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Assessment of compliance with DVT prophylaxis guidelines in orthopedic trauma in an East Indian population

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ABSTRACT

Background: Venous thromboembolism (VTE) remains a significant preventable cause of morbidity and mortality in orthopedic trauma patients. Despite established guidelines, compliance with VTE prophylaxis protocols is often suboptimal. This study assessed adherence to DVT prophylaxis guidelines in orthopedic trauma patients at a tertiary care center in Eastern India.

Methods: A prospective observational audit was conducted over three months involving 30 consecutive orthopedic trauma patients requiring operative management. Compliance with key process measures was evaluated based on NICE NG89 guidelines: VTE risk assessment within 24 hours of admission, prophylaxis initiation within 14 hours, 24-hour risk reassessment, appropriate agent selection, mechanical prophylaxis utilization, and inpatient dose administration.

Results: The mean age was 42.3±16.8 years, with 73.3% males. Initial VTE risk assessment was documented in 76.7% of patients, but only 26.7% underwent 24-hour reassessment. Pharmacological prophylaxis was appropriately prescribed in 89.3% of indicated patients; however, only 44.0% received it within the recommended 14-hour timeframe. Mechanical prophylaxis was utilized in 46.7% of patients, with significantly higher rates in ICU admissions (100%) versus ward patients (27.3%, $p<0.001$). Inpatient dose compliance was 87.6%, with 48.0% of patients missing at least one dose. Complete guideline-concordant care was achieved in only 13.3% of patients. One symptomatic DVT occurred (3.3%) with no major bleeding complications.

Conclusion: Significant gaps exist in VTE prophylaxis compliance, particularly in 24-hour reassessment, timely initiation, and mechanical prophylaxis use. Targeted quality improvement interventions including structured documentation, automated reminders, and staff education are needed to optimize prophylaxis delivery in orthopedic trauma patients.

KEYWORDS: Deep vein thrombosis; venous thromboembolism; prophylaxis; orthopedic trauma; guideline compliance; quality improvement; Eastern India

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INTRODUCTION

Venous thromboembolism (VTE), encompassing deep vein thrombosis (DVT) and pulmonary embolism (PE), represents one of the most significant preventable causes of morbidity and mortality among hospitalized patients. Orthopedic trauma patients occupy the extreme high-risk end of this spectrum, with historical studies documenting venographic DVT rates of 40 to 60 percent following major lower limb orthopedic procedures in the absence of prophylaxis, symptomatic VTE occurring in approximately 2 to 5 percent of patients, and fatal PE in about 0.1 to 0.5 percent of cases.[1] While contemporary chemoprophylaxis regimens have substantially reduced the incidence of symptomatic events, the residual risk remains clinically significant, particularly among trauma patients who frequently present with polytrauma, prolonged immobilization, and require multiple surgical interventions.

The multifactorial nature of VTE risk in orthopedic trauma patients reflects the convergence of patient-specific factors—including advanced age, obesity, prior VTE history, malignancy, hormonal therapy, and inherited thrombophilia—with trauma-related determinants such as long bone or pelvic fractures, spinal cord injury, extended periods of immobility, multiple operative

procedures, and intensive care unit admission.[1] This constellation of risk factors has prompted multiple national and international organizations to develop comprehensive guidelines for systematic risk assessment and prophylaxis implementation. The American College of Chest Physicians (ACCP) ninth edition antithrombotic guidelines recommend pharmacological prophylaxis with low molecular weight heparin (LMWH) as first-line therapy for major orthopedic procedures, with alternative agents including fondaparinux, low-dose unfractionated heparin, adjusted-dose warfarin, aspirin, or intermittent pneumatic compression devices, typically administered for a minimum of 10 to 14 days and preferably extended to 35 days.[2] The National Institute for Health and Care Excellence (NICE) guideline NG89 emphasizes time-sensitive process measures, stipulating that all patients undergo documented VTE risk assessment on admission, with pharmacological prophylaxis initiated within 14 hours of admission when VTE risk outweighs bleeding risk, and mandatory reassessment at 24 hours and whenever clinical circumstances change.[3] More recently, the International Consensus Meeting on VTE (ICM VTE) published trauma-specific recommendations in 2022, advocating for LMWH as the most appropriate primary pharmacological prophylaxis in multiply-injured orthopedic trauma patients when not contraindicated, with emphasis on early initiation once hemostasis is reasonably secured and combination with mechanical devices in very high-risk populations.[4]

Despite the widespread availability and dissemination of these evidence-based guidelines, real-world data consistently demonstrate incomplete adherence to recommended prophylaxis protocols, with substantial variation observed across individual surgeons, clinical services, and healthcare institutions.[5] Global audits examining VTE prophylaxis practices have revealed that a significant proportion of high-risk patients fail to receive guideline-recommended prevention strategies, attributed to inadequate risk assessment, limited guideline awareness, and insufficient systems for prescribing and monitoring prophylaxis.[5] Within acute orthopedic and trauma settings specifically, compliance audits have documented variable performance. Watts and Grant's quality improvement project in acute orthopedic admissions in the United Kingdom reported baseline compliance rates of approximately 70 percent for VTE risk assessment on admission, with appropriate prophylaxis prescribing falling below optimal levels, though targeted interventions including staff education and dedicated risk assessment proformas achieved near-complete compliance on re-audit.[6] Similarly, examination of VTE prophylaxis in emergency trauma admissions revealed initially poor compliance with guideline-recommended risk assessment and prescription, with improvement following protocol implementation and education, though persistent gaps remained.[7]

Recent investigations have identified critical deficiencies in specific components of the prophylaxis pathway. A 2024 study evaluating compliance with 24-hour VTE risk reassessment using electronic health records found generally low reassessment rates across hospital specialties, with one audit of 400 orthopedic patients reporting zero percent completion of the 24-hour reassessment field despite high rates of initial risk assessment.[10] This pattern suggests that while orthopedic and trauma teams may demonstrate reasonable compliance with initial risk assessment and prophylaxis prescription, they frequently fail to perform ongoing reassessment and documentation. Even within the controlled environment of a randomized trial at a level I trauma center, Haac and colleagues documented that approximately 41 to 43 percent of orthopedic trauma patients with operative extremity or pelvic fractures missed at least one dose of prescribed prophylaxis during their inpatient stay, with missed doses commonly occurring during perioperative periods.[8] Furthermore, clinical vignette surveys of orthopedic trauma surgeons have revealed striking heterogeneity in both prophylactic agent selection and duration of therapy across similar clinical scenarios, indicating that local protocols and individual preferences substantially influence decision-making in the absence of strict guideline adherence.[9]

The determinants of non-compliance are multifactorial and include poor or inconsistent documentation, lack of awareness or confusion regarding guideline content, concerns about bleeding risk and medico-legal implications, systemic process failures related to staff rotation and inadequate prompting mechanisms, and deficiencies in reassessment protocols.[5,10] While the absolute impact of non-compliance on clinical outcomes requires further investigation, observational data suggest associations between missed prophylaxis doses and higher VTE rates in trauma populations, and medicolegal reviews of fatal or severe VTE events frequently identify absent risk assessments, failure to commence prophylaxis, or inadequate reassessment as preventable gaps in care.[8]

Despite the substantial body of evidence supporting VTE prophylaxis in orthopedic trauma and the existence of comprehensive international guidelines, there is a paucity of published data examining real-world compliance with these recommendations in Indian tertiary care centers. The majority of Indian literature has focused on intensive care unit or general surgical populations rather than orthopedic trauma services specifically.[11] Furthermore, practice patterns and systemic barriers to guideline implementation may differ substantially across healthcare systems and geographic regions, necessitating local assessment to identify institution-specific opportunities for quality improvement.

The present study was therefore designed to assess compliance with established DVT prophylaxis guidelines among orthopedic trauma patients admitted to a tertiary care center in Eastern India. By quantifying adherence to key process measures including timely risk assessment, appropriate prophylaxis initiation, agent selection, mechanical prophylaxis utilization, and 24-hour reassessment, this audit aims to identify modifiable system-level barriers and establish baseline performance metrics that can guide targeted quality improvement interventions and inform future multi-center investigations in this underrepresented geographic population.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational audit was conducted in the Department of Orthopedics at a tertiary care teaching hospital in Eastern India over a period of three months from July 2024 to September 2024. The study was designed to assess compliance with

established DVT prophylaxis guidelines, specifically the National Institute for Health and Care Excellence (NICE) guideline NG89 and recommendations from the American College of Chest Physicians (ACCP) and International Consensus Meeting on VTE (ICM VTE) for trauma patients.[2,3,4] The study protocol was approved by the Institutional Ethics Committee, and informed consent was obtained from all participants or their legally authorized representatives.

Study Population

Inclusion Criteria

Consecutive patients admitted to the orthopedic trauma service who met the following criteria were enrolled:

- Age 16 years or above
- Admission with acute orthopedic trauma requiring hospitalization
- Operative management planned or performed for fracture fixation or related procedures
- Hospital stay of at least 48 hours to allow assessment of initial and 24-hour reassessment compliance

Exclusion Criteria

Patients were excluded if they:

- Were already on therapeutic anticoagulation for pre-existing conditions (e.g., atrial fibrillation, previous VTE)
- Had contraindications to both pharmacological and mechanical prophylaxis documented at admission
- Were transferred from other institutions with prophylaxis already initiated and inadequate documentation of initial assessment
- Expired or were discharged within 24 hours of admission
- Declined consent for participation

A total of 30 patients meeting the eligibility criteria were enrolled consecutively during the study period.

Data Collection

A standardized data collection proforma was developed based on key process measures identified in NICE NG89 and prior compliance audits in acute orthopedic settings.[3,6,7] Two trained research assistants reviewed patient medical records, nursing charts, medication administration records, and operative notes to extract relevant information. Data collection was performed daily during the patient's hospital stay and verified by the principal investigator.

Demographic and Clinical Variables

The following baseline information was recorded for each patient:

- Age, gender, and body mass index
- Mechanism of injury (road traffic accident, fall from height, assault, other)
- Type and location of fracture(s)
- Injury Severity Score for polytrauma patients
- Presence of VTE risk factors: prior history of VTE, active malignancy, obesity (BMI >30 kg/m²), hormonal therapy, known thrombophilia, admission to intensive care unit, spinal cord injury
- Presence of bleeding risk factors: active bleeding, recent intracranial hemorrhage, coagulopathy, thrombocytopenia, concurrent antiplatelet therapy

Compliance Process Measures

In accordance with NICE NG89 recommendations and methodology employed in prior audits,[3,6,10] the following compliance metrics were assessed:

1. VTE Risk Assessment on Admission

- Presence of documented VTE risk assessment within 24 hours of hospital admission
- Completion of all required fields in the institutional VTE risk assessment form (if applicable)
- Documentation of individual risk factors

2. Timing of Prophylaxis Initiation

- Time from admission to first dose of pharmacological prophylaxis (when indicated)
- Compliance with NICE NG89 recommendation for initiation within 14 hours of admission[3]
- Documentation of reasons for delayed initiation or non-initiation.
- Delays due to active bleeding risk or pending surgerys were considered acceptable under guideline recommendations and were not categorized as inappropriate practice.

3. Appropriateness of Prophylaxis Agent Selection

- Type of pharmacological prophylaxis prescribed: low molecular weight heparin (LMWH), unfractionated heparin, fondaparinux, aspirin, or other
- Dose and frequency of administration
- Concordance with guideline recommendations for patient's risk profile[2,3,4]

4. Mechanical Prophylaxis Utilization

- Use of graduated compression stockings, intermittent pneumatic compression devices, or foot pumps
- Timing of mechanical prophylaxis initiation
- Documentation of contraindications to mechanical prophylaxis (e.g., peripheral vascular disease, severe leg injury)

5. 24-Hour VTE Risk Reassessment

- Presence of documented reassessment of VTE risk at 24 hours after admission
- Reassessment following surgical intervention
- Reassessment with any change in clinical condition
- Documentation of modifications to prophylaxis regimen based on reassessment

6. Inpatient Compliance with Prescribed Prophylaxis

- Total number of prophylaxis doses prescribed during hospital stay
- Number of missed doses
- Reasons for missed doses (patient refusal, held for procedure, medication unavailable, other)
- Percentage of prescribed doses actually administered, calculated as per Haac et al methodology[8]

7. Documentation Quality

- Presence of written prophylaxis plan in admission notes
- Clear documentation of contraindications when prophylaxis not given
- Evidence of communication regarding VTE prophylaxis in handover notes

Outcome Measures

Primary Outcome

The primary outcome was the proportion of patients who received complete guideline-concordant VTE prophylaxis, defined as:

- Documented risk assessment within 24 hours of admission
- Appropriate pharmacological and/or mechanical prophylaxis initiated within 14 hours (when indicated)
- Documented 24-hour reassessment
- At least 90% of prescribed inpatient doses administered

Secondary Outcomes

Secondary outcomes included:

- Individual compliance rates for each process measure
- Identification of common barriers to compliance (documentation gaps, system failures, clinical contraindications)
- Comparison of compliance rates between different injury patterns (isolated extremity fractures vs. polytrauma)
- Rate of symptomatic VTE events during hospital admission

Statistical Analysis

Descriptive statistics were used to characterize the study population and summarize compliance metrics. Continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on distribution normality assessed by Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages.

Compliance rates for each process measure were calculated with 95% confidence intervals using the Wilson score method. Comparisons between subgroups (e.g., isolated fractures vs. polytrauma, ICU vs. ward patients) were performed using Fisher's exact test for categorical variables and Mann-Whitney U test for continuous variables, given the small sample size.

A p-value of less than 0.05 was considered statistically significant. All statistical analyses were performed using [specify software: SPSS version XX, GraphPad Prism, or R statistical software].

Quality Assurance

To ensure data accuracy and completeness:

- Data collection forms were pilot-tested on five patients prior to study commencement
- Regular meetings were held between research assistants and the principal investigator to resolve ambiguities in documentation interpretation
- A random sample of 20% of cases underwent independent dual data extraction to assess inter-rater reliability
- Missing data were clearly documented, and attempts were made to retrieve information from alternate sources (verbal communication with treating team, nursing records)

RESULTS

Study Population Characteristics

During the three-month study period, a total of 35 orthopedic trauma patients were screened for eligibility. Of these, 30 patients met the inclusion criteria and were enrolled in the study. Three patients were excluded due to pre-existing therapeutic anticoagulation, one patient was transferred with incomplete documentation, and one patient was discharged within 24 hours. All 30 enrolled patients completed the study protocol, and no patients were lost to follow-up during their hospital admission.

The baseline demographic and clinical characteristics of the study population are presented in Table 1. The mean age of participants was 42.3 ± 16.8 years (range: 18-76 years), with a male predominance (73.3%, n=22). The majority of injuries resulted from road traffic accidents (60.0%, n=18), followed by falls from height (26.7%, n=8), and other mechanisms (13.3%, n=4). Isolated lower extremity fractures were present in 16 patients (53.3%), while 14 patients (46.7%) sustained polytrauma with multiple injuries. The median Injury Severity Score for polytrauma patients was 18 (IQR: 12-24). The mean length of hospital stay was 8.6 ± 4.2 days (range: 3-21 days).

Table 1: Baseline Demographic and Clinical Characteristics of Study Population (N=30)

Characteristic	Value
Demographics	
Age (years), mean ± SD	42.3 ± 16.8
Age range (years)	18 - 76
Male gender, n (%)	22 (73.3)
Body Mass Index (kg/m²), mean ± SD	24.8 ± 3.6
Obesity (BMI >30 kg/m²), n (%)	4 (13.3)
Mechanism of Injury	
Road traffic accident, n (%)	18 (60.0)
Fall from height, n (%)	8 (26.7)
Other mechanisms, n (%)	4 (13.3)
Injury Pattern	
Isolated extremity fracture, n (%)	16 (53.3)
Polytrauma, n (%)	14 (46.7)
Injury Severity Score*, median (IQR)	18 (12-24)
Fracture Location	
Lower limb fractures, n (%)	24 (80.0)
- Femur	10 (33.3)
- Tibia/fibula	9 (30.0)
- Ankle	5 (16.7)
Upper limb fractures, n (%)	6 (20.0)
Pelvic fractures, n (%)	5 (16.7)
Spinal fractures, n (%)	3 (10.0)
VTE Risk Factors	
Age >60 years, n (%)	6 (20.0)
Previous VTE history, n (%)	0 (0.0)
Active malignancy, n (%)	1 (3.3)
ICU admission, n (%)	8 (26.7)
Spinal cord injury, n (%)	2 (6.7)
Multiple surgeries, n (%)	7 (23.3)
Bleeding Risk Factors	
Intracranial hemorrhage, n (%)	2 (6.7)
Active bleeding at admission, n (%)	3 (10.0)
Thrombocytopenia (<100,000/μL), n (%)	1 (3.3)
Clinical Outcomes	
Length of hospital stay (days), mean ± SD	8.6 ± 4.2
ICU stay (days)*, median (IQR)	4 (2-6)

*For polytrauma patients (n=14) and ICU admissions (n=8) respectively. SD: Standard deviation; IQR: Interquartile range; VTE: Venous thromboembolism; ICU: Intensive care unit

Fig 1: Bar chart showing distribution of injury mechanisms and fracture locations

Compliance with VTE Risk Assessment

Initial Risk Assessment on Admission

Of the 30 patients enrolled, 23 patients (76.7%, 95% CI: 57.7-90.1%) had documented VTE risk assessment within 24 hours of hospital admission. The remaining 7 patients (23.3%) had no documented risk assessment during this timeframe. Among the 23 patients with documented assessment, the institutional VTE risk assessment form was completely filled in 18 cases (78.3%), while 5 cases (21.7%) had incomplete documentation with missing fields.

Stratification by injury severity revealed that compliance with initial risk assessment was higher in polytrauma patients compared to those with isolated fractures (12/14, 85.7% vs. 11/16, 68.8%), though this difference did not reach statistical significance (p=0.41, Fisher's exact test). Similarly, patients admitted to the ICU had higher rates of documented risk assessment compared to ward admissions (7/8, 87.5% vs. 16/22, 72.7%, p=0.65).

24-Hour Risk Reassessment

Compliance with 24-hour VTE risk reassessment was markedly lower than initial assessment. Only 8 patients (26.7%, 95% CI: 12.3-45.9%) had documented reassessment at 24 hours after admission. Among the 27 patients who underwent surgical intervention during their hospital stay, post-operative reassessment was documented in only 11 cases (40.7%). Reassessment following any change in clinical condition was documented in 6 out of 15 applicable cases (40.0%).

Table 2: Compliance with VTE Risk Assessment Process Measures (N=30)

Assessment Measure	Compliance n (%)	95% CI
Initial VTE Risk Assessment		
Documented within 24 hours of admission	23 (76.7)	57.7 - 90.1
Complete institutional form	18/23 (78.3)	56.3 - 92.5
Documentation of individual risk factors	20/23 (87.0)	66.4 - 97.2
By Patient Group		
Isolated fractures (n=16)	11 (68.8)	41.3 - 89.0
Polytrauma (n=14)	12 (85.7)	57.2 - 98.2
ICU admission (n=8)	7 (87.5)	47.3 - 99.7
Ward admission (n=22)	16 (72.7)	49.8 - 89.3
24-Hour Risk Reassessment		
Documented 24-hour reassessment	8 (26.7)	12.3 - 45.9
Post-operative reassessment (n=27)*	11 (40.7)	22.4 - 61.2
Reassessment with clinical change (n=15)†	6 (40.0)	16.3 - 67.7

*Three patients did not undergo surgery during admission. †Fifteen patients experienced significant clinical changes (e.g., transfer to ICU, development of complications). CI: Confidence interval; VTE: Venous thromboembolism; ICU: Intensive care unit

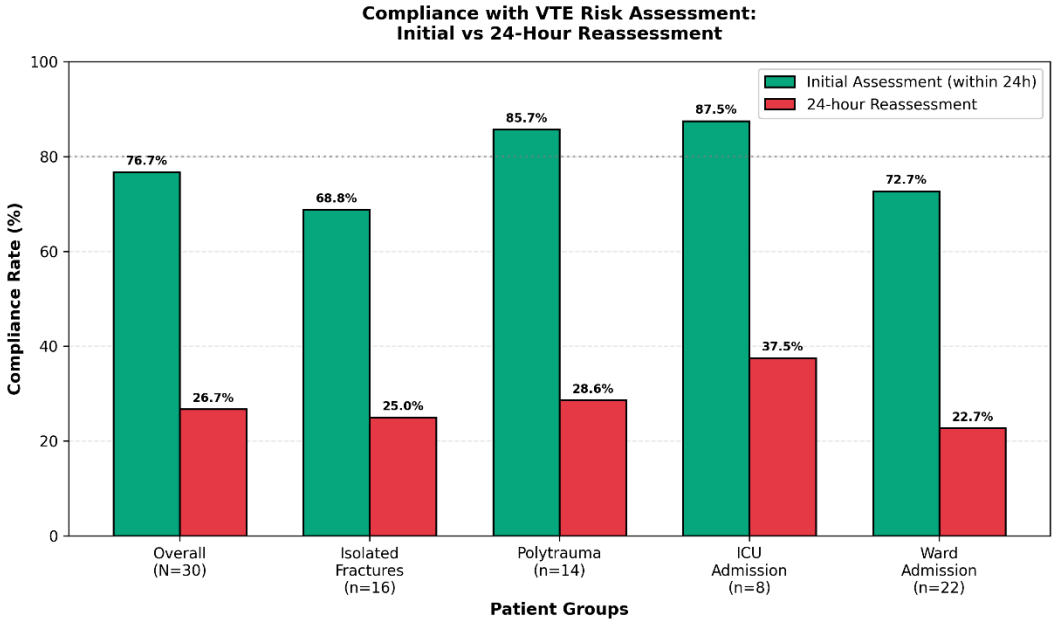

Fig 2: Comparison bar chart showing compliance rates for initial assessment vs. 24-hour reassessment, with stratification by patient group (isolated vs. polytrauma)

Prophylaxis Prescription and Timing

Pharmacological Prophylaxis

Among the 30 patients, pharmacological VTE prophylaxis was indicated in 28 patients (93.3%) based on their risk profile. Two patients had absolute contraindications to anticoagulation due to active intracranial hemorrhage at admission. Of the 28 patients with indications for pharmacological prophylaxis, 25 patients (89.3%, 95% CI: 71.8-97.7%) received appropriate prescription.

The most commonly prescribed agent was low molecular weight heparin (LMWH) enoxaparin 40 mg subcutaneously once daily, administered to 21 patients (84.0% of those receiving prophylaxis). Unfractionated heparin 5000 units subcutaneously twice daily was prescribed in 3 patients (12.0%), and aspirin 150 mg once daily was used in 1 patient (4.0%). The choice of agent was concordant with ACCP and NICE guidelines in 23 of 25 cases (92.0%).

Timing of Prophylaxis Initiation

Among the 25 patients who received pharmacological prophylaxis, the median time from admission to first dose was 16 hours (IQR: 10-24 hours). Only 11 patients (44.0%, 95% CI: 24.4-65.1%) received their first dose within the NICE NG89 recommended timeframe of 14 hours from admission. The remaining 14 patients (56.0%) experienced delayed initiation beyond 14 hours.

Reasons documented for delayed initiation included: pending surgical intervention (n=8, 57.1%), concern about bleeding risk (n=4, 28.6%), delayed risk assessment (n=1, 7.1%), and no clear reason documented (n=1, 7.1%).

Aspirin was prescribed in one patient due to relative contraindication to heparin based agent.

Table 3: Pharmacological VTE Prophylaxis Prescription and Timing (N=30)

Measure	Value n (%)	95% CI
Indication and Prescription		
Pharmacological prophylaxis indicated	28 (93.3)	77.9 - 99.2
Contraindications to anticoagulation	2 (6.7)	0.8 - 22.1
Appropriate prophylaxis prescribed*	25/28 (89.3)	71.8 - 97.7
Type of Pharmacological Agent		
LMWH (enoxaparin 40 mg SC daily)	21 (84.0)	63.9 - 95.5
Unfractionated heparin (5000 U SC BID)	3 (12.0)	2.5 - 31.2
Aspirin (150 mg daily)	1 (4.0)	0.1 - 20.4
Guideline Concordance		
Agent selection concordant with guidelines	23/25 (92.0)	74.0 - 99.0
Timing of Initiation		
Time to first dose (hours), median (IQR)	16 (10-24)	-
Initiated within 14 hours of admission	11/25 (44.0)	24.4 - 65.1
Delayed beyond 14 hours	14/25 (56.0)	34.9 - 75.6
Reasons for Delayed Initiation (n=14)		
Pending surgical intervention	8 (57.1)	28.9 - 82.3
Bleeding risk concerns	4 (28.6)	8.4 - 58.1

Delayed risk assessment	1 (7.1)	0.2 - 33.9
No documented reason	1 (7.1)	0.2 - 33.9

*Three patients with indication did not receive prophylaxis: 1 physician decision not documented, 2 delayed prescription. LMWH: Low molecular weight heparin; SC: Subcutaneous; BID: Twice daily; U: Units; IQR: Interquartile range; CI: Confidence interval

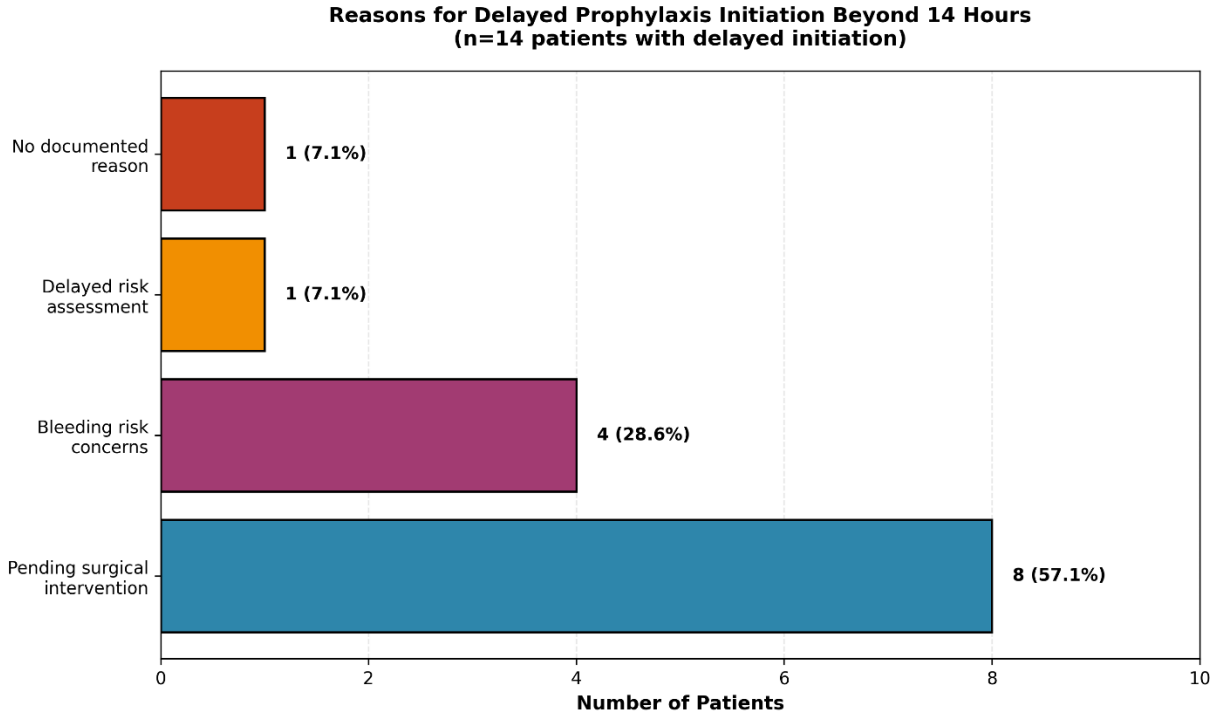

Fig 3: Horizontal bar chart showing reasons for delayed prophylaxis initiation beyond 14 hours

Mechanical Prophylaxis Utilization

Mechanical VTE prophylaxis was utilized in 14 patients (46.7%, 95% CI: 28.3-65.7%). Graduated compression stockings were the most common modality, applied in 12 patients (40.0%), while intermittent pneumatic compression devices were used in 2 patients (6.7%) who were admitted to the ICU. Among patients receiving mechanical prophylaxis, the median time to initiation was 6 hours (IQR: 4-12 hours) from admission.

Mechanical prophylaxis was more frequently employed in polytrauma patients (9/14, 64.3%) compared to those with isolated fractures (5/16, 31.3%, p=0.09). All patients admitted to the ICU received mechanical prophylaxis (8/8, 100%) compared to only 6 of 22 ward patients (27.3%, p<0.001).

Documented contraindications to mechanical prophylaxis were noted in 4 patients (13.3%) due to severe lower limb injuries with compartment syndrome or external fixators. However, 12 patients (40.0%) who had no documented contraindications did not receive any form of mechanical prophylaxis.

Table 4: Mechanical VTE Prophylaxis Utilization (N=30)

Measure	**Value n (%)**	**95% CI**
Overall Utilization		
Any mechanical prophylaxis	14 (46.7)	28.3 - 65.7
Graduated compression stockings	12 (40.0)	22.7 - 59.4
Intermittent pneumatic compression	2 (6.7)	0.8 - 22.1
Timing of Initiation		
Time to initiation (hours), median (IQR)	6 (4-12)	-
Utilization by Patient Group		
Isolated fractures (n=16)	5 (31.3)	11.0 - 58.7
Polytrauma (n=14)	9 (64.3)	35.1 - 87.2
ICU admission (n=8)	8 (100.0)	63.1 - 100.0
Ward admission (n=22)	6 (27.3)	10.7 - 50.2
Contraindications and Gaps		
Documented contraindications	4 (13.3)	3.8 - 30.7
No contraindication, no prophylaxis given	12 (40.0)	22.7 - 59.4
Combination Prophylaxis		

Both pharmacological and mechanical	13 (43.3)	25.5 - 62.6
Pharmacological only	12 (40.0)	22.7 - 59.4
Mechanical only	1 (3.3)	0.1 - 17.2
Neither modality	4 (13.3)	3.8 - 30.7

IQR: Interquartile range; CI: Confidence interval; ICU: Intensive care unit

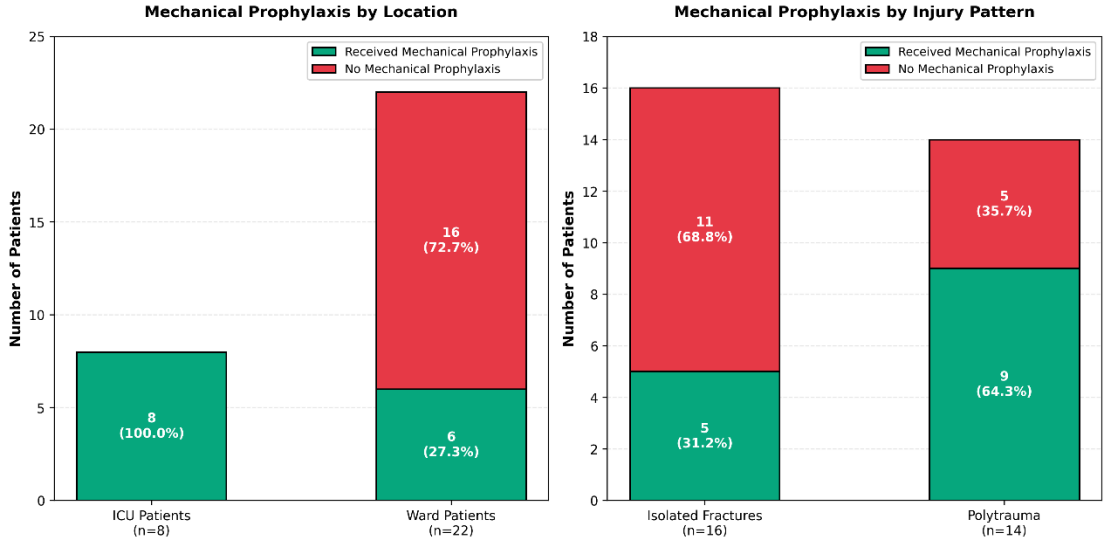

Fig 4: Stacked bar chart comparing mechanical prophylaxis utilization rates between ICU and ward patients, and between isolated fractures and polytrauma

Inpatient Compliance with Prescribed Prophylaxis

Among the 25 patients who received pharmacological prophylaxis, the mean duration of inpatient prophylaxis was 7.4 ± 3.8 days. A total of 185 doses were prescribed during the study period. Of these, 162 doses were administered (87.6%), while 23 doses were missed (12.4%).

Complete compliance with prescribed prophylaxis, defined as receiving all scheduled doses without any missed administrations, was achieved in 13 patients (52.0%, 95% CI: 31.3-72.2%). The remaining 12 patients (48.0%) missed at least one dose during their hospital stay. The median number of missed doses per patient was 0 (IQR: 0-2), with a range of 0 to 5 missed doses.

Reasons documented for missed doses included: patient held nil per oral (NPO) for surgery or procedures (n=14, 60.9%), temporary discontinuation due to bleeding concerns (n=4, 17.4%), medication not available on ward (n=3, 13.0%), and no documented reason (n=2, 8.7%).

Patients with polytrauma had a higher proportion of missed doses compared to those with isolated fractures (15/85 prescribed doses [17.6%] vs. 8/100 prescribed doses [8.0%], p=0.048), likely related to more frequent surgical interventions and perioperative holds in the polytrauma group.

Table 5: Inpatient Compliance with Prescribed Pharmacological Prophylaxis (N=25*)

Measure	**Value**
Prophylaxis Duration	
Duration of inpatient prophylaxis (days), mean ± SD	7.4 ± 3.8
Dose Administration	
Total doses prescribed	185
Total doses administered, n (%)	162 (87.6)
Total doses missed, n (%)	23 (12.4)
Patient-Level Compliance	
Patients with 100% compliance (no missed doses), n (%)	13 (52.0)
95% CI	31.3 - 72.2
Patients with ≥1 missed dose, n (%)	12 (48.0)
Missed doses per patient, median (IQR)	0 (0-2)
Range of missed doses	0 - 5
Reasons for Missed Doses (n=23)	
NPO for surgery/procedures, n (%)	14 (60.9)
Bleeding concerns/temporary hold, n (%)	4 (17.4)
Medication unavailable, n (%)	3 (13.0)
No documented reason, n (%)	2 (8.7)

Compliance by Patient Group	
Isolated fractures (n=13)	
- Doses prescribed	100
- Doses missed, n (%)	8 (8.0)
Polytrauma (n=12)	
- Doses prescribed	85
- Doses missed, n (%)	15 (17.6)
- p-value†	0.048

*Among 30 total patients, 25 received pharmacological prophylaxis. †Fisher's exact test comparing proportion of missed doses between groups. SD: Standard deviation; IQR: Interquartile range; NPO: Nil per oral; CI: Confidence interval

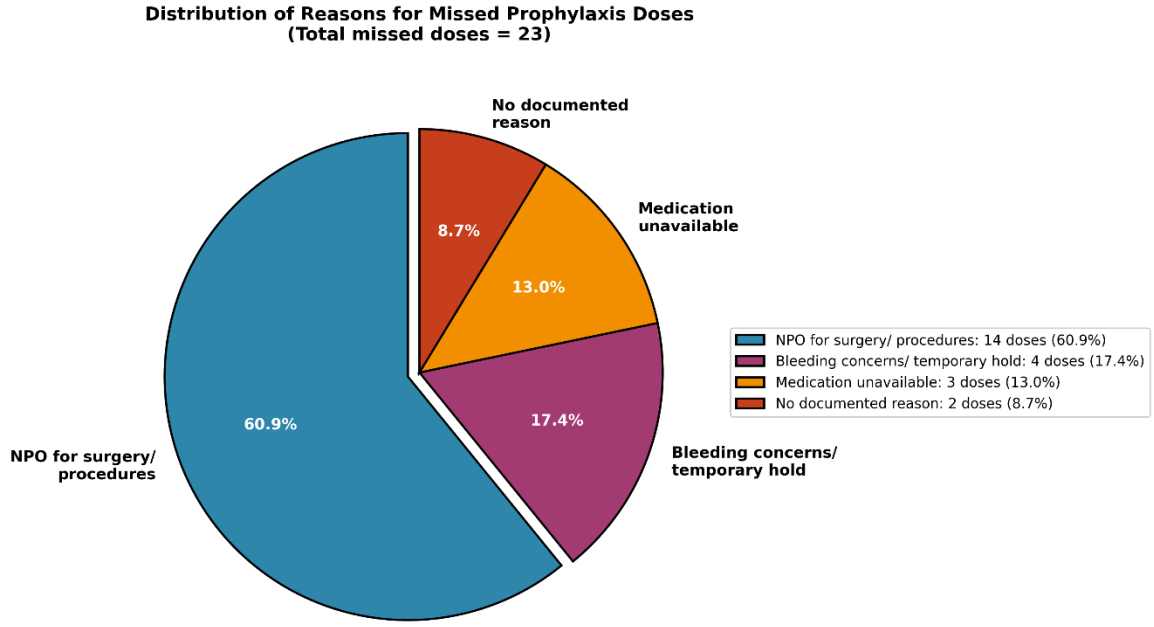

Fig 5: Pie chart showing distribution of reasons for missed prophylaxis doses

Overall Guideline Concordance

Complete guideline-concordant VTE prophylaxis, defined as meeting all of the following criteria: (1) documented risk assessment within 24 hours, (2) appropriate prophylaxis initiated within 14 hours when indicated, (3) documented 24-hour reassessment, and (4) at least 90% of prescribed doses administered, was achieved in only 4 patients (13.3%, 95% CI: 3.8-30.7%).

Partial compliance, meeting at least 3 of the 4 criteria, was observed in 12 patients (40.0%), while 14 patients (46.7%) met fewer than 3 criteria. The most common deficiency was absence of 24-hour reassessment, which was missing in 73.3% of patients.

Table 6: Overall Compliance with Guideline-Concordant VTE Prophylaxis (N=30)

Compliance Measure	**n (%)**	**95% CI**
Individual Components Met		
VTE risk assessment within 24 hours	23 (76.7)	57.7 - 90.1
Prophylaxis initiated within 14 hours*	11/28 (39.3)	21.5 - 59.4
24-hour risk reassessment performed	8 (26.7)	12.3 - 45.9
≥90% prescribed doses administered*	19/25 (76.0)	54.9 - 90.6
Overall Guideline Concordance		
Complete compliance (all 4 criteria met)	4 (13.3)	3.8 - 30.7
Partial compliance (3 of 4 criteria met)	12 (40.0)	22.7 - 59.4
Poor compliance (<3 criteria met)	14 (46.7)	28.3 - 65.7
Most Common Deficiencies		
Absent 24-hour reassessment	22 (73.3)	54.1 - 87.7
Delayed prophylaxis initiation (>14 hours)	17 (56.7)	37.4 - 74.5
Incomplete initial risk assessment	7 (23.3)	9.9 - 42.3
Missed prophylaxis doses	12 (40.0)	22.7 - 59.4

*Denominator reflects patients for whom prophylaxis was indicated (n=28) and prescribed (n=25). CI: Confidence interval; VTE: Venous thromboembolism

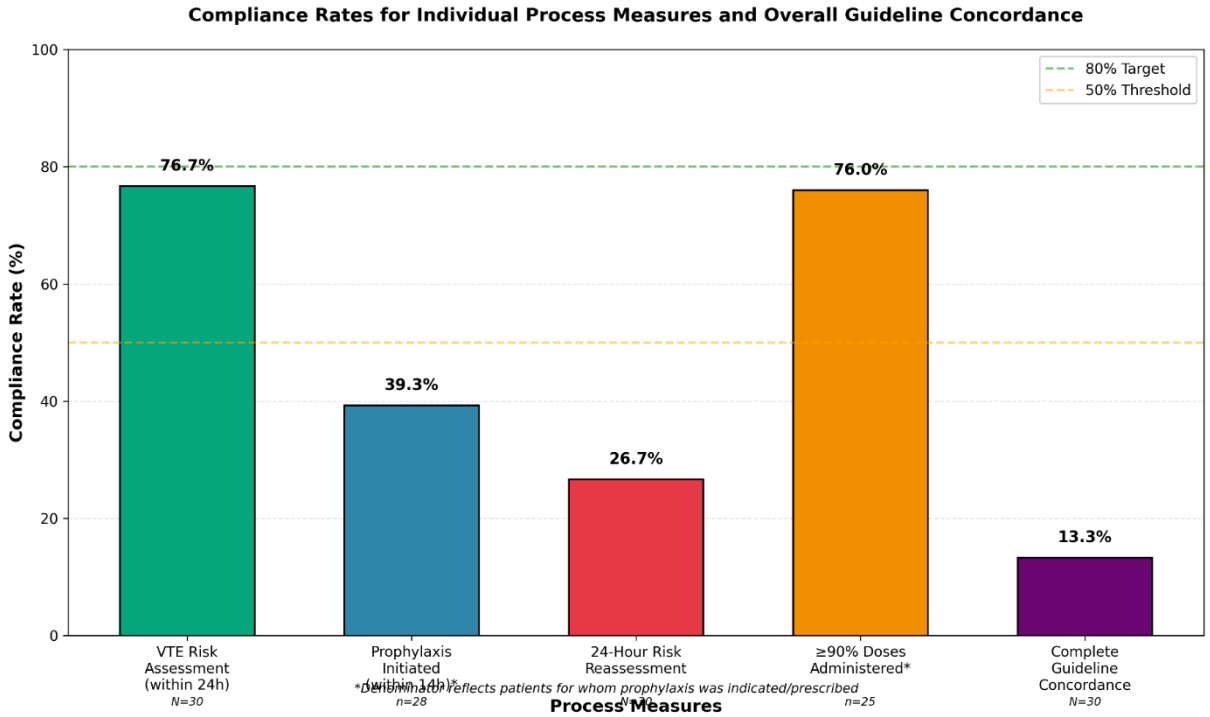

Fig 6: Multi-bar chart showing compliance rates for each of the four key process measures, with a separate bar for overall complete compliance

Clinical Outcomes

During the study period, one patient (3.3%, 95% CI: 0.1-17.2%) developed symptomatic VTE, specifically a distal deep vein thrombosis diagnosed on compression ultrasonography on post-admission day 6. This patient was a 58-year-old male with polytrauma including bilateral femur fractures who had documented risk assessment and received LMWH prophylaxis, but had 3 missed doses perioperatively and no documented 24-hour reassessment. The patient was successfully treated with therapeutic anticoagulation without development of pulmonary embolism.

No fatal pulmonary emboli occurred during the study period. Major bleeding complications attributable to prophylactic anticoagulation were not observed. One patient experienced minor bleeding from a surgical drain site that resolved with temporary discontinuation of LMWH for 24 hours.

Table 7: Clinical Outcomes (N=30)

Outcome	n (%)	95% CI
Thromboembolic Events		
Symptomatic DVT	1 (3.3)	0.1 - 17.2
Symptomatic PE	0 (0.0)	0.0 - 11.6
Fatal PE	0 (0.0)	0.0 - 11.6
Bleeding Complications		
Major bleeding	0 (0.0)	0.0 - 11.6
Minor bleeding	1 (3.3)	0.1 - 17.2
Other Outcomes		
Hospital mortality	0 (0.0)	0.0 - 11.6
30-day readmission for VTE	0 (0.0)	0.0 - 11.6

DVT: Deep vein thrombosis; PE: Pulmonary embolism; VTE: Venous thromboembolism; CI: Confidence interval

DISCUSSION

This prospective audit of 30 orthopedic trauma patients at a tertiary care center in Eastern India revealed significant gaps in compliance with established VTE prophylaxis guidelines, with complete guideline-concordant care achieved in only 13.3% of patients. While initial risk assessment (76.7%) and pharmacological prophylaxis prescription (89.3%) were reasonably adequate, critical deficiencies were identified in 24-hour reassessment (26.7%), timely prophylaxis initiation within 14 hours (44.0%), and mechanical prophylaxis utilization (46.7%). These findings align with international audits demonstrating persistent challenges in translating evidence-based guidelines into consistent clinical practice.[5,6,7]

Comparison with Previous Studies

Our baseline compliance rate of 76.7% for initial VTE risk assessment is comparable to the 70% reported by Watts and Grant in acute orthopedic admissions in the United Kingdom prior to their quality improvement interventions.[6] Similarly, Ng et al

documented poor initial compliance in emergency trauma admissions, which improved following protocol implementation and education.[7] The most striking deficiency in our study was the 24-hour reassessment rate of 26.7%, mirroring recent findings by Imtiaz et al who reported zero percent completion of 24-hour reassessment in 400 orthopedic patients despite high initial assessment rates.[10] This consistent pattern across multiple institutions suggests that while admission protocols may prompt initial risk assessment, systematic reassessment mechanisms are frequently absent or poorly implemented.

Our finding that 56.0% of patients experienced delayed prophylaxis initiation beyond the NICE-recommended 14-hour timeframe[3] reflects the tension between VTE prevention and bleeding risk concerns in acute trauma settings. The ICM VTE trauma consensus emphasizes early LMWH initiation once hemostasis is reasonably secure,[4] yet our data show that pending surgical intervention (57.1%) and bleeding risk concerns (28.6%) were the primary reasons for delay. This highlights the need for trauma-specific protocols that provide clearer guidance on balancing these competing risks in the perioperative period.

The inpatient dose compliance rate of 87.6% in our study is similar to the findings of Haac et al, who reported that 41-43% of orthopedic trauma patients in the ADAPT trial missed at least one dose during hospitalization, with perioperative periods being particularly vulnerable.[8] Our observation that polytrauma patients missed significantly more doses than those with isolated fractures (17.6% vs. 8.0%, p=0.048) likely reflects their more complex clinical course with multiple surgical procedures requiring perioperative holds.

Barriers to Compliance

The determinants of non-compliance identified in our study mirror those reported in broader systematic reviews.[5] Inadequate documentation, particularly of 24-hour reassessment, suggests the absence of structured prompts or electronic reminders integrated into routine clinical workflows. The underutilization of mechanical prophylaxis in ward patients (27.3%) compared to universal use in the ICU (100%) indicates that mechanical modalities may be perceived as ICU-specific interventions rather than standard adjuncts to pharmacological prophylaxis. The heterogeneity in prophylactic agent selection and duration observed in clinical practice,[9,11] despite clear guideline recommendations,[2,3,4] further underscores the influence of individual physician preferences and institutional culture on adherence.

Clinical Significance

While our study documented one symptomatic DVT event (3.3%), the small sample size precludes definitive assessment of the relationship between compliance deficiencies and clinical outcomes. However, this rate is within the expected range for modern chemoprophylaxis,[1] and the affected patient had multiple compliance gaps including missed doses and absent reassessment. Medicolegal analyses consistently identify failure to assess, prescribe, or reassess VTE prophylaxis as preventable gaps in care,[8] reinforcing the importance of systematic adherence to guideline processes regardless of absolute event rates in individual audits.

Implications for Practice

Our findings identify several actionable targets for quality improvement. First, implementation of mandatory 24-hour reassessment prompts, ideally integrated into electronic health records or paper-based admission proformas, could address the most prominent deficiency. Watts and Grant demonstrated that adding a dedicated risk assessment section to admission forms and providing staff education improved compliance to nearly 100%.[6] Second, development of trauma-specific pathways for prophylaxis initiation that balance VTE and bleeding risks, informed by ICM VTE trauma recommendations,[4] may reduce delays beyond 14 hours. Third, expanding mechanical prophylaxis education and availability on general wards, rather than limiting it to ICU settings, would increase utilization in appropriate patients. Finally, automated medication reconciliation systems that flag missed doses and prompt nursing staff could improve inpatient compliance.

Limitations

This study has several limitations. The small sample size (n=30) limits statistical power and generalizability, though our compliance rates are consistent with larger international audits. The sample size of 30 was chosen based on feasibility for an initial baseline audit designed to support a future quality improvement cycle. The single-center design may not reflect practices across diverse Indian healthcare settings. Documentation review may underestimate actual clinical practice if assessments were performed but not recorded, though this still represents a quality and medico-legal concern. The three-month study duration may not capture seasonal variations in trauma patterns or staffing. Finally, we did not assess post-discharge prophylaxis compliance or outpatient VTE events, which are increasingly recognized as important outcomes.[4] Post-discharged prophylaxis and VTE events were not assessed so the true incidence may be underestimated.

Future Directions

This audit establishes baseline compliance metrics that can guide a Plan-Do-Study-Act quality improvement cycle. We recommend implementing the targeted interventions described above and conducting a second audit at six months to assess improvement. Given the consistency of compliance deficiencies across international settings, multi-center audits involving multiple Indian trauma centers would provide more robust data and allow identification of system-level barriers specific to resource-limited settings. Future studies should also examine the cost-effectiveness of various prophylaxis strategies and quality improvement interventions in the Indian healthcare context.

CONCLUSION

This audit demonstrates suboptimal compliance with VTE prophylaxis guidelines in orthopedic trauma patients, particularly for 24-hour reassessment, timely prophylaxis initiation, and mechanical prophylaxis utilization. These findings are consistent with international data showing persistent gaps between evidence-based recommendations and clinical practice. Simple, low-cost

interventions such as structured documentation forms, automated reminders, and targeted staff education have proven effective in similar settings and should be prioritized. Systematic adherence to guideline processes remains an essential component of high-quality trauma care and a defensible standard for reducing preventable VTE-related morbidity and mortality.

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