



Deep vein thrombosis: A Walker and Avant concept analysis

Khadijeh Kalan Farmanfarma ¹, Esmail Fakharian ^{1,2}, Robbert J Gobbens ^{3,4,5,6}, Soudabeh Yarmohammadi ¹, Mohammad-Sajjad Lotfi ⁷, Mehrdad Mahdian ¹, Gholamreza Khosravi ¹, Masoumeh Abedzadeh-Kalahroudi ⁷, Mohammad Reza Fazel ¹, Reza Fadaei Vatan ⁸, Mojtaba Sehat ^{1,9*}

¹ Trauma Research Center, Kashan University of Medical Sciences, Kashan, Iran

² Department of Neurosurgery, Kashan University of Medical Sciences, Kashan, Iran

³ Faculty of Health, Sports and Social Work, Inholland University of Applied Sciences, Amsterdam, the Netherlands

⁴ Zonnehuisgroep Amstel land, Amstelveen, the Netherlands

⁵ Department of Family Medicine and Population Health, Faculty of Medicine and Health Sciences, University of Antwerp, Antwerp, Belgium

⁶ Tranzo, Tilburg University, Tilburg, the Netherlands

⁷ Trauma Nursing Research Center, Kashan University of Medical Sciences, Kashan, Iran

⁸ Iranian Research Center on Ageing, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

⁹ Department of Community Medicine, Faculty of Medicine, Kashan University of Medical Sciences, Kashan, Iran

* **Corresponding author: Mojtaba Sehat.** Trauma Research Center, Kashan University of Medical Sciences, Kashan, Iran, Department of Community Medicine, Faculty of Medicine, Kashan University of Medical Sciences, Kashan, Iran. **Email:** mojtabasehat982@gmail.com

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Abstract

Background: Deep vein thrombosis (DVT) is a serious condition, particularly prevalent among hip fracture patients, with high morbidity and mortality.

Objectives: This study applied the Walker and Avant model to clarify the concept of DVT and enhance clinical understanding.

Methods: A systematic concept analysis was undertaken in accordance with the Walker and Avant framework, which delineates eight essential steps from concept selection to the identification of empirical referents. The literature review was conducted using the PRISMA methodology, encompassing a comprehensive search across multiple databases, including PubMed and Google Scholar, covering the period from 2019 to 2023. Studies were included based on their relevance to DVT, publication in English, and the presence of pertinent keywords within titles and abstracts.

Results: The analysis confirmed the high incidence of DVT following surgery in patients with hip fractures and identified key risk factors, including immobility and inadequate post-operative care. Prophylactic interventions were shown to reduce the incidence of DVT, underscoring the critical importance of preventive strategies in clinical practice.

Conclusion: DVT presents a major postoperative risk, especially in orthopedic patients. This analysis outlines its pathophysiology, key risk factors, and evidence-based strategies to enhance prevention and perioperative care, guiding clinical teams to reduce its incidence and improve outcomes.

Keywords: Deep vein thrombosis, Prophylaxis, Walker and Avant model, Concept analysis.

Introduction

The annual incidence of deep vein thrombosis (DVT) is about 1 per 1,000, and the occurrence of DVT confers significant morbidity and mortality.^[1] DVT frequently complicates hip fractures, occurring both before and after surgery, and is primarily driven by prolonged immobilization and disturbances in coagulation pathways.^[2] Studies have shown that the incidence of DVT ranges from 8% to 34.9% before surgery, which may increase to 62% postoperatively.^[3] The primary

mechanism of DVT is pathologic thrombus formation within the deep venous system, which may present clinically with limb swelling and pain and can progress to pulmonary embolism; however, DVT is often clinically silent and may produce manifestations remote from the affected limb.^[4,5] Initial evaluation for suspected DVT routinely combines clinical prediction rules, plasma D-dimer testing, and confirmatory imaging.^[1] Major risk factors for deep vein thrombosis include prolonged immobility, major surgical procedures, obesity, advanced

age, and pregnancy. Patients with surgery, particularly those who do not receive prophylaxis, face an elevated risk because operative interventions can cause venous endothelial injury.^[6] Preventive pharmacologic and mechanical measures have been demonstrated to reduce DVT incidence by as much as 70%, underscoring their clinical efficacy.^[7] Poor awareness of thrombosis and associated risk factors markedly impedes prevention efforts.^[8]

Objectives

Therefore, this study aimed to conduct a comprehensive analysis of the concept of DVT, examining its diagnosis, defining characteristics, predictors, outcomes, and empirical manifestations using the Walker and Avant model. This analysis is intended to deepen the clinical team's understanding of DVT, thereby enhancing patient management and improving outcomes.

Methods

A concept analysis was conducted using the Walker and Avant's model, which proposes eight steps for the analysis:

1. Choosing a concept
2. Determining the purpose of the analysis
3. Identifying all uses of the concept
4. Defining attributes
5. Identifying a model case
6. Identifying borderline and opposite cases
7. Identifying antecedents (events that precede DVT) and consequences (events that follow DVT)
8. Defining empirical referents (methods for measuring DVT in clinical practice)^[9]

To gather relevant literature, the PRISMA method was employed for the article search.^[10] The search strategy was conducted using MeSH-aligned keywords across several major international databases, including PubMed, Web of Science, Scopus, and Google Scholar. Synonyms were combined with the OR operator, and the AND operator was applied to merge the retrieved results. All English language cross-sectional and cohort studies published from 2019 to 2023 were reviewed. Studies deemed irrelevant or lacking sufficient information were excluded, as were conference proceedings, news articles, editorials, commentaries, case series, studies involving pediatric

populations, books, and clinical guidelines. Following the removal of duplicates, abstracts, and unrelated records, the full texts of the remaining studies were comprehensively assessed, yielding a final inclusion of eight studies [Figure-1]. Two researchers (KFF and SM) independently reviewed the summaries and full texts of all retrieved articles using a standardized checklist. This checklist included the author's name, year of publication, study design, sample size, participants' age and sex, method of DVT diagnosis, and study outcomes [Table-1]. To ensure the accuracy and reliability of the extracted data, the first researcher conducted an additional review. Study selection was performed through a stepwise process, beginning with the screening of titles, followed by abstract review, and finally applying the inclusion criteria. The inclusion criteria consisted of English-language publications, the presence of relevant keywords in the title or abstract, relevance to the DVT concept, and availability of the full text.

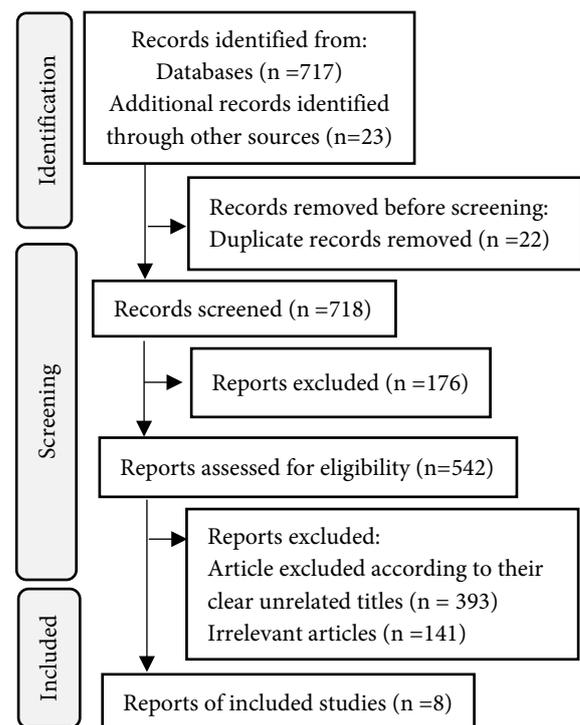


Figure-1. Flowchart of the included eligible studies

Table-1. Characteristics of included studies

Authors (year)	Sample size	Type of study	Age/sex	DVT was diagnosed	Outcome (result)
Kumar et al (2023) ^[12]	75	Prospective randomized controlled	aged ≥ 55 years/MF	Computed tomography venography (CTV)	There is no significant difference in the incidence of proximal DVT between mechanical alone and combined chemical-mechanical prophylaxis in elderly patients sustaining hip trauma. The incidence of proximal DVT can be reduced by mechanical prophylaxis alone.
Beauchamp -Chalifour et al (2022) ^[13]	5184	Retrospective cohort	≥ 65 /MF	Imaging	In total, 98.8% of this cohort received postoperative thromboprophylaxis.
Fu et al (2022) ^[14]	2429	Retrospective, cohort	60.3 \pm 16.4 years in FPX group while 61.1 \pm 14.5 years in LMWH group/MF	-	FPX group exhibited lower in-hospital VTE (0.1% vs. 0.8%; P=0.032, crude OR=0.11 before IPTW; P = 0.046, weighted OR = 0.12 after IPTW)
He et al (2019) ^[19]	188	Retrospective	>60-<60/MF	-	The wound healing rate of the control group was significantly lower than that of the intervention group (P<0.05). The Harris score (total hip arthritis score (Harry)) and Barthel index of the control group were lower than those of the intervention group (both P<0.05). The HAMA score and HAMD score of the control group were significantly higher than those of the intervention group (both P<0.05).
HU et al (2022) ^[15]	54	-	74.84 \pm 6.35/MF	Color Doppler ultrasound	The incidence of postoperative deep venous thrombosis (DVT) in the control group (62.96%) was significantly increased compared with the treatment group (14.81%). The results showed that the use of LMWH in elderly patients with hip fracture after the operation could significantly reduce the pain of the affected limb, reduce the plasma D-dimer content, inhibit PLT proliferation, promote HGB recovery, and reduce postoperative drainage volume, with high safety.
Yan et al (2020) ^[16]	2336	Meta-Analysis	>44	-	Xue shuantong injection can effectively prevent the formation of lower extremity DVT after orthopedic surgery and antagonize the postoperative hypercoagulable state of blood, which has high clinical value.
Zeng et al (2023) ^[17]	209	Retrospective	>60/MF	Color Doppler ultrasonography	Conclusion upon admission, BMI, NLR, and SII are independent predictors of DVT before surgery among cases developing intertrochanteric femoral fractures. Additionally, the nomogram based on the BMI, NLR, and SII can assist clinicians in determining if preventive and symptomatic therapies are required to improve DVT prognosis and reduce its associated mortality.
Zhao et al (2022) ^[18]	607	Retrospective, single-center study	>18/MF	Venography/duplex ultrasound	A total of 607 patients with pelvic and acetabular fractures were included, among whom 82 (13.5%) patients sustained

preoperative DVTs. Specifically, 31.7% (26/82) were diagnosed with proximal DVTs. Fifty-two (63.4%) patients had DVT within 7 days after injury, and 67 (81.7%) patients within 10 days. The multivariate logistic regression analysis identified 6 factors independently associated with the presence of preoperative DVT, including age > 46 years (odds ratio [OR] = 2.94), BMI > 26.73 kg/m² (OR = 3.91), time from injury to surgery > 9 days (OR = 5.39), associated injury (OR = 7.85), and ALB < 35.4 g/L (OR = 4.72), D-Dimer > 3.095 g/L (OR = 3.34).

Results

The subsequent findings are systematically organized according to Walker and Avant's concept analysis framework, encompassing its eight foundational steps to refine and clarify the concept of DVT.

1. Choosing a Concept

Deep vein thrombosis is a form of venous thrombosis characterized by the development of a blood clot within a deep vein, most commonly in the lower limbs. Clinical manifestations typically include swelling, tenderness, and pain in the affected area.^[11] A detailed analysis of this concept can contribute to a deeper understanding of its underlying mechanisms and implications.

2. Determining the Purpose of Analysis

This study applies the Walker and Avant concept analysis framework to explore and clarify the defining attributes, antecedents, and consequences of DVT.^[9] This analysis aims to enhance healthcare professionals' understanding of DVT, thereby facilitating more accurate and confident identification of the condition in clinical settings. Analysis of the eight included studies underscored the efficacy of prophylactic interventions in managing DVT and explored multiple determinants of thrombosis, such as predictors of occurrence and the standard of perioperative care.^[12-19]

3 & 4. Defining attributes and identifying all uses of the concept

This step involves identifying and describing the defining characteristics of the concept. Although abstract concepts often encompass multiple attributes, the analysis should focus on those most relevant. Defining attributes are the characteristics most frequently associated with the concept in the literature and are essential for distinguishing it from related or overlapping concepts.^[20] For example, Webster's Dictionary defines DVT as the formation of a thrombus within a deep vein, which may be asymptomatic or present with symptoms such as swelling and pain. Dislodgement of the thrombus can result in a potentially life-threatening

pulmonary embolism.^[21]

According to the Centers for Disease Control and Prevention (CDC), DVT is a medical condition in which a blood clot forms in a deep vein -commonly in the leg, thigh, pelvis, or arm and requires prompt diagnosis and treatment, as it is both preventable and treatable.^[22] The reviewed studies identified several key characteristics associated with DVT, including abnormal blood clot formation in deep veins, the effectiveness of prophylactic interventions, predictors of thrombosis, and the quality of care provided in the operating room.^[12-19]

5 & 6. Model Case and Contrary Case

One objective is to illustrate the practical application of the concept, while another is to present an example of a scenario in which the concept and its defining attributes are not present.^[8] Both cases are fictitious and constructed by the authors for study.

Model Case: A 50-year-old married man, overweight, a smoker, with a history of hypertension, who underwent surgery for a femur fracture two weeks ago, presents with severe leg pain and a rapid, irregular pulse. A Doppler ultrasound confirms the diagnosis of DVT.

Contrary Case: A 47-year-old single woman, on Enoxaparin for six months post-leg fracture surgery, shows no signs of DVT on Doppler ultrasound, maintaining a stable heart rate and blood pressure. The most common diagnostic methods for DVT in the studies reviewed were computed tomography venography and color Doppler ultrasound.^[12-19]

Borderline Case:

Borderline cases exhibit some, but not all, of the defining features of the concept. Examining these cases helps clarify the essential attributes required for model cases and minimizes ambiguity at the conceptual boundaries.

Example: A 70-year-old man with a history of heart disease was hospitalized for hip replacement surgery. During his hospital stay, he exhibited no signs or symptoms of DVT and received Enoxaparin

prophylactically. Upon discharge, there was no emphasis on continuing anticoagulation or adhering to post-operative physiotherapy.

7. Identifying Antecedents and Consequences

Elucidating the antecedents and consequences of DVT establishes a rigorous conceptual framework for identifying empirical referents that support its precise detection and quantification in clinical contexts.

Antecedents: Antecedents are activities, situations, or events that precede the onset of symptoms and may contribute to the development of DVT.^[23] In patients, antecedents of DVT are often influenced by underlying medical conditions, particularly in elderly individuals, those with prolonged immobility, and individuals with obesity. Within the healthcare system, contributing factors include inadequate communication and coordination among hospital departments, insufficient equipment, extended general anesthesia, and failure to prescribe prophylactic medications for patients experiencing prolonged pre- or post-operative immobility.^[24]

Consequences: The consequences of DVT are events that arise from the development of the condition.^[24] These include prolonged hospitalization, the potential for pulmonary embolism, and an increased risk of mortality.^[25]

8. Defining Empirical Referents

The study identified computed tomography (CT) venography and color Doppler ultrasound as the most commonly used diagnostic methods for DVT^[12, 15, 17, 18]. These methods serve as measurable indicators for the confirmation of DVT in clinical settings.

Discussion

This study was conducted to analyze the conceptual framework of DVT. Previous studies have highlighted the critical roles of prophylactic interventions, predictors of DVT occurrence, and the quality of care provided in the operating room. Focusing on these aspects can play a crucial role in the prevention of DVT. The condition most commonly affects the lower extremities and, to a lesser extent, the upper extremities.^[26] Hip fractures are particularly prone to thrombosis in the pelvic veins, which can result from direct injury to the vein, surgical intervention, thermal damage during cement polymerization, compression by a hematoma, or prolonged immobility. In trauma patients, the pathogenesis of DVT begins at the time of injury, with thrombin production initiating within 24 hours and peaking approximately two weeks post-trauma.^[12] Venous thromboembolism (VTE) is a common postoperative

complication following hip fracture surgery, with pulmonary embolism (PE) being the most frequent consequence of thrombus migration to the pulmonary arteries. Embolization from deep veins in the legs occurs in approximately one-third of DVT patients. Therefore, effective prevention of DVT is essential for reducing the incidence of PE, which has a substantial impact on patient mortality.^[5,26] Prophylaxis is widely recognized as the most critical preventive strategy for DVT. Identifying patient-specific risk factors is essential for determining who would benefit most from thromboprophylaxis. The risk of developing DVT is influenced by factors such as genetic predisposition, age, body mass index, and acquired conditions related to specific patient circumstances, including hospitalization, surgery, or malignancy. These risk factors are often categorized according to their transient or persistent nature and their relative significance. Such distinctions are valuable for assessing ongoing risk and determining the appropriate duration of prophylactic interventions.^[27] The primary objective of pharmacological VTE prophylaxis is to prevent potentially fatal pulmonary embolism. In intensive care and surgical settings, pharmacological VTE prophylaxis has been demonstrated to reduce patient mortality. Early clinical studies on VTE prevention primarily investigated the benefits of anticoagulant therapy in populations at high risk for VTE. Pharmacological VTE prophylaxis can be readily incorporated into routine patient care and is commonly included in clinical protocols for both medical and surgical patients. However, recent evidence indicates that the risk of bleeding associated with anticoagulant thromboprophylaxis may, in certain patient populations, outweigh its potential benefits.^[27-29]

Thromboprophylaxis in trauma patients can be achieved through pharmacological anticoagulants, mechanical prophylactic devices, and the use of inferior vena cava (IVC) filters.^[30] Key antecedent factors contributing to DVT include pre-existing medical conditions, particularly in elderly patients, as well as prolonged or severe immobility and obesity. Significant healthcare-related contributors to DVT include inadequate communication and coordination among hospital departments, insufficient equipment, prolonged general anesthesia, and failure to prescribe prophylactic medications for patients experiencing extended immobility before and after surgery. The primary consequences of DVT include prolonged hospitalization, the development of pulmonary embolism, and, ultimately, increased risk of mortality.^[24] CT venography and color Doppler ultrasound were identified as the primary diagnostic methods for DVT in

the study. According to previous research, CT venography is widely regarded as the gold standard for detecting DVT. In contrast, color Doppler ultrasound, due to its non-invasive nature, high reproducibility, patient tolerability, and low cost, is considered the first-line imaging modality for diagnosing venous thrombosis. Although it is not the gold standard, Doppler ultrasound is widely accepted as a clinical standard in routine practice.^[31,32] One limitation of the present study is the inability to access the full texts of certain relevant articles in this field.

Conclusions

This conceptual analysis identified key determinants such as prophylactic interventions, predictors of DVT occurrence, and the quality of perioperative care as critical factors in the prevention and management of DVT. The most prominent risk factors for DVT were severe immobility, prolonged general anesthesia, and the absence of pharmacological prophylaxis in patients with extended periods of immobility. The most serious consequences of DVT include pulmonary embolism and increased mortality. Elucidating the concept of DVT, along with its associated risk factors and clinical consequences, can enable healthcare professionals to make informed and timely decisions in the management of at-risk patients, thereby minimizing harm and enhancing patient outcomes.

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None.

Competing interests

The authors declare that they have no competing interests.

Abbreviations

DVT: Deep Vein Thrombosis; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; VTE: Venous Thromboembolism; PE: Pulmonary Embolism; CTV: Computed Tomography Venography; LMWH: Low Molecular Weight Heparin; FPX: Fondaparinux (Sodium); IPTW: Inverse Probability of Treatment Weighting; HAMA: Hamilton Anxiety Rating Scale; HAMD: Hamilton Depression Rating Scale; PLT: Platelets; HGB: Hemoglobin; BMI: Body Mass Index; NLR: Neutrophil-to-Lymphocyte Ratio; SII: Systemic Immune-Inflammation Index; OR: Odds Ratio; ALB: Albumin; CDC: Centers for Disease Control and Prevention; CT: Computed Tomography; IVC: Inferior Vena Cava.

Authors' contributions

All authors read and approved the final manuscript. All authors take responsibility for the integrity of the data and the accuracy of the data analysis.

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Availability of data and materials

The data used in this study are available from the corresponding author on request.

Ethics approval and consent to participate

The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

By submitting this document, the authors declare their consent for the final accepted version of the manuscript to be considered for publication.

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