma patients.

Methods

Study design

We conducted a retrospective medical record review of 40 randomly selected trauma patients (data only) admitted to a 448-bed urban level-I American College of Surgeons-verified adult trauma center from January 2013 to January 2014. Random selection was by the closed-envelope draw technique. Accordingly, 500 envelopes were made for patients seen and randomly selected. The sample was equally distributed between patients admitted to the floor and the intensive care unit. As this study had deidentified data that were used for study/review, the institutional review board (IRB) at SUNY Downstate exempted this study from full IRB review. Because of this, the IRB of SUNY Downstate Medical Center deemed patient consent also unnecessary.

Data analysis

Eight fourth-year medical students on surgical rotation performed the risk assessments using the deidentified medical records. Two forms for risk assessment were used, a qualitative screening and a quantitative screening. Students were instructed to carry out the following: 1) risk score assessment; 2) risk stratification – low, medium, and high risk; 3) identification of contraindications to pharmacological prophylaxis, whether absolute or relative; and 4) VTE prophylaxis plan. The qualitative screening comprised the point-based VTE protocol currently followed in our hospital (not an established risk assessment), wherein the students had to identify the medical conditions associated with risk for VTE, contraindications to pharmacological prophylaxis, and, based on their assessment, choose the appropriate prophylaxis from the order set according to the risk (Figure 1). The quantitative method was a modified version of the Caprini score; students had to identify the risk factors, which in turn were given a particular score to be added to estimate the cumulative score. Patients were then classified to be at low (<2), medium (2–5), and high (>5) risk (Figure 2). Prophylaxis included early ambulation, enoxaparin, unfractionated heparin, and warfarin. Students were instructed on how to fill the assessment forms. Statistical analysis was performed by calculation of interclass correlation coefficient (ICC) based on a two-way mixed model. The composite of intraobserver and interobserver variabilities was determined.

Results

We excluded incomplete charts from the final sample. We also excluded one observer due to multiple incomplete assessments. The final sample thereby consisted of 35 patients assessed by seven observers for qualitative assessment and 37 charts assessed by eight observers for quantitative assessment.

Qualitative risk assessment

The final sample had 35 charts assessed by seven observers. Cronbach's alpha was measured to be 0.644. The ICC for this group was 0.845 (95% CI 0.753–0.911) (Figure 3).

Quantitative risk assessment

The final sample had 37 patients assessed by eight observers. Cronbach's alpha was determined to be 0.869 for this group, and ICC was determined to be 0.628 (95% CI 0.413–0.787) (Figure 4).

VTE PROPHYLAXIS SCREENING AND ORDERING FORM

Date _____ Time _____ Age _____ Weight _____ SCr _____ GFR _____ ml/min

MEDICAL CONDITIONS ASSOCIATED WITH RISK FOR VTE		
☐ Active malignancy	☐ Hormonal Replacement	☐ Nephrotic Syndrome
☐ Acute Chronic Lung Disease	☐ Impaired Mobility	☐ Obesity
☐ Age greater than 50 years	☐ Inflammatory Bowel Disease	☐ Prior History of VTE
☐ Central Venous Catheter	☐ Known Thrombophilic State	☐ Recent Postpartum & Immobile
☐ Congestive Heart Failure	☐ Moderate to Major Surgery	☐ Sepsis/Infection
☐ Dehydration	☐ Myeloproliferative	☐ Sickle Cell Disease
☐ Estrogen Contraception	☐ Myocardial Infarction	☐ Varicose veins /chronic stasis
CONTRAINDICATIONS TO PHARMACOLOGICAL PROPHYLAXIS FOR VTE		
ABSOLUTE	**RELATIVE (Weigh risk or benefit)**	**OTHER CONDITIONS**
☐ Active bleeding	☐ Intraocular surgery within 2 weeks	☐ Thrombocytopenia(HIT)
☐ Hemorrhagic Stroke	☐ GI/GU Bleed within 1 month	☐ Epidural/Spinal Catheter
☐ Head/Spinal Cord Trauma	☐ Intracranial Hemorrhage within 1 year	
Within 4 weeks	☐ Coagulation disorder	
☐ Anticoagulant allergy	☐ Post Op Bleeding concerns*	
☐ Medical contraindication	☐ End Stage Liver Disease	
☐ Surgical contraindication	☐ Intracranial Lesions	
	☐ PLT Count less than 50K	
	☐ Craniotomy within 2 weeks	
	☐ Hypertensive Urgency	
*Scheduled return to OR within the next 24 hours; major ortho; 24 hrs leeway; spinal cord or ortho spine; 7 days leeway; General surgery, status post transplant, post trauma admission: 48 hours leeway		
ORDER SET		
LOW RISK	MODERATE RISK	HIGH RISK
• Ambulatory patient without additional VTE risk factors	• Patients with Medical conditions associated with risk for VTE(above)	• Elective hip or knee arthroplasty • Actual spinal cord injury with paresis
• Minor surgery in patient without additional VTE risk factors	• Patients who aren't in either Low Risk or High Risk group	• Multiple major trauma • Abdominal/pelvic surgery for cancer
	Select one pharmacologic option	**Select one pharmacologic option**
☐ Early Ambulation	☐ **Enoxaparin 40mg q 24 hours** (only SCr less than 2.0mg% or GFR more than 30ml/min and no epidural catheter in place)	☐ **Enoxaparin 40mg q 24 hours** (only SCr less than 2.0mg% or GFR more than 30ml/min and no epidural catheter in place)
	☐ **UFH 5,000 units SQ q 8 hours**	☐ **Enoxaparin 30mg SQ q 12 hours** (knee replacement)
	☐ **UFH 5,000 units SQ q 12 hours** (only if wt under 50 kg or age over 75 years)	☐ **Warfarin _____mg PO daily** (target 2-3: hold if INR more than 30)
	OR	**OR**
	☐ **No pharmacologic prophylaxis** because of contraindication	☐ **UFH 5,000 units SQ q 8 hours** (only if SCr more than 2.0 or GFR less Than 30ml/min and Warfarin not an option
	PLUS	**OR**
	☐ GCS ☐ IPC	☐ **No pharmacologic prophylaxis** because of contraindication
		PLUS
		☐ GCS ☐ IPC

Figure 1 VTE prophylaxis screening and ordering form.

Abbreviations: VTE, venous thromboembolism; SCr, serum creatinine; GFR, glomerular filtration rate; GI/GU, gastrointestinal/urogenital; PLT, platelet; HIT, heparin-induced thrombocytopenia; OR, operating room; wt, weight INR, international normalized ratio; SQ, subcutaneous; PO, per os; IPC, intermittent pneumatic compression; GCS, graduated compression stockings; UFH, unfractionated heparin;q, every.

Discussion

PE resulting from DVT, collectively referred to as VTE, is the most common preventable cause of hospital death.[9] Despite the reality that hospitalized medical and surgical patients routinely have multiple risk factors for VTE, making the risk for VTE nearly universal among inpatients, large prospective studies continue to demonstrate that these preventive methods are significantly underutilized.[6,10,11–13] The Agency for Healthcare Research and Quality[9,15] calls thromboprophylaxis the "number one patient safety practice" against VTE. Current estimates suggest that only 30%–60% of patients at risk receive appropriate VTE prophylaxis. Prevention requires a reliable tool for risk stratification for the development of VTE, screening strategies, and effective prophylaxis to significantly reduce mortality in trauma patients. A study has shown that implementation of a mandatory computerized provider order entry-based clinical decision support tool significantly improved

Diagnostic section

1. Predisposing risk factors (scores are additive) = score A

Hypercoagulable states (thrombophilia) assign 3 points for each	Clinical risk factors (assign 1 point each unless otherwise noted)
Points ○ 3 Antiphospholipid syndrome (anticardiolipin antibody, lupus anticoagulant) ○ 3 Antithrombin deficiency ○ 3 Disorders of plaminogen or plasmin activation ○ 3 Dysfibrin ogenemia ○ 3 Elevated factor VII/normal CRP ○ 3 Factor V Leiden/activated protein C resistance ○ 3 Hyperhomocysteinemia ○ 3 Hyperviscosity syndrome ○ 3 Myeloproliferative disorders ○ 3 Protein C or S deficiency ○ 3 Prothombin gene mutation	Points ○ 1 Abnormal pulmonary function (COPD) ○ 1 Age 41–60 years ○ 2 Age 60–74 years ○ 3 Age 75 and above ○ 1 Collagen vascular disease ○ 1 Estrogen use (OC, HRT, tamoxifen) ○ 3 Heparin-induced thrombocytopenia (<3 months) ○ 3 History of DVT/PE ○ 1 History of recent surgery (<1 month) ○ 1 History of unexplained still-born infant or recurrent spontaneous abortion (>3 months) ○ 1 Inflammatory bowel disease ○ 3 Malignancy ○ 1 Nephrotic syndrome ○ 2 Obesity (BMI >25) ○ 3 Pregnancy or postpartum <1 month ○ 1 Varicose veins

2. Exposing risk factors (choose highest risk category) = score B

Assign 5 points	Assign 2 points	Assign 1 point
○ Acute spinal cord injury (<1 month) ○ Elective hip/knee arthroplasty ○ Hip, pelvis, or leg fracture (<1 month) ○ Multiple trauma (<1 month) ○ Stroke (<1 month)	○ Central venous access ○ Immobilizing plaster cast (<1 month) ○ Laparoscopic surgery (>45 minutes) ○ Major surgery (>45 minutes) ○ Patient confined to bed >72 hours	○ Acute myocardial infarction ○ Acute CHF exacerbation ○ Acute respiratory failure ○ Infection, serious ○ Medical patient at bed rest (<72 hours) ○ Minor surgery (<45 minutes)
Total score for any checked risk factors = 5	Total score for any checked risk factors = 2	Total score for any checked risk factors = 1

3. Total risk factor score = A__ + B__ =___

Figure 2 VTE risk assessment form.
Abbreviations: VTE, venous thromboembolism; CRP, C-reactive protein; COPD, chronic obstructive pulmonary disease; OC, oral contraceptive; HRT, hormone replacement therapy; DVT/PE, deep vein thrombosis/pulmonary embolism; BMI, body mass index; CHF, congestive heart failure.

compliance with VTE prophylaxis guidelines in hospitalized adult trauma patients.[14] Many risk assessment tools are available for estimating thromboembolism risk.[15] Examples are the Caprini score,[16,17] Padua score,[18] Wells score,[19,20] the risk assessment profile developed by Greenfield et al,[21] the revised Geneva score, and the simplified revised Geneva score.[22] No single risk assessment has been prospectively validated as being superior to others. Using an individualized, point-based protocol in the assessment process is a complex task and might contribute to variability in VTE prophylaxis-prescribing behavior. There are no published data on how reliably medical residents can perform risk assessment and prophylaxis using a point-based VTE risk assessment tool.[23] The relative inexperience of interns might lead to inconsistency and underutilization of VTE prevention strategies. It is necessary that a risk assessment tool that would reduce inconsistency among residents be utilized, thereby enabling them to order an effective prophylactic

Case processing summary

Cases	N	%
Valid	35	87.5
Excluded[a]	5	12.5
Total	40	100.0

[a]Listwise deletion based on all variables used in the procedure.

Reliability statistics

Cronbach's alpha	Number of items
0.644	7

Intraclass correlation coefficient

	Intraclass Correlation[a]	95% Confidence interval		*F*-test with true value 0			
		Lower bound	Upper bound	Value	*df*1	*df*2	Significance
Single measures	0.194[b]	0.091	0.345	2.806	34	204	0.000
Average measures	0.628[c]	0.413	0.787	2.806	34	204	0.000

Two-way mixed-effects model where people effects are random and measure effects are found

[a]Type A intraclass correlation ceefficients using absolute agreement decision.

[b]The estimator is the same, whether the interaction effect is present or not.

[c]This estimate is computed assuming the interaction effect is absent because it is not estimable otherwise.

Figure 3 Qualitative VTE risk assessment.
Abbreviations: VTE, venous thromboembolism; df, degrees of freedom.

measure. Studies have suggested that even with repetitive use of a VTE risk assessment tool, the aggregate resident interrater reliability is moderate for risk stratification and contraindications, with reliability being only fair for VTE plan.[24] Some have suggested that risk-appropriate VTE prophylaxis prescription varied dramatically among residents and that a substantial number of residents may habitually provide suboptimal care. Residents may be a more reliable target for quality improvement efforts.[25] Providing personal clinical effectiveness feedback, including data and peer-to-peer coaching, improves resident performance and results in significant reduction in harm for patients.[26]

In our study, we sought to compare interobserver reliability for qualitative and quantitative assessment in trauma patients and to determine whether qualitative or quantitative risk assessment is a better tool for residents to evaluate VTE risk, as these forms are often completed by first-year residents.

Limitations of this study include that we presumed that fourth-year medical students are equivalent to incoming first-year residents in terms of clinical experience, and risk assessment forms were completed by them. It would have been ideal if the observer pool consisted of incoming residents. Another limitation is that performance of the residents should have been compared to that of senior residents to determine the effect of formal training on resident performance. As most of the history and physical examinations are done by junior residents, and hence

Case processing summary

Cases	N	%
Valid	37	92.5
Excluded[a]	3	7.5
Total	40	100.0

[a]Listwise deletion based on all variables used in the procedure.

Reliability statistics

Cronbach's alpha	Number of items
0.869	8

Intraclass correlation coefficient

	Intraclass Correlation[a]	95% Confidence interval		*F*-test with true value 0			
		Lower bound	Upper bound	Value	*df*1	*df*2	Significance
Single measures	0.405[b]	0.276	0.580	7.613	38	252	0.000
Average measures	0.845[c]	0.753	0.911	7.613	38	252	0.000

Two-way mixed-effects model where people effects are random and measure effects are found

[a]Type A intraclass correlation ceefficients using absolute agreement decision.

[b]The estimator is the same, whether the interaction effect is present or not.

[c]This estimate is computed assuming the interaction effect is absent because it is not estimable otherwise.

Figure 4 Quantitative VTE risk assessment.
Abbreviation: VTE, venous thromboembolism.

the DVT risk assessment, ideally, the study should track incoming resident performance and evaluate which type of risk assessment has better patient outcomes. However, our aim was to see whether quantitative assessment gave better assessment of VTE risk and whether the interobserver reliability was optimal.

Conclusion

Quantitative VTE risk assessment has been shown to be more reliable than qualitative assessment, yet our findings suggest that quantitative interobserver reliability is suboptimal among fourth-year medical students to first-year residents. To optimize the accuracy of VTE risk stratification and appropriate prophylaxis, inexperienced clinicians should be formally trained to perform quantitative assessments. Qualitative VTE risk assessment is more challenging to use, and institutes should consider using the quantitative method for VTE risk assessment.

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Author contributions

All authors contributed toward data analysis, drafting, and revising the paper, and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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