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EVALUATION OF DEEP VEIN THROMBOSIS RISK IN SURGICAL PATIENTS USING CAPRINI RISK ASSESSMENT MODEL

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ABSTRACT

Background:

Deep vein thrombosis (DVT) remains a significant cause of postoperative morbidity and mortality in surgical patients. Risk stratification tools like the Caprini Risk Assessment Model have been widely utilized to guide prophylactic strategies. However, adaptations to the original Caprini score may enhance its relevance in specific populations and surgical contexts.

Aim:

To evaluate the effectiveness of a modified Caprini Risk Assessment Model in predicting the risk of DVT among patients undergoing various surgical procedures.

Methodology:

This prospective observational study was conducted over a 10-month period at a tertiary care hospital in South India. This study included adult patients undergoing major surgical procedures. The modified Caprini score was calculated preoperatively for each patient, incorporating both conventional and newly adapted risk factors. Patients were monitored postoperatively for clinical signs of DVT and confirmed via duplex ultrasonography where indicated. Data were analyzed to assess the correlation between the risk score and actual DVT incidence.

Results:

A total of 250 patients were enrolled, with an overall 30-day VTE incidence of 6.8%, mostly within 3 days postoperatively. VTE risk increased significantly with higher Caprini scores, particularly >8 (10.4% incidence, OR = 153.5, $p < 0.001$). Significant predictors included age >60, malignancy, COPD, bed rest, central venous access, and prior DVT/PE. All affected patients received standard anticoagulation and were asymptomatic at 30-day follow-up.

Conclusion:

The Modified Caprini Risk Assessment Model is a more effective tool for predicting DVT risk in surgical patients than the conventional model. Its implementation in preoperative evaluations can enhance patient safety through better-targeted prophylaxis and risk mitigation strategies.

Keywords: Caprini score, Deep vein thrombosis, Thromboembolism, Thromboprophylaxis.

INTRODUCTION

Venous thromboembolism (VTE), which includes deep vein thrombosis (DVT) and

pulmonary embolism (PE), is a considerable but sometimes overlooked contributor to postoperative morbidity and mortality. It is one of the most preventable causes of in-hospital mortality worldwide.[1] The prevalence and consequences of VTE are extensively recorded in Western societies, although the actual burden in Asian nations, especially India, has traditionally been undervalued. This perception has resulted in insufficient widespread implementation of standardised prophylactic methods and risk assessment protocols within Indian surgical practice.[2]

Recent Indian research have started to contest the presumption that VTE is less common in the Indian population. These studies reveal that VTE is more prevalent than previously acknowledged, particularly among hospitalised and postoperative patients. Nonetheless, various obstacles persist in obstructing the precise assessment of VTE incidence in India. This encompasses the absence of standardised and validated risk assessment models specific to the Indian population, underreporting due to nonspecific presentations, prevalent misdiagnosis, and insufficient postoperative surveillance and follow-up.[3,4]

Although universal thromboprophylaxis could potentially diminish the risk of VTE in surgical patients, it may not be appropriate for every individual. The indiscriminate preventive use may lead to heightened bleeding issues and superfluous healthcare costs.[5] Consequently, precise identification of at-risk patients is essential to weigh the advantages of prophylaxis against the associated risks and expenses. Risk assessment methodologies for VTE can be categorised into group-based procedures and individualised models. The latter have demonstrated enhanced potential in correlating prophylaxis with individualised patient risk profiles.[6]

Among the several risk assessment models established—such as those formulated by Caprini, Cohen, Kucher, Roger, and endorsed by NICE—the Caprini RAM is one of the most thoroughly examined and widely utilised instruments.[7]

The Caprini model, formulated through clinical experience and data synthesis, allocates weighted scores to various patient-specific risk factors to categorise patients into VTE risk levels and inform prophylactic measures. In 1986, Dr. Joseph Caprini partnered with a consortium of physicians, surgeons, nurses, and scientists to create a risk assessment score predicated on characteristics linked to the occurrence of VTE episodes in patients. The score included both genetic and environmental risk variables and was initially published in 1991.This approach has been verified and refined in several Western surgical populations and certain Asian cohorts, including hospitalised patients in China. Notwithstanding its extensive utilisation, it remains unvalidated within the Indian surgical demographic.[8,9]

Currently, there is a lack of data assessing the efficacy of the Caprini RAM in the Indian environment. This study attempts to fill the gap by investigating the incidence of VTE in Indian surgical patients and assessing the reliability and validity of a Modified Caprini Risk Assessment Model adapted for Indian hospitals. This study contextualises the scoring system to accurately represent the risk profile and healthcare realities of the Indian population, introducing a novel method for individualised VTE risk stratification and aiming to offer evidence-based recommendations for safer and more cost-effective prophylaxis strategies in Indian surgical practice.

AIM

To evaluate the effectiveness of a modified Caprini Risk Assessment Model in predicting the risk of DVT among patients undergoing various surgical procedures.

METHODOLOGY

This was a prospective cohort study conducted over a 10-month period at the Department of General Surgery, Sree Mookambika Institute of Medical Sciences, in collaboration with the Departments of Anaesthesiology and Critical Care. A total of 250 patients undergoing surgical procedures during the study period were included.

Inclusion Criteria

- Patients undergoing elective or emergency surgical procedures under general or regional anaesthesia in the Department of General Surgery.

Exclusion Criteria

- Patients diagnosed with DVT at the time of admission.
- Patients already on anticoagulant therapy for any reason.
- Patients scheduled for lower limb vascular surgeries.
- Patients with known contraindications to anticoagulant therapy.
- Patients receiving antiplatelet medications.

Adapted Caprini Risk Assessment Model

The standard Caprini Risk Assessment Model was utilized with specific modifications tailored to local resource constraints. Each patient was evaluated based on clinical risk factors, with each factor assigned a weighted score from 1 to 5 according to its associated VTE risk. Laboratory-based risk markers—including Factor V Leiden, serum homocysteine, anti-cardiolipin antibodies, prothrombin 20210A mutation, and lupus anticoagulant—were

excluded due to cost limitations and limited availability. Each risk factor was assigned a weight (1–5), and total scores stratified patients into four risk categories.

Risk Category	Caprini Score	Estimated VTE Incidence
Low risk	0–1	~2%
Moderate risk	2	~10–20%
High risk	3–4	~20–40%
Highest risk	≥5	~40–80%

Table 1: Modified Caprini Risk Assessment Model

All patients meeting inclusion criteria were enrolled after informed consent. A pre-designed and validated proforma was used to collect demographic data, comorbidities, surgical details, and perioperative risk factors at the time of admission. Risk scoring was performed independently by two investigators to minimize subjective bias and assess inter-rater reliability.

Patients were closely monitored for signs and symptoms suggestive of DVT and pulmonary embolism (PE). DVT was clinically suspected in the presence of unilateral leg swelling, localized tenderness, pain during ambulation, increased local temperature, or discoloration. PE was considered in patients with unexplained dyspnea, pleuritic chest pain, or respiratory distress.

Postoperative evaluation for VTE was conducted in-hospital on postoperative days 3, 7, 14, and 30. Patients discharged early were advised for follow-up and were instructed to report any symptoms suggestive of VTE. Where clinically indicated, duplex ultrasonography and other diagnostic tests were used to confirm DVT or PE.

Statistical analysis was performed using SPSS software version 25. The incidence of VTE and Caprini risk scores were reported as percentages along with 95% confidence intervals to provide a measure of precision. Associations between individual risk factors and the occurrence of VTE were evaluated using the Chi-square test. In addition, relative risk (RR) was calculated to assess the strength of association between categorized risk levels and VTE development. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 250 surgical patients were enrolled in the study over the 10-month period. The majority of patients (43.2%) were in the 41–60-year age group, while 18.3% were aged over 61 years. The gender distribution included 58.8% male and 41.2% female participants.

A total of 17 cases of VTE were diagnosed and confirmed via duplex ultrasonography. All VTE cases were DVT; no patients of pulmonary embolism (PE) were identified. The overall 30-day incidence of VTE in the study population was 6.8%**.**

Based on the modified Caprini Risk Assessment Model:

- 106 patients (42.4%) were categorized as highest risk (score >8)
- 72 patients (28.8%) were in the high-risk group (score 7–8)
- 48 patients (19.2%) were in the moderate-risk group (score 5–6)
- 24 patients (9.6%) were classified as low risk (score 3–4)

Majority of the VTE cases were observed in patients classified within the highest risk group. VTE incidence increased proportionally with higher Caprini scores. Table 2 presents the 30-day VTE rates, relative risks (RR), and statistical significance for each risk category. The odds of developing VTE were significantly higher for patients with Caprini scores >8 (OR = 153.5, $p < 0.001$), compared to all lower categories. Similarly, patients in the 7–8 group had significantly elevated risk compared to those with scores 3–4 and 5–6 ($p < 0.001$).

Caprini Score	No. of DVT Cases (%)	Relative Risk (95% CI)	p-Value
3–4	0	1.0	0.83
5–6	1 (2.1%)	2.8 (0.1–67.1)	0.51
7–8	5 (6.9%)	64.5 (3.8–1083)	<0.001
>8	11 (10.4%)	146.7 (9.2–2343)	<0.001

Table 2: Distribution of VTE Rates by Caprini Risk Category

An analysis of individual risk factors from the Caprini RAM revealed several statistically significant predictors of VTE. The analysis showed that increasing age, especially above 60 years, significantly raises VTE risk. Conditions like COPD, severe lung disease, malignancy, bed rest, and use of central venous access also showed strong associations. The highest risks were observed in patients with prior DVT/PE or current leg swelling. Most of these associations were statistically significant, indicating they are important predictors for

VTE in surgical patients. Table 3 summarizes the prevalence, relative risk, and statistical significance of each factor.

Risk Factor	RR (95% CI)	No. of Patients	% of Total	p-value
Age 41–60	4.1 (0.9–17.5)	108	43.2%	0.07
Age 61–74	9.1 (2.0–40.4)	40	16.0%	0.003
Age >75	21.3 (4.5–103.7)	10	4.0%	<0.001
COPD	3.9 (1.5–11.4)	13	5.2%	0.02
Severe lung disease	9.6 (4.0–24.1)	3	1.2%	0.02
Bed rest	5.2 (1.9–14.5)	8	3.2%	0.02
Central venous access	6.3 (2.7–14.2)	12	4.8%	0.002
Major surgery	4.1 (1.1–16.5)	179	71.6%	0.043
Malignancy	4.7 (1.7–10.8)	94	37.6%	0.001
Patient confined to bed	9.3 (4.2–18.9)	20	8.0%	<0.001
History of DVT/PE	15.1 (9.7–22.5)	2	0.8%	0.004
Swollen legs (current)	15.7 (10.1–24.5)	3	1.2%	<0.001

Table 3: Distribution of risk Factors Associated with VTE

Of the 17 confirmed cases of deep vein thrombosis (DVT), 15(88.2%) cases were diagnosed by postoperative day 3, indicating an early onset in the majority of affected patients. All individuals received standard anticoagulation therapy promptly and were asymptomatic at the 30-day follow-up. No cases progressed to pulmonary embolism, and there were no reports of serious complications such as ischemia, compartment syndrome, or limb amputation.

DISCUSSION

The present study evaluated the incidence of VTE in surgical patients with a modified Caprini Risk Assessment Model, focussing on its applicability and predictive usefulness within an Indian clinical context. In a cohort of 250 patients receiving general or regional anaesthesia for diverse surgical interventions, the 30-day incidence of VTE was determined to be 6.8%, with all patients manifesting as DVT and none advancing to PE. This incident

corresponds with the growing acknowledgement that VTE was underdiagnosed and underreported in Indian surgical populations, contradicting the previous assumption that Asian people, particularly Indians, possess a reduced VTE risk.

The study revealed a robust association between elevated Caprini scores and the occurrence of DVT. All 17 VTE patients were reported in patients with Caprini scores of 7 or higher, with no occurrences in the low and moderate-risk categories (scores 3–6). This indicates that the Caprini RAM, even in its altered version omitting laboratory information, maintains significant discriminatory capability in identifying patients at heightened risk of postoperative VTE. Patients with scores over 8 exhibited a significantly heightened relative risk (RR = 146.7; $p < 0.001$), underscoring the necessity for targeted prophylactic measures for this cohort. These results align with Western validation studies and further endorse the application of risk assessment model in personalised VTE risk classification.

The present study also assessed the impact of individual risk variables on the development of VTE. Advanced age, namely above 60 years, demonstrated a statistically significant correlation with venous thromboembolism, underscoring the necessity for thorough evaluation in geriatric patients. Likewise, comorbidities like chronic obstructive pulmonary disease (COPD), severe pulmonary conditions, malignancies, extended bed rest, and central venous access were all substantially correlated with an increased risk of venous thromboembolism (VTE). Laparoscopic surgery did not demonstrate a significant correlation and may be linked to a reduced risk profile; nevertheless, additional assessment with a larger sample is required.

An important finding was that 88.2% of VTE patients were identified by postoperative day 3, highlighting the necessity of early surveillance during the perioperative phase. The early diagnosis and timely commencement of anticoagulant medication likely facilitated the positive results observed—no progression to pulmonary embolism and no significant problems were recorded at the 30-day follow-up.

The study conducted by Bo H et al.[10] encompassed a total of 24,524 patients. Fresh deep vein thrombosis (DVT) was identified in 221 patients, resulting in an overall incidence of 0.9%. A link was identified between DVT incidence and Caprini score based on risk stratification ($\chi 2 = 196.308$, $P < 0.001$). The incidence of DVT in the low-risk and moderate-risk categories was less than 0.5%. Over fifty percent of patients with DVT belonged to the highest risk category. Relative to the low-risk group, the risk was 2.10 times higher in the moderate-risk group, 3.34 times higher in the high-risk group, and 16.12 times higher in the

highest-risk group with Caprini scores ≥ 9. The area beneath the receiver operating characteristic curve was 0.74 (95% confidence range, 0.71–0.78; P<0.01) for the entire patient cohort. A Caprini score of ≥ 5 points was deemed the threshold for a significantly elevated risk of DVT in surgical patients receiving routine thromboprophylaxis.

Bilgi K et al.[11] incorporated 301 patients in their investigation, revealing an overall incidence of VTE at 30 days of 7.3%. The likelihood of getting VTE was considerably elevated in the >8 score group compared to the 3e4 group (OR ¼ 153.5, p < 0.001), the 5e6 group (OR ¼ 52.9, p < 0.001), or the 7e8 group (OR ¼ 2.3, p ¼ 0.002). Patients with a score of 7e8 exhibited a higher likelihood of developing VTE compared to the 3e4 group (OR = 67.5, p < 0.001) and the 5e6 group (OR = 23.2, p < 0.001).

Hanh BM et al.[12] demonstrated that 90-day postoperative venous thromboembolism occurred in 3,068 individuals. A majority of VTE cases (46.97%) were identified in the highest risk category (Caprini score > 5). In the high-risk category, 37.19% were observed, whilst the remaining 15.84% belonged to low to moderate risk groups. The probability of venous thromboembolism (VTE) was increased 2.83-fold for patients with a Caprini score of 3–4, 4.83-fold for a score of 5–6, 8.84-fold for a score of 7–8, and 11.42-fold for a score exceeding 8, in comparison to those with a score of 0 to 2 (all p values < 0.05). Consequently, the incidence of postoperative venous thromboembolism significantly increases, as indicated by the elevated Caprini score.

In the study conducted by Tadesse TA et al.[13] of the 155 hospitalised patients, the majority (135, 87.10%) were identified as being at risk for having VTE (Caprini risk score >1), with 47.11% classified in the highest risk category (Caprini score ≥5). The overall risk scores ranged from a maximum of 19 to a low of 1, with a mean value of 4.53±2.31. Of the patients at risk for developing VTE and qualified for thromboprophylaxis, merely 17.78% received such intervention, while two ineligible patients were administered prophylaxis. Only 3 patients (1.93%) admitted to surgical wards developed venous thromboembolism during hospitalisation.

In their study, Rocher WD et al.[14] applied a risk assessment model and found that 77% of patients were at risk of venous thromboembolism (VTE) (Caprini score ≥2), with 81% of elective patients and 74% of emergency patients identified as at risk. The predominant risk factors for VTE included major surgery (34%), age 41 to 60 years (30%), age 61 to 74 years (20%), and sepsis during the preceding month (27%).

The limitations of the study include single-center design, potentially restricting generalisability, and the exclusion of specific high-risk factors (e.g., pregnancy, hormone medication, significant orthopaedic surgery), which could not be assessed. Moreover, follow-up was restricted to 30 days, and imaging for VTE confirmation was conducted solely when clinically warranted, perhaps leading to an underestimation of asymptomatic patients' occurrence.

CONCLUSION

The study demonstrated that the modified Caprini Risk Assessment Model is an effective tool for predicting VTE risk in surgical patients within the Indian healthcare setting. The incidence of VTE was significantly higher in patients with elevated Caprini scores, particularly those scoring above 7. All confirmed VTE cases were DVT, with early detection and appropriate treatment resulting in favorable outcomes and no associated complications. These findings support the utility of the Caprini RAM in guiding individualized prophylaxis and highlight its practicality even when limited to clinical criteria. Routine implementation of this scoring system can enhance patient safety by facilitating early risk identification and targeted intervention, especially in resource-constrained environments.

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