

Underutilization of Venous Thromboembolism Prophylaxis in Hospitalised Patients: Evidence, Risk Stratification and Strategies for Optimization

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Abstract: Venous thromboembolism (VTE) which encompasses deep vein thrombosis and pulmonary embolism represents a significant cause of preventable morbidity and mortality among hospitalized patients worldwide. Hospital-associated thrombosis accounts for a substantial proportion of VTE events and is often linked to prolonged immobility, surgical procedures, trauma, and underlying comorbidities. Although numerous clinical guidelines recommend routine risk assessment and implementation of prophylactic strategies, studies consistently demonstrate that thromboprophylaxis remains underutilized in many healthcare settings. Inadequate risk stratification, lack of awareness of clinical guidelines, fear of bleeding complications, and absence of standardized institutional protocols contribute to this gap in optimal care. Risk assessment models such as the Caprini Risk Assessment Model, Padua Prediction Score, and IMPROVE risk score have been developed to facilitate the identification of high-risk patients and guide prophylactic interventions. Pharmacological prophylaxis using anticoagulants, including low molecular weight heparins, unfractionated heparin, and factor Xa inhibitors, along with mechanical methods such as intermittent pneumatic compression devices, have demonstrated significant efficacy in reducing VTE incidence in high-risk patients. Despite the availability of these effective preventive strategies, implementation remains inconsistent across hospitals globally. Clinical pharmacists and multidisciplinary teams play a critical role in improving adherence to thromboprophylaxis guidelines through risk assessment, medication optimization, and monitoring. This review summarizes the epidemiology of VTE, associated risk factors in hospitalized patients, currently available risk assessment models, pharmacological and mechanical prophylaxis options, barriers contributing to underutilization, and potential strategies to improve prophylaxis utilization and patient outcomes.

Keywords: Venous Thrombo Embolism, Deep Vein Thrombosis, Pulmonary Embolism, Thrombo Prophylaxis, Risk Assessment Models, Anticoagulants, Guideline Adherence.

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I. INTRODUCTION

Venous thromboembolism (VTE) is a major health concern and a leading cause of preventable death among hospitalized patients (6,11). It encompasses two interrelated conditions: deep vein thrombosis (DVT), which involves the formation of blood clots in deep veins, typically in the lower

extremities, and pulmonary embolism (PE), which occurs when a thrombus dislodges and travels to the pulmonary arteries (10,14). These conditions collectively contribute to significant morbidity, mortality, and healthcare costs worldwide (9,11).

The pathogenesis of VTE is commonly explained by Virchow's triad, which includes venous stasis, endothelial injury, and hypercoagulability (7,26). Hospitalized patients frequently experience these risk factors due to immobilization, surgical interventions, trauma, cancer, or underlying comorbidities. Consequently, hospitalization itself is considered one of the most important risk factors for the development of VTE (9,25).

Several epidemiological studies indicate that a large proportion of VTE events are hospital-associated. Estimates suggest that nearly 60% of VTE cases occur during hospitalization or shortly after discharge (9,18). Moreover, pulmonary embolism is recognized as one of the leading causes of sudden death in hospitalized patients (14,22). Despite this, VTE remains largely preventable through appropriate thromboprophylaxis strategies (1,21).

Clinical practice guidelines developed by organizations such as the American College of Chest Physicians recommend routine assessment of VTE risk in hospitalized patients and implementation of prophylactic measures in individuals identified as high risk (1,8). These guidelines emphasize the use of pharmacological agents, mechanical prophylaxis, or a combination of both, depending on patient-specific factors (1,13).

However, real-world clinical practice reveals significant discrepancies between guideline recommendations and actual prophylaxis utilization (18,29). Numerous studies across different countries and healthcare settings have demonstrated that a considerable proportion of eligible patients do not receive appropriate thromboprophylaxis (18,30). This underutilization may lead to preventable complications, increased hospital stays, and higher healthcare expenditures (19,29).

In addition, awareness and implementation of standardized risk assessment models remain inconsistent in many healthcare institutions (28,29). Tools such as the Caprini Risk Assessment Model and the Padua Prediction Score were developed to assist clinicians in identifying patients at risk and determining the need for prophylaxis (3,4). Nevertheless, their use in routine clinical practice is often limited due to a lack of training, time constraints, or institutional barriers (28,29).

Given the substantial burden associated with VTE and the availability of effective preventive strategies, improving prophylaxis utilization represents a critical priority in hospital medicine (21,29). This review aims to summarize the current evidence regarding VTE epidemiology, risk factors among hospitalized patients, risk assessment models, prophylactic strategies, and barriers contributing to underutilization. Additionally, it highlights the potential role of multidisciplinary interventions, including clinical pharmacist involvement, in optimizing thromboprophylaxis practices.

II. EPIDEMIOLOGY OF VENOUS THROMBOEMBOLISM

Venous thromboembolism is a significant global health concern affecting millions of individuals each year (6,11). The estimated annual incidence of VTE ranges from 1 to 2 cases per 1,000 individuals in the general population, with incidence increasing substantially with advancing age (6). Elderly individuals are particularly susceptible due to age-related physiological changes, reduced mobility, and the presence of comorbidities (26).

Hospitalized patients represent a population at particularly high risk for VTE. Studies have shown that hospital-associated thrombosis accounts for the majority of VTE cases (9,18). The risk of VTE increases significantly during hospitalization and may persist for several weeks after discharge (30).

Several factors contribute to the elevated risk of VTE in hospitalized patients. Prolonged immobilization leads to venous stasis, which promotes clot formation (7,26). Surgical procedures and trauma may cause endothelial injury, while certain medical conditions, such as cancer, infections, and inflammatory disorders, may result in a hypercoagulable state (25,26).

Pulmonary embolism is one of the most severe complications of VTE and may lead to sudden death if not promptly diagnosed and treated (14,22). It is estimated that a considerable proportion of fatal pulmonary embolism cases occur in hospitalized patients who did not receive adequate prophylaxis (18,21).

The economic burden associated with VTE is also substantial. Healthcare costs related to diagnostic procedures, anticoagulant therapy, hospital readmissions, and long-term complications such as post-thrombotic syndrome contribute significantly to overall healthcare expenditure (19,31).

Despite advancements in medical knowledge and preventive strategies, VTE continues to pose a major challenge to healthcare systems worldwide (6,21). Increasing awareness, improving risk assessment, and implementing effective prophylaxis strategies are essential to reduce the incidence and impact of this preventable condition (1,29).

III. RISK FACTORS FOR VTE IN HOSPITALIZED PATIENTS

The development of venous thromboembolism is influenced by multiple risk factors that may be categorized as patient-related or hospital-related (7,26). Identification of these risk factors is essential for effective risk stratification and implementation of prophylactic measures (28).

A. Patient-Related Risk Factors

Several patient-specific characteristics increase the likelihood of developing VTE. Advanced age is a well-established risk factor, with incidence increasing significantly in individuals over the age of 60 (6,26). Obesity is another important factor, as excess body weight contributes to venous stasis and inflammation (7).

Cancer is strongly associated with an increased risk of thrombosis due to tumor-related procoagulant activity and the effects of chemotherapy (25). Patients with a prior history of VTE are also at significantly higher risk of recurrence, particularly during periods of immobilization or hospitalization (26).

Genetic conditions such as thrombophilia may predispose individuals to hypercoagulability, increasing their susceptibility to clot formation (25). Hormonal factors, including oral contraceptives or hormone replacement therapy, have also been associated with increased thrombotic risk (7).

B. Hospital-Related Risk Factors

Hospitalization itself introduces several factors that increase VTE risk. Prolonged bed rest or immobility is one of the most common contributors to venous stasis (7,26). Surgical procedures, particularly orthopedic surgeries such as hip or knee replacement, significantly elevate the risk of thrombosis (33).

Trauma patients are also at increased risk due to tissue injury, immobilization, and inflammatory responses (34). Intensive care unit patients often exhibit multiple risk factors simultaneously, including mechanical ventilation, central venous catheters, and severe infections (25).

Other hospital-related factors include central venous lines, major medical illnesses such as heart failure or stroke, and extended hospitalization duration (25,30).

IV. RISK ASSESSMENT MODELS

Identification of patients at risk for venous thromboembolism (VTE) is a fundamental step in preventing hospital-associated thrombosis. Risk assessment models (RAMs) have been developed to provide standardized,

evidence-based approaches for evaluating thrombotic risk and guiding prophylaxis decisions (28,29). These tools integrate multiple patient-specific and clinical variables to stratify individuals into low-, moderate-, or high-risk categories.

A. Caprini Risk Assessment Model

The Caprini Risk Assessment Model is one of the most extensively validated RAMs for surgical patients (3). It assigns weighted scores to risk factors such as age, body mass index, prior VTE, malignancy, immobility, and the type and duration of surgery. Based on the cumulative score, patients are categorized into distinct risk levels that correspond to recommended prophylactic strategies. Numerous studies have demonstrated that higher Caprini scores are strongly associated with increased postoperative VTE incidence, particularly in orthopedic and major abdominal surgeries (17,33). Consequently, this model is widely recommended in perioperative guidelines to individualize thromboprophylaxis and reduce preventable complications (3,8).

B. Padua Prediction Score

The Padua Prediction Score is specifically designed for hospitalized medical patients (4). It evaluates clinical variables including active cancer, reduced mobility, previous VTE, thrombophilia, trauma, and advanced age. Patients with a score of four or greater are classified as high risk and are recommended to receive pharmacological prophylaxis unless contraindicated (4,28). This model has demonstrated good predictive accuracy and practicality in routine clinical settings. Its simplicity allows rapid bedside assessment, facilitating timely preventive interventions (4).

C. IMPROVE Risk Score

The IMPROVE (International Medical Prevention Registry on Venous Thromboembolism) score is another validated tool for hospitalized medical patients (5). It incorporates factors such as prior VTE, immobilization, cancer, intensive care unit admission, and thrombophilia. An important advantage of the IMPROVE model is its ability to assess both thrombotic and bleeding risk, enabling clinicians to balance the benefits and potential harms of anticoagulant therapy (5,28). Integration of these models into clinical workflows has been shown to significantly improve appropriate prophylaxis utilization.

Table 1: Comparison of VTE Risk Assessment Models.

Model	Developed For	Main Risk Factors	Scoring System	Interpretation
Caprini Score	Surgical patients	Age, obesity, cancer, previous VTE, surgery duration	Points assigned (1–5)	Higher score = higher VTE risk
Padua Prediction Score	Hospitalized medical patients	Cancer, immobility, thrombophilia, trauma	Score ≥4	High risk requiring prophylaxis
IMPROVE Score	Medical patients	Previous VTE, ICU stay, cancer, immobilization	Multiple weighted points	Predicts VTE and bleeding risk

V. PHARMACOLOGICAL PROPHYLAXIS

Pharmacological thromboprophylaxis is a cornerstone of VTE prevention in high-risk hospitalized patients. Anticoagulant medications reduce thrombus formation by inhibiting specific components of the coagulation cascade (13,16). Numerous randomized trials and meta-analyses have confirmed their efficacy in reducing both DVT and pulmonary embolism incidence.

A. Low Molecular Weight Heparin (LMWH)

LMWHs are widely regarded as first-line agents for VTE prophylaxis due to their predictable pharmacokinetics, longer half-life, and lower risk of heparin-induced thrombocytopenia compared with unfractionated heparin (13). Agents such as enoxaparin are commonly administered subcutaneously once or twice daily depending on patient risk and renal function (27).

Clinical studies have demonstrated that LMWH significantly reduces postoperative and medical VTE events without substantially increasing major bleeding risk (16,27).

B. Unfractionated Heparin (UFH)

UFH remains an important option, particularly for patients with severe renal impairment because its effects are reversible and easily monitored (13). It acts by enhancing antithrombin activity, thereby inhibiting thrombin and factor Xa.

Although UFH requires more frequent dosing and monitoring, it is widely used in critically ill patients and those with fluctuating renal function (13).

C. Factor Xa Inhibitors and New Anticoagulants

Synthetic agents such as fondaparinux selectively inhibit factor Xa and have demonstrated efficacy in orthopedic and high-risk surgical patients (24,27). In addition, direct oral anticoagulants (DOACs) have emerged as promising alternatives for thromboprophylaxis in selected populations.

Extended prophylaxis with factor Xa inhibitors has been shown to reduce post-discharge VTE risk in high-risk medical patients (24).

Despite their effectiveness, pharmacological agents must be used cautiously in individuals with elevated bleeding risk, necessitating careful patient selection and monitoring (16).

VI. MECHANICAL PROPHYLAXIS

Mechanical methods of thromboprophylaxis are particularly valuable in patients with contraindications to anticoagulant therapy, such as active bleeding, recent surgery with high bleeding risk, or severe thrombocytopenia (32).

A. Intermittent Pneumatic Compression Devices

These devices cyclically inflate cuffs around the lower extremities, enhancing venous return and reducing venous

stasis. They have been shown to decrease DVT incidence, especially in surgical and immobilized patients (32).

B. Graduated Compression Stockings

Compression stockings apply graded pressure from distal to proximal regions of the leg, promoting venous flow and preventing blood pooling in deep veins. Their use is supported in both surgical and medical populations (32).

C. Early Mobilization

Encouraging ambulation as early as clinically feasible is a simple yet highly effective preventive measure. Mobilization improves circulation, reduces venous stasis, and lowers thrombotic risk (19).

Mechanical methods are often combined with pharmacological prophylaxis in high-risk patients to achieve additive protective effects (33).

VII. CLINICAL GUIDELINES

Multiple international organizations have developed evidence-based guidelines to standardize VTE prevention strategies. Among these, the recommendations from the American College of Chest Physicians (ACCP) are the most widely cited (1,8).

These guidelines emphasize universal risk assessment for hospitalized patients and recommend pharmacological prophylaxis for individuals at moderate to high risk unless contraindicated (1). They also advocate mechanical methods for patients with high bleeding risk.

Guidelines for orthopedic surgery patients highlight the particularly elevated thrombotic risk associated with procedures such as hip and knee replacement and recommend extended prophylaxis in many cases (33).

Despite the availability of comprehensive guidelines, adherence varies considerably across institutions due to differences in resources, awareness, and implementation strategies (29).

VIII. UNDERUTILIZATION OF VTE PROPHYLAXIS

Underutilization of thromboprophylaxis remains a persistent global problem. Studies indicate that a significant proportion of high-risk hospitalized patients do not receive appropriate preventive therapy (18,29).

➤ Key Contributing Factors

- Lack of Routine Risk Assessment
Failure to systematically evaluate VTE risk leads to missed prevention opportunities (28).
- Fear of Bleeding Complications
Clinicians may avoid anticoagulants due to concerns about hemorrhagic events, particularly in elderly or critically ill patients (16).

- Insufficient Awareness of Guidelines Limited familiarity with current recommendations contributes to inconsistent prescribing practices (29).
- Absence of Institutional Protocols Hospitals without standardized prophylaxis pathways demonstrate lower compliance rates (19).
- Economic and Resource Constraints Cost considerations and limited access to medications may also hinder implementation, especially in resource-limited settings (30).

Addressing these barriers is essential to reduce preventable morbidity and mortality associated with hospital-acquired VTE.

IX. ROLE OF CLINICAL PHARMACISTS

Clinical pharmacists play a crucial role in optimizing thromboprophylaxis practices through medication expertise and active participation in multidisciplinary care (29,31).

Their responsibilities include:

- Identifying high-risk patients
- Conducting medication reviews
- Recommending appropriate prophylaxis
- Monitoring therapy effectiveness and safety
- Preventing drug interactions
- Educating healthcare staff and patients
- Evidence indicates that pharmacist-led interventions significantly improve adherence to guidelines, reduce medication errors, and enhance patient outcomes (31).

X. STRATEGIES TO IMPROVE UTILIZATION

Several interventions have been shown to enhance the appropriate use of thromboprophylaxis in hospitals.

A. Electronic Decision Support Systems

Computerized alerts integrated into electronic health records can automatically identify high-risk patients and prompt clinicians to prescribe prophylaxis. Such systems have demonstrated substantial improvements in compliance rates (20).

B. Institutional Protocols and Pathways

Standardized hospital policies ensure consistent application of evidence-based practices (19).

C. Education and Training Programs

Regular educational initiatives increase awareness of VTE risk factors and guideline recommendations among healthcare professionals (29).

D. Multidisciplinary Collaboration

Coordinated efforts among physicians, pharmacists, nurses, and administrators facilitate comprehensive prevention strategies and improve patient safety (31).

XI. FUTURE PERSPECTIVES

Advancements in technology and precision medicine are expected to transform VTE prevention in the coming years.

Artificial intelligence and machine learning algorithms are being developed to analyze electronic health record data and predict thrombotic risk with greater accuracy (28,30). These tools may enable real-time risk stratification and personalized prophylaxis recommendations.

Personalized medicine approaches incorporating genetic, clinical, and biomarker data may further refine patient-specific prevention strategies.

In addition, newer anticoagulant agents with improved efficacy and safety profiles are under investigation, potentially expanding prophylaxis options while minimizing bleeding complications (24).

Continued research and implementation of innovative strategies are essential to reduce the global burden of VTE and improve outcomes in hospitalized patients.

XII. CONCLUSION

Venous thromboembolism is a significant and largely preventable cause of morbidity and mortality among hospitalized patients worldwide. Validated risk assessment models such as Caprini, Padua, and IMPROVE enable early identification of high-risk individuals, while pharmacological and mechanical prophylaxis strategies effectively reduce VTE incidence when appropriately applied. Despite clear clinical guidelines, thromboprophylaxis remains underutilized due to inadequate risk assessment, concerns regarding bleeding, and lack of standardized institutional protocols. Multidisciplinary approaches involving clinical pharmacists, adherence to evidence-based guidelines, and implementation of decision-support systems are essential to improve prophylaxis utilization and patient outcomes. Strengthening these preventive strategies can substantially reduce the burden of hospital-associated VTE and prevent avoidable complications.

A. Abbreviations and Acronyms

VTE — Venous Thromboembolism; DVT — Deep Vein Thrombosis; PE — Pulmonary Embolism; RAM — Risk Assessment Model; LMWH — Low Molecular Weight Heparin; UFH — Unfractionated Heparin; DOACs — Direct Oral Anticoagulants; ICU — Intensive Care Unit; ACCP — American College of Chest Physicians; NICE — National Institute for Health and Care Excellence; WHO — World Health Organization; IMPROVE — International Medical Prevention Registry on Venous Thromboembolism

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REFERENCES

- [1]. Kahn SR, Lim W, Dunn AS, Cushman M, Dentali F, Akl EA, et al. Prevention of VTE in nonsurgical patients. *Chest*. 2012;141(2 Suppl):e195S–e226S.
- [2]. Gould MK, Garcia DA, Wren SM, Karanicolas PJ, Arcelus JI, Heit JA, et al. Prevention of VTE in nonorthopedic surgical patients. *Chest*. 2012;141(2 Suppl):e227S–e277S.
- [3]. Caprini JA. Thrombosis risk assessment as a guide to quality patient care. *Dis Mon*. 2005;51(2–3):70–78.
- [4]. Barbar S, Noventa F, Rossetto V, Ferrari A, Brandolin B, Perlati M, et al. A risk assessment model for identification of hospitalized medical patients at risk for VTE: The Padua Prediction Score. *J ThrombHaemost*. 2010;8(11):2450–2457.
- [5]. Spyropoulos AC, Anderson FA, FitzGerald G, Decousus H, Pini M, Chong BH, et al. Predictive and associative models to identify hospitalized medical patients at risk for VTE. *Chest*. 2011;140(3):706–714.
- [6]. Heit JA. Epidemiology of venous thromboembolism. *Nat Rev Cardiol*. 2015;12(8):464–474.
- [7]. Anderson FA, Spencer FA. Risk factors for VTE. *Circulation*. 2003;107:19–116.
- [8]. Geerts WH, Bergqvist D, Pineo GF, Heit JA, Samama CM, Lassen MR, et al. Prevention of VTE: ACCP guidelines. *Chest*. 2008;133(6 Suppl):381S–453S.
- [9]. Cohen AT, Tapson VF, Bergmann JF, Goldhaber SZ, Kakkar AK, Deslandes B, et al. Venous thromboembolism risk in hospitalized patients. *Lancet*. 2008;371:387–394.
- [10]. Goldhaber SZ. Pulmonary embolism and deep vein thrombosis. *Lancet*. 2012;379:1835–1846.
- [11]. Heit JA, Spencer FA, White RH. The epidemiology of venous thromboembolism. *J Thromb Thrombolysis*. 2016;41:3–14.
- [12]. Piazza G. Venous thromboembolism and atherothrombosis. *Circulation*. 2013;128:2145–2150.
- [13]. Hull RD, Garcia DA, Vazquez SR. Heparin and LMWH for thromboprophylaxis. *Chest*. 2012;141:e24S–e43S.
- [14]. Agnelli G, Becattini C. Acute pulmonary embolism. *N Engl J Med*. 2010;363:266–274.
- [15]. Samama MM. Epidemiology of risk factors for VTE. *Thromb Res*. 2000;100:V127–V133.
- [16]. Dentali F, Douketis JD, Gianni M, Lim W, Crowther MA. Meta-analysis of anticoagulant prophylaxis. *Ann Intern Med*. 2007;146:278–288.
- [17]. Rogers SO, Kilaru RK, Hosokawa P, Henderson WG, Zinner MJ, Khuri SF. Multivariable prediction model for postoperative VTE. *Ann Surg*. 2007;245:490–497.
- [18]. Amin AN, Stemkowski S, Lin J, Yang G. Preventable hospital-acquired VTE. *J Thromb Thrombolysis*. 2011;31:81–91.
- [19]. Maynard G, Stein J. Preventing hospital-acquired VTE. *J Hosp Med*. 2008;3:148–159.
- [20]. Kucher N, Koo S, Quiroz R, Cooper JM, Paterno MD, Soukonnikov B, et al. Electronic alerts to prevent VTE. *N Engl J Med*. 2005;352:969–977.
- [21]. Piazza G, Goldhaber SZ. Prevention of VTE in hospitalized patients. *Circulation*. 2010;121:2197–2204.
- [22]. Tapson VF. Acute pulmonary embolism. *N Engl J Med*. 2008;358:1037–1052.
- [23]. Akl EA, Kahale LA, Ballout RA, Barba M, Neumann I, Labedi N, et al. Anticoagulation for thromboprophylaxis. *Cochrane Database Syst Rev*. 2017;Issue 12.
- [24]. Cohen AT, Harrington RA, Goldhaber SZ, Hull RD, Wiens BL, Gold A, et al. Extended thromboprophylaxis with factor Xa inhibitor. *N Engl J Med*. 2013;368:513–523.
- [25]. Decousus H, Tapson VF, Bergmann JF, Chong BH, Froehlich JB, Kakkar AK, et al. Risk factors for VTE in hospitalized medical patients. *Arch Intern Med*. 2011;171:176–184.
- [26]. Heit JA, Silverstein MD, Mohr DN, Petterson TM, O’Fallon WM, Melton LJ. Risk factors for VTE. *Arch Intern Med*. 2000;160:809–815.
- [27]. Kakkar AK, Cimminiello C, Goldhaber SZ, Parakh R, Wang C, Bergmann JF. Low molecular weight heparin prophylaxis study. *ThrombHaemost*. 2010;103:736–748.
- [28]. Spyropoulos AC. Risk assessment and prophylaxis of VTE. *Clin Appl ThrombHemost*. 2011;17:11–20.
- [29]. Maynard GA. Preventing hospital-associated thrombosis. *Hosp Pract*. 2016;44:203–212.
- [30]. Amin AN, Varker H, Princic N, Lin J, Thompson S, Johnston S. Duration of VTE risk after hospitalization. *J Hosp Med*. 2012;7:231–238.
- [31]. Piazza G, Fanikos J, Zayaruzny M, Goldhaber SZ. Hospital prevention strategies. *Am J Med*. 2009;122:115–122.
- [32]. Dentali F, Ageno W. Mechanical thromboprophylaxis methods. *Thromb Res*. 2012;129:197–201.
- [33]. Falck-Ytter Y, Francis CW, Johanson NA, Curley C, Dahl OE, Schulman S, et al. Prevention of VTE in orthopedic surgery patients. *Chest*. 2012;141:e278S–e325S.
- [34]. Rogers FB. Venous thromboembolism in trauma patients. *Trauma Surg Acute Care Open*. 2017;2:e000088.
- [35]. Geerts WH. Prevention of venous thromboembolism. *Hematology Am Soc Hematol Educ Program*. 2006;2006:462–466.