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Eliminating Healthcare Disparities Via Mandatory Clinical Decision Support: The Venous Thromboembolism (VTE) Example

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Abstract

Background—All hospitalized patients should be assessed for VTE risk factors and prescribed appropriate prophylaxis. To improve best-practice VTE prophylaxis prescription for all hospitalized patients, we implemented a mandatory computerized clinical decision support (CCDS) tool. The tool requires completion of checklists to evaluate VTE risk factors and contraindications to pharmacologic prophylaxis, and then recommends the risk-appropriate VTE prophylaxis regimen.

Objectives—To examine the effect of a quality improvement intervention on race- and gender-based healthcare disparities across two distinct clinical services.

Research Design—Retrospective cohort study of a quality improvement intervention

Subjects—1942 hospitalized medical patients and 1599 hospitalized adult trauma patients

Measures—Proportion of patients prescribed risk-appropriate, best-practice VTE prophylaxis

Results—Racial disparities existed in prescription of best-practice VTE prophylaxis in the pre-implementation period between black and white patients on both the trauma (70.1% vs. 56.6%, p=0.025) and medicine (69.5% vs. 61.7%, p=0.015) services. After implementation of the CCDS tool, compliance improved for all patients and disparities in best-practice prophylaxis prescription between black and white patients were eliminated on both services: trauma (84.5% vs. 85.5%, p=0.99) and medicine (91.8% vs. 88.0%, p=0.082). Similar findings were noted for gender disparities in the trauma cohort.

Conclusions—Despite the fact that risk-appropriate prophylaxis should be prescribed equally to all hospitalized patients regardless of race and gender, practice varied widely prior to our quality improvement intervention. Our CCDS tool eliminated racial disparities in VTE prophylaxis

prescription across two distinct clinical services. Health information technology approaches to care standardization are effective to eliminate healthcare disparities.

Keywords

clinical decision support; venous thromboembolism; disparities

BACKGROUND

Race is shown to be a predictor of healthcare quality and outcomes in the United States.[1, 2] Several different mechanisms including institutional, systemic,[3, 4] and provider factors have been postulated to explain differences in quality. Many urban hospitals located in economically underprivileged areas serve a greater proportion of minority patients and have generally been associated with a lower quality of care.[3, 5, 6] A meta-analysis recently reported that black patients are more likely to experience worse outcomes after trauma.[7] Unconscious, or implicit, biases exist among clinicians[8] that may influence clinical decision making,[9] and may be a root cause of existing disparities in the provision of high quality healthcare.[10, 11]

Despite widespread recognition of the existence of healthcare disparities, effective solutions to eliminate these disparities have been an elusive goal for many years,[12,13] and few, if any, interventions have proven to be beneficial. Health information technology has been proposed as a possible theoretical solution.[14–16]

Venous thromboembolism (VTE), comprised of deep vein thrombosis and/or pulmonary embolism, is one of the most common causes of mortality among hospitalized patients.[17–20] While some VTE events are unavoidable,[21, 22] many can be prevented with universal risk assessment and prescription of risk-appropriate prophylaxis.[23–28] However, many patients do not receive risk-appropriate prophylaxis.[29–31] The Agency for Healthcare Research and Quality has stated that implementing strategies to improve VTE prophylaxis is one of the top patient safety practices that should be implemented[32, 33] and the “number one patient safety practice” to prevent in-hospital death.[18] Numerous tactics have been developed, with varying degrees of success.[34–36]

All hospitalized patients are at increased risk of developing VTE.[37] Irrespective of clinical condition, race, or gender, all patients should be assessed for VTE risk factors and prescribed risk-appropriate prophylaxis when they are admitted to the hospital. Computerized clinical decision support (CCDS) tools are an objective and reliable method to enhance clinical decision making. Using a mandatory CCDS tool, we have previously demonstrated significant improvements in prescription of risk-appropriate VTE prophylaxis and reduction in potentially preventable VTE.[38–41]

The purpose of this study is to examine the effect of a quality improvement (QI) intervention on healthcare disparities. We will examine subgroups of patients across two distinct clinical services to determine if our mandatory CCDS tool affects subgroups of patients who are prescribed risk-appropriate VTE prophylaxis.

METHODS

Setting

In December 2007, the Johns Hopkins Hospital implemented a mandatory service-specific CCDS VTE risk assessment tool into the provider order entry (POE) system for adult patients hospital-wide.[38] The Johns Hopkins Hospital is an academic medical and state-designated Level 1 trauma center in Baltimore, Maryland. Approval was obtained from the Johns Hopkins Institutional Review Board.

VTE order set

A mandatory, service-specific CCDS tool was developed to improve prescription of best-practice VTE prophylaxis for all hospitalized patients.[38, 39] When an admitting provider is writing the admission orders for any patient at our hospital, they must complete short checklists of VTE and bleeding risk factors. The tool then follows an evidence-based, service-specific algorithm to determine the patient's VTE risk as moderate, high, or very high, with or without contraindications for pharmacological prophylaxis. Based on the individual patient's risk stratum, the CCDS tool displays the recommended risk-appropriate VTE prophylaxis regimen to the admitting provider. Providers are not required to prescribe the CCDS suggested regimen but may opt-in to the recommendation.

Study Population

Two arms were included in this study, hospitalized adult trauma patients and internal medicine patients, to represent distinct clinical services with minimal overlap in clinical providers. Each arm uses data from previously published cohort studies within the same hospital, [39, 41] employing novel analyses to explore the impact of the intervention on the basis of race and gender.

The first arm included all patients admitted to the adult trauma service. Patients admitted in 2007 served as our pre-implementation group and were compared with the post-implementation group (patients admitted January 1, 2008 through December 31, 2010).[39] The second arm included all adult patients admitted to the internal medicine service during the month of November 2007 (the month immediately prior to implementation of the CCDS tool) and during the month of April 2010 (the last month prior to data collection for the study).[41]

Data collection

For each pre-implementation group, a single data abstracter reviewed patient charts to collect the following VTE-related variables: patient demographic information, VTE risk factors, contraindications to pharmacological prophylaxis, and written orders for prophylaxis (pharmacological and/or mechanical) within 24 hours of admission. For the post-implementation groups, these variables were extracted directly from the POE system and the trauma center registry (Collector Trauma Registry, Digital Innovation, Inc). Compliance with best-practice VTE prophylaxis in both the pre- and post-implementation groups was defined as adherence to our service-specific VTE prevention algorithm.[38, 39, 41] Race and

gender were determined based on documentation of patient self-identification collected by administrative personnel during hospitalization.

Statistical analysis

We compared prescription of best-practice prophylaxis between races and genders both in the pre-implementation and post-implementation periods using the two-sided chi square test. Mean age was compared using unpaired t-test, categorical variables were compared using two-sided Fisher's exact test, and median injury severity score, and median LOS were compared using Wilcoxon rank-sum test. A p-value of <0.05 was considered statistically significant. Statistical analyses were performed using STATA version 12.0 (Statacorp, College Station, TX).

RESULTS

1599 hospitalized adult trauma patients and 1942 hospitalized adult internal medicine patients met inclusion criteria. Within the trauma population, there were few Hispanic (n=68), Asian (n=3), Native American (n=1) and unreported ethnicity (n=33) patients. In the medicine cohort, similarly small numbers were noted [Hispanic (n=24), Asian (n=22), and unreported (n=39)]. Due to extremely low numbers we decided to analyze the two most common racial groups, black and white patients, only. The patient populations had a similar age, race, and gender distribution before and after implementation of the CCDS tool (Table 1).

Trauma Patients

Black trauma patients were younger (32.5 years vs. 46.5 years, $p<0.001$), disproportionately male (83.9% vs. 61.0%, $p<0.001$), more likely to present with penetrating trauma (57.5% vs. 9.9%, $p<0.001$), and less likely to present with one or more risk factors for VTE (77.8% vs. 82.8%, $p=0.047$) compared with white trauma patients (Table 2). Black trauma patients had a longer length of stay and were more often male in the pre-implementation group than the post-implementation group. There were no differences among white trauma patients before and after implementation (Table 3).

In the pre-implementation period, the proportion of trauma patients prescribed risk-appropriate VTE prophylaxis was significantly higher for black (70.1%) than white (56.6%) patients ($p=0.025$). After implementation, prescription of risk-appropriate prophylaxis significantly increased for all patients [black (84.5%) and white (85.5%)], and there were no differences between racial groups ($p=0.99$) (Figure 1A).

Before implementation, the proportion of male trauma patients prescribed risk-appropriate VTE prophylaxis was significantly higher (69.5% vs. 55.1%, $p=0.045$). After implementation, compliance increased significantly for both male (85.7%) and female (81.2%) patients and there were no differences between groups ($p=0.078$) (Figure 2A).

Internal Medicine Patients

Between racial groups, black internal medicine patients were younger (54.0 vs. 58.1 years, p<0.001) and less frequently male (48.6% vs. 54.5%, p=0.012). In the pre-implementation period, significantly more white than black patients (68.6% vs. 61.0%, p=0.017) had at least one major VTE risk factor (Table 2). White patients were younger in the pre-implementation group (60.4 vs. 56.9 years, p=0.004). Fewer black (54.7% vs. 61.0%, p=0.034) and white (68.6% vs. 55.0%, p<0.001) patients presented with a major risk factor in the post-implementation period (Table 3).

Before implementation, significantly more black patients were prescribed risk-appropriate VTE prophylaxis than white patients (69.5% vs. 61.7%, p=0.015). After implementation, compliance increased significantly for both black (91.8%) and white (88.0%) patients and there were no differences between races (p=0.082) (Figure 1B). There were no differences in risk-appropriate VTE prophylaxis prescription between genders, before or after implementation (Figure 2B).

DISCUSSION

Implementation of a mandatory CCDS tool eliminated race-based healthcare disparities in risk-appropriate VTE prophylaxis prescription for hospitalized medical and trauma patients. Gender disparities in best-practice VTE prophylaxis prescription were also eliminated by the same CCDS tool. These findings highlight the potential of health information technology approaches to improve the quality of care for all patients and eradicate healthcare disparities. The intended purpose of this QI intervention was to improve the care for all hospitalized patients rather than specifically targeting subgroups of patients who were receiving suboptimal care. We recognize that eliminating disparities in providing best-practice VTE prevention was an unintended consequence of this intervention. However, disparities elimination falls under the general umbrella of QI and has been a goal of health information technologies. Previous studies of QI interventions that have been shown to lessen or eliminate disparities focused narrowly on certain patient populations, such as patients with diabetes[42] or myocardial infarction,[43] or patients with cancer undergoing surgery.[44] Our findings demonstrate the power of broadly applied QI interventions targeting all hospitalized patients and represent another beneficial consequence of QI efforts in healthcare.

It remains unclear which specific factors are most strongly associated with healthcare disparities and may influence disparities in real-world decision making. One possible explanation is that black patients are known to have undiagnosed co-morbidities and be at risk for cardiovascular complications, [45] including VTE. Providers who were making clinical decisions entirely independently, without the use of a standardized mandatory decision support tool, may have chosen to prescribe more aggressive VTE prophylaxis regimens for these black patients to overcompensate for these issues. Providers may not necessarily believe that all patients require VTE prophylaxis and this misguided, subconscious calculation of the risk benefit ratio did not favor prescribing VTE prophylaxis for white patients. A recent study using an Implicit Association Test, and a series of clinical vignettes applied to first-year medical students showed an overall preference for white individuals but the clinical vignette responses were not associated with patient race.[11] While

these findings are important insights to clinician perceptions, they represent simulated decision making in controlled environments rather than real world clinical decisions for actual hospitalized patients. However, our study demonstrates that a well-integrated CCDS tool transcends those factors, regardless of the causal pathway, and is capable of modifying the decisional behavior that may create healthcare disparities by reducing the impact of bias.

Data show that black patients more commonly receive lower quality care than white patients[1, 46] and efforts to reduce healthcare disparities have often failed. Therefore we were somewhat surprised to find that white hospitalized patients were less likely to be prescribed risk-appropriate VTE prophylaxis during the pre-implementation period. However, previous studies have demonstrated better outcomes for black patients compared with white patients undergoing kidney dialysis[47] or survival after trauma.[48] Similar to what has been reported in these studies, age or clinical condition may be confounding variables which requires further exploration in a larger dataset. Another potential explanation was identified in a study where black hospitalized patients rated their interaction with prescribers as less participatory than whites.[49] Consequently, it is possible that shared decision making between white patients and prescribers resulted in suboptimal VTE prophylaxis.

We recognize that our study has several limitations. First, we were not able to evaluate variation among individual types of clinicians (i.e. physicians, nurse practitioners), limiting our ability to evaluate the impact of experience on healthcare disparities. However, our findings were well-conserved across two very different clinical services indicating that these disparities are neither random nor attributable to select prescribers within a single clinical service. Second, our limited sample size did not allow for multivariable analysis to elucidate other associations with the observed disparity. Third, our results were demonstrated using only a single evidence-based practice (VTE prophylaxis) at a single academic medical center. Nevertheless, the CCDS intervention eliminated disparities among a diverse group of medical and surgical patients, proving its effectiveness in a “real-world” setting. Finally, there were differences in the number of patients who presented with major VTE risk factors. However, risk-appropriate prophylaxis is determined on an individual patient basis, so these differences should not have affected the decision making process.

When designing CCDS tools to impact provider behavior, it is important to consider how the tool will be integrated into the clinical and decisional workflow.[50] Our mandatory CCDS tool focuses clinician attention on completing a task and forces VTE risk assessment for every patient. Passive CCDS tools that do not require provider action have been shown to be less effective at impacting provider behavior[51] and will likely have less impact on eliminating disparities in care delivery.

Despite repeated evidence of the existence of healthcare disparities, we do not know of previous interventions that have been as successful at eliminating these disparities. Mandatory CCDS tools reduce the burden of complex and repetitive decision making, while promoting best practice care for all patients equally.

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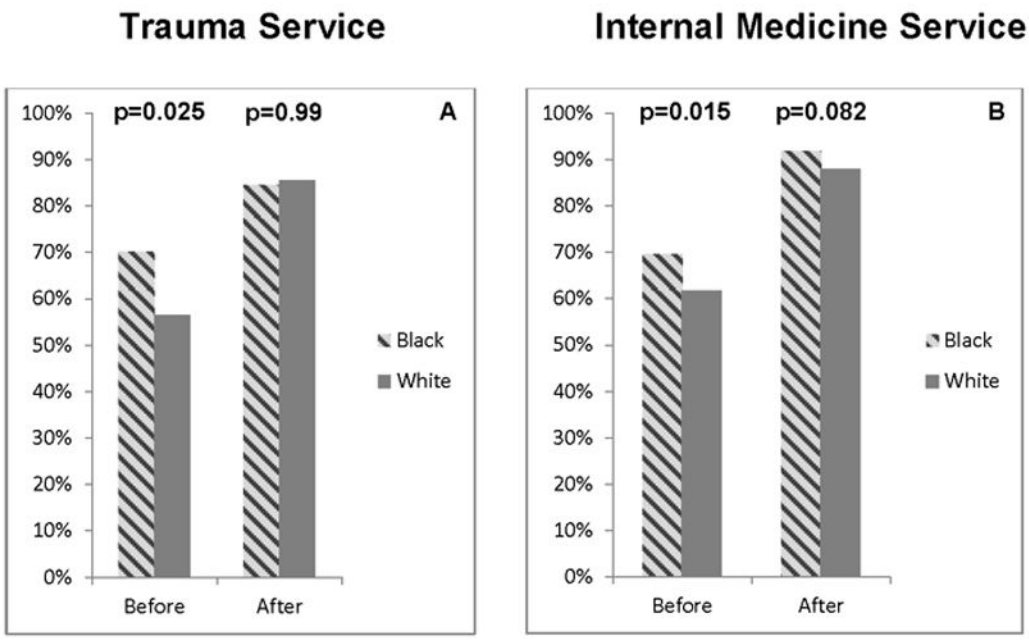

Figure 1.

compares the rates for risk-appropriate VTE prophylaxis prescription for black (hashed gray) and white (dark gray) patients before and after implementation of the mandatory computerized provider order entry (CPOE) clinical decision support (CDS) VTE module on the trauma (A) and internal medicine (B) services. The proportion of patients prescribed best-practice VTE prophylaxis increased significantly ($p<0.05$) within both race categories for both trauma and internal medicine patients.

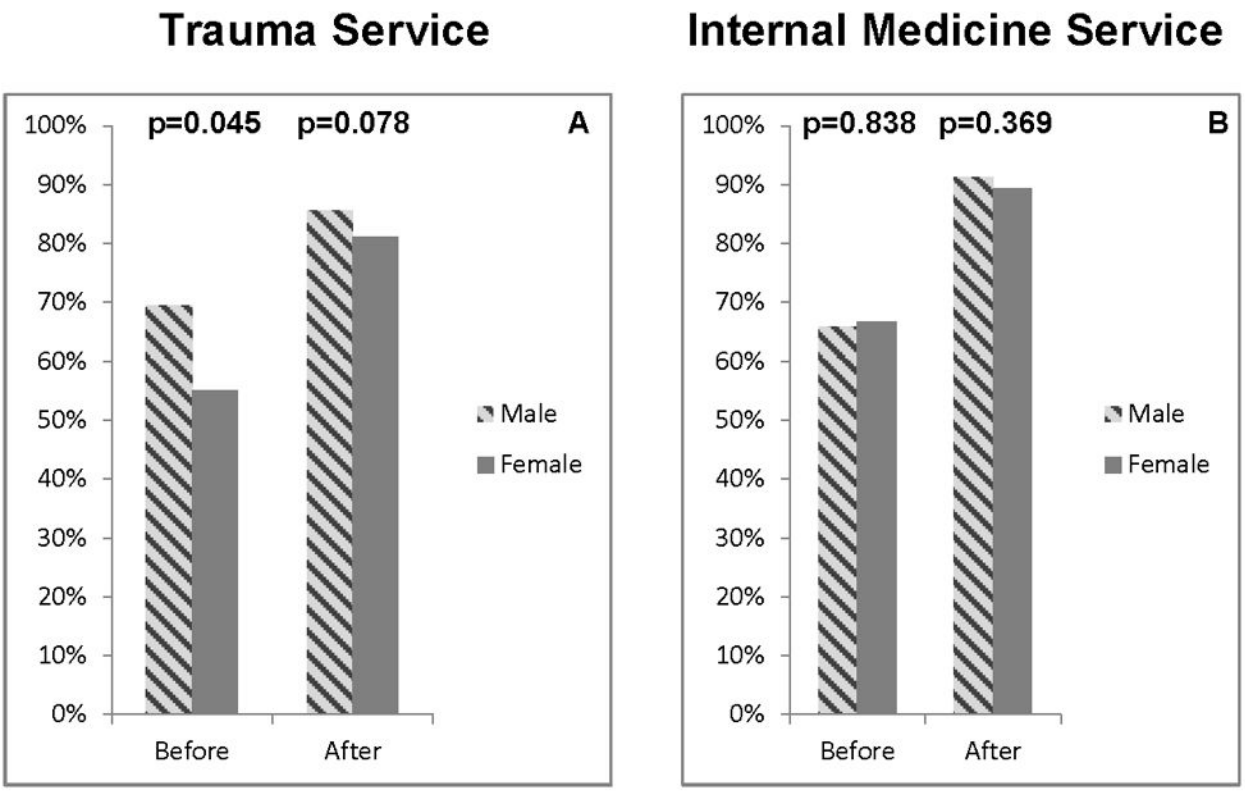

Figure 2.

compares the rates for risk-appropriate VTE prophylaxis prescription for female (dark gray) and male (hashed gray) hospitalized patients before and after of the mandatory CPOE clinical decision support VTE module was implemented on the trauma (A) and internal medicine (B) services. The proportion of patients prescribed best-practice VTE prophylaxis increased significantly ($p<0.05$) within both gender categories for both trauma and internal medicine patients.

Table 1

Demographics of included hospitalized adult trauma and internal medicine patients

	Pre- implementation	Post- implementation	p-value
Trauma	**N=374**	**N=1120**	
Mean age (SD), years	36.2 (18.1)	35.9 (17.4)	0.775
Black, n (%)	291 (77.8)	831 (74.1)	0.168
Male, n (%)	305 (81.6)	863 (77.1)	0.071
Median ISS (IQR)	9 (4–16)	9 (4–16)	0.179
Blunt Trauma, n (%)	192 (51.3)	620 (55.4)	0.187
GCS<15, n (%)	57 (15.2)	132 (11.8)	0.088
Median LOS (IQR), days	4 (2–8)	4 (2–7)	0.009
Any VTE Risk Factor, n (%)	291 (77.8)	890 (79.5)	0.509
Internal Medicine	**N=959**	**N=898**	
Mean age (SD), years	56.1 (17.1)	55.2 (16.3)	0.247
Black, n (%)	567 (59.1)	547 (60.9)	0.448
Male, n (%)	481 (50.1)	465 (51.8)	0.486
Median LOS (IQR), days	3 (2–6)	3 (2–6)	0.249
Any VTE Risk Factor, n (%)	615 (64.1)	492 (54.8)	<0.001

IQR: interquartile range; ISS: injury severity score; LOS: length of stay; SD: standard deviation; VTE: venous thromboembolism

Table 2

Clinical characteristics of included hospitalized adult trauma and internal medicine patients before and after implementation of the computerized clinical decision support tool, by race

	Pre-implementation			Post-implementation		
	Black	**White**	**p-value**	**Black**	**White**	**p-value**
Trauma	**n=291**	**n=83**		**n=831**	**n=289**	
Mean age (SD), years	32.8 (15.3)	47.9 (21.8)	<0.001	32.4 (14.6)	46.1 (20.6)	<0.001
Male, n (%)	256 (88.0)	49 (59.0)	<0.001	685 (82.4)	178 (61.6)	<0.001
Median ISS (IQR)	9 (4–16)	9 (4–17)	0.58	9 (4–16)	9 (4–16)	0.730
Blunt Trauma, n (%)	113 (38.8)	79 (95.2)	<0.001	364 (43.8)	256 (88.6)	<0.001
GCS<15, n (%)	48 (16.5)	9 (10.8)	0.23	105 (12.6)	27 (9.3)	0.140
Median LOS (IQR), days	5 (3–8)	4 (2–6)	0.053	4 (2–8)	4 (2–8)	0.182
Any VTE Risk Factor, n (%)	226 (77.7)	65 (78.3)	0.99	647 (77.9)	243 (84.1)	0.028
Internal Medicine	**n=567**	**n=392**		**n=547**	**n=351**	
Mean age (SD), years	54.0 (16.4)	60.4 (16.3)	<0.001	54.0 (15.9)	56.9 (16.7)	0.009
Male, n (%)	255 (45.0)	226 (57.7)	<0.001	286 (52.3)	179 (51.0)	0.732
Median LOS (IQR), days	3 (2–6)	3 (2–7)	0.625	3 (2–6)	4 (2–6)	0.853
Any VTE Risk Factor, n (%)	346 (61.0)	269 (68.6)	0.017	299 (54.7)	193 (55.0)	0.945

IQR: interquartile range; ISS: injury severity score; LOS: length of stay; SD: standard deviation; VTE: venous thromboembolism

Table 3

Clinical characteristics of included hospitalized adult trauma and internal medicine patients, by race before (pre-) and after (post-) implementation

	Black Patients			White Patients		
	Pre	**Post**	**p-value**	**Pre**	**Post**	**p-value**
Trauma	**n=291**	**n=831**		**n=83**	**n=289**	
Mean age (SD), years	32.8 (15.3)	32.4 (14.6)	0.691	47.9 (21.8)	46.1 (20.6)	0.489
Male, n (%)	256 (88.0)	685 (82.4)	0.026	49 (59.0)	178 (61.6)	0.703
Median ISS (IQR)	9 (4–16)	9 (4–16)	0.197	9 (4–17)	9 (4–16)	0.727
Blunt Trauma, n (%)	113 (38.8)	364 (43.8)	0.148	79 (95.2)	256 (88.6)	0.095
GCS<15, n (%)	48 (16.5)	105 (12.6)	0.112	9 (10.8)	27 (9.3)	0.676
Median LOS (IQR), days	5 (3–8)	4 (2–8)	p<0.001	4 (2–6)	4 (2–8)	0.410
Any VTE Risk Factor, n (%)	226 (77.7)	647 (77.9)	0.935	65 (78.3)	243 (84.1)	0.248
Internal Medicine	**n=567**	**n=547**		**n=392**	**n=351**	
Mean age (SD), years	54.0 (16.4)	54.0 (15.9)	0.99	60.4 (16.3)	56.9 (16.7)	0.004
Male, n (%)	255 (45.0)	286 (52.3)	0.016	226 (57.7)	179 (51.0)	0.077
Median LOS (IQR), days	3 (2–6)	3 (2–6)	0.533	3 (2–7)	4 (2–6)	0.319
Any VTE Risk Factor, n (%)	346 (61.0)	299 (54.7)	0.034	269 (68.6)	193 (55.0)	p<0.001

IQR: interquartile range; ISS: injury severity score; LOS: length of stay; SD: standard deviation; VTE: venous thromboembolism