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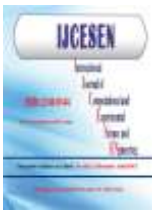

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Research Article

Nursing Interventions in the Prevention and Management of Deep Vein Thrombosis in Hospitalized Patients

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Abstract:

Deep vein thrombosis (DVT) is a significant concern in hospitalized patients, as immobility, surgical procedures, and certain medical conditions increase its risk. Effective nursing interventions are essential in both the prevention and management of DVT in this vulnerable population. Prevention strategies include performing thorough risk assessments using validated protocols, ensuring adequate patient education on the importance of mobility, and implementing early ambulation when possible. Nurses also play a crucial role in administering prophylactic anticoagulants, utilizing compression stockings, and monitoring for signs of thrombosis to mitigate the risk of DVT. Regular patient assessments help nurses identify high-risk individuals and tailor interventions accordingly. In terms of management, nursing interventions require a proactive approach that includes vigilant monitoring for symptoms of DVT, such as swelling, pain, and warmth in the affected limb. If DVT is suspected or confirmed, nurses must collaborate with the healthcare team to promptly initiate treatment plans, which may include anticoagulation therapy and, in certain cases, thrombolytic treatments or surgical interventions. Education and support for patients and their families are crucial, as understanding the condition and treatment options can alleviate anxiety and promote adherence to therapy. Furthermore, continual reassessment and adjustment of interventions based on patient response are vital for optimizing outcomes and preventing complications such as pulmonary embolism.

1. Introduction

Deep Vein Thrombosis (DVT) represents a formidable and potentially life-threatening challenge within the contemporary healthcare landscape, particularly in the inpatient setting. Characterized by the formation of a blood clot, or thrombus, within the deep venous system—most commonly in the deep veins of the lower extremities such as the popliteal, femoral, and iliac veins—this condition is a critical medical priority [1]. DVT is not an isolated pathology but is, rather, the primary instigator within the broader, more dangerous phenomenon of venous thromboembolism (VTE). VTE encompasses both DVT and its acute and often fatal sequela, pulmonary embolism (PE), where a fragment of the deep vein clot dislodges, travels through the circulatory system, and obstructs the pulmonary arteries [1].

The burden imposed by DVT and VTE on global healthcare systems, economies, and, most importantly, patient lives is profound and multifaceted. Epidemiological studies consistently highlight VTE as a leading cause of preventable hospital death, with incidence rates remaining persistently high despite advances in medical knowledge and prophylactic strategies [2]. The morbidity associated with DVT extends beyond the acute event; survivors often face long-term sequelae such as post-thrombotic syndrome (PTS), characterized by chronic limb pain, swelling, heaviness, and in severe cases, venous ulcers, which drastically impair quality of life and impose significant long-term care costs [3]. Furthermore, the financial burden is staggering, encompassing costs related to extended hospital stays, diagnostic imaging, pharmacological treatments, management of complications like PE and PTS, and readmissions. This economic impact resonates through healthcare institutions, making DVT prevention not only a clinical imperative but also a key component of value-based care and hospital quality metrics [4]. Within this high-stakes context, the hospital environment itself paradoxically serves as a significant risk incubator. Hospitalized patients, by virtue of their acute illness, enforced immobilization, traumatic injuries, and frequent surgical interventions, constitute one of the highest-risk populations for developing this complication. The very factors that necessitate hospitalization—such as major surgery, cancer therapy, stroke, or severe infection—directly potentiate the conditions that favor thrombogenesis.

The pathophysiological foundation for understanding DVT was elegantly established in the 19th century by Rudolf Virchow, whose seminal description of the triad of venous stasis, endothelial injury, and hypercoagulability remains the unchallenged cornerstone of our conceptual model [5]. Venous stasis refers to the slowing or pooling of blood flow, a common occurrence in patients confined to bed rest or with limbs immobilized by casts or paralysis. Hypercoagulability denotes a systemic increase in the blood's propensity to clot, which can arise from genetic predispositions (e.g., Factor V Leiden) or be acquired due to conditions like active malignancy, pregnancy, or the systemic inflammatory response triggered by critical illness or surgery. Endothelial injury involves damage to the inner lining of the vein, exposing pro-thrombotic subendothelial collagen and tissue factor; this injury can be mechanical from direct

trauma, surgical manipulation, or intravenous catheters, or biochemical due to toxins or inflammatory mediators [5]. The hospital environment uniquely and synergistically amplifies each component of Virchow's triad. Illness and surgery promote hypercoagulability; bed rest and anesthesia induce stasis; and vascular access, surgical dissection, and trauma directly cause endothelial damage. Thus, the inpatient setting creates a perfect storm for thrombus formation, making vigilant, protocol-driven prevention an ethical and clinical mandate for all healthcare providers involved in a patient's care.

Within this complex and high-risk clinical scenario, the role of the professional nurse decisively transcends tasks of basic care delivery and emerges as a critical, proactive, and multidimensional force in the scientific combat against VTE. Nurses are the healthcare professionals endowed with the most continuous, around-the-clock patient contact, positioning them uniquely at the nexus of observation, assessment, intervention, and coordination. This privileged position is not merely one of proximity but of profound responsibility and opportunity. It enables nurses to perform dynamic, ongoing risk assessments that can detect a patient's evolving vulnerability. It empowers them to implement, meticulously monitor, and ensure adherence to both mechanical and pharmacological prophylactic strategies prescribed by the interdisciplinary team. It places them on the front line for the early recognition of subtle signs and symptoms that may herald the development of a DVT or, more critically, a PE. Furthermore, their role encompasses the essential tasks of coordinating complex care pathways, advocating for patient safety and protocol compliance, and educating patients and their families for both in-hospital safety and long-term secondary prevention [6].

2. Pathophysiology and Risk Factors:

A thorough understanding of the mechanisms underlying DVT formation is essential for nurses to appreciate the rationale behind preventive interventions and identify vulnerable patients. Virchow's triad provides the framework: venous stasis, hypercoagulability, and endothelial (vascular) injury. Venous stasis, or slowed blood flow, allows clotting factors and platelets to accumulate and adhere to the vessel wall. This is common in patients confined to bed, those with limb paralysis, or individuals with heart failure [3]. Hypercoagulability refers to an increased tendency of the blood to clot, which can be inherited (e.g., Factor V Leiden mutation) or acquired due to conditions like cancer, pregnancy, estrogen therapy, or systemic inflammatory states [4]. Endothelial injury disrupts the normal antithrombotic lining of the vein, exposing pro-thrombotic material and triggering the coagulation cascade; this can result from direct trauma, surgery (particularly orthopedic procedures on the lower limbs), intravenous catheters, or previous DVT [5].

Nurses must be adept at conducting a systematic and continuous risk assessment using validated tools. The most commonly employed tool is the Caprini Risk Assessment Model, which assigns weighted points to numerous patient-specific risk factors, stratifying patients into low, moderate, high, and highest risk categories [6]. These factors span patient history (e.g., age over 60, personal or family history of VTE, known thrombophilia), current clinical status (e.g., active cancer, congestive heart failure, severe lung disease), and the present hospitalization (e.g., major surgery, expected immobilization, central venous access). The Autar DVT Risk Assessment Scale is another tool specifically designed for nursing use, focusing on age, body mass index, mobility, special risk factors, trauma, surgical intervention, and associated medical conditions [7]. The nursing imperative is to perform this assessment upon admission, at regular intervals during hospitalization, and with any significant change in patient condition, ensuring that the level of prophylaxis is appropriate to the dynamically changing level of risk.

3. Nursing Interventions in DVT Prevention:

Prevention is unequivocally the most effective strategy in managing DVT, and nursing-led interventions form the backbone of prophylactic care. These interventions are categorized into mechanical and pharmacological methods, almost always used in combination for high-risk patients unless contraindicated.

Mechanical Prophylaxis: Enhancing Venous Return. Mechanical methods aim to reduce venous stasis without the risks associated with anticoagulant drugs. Nursing responsibilities in this domain are extensive and detail-oriented. Graduated compression stockings (GCS) are elastic stockings that provide the greatest degree of compression at the ankle, gradually decreasing up the leg. Nurses are responsible for ensuring correct sizing, as improper fit can be ineffective or even harmful, acting as a tourniquet [8]. They must assess the patient's skin and circulation before application and regularly thereafter, educate the patient on their purpose and proper wear, and ensure they are removed for daily hygiene and skin inspection. Intermittent pneumatic compression

(IPC) devices consist of sleeves wrapped around the legs that intermittently inflate and deflate, mechanically milking blood from the deep veins. Nurses must apply the sleeves correctly, ensure the device is functioning and cycling properly, and encourage patient compliance, as the benefit is lost if the device is disconnected for prolonged periods [9]. For patients who are ambulatory, the most fundamental and critical nursing intervention is the early and frequent mobilization. Nurses coordinate with physiotherapists, encourage active and passive range-of-motion exercises, and assist patients out of bed as soon as medically feasible, as muscular contraction is the most physiological pump for venous return.

4. Pharmacological Prophylaxis: Monitoring and Administration.

For patients at moderate to high risk, pharmacological prophylaxis is the standard of care. Nurses play a pivotal role in the safe administration and monitoring of these agents. Common agents include low-molecular-weight heparins (LMWHs) like enoxaparin, unfractionated heparin (UFH), fondaparinux, and direct oral anticoagulants (DOACs) such as rivaroxaban or apixaban [10]. Nursing responsibilities encompass verifying the physician's order, checking for any contraindications (e.g., active bleeding, severe thrombocytopenia), administering the medication via the correct subcutaneous or oral route at the prescribed time, and employing techniques to minimize bruising (e.g., subcutaneous injection in the abdominal wall, not rubbing the site). Crucially, nurses must monitor for signs of bleeding complications, which can range from overt bleeding at surgical sites or from invasive lines to more subtle signs like a drop in hemoglobin, hematuria, or melena. Regular laboratory monitoring, particularly for platelet counts in patients on heparin (to detect heparin-induced thrombocytopenia) and renal function for drugs cleared renally, falls under nursing vigilance [11]. The nurse acts as the final safety checkpoint, ensuring the right patient receives the right prophylactic drug at the right time and dose.

5. Nursing Management of the Patient with Suspected or Confirmed DVT

When prevention fails, or in patients presenting with DVT, the nursing role shifts rapidly to one of acute management, diagnostic coordination, and complication prevention.

Early Recognition and Immediate Response. The classic signs and symptoms of DVT include unilateral leg swelling, pain or tenderness (often described as a cramp or soreness), warmth, and erythema. However, it is vital to note that up to 50% of DVTs can be asymptomatic, making risk awareness paramount [12]. Upon suspicion of DVT, the nurse's immediate actions are critical. These include promptly notifying the physician or advanced practice provider, applying supportive measures such as elevating the affected limb (without forceful flexion at the knee or hip), ensuring the patient remains on bed rest initially to prevent clot dislodgement, and avoiding any massage or vigorous manipulation of the limb. The nurse prepares the patient for diagnostic studies, most commonly a compression ultrasonography, which is non-invasive and highly sensitive for proximal DVTs [13]. Providing clear explanations and emotional support during this anxious period is an essential nursing function.

Coordinating Anticoagulant Therapy and Monitoring**.** The cornerstone of DVT treatment is therapeutic anticoagulation to prevent clot extension and PE. The initiation of this therapy is a high-risk, high-responsibility phase for nursing. For acute treatment, options often include a parenteral agent (like therapeutic-dose LMWH or intravenous UFH) bridged to an oral agent (warfarin or a DOAC), or in some cases, a DOAC alone [14]. Nursing management during intravenous UFH infusion is particularly intensive, requiring strict adherence to protocol-driven dosing adjustments based on activated partial thromboplastin time (aPTT) monitoring. Nurses must be expert in managing infusion pumps, drawing appropriate lab samples, and recognizing signs of heparin overdose or underdose. For warfarin therapy, nurses coordinate with pharmacy and utilize patient education on the importance of consistent vitamin K intake, frequent International Normalized Ratio (INR) monitoring, and recognition of bleeding signs. With DOACs, while monitoring is less frequent, nurses ensure proper administration regarding food interactions (e.g., rivaroxaban with food) and assess renal function periodically [15].

Preventing Complications: Pulmonary Embolism and Post-Thrombotic Syndrome**.** A primary fear in DVT management is clot embolization leading to PE. Nurses are the frontline monitors for signs of this emergency, which include sudden onset dyspnea, pleuritic chest pain, tachycardia, tachypnea, hemoptysis, and hypoxemia. Any such development warrants immediate emergency response [16]. Another long-term complication is post-thrombotic syndrome (PTS), characterized by chronic leg pain, swelling, heaviness, and in severe cases, venous ulcers. A key nursing intervention to reduce the risk of PTS is the consistent use of

therapeutic-grade compression stockings (30-40 mmHg pressure) for two years or more following DVT diagnosis, as evidence suggests they can alleviate symptoms and improve venous return [17]. Nurses educate patients on this long-term commitment, assist with fitting, and reinforce adherence during follow-up.

6. Patient and Family Education: Empowering for Continuity of Care

Education is a powerful and independent nursing intervention that bridges hospital care with long-term management and secondary prevention. Effective education must be tailored, iterative, and delivered using multiple methods (verbal, written, demonstrations).

Medication Management and Safety**.** Patients and families require comprehensive education on their prescribed anticoagulant. This includes the drug name, purpose, exact dosage, timing, and route of administration. For warfarin, this extends to the concept of INR, the need for regular blood tests, and the effect of diet and other medications. For all anticoagulants, a major focus is on recognizing and reporting signs of bleeding (e.g., unusual bruising, bleeding gums, red or black stools, severe headache) and signs of clot recurrence or PE [18]. Nurses must emphasize the critical importance of not missing doses and not taking over-the-counter medications (especially NSAIDs like ibuprofen or aspirin) without consulting a healthcare provider.

Education extends beyond medication. Nurses counsel patients on the importance of regular ambulation and avoidance of prolonged sitting or standing. They provide guidance on proper hydration to avoid hemoconcentration. For patients with ongoing risk factors, the use of compression stockings is reinforced. Patients are educated on the importance of keeping all follow-up appointments with their primary care provider or hematologist. Furthermore, they should be advised to inform all future healthcare providers, including dentists, about their history of DVT and current anticoagulant use [19]. This comprehensive discharge planning, led by the nurse, is vital for preventing recurrence and managing chronic aspects of the condition.

7. The Role of Interdisciplinary Collaboration and Nursing Advocacy

The prevention and management of DVT cannot be achieved by nursing in isolation. It demands seamless interdisciplinary collaboration. Nurses act as the central hub of communication, liaising between physicians (hospitalists, surgeons, hematologists), pharmacists, physiotherapists, occupational therapists, and dietitians. The nurse communicates changes in patient condition, shares risk assessment findings, clarifies orders for prophylaxis, and coordinates mobilization efforts with therapy teams. The pharmacist is a key partner in verifying appropriate anticoagulant dosing and providing drug information [20]. Furthermore, nurses serve as powerful patient advocates. They advocate for timely risk assessment and appropriate prophylaxis orders based on established hospital protocols. They advocate for patient mobility, challenging unnecessary bed rest orders when possible. They advocate for patient understanding, ensuring health literacy does not become a barrier to safe self-care post-discharge [20]. This advocacy role is fundamental to ensuring that institutional VTE prevention policies are translated into consistent, individualized patient care [21].

8. Conclusion

Deep Vein Thrombosis in hospitalized patients is a pervasive threat with serious implications for patient outcomes and healthcare systems. Its prevention and effective management represent a quintessential example of where sophisticated nursing science and compassionate clinical practice converge. From the foundational act of meticulous risk stratification to the hands-on application of mechanical devices, the precise administration of high-risk medications, the vigilant surveillance for complications, and the empowering delivery of patient education, nursing interventions are woven into every facet of the VTE care continuum. The modern nurse functions not as a passive executor of orders but as an active, knowledgeable, and vigilant professional whose judgment and actions are critical in interrupting the pathophysiological cascade described by Virchow. By embracing evidence-based practice, committing to continuous monitoring, fostering interdisciplinary teamwork, and prioritizing patient education, nurses stand as the most consistent and potent defense against the development and devastating consequences of DVT. Ultimately, a healthcare culture that recognizes, supports, and optimizes these multidimensional nursing roles is essential for achieving the paramount goal of safer hospitalization and improved long-term patient well-being.

Author Statements:

- **Ethical approval:** The conducted research is not related to either human or animal use.

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