Recent incidence of deep-vein thrombosis in surgical departments, 2015 - 2022: A systematic review

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Background. Deep-vein thrombosis (DVT) refers to the formation of blood clots in the deep veins of the body, and together with pulmonary embolism, accounts for ~60 000 - 100 000 deaths annually worldwide.
Objectives. To review recent data on DVT in surgical departments globally.
Methods. An online search of publications was done through Google Scholar, PubMed, Scopus and the Cochrane Library from 2015 to July 2022 with search phrases 'Epidemiology of DVT in surgery', 'Deep-vein thrombosis', 'Virchow's triad', 'Diagnosis and management of DVT' and 'DVT complications'.
Results. A total of 28 publications with a total sample size of 10 694 were selected and reviewed. It has been reported that 50% of DVTs occur as a result of decreased mobility in longer hospital admissions and after surgery. Most cases in this review were reported from orthopaedic surgery departments. The pathogenesis of DVT follows Virchow's triad of venous stasis, hypercoagulability and endothelial damage. DVT is diagnosed by evaluating signs and symptoms, D-dimer testing, venography and Doppler ultrasound scans. Antithrombotic agents with or without mechanical prophylaxis remain the mainstay of DVT management. A recently established American College of Chest Physicians guideline may be used to aid in management decisions.
Conclusion. DVT can pose a significant healthcare burden owing to complications if it is not managed adequately. Studies on DVT in Africa, Asia and South America are scarce, and there is a need for research on DVT worldwide. These studies can be done in individual surgical departments, countries and areas such as sub-Saharan Africa, North Africa and East Africa.

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Cardiovascular disease (CVD) constitutes a significant number of illnesses that together cause a vast amount of morbidity and mortality. Venous thromboembolism (VTE) is one of the top three causes of CVD mortality and comprises two conditions, deep-vein thrombosis (DVT) and pulmonary embolism (PE).[1] The most common sites for the formation of DVT are shown in Fig. 1.[2] The estimated annual incidence of VTE in individuals of European ancestry is ~104 - 183 per 100 000 person-years, although it is speculated that this figure may be higher in African Americans and lower in Asians.[3] The pathogenesis of DVT is best understood using Virchow's triad of venous stasis, hypercoagulability and vascular endothelial damage.[1,4] In 2021, the Centers for Disease Control and Prevention reported that 50% of DVTs were a result of surgery and hospital admission.[5] Management of DVT is aimed at primary prevention, managing symptoms, and preventing complications. The three main complications of DVT are recurrent DVT, PE and post-thrombotic syndrome (PTS).[6]

The objective of this review was to answer the following questions:

- What is the incidence of DVT in surgical departments?
- What factors increase the risk of DVT development in surgical patients?
- How is DVT diagnosed and treated?
- What are the existing gaps in knowledge?

Methods

Literature search

A comprehensive online search was conducted through Google Scholar, PubMed, the Cochrane Library and Scopus to identify published articles on VTE worldwide from 2015 to July 2022. The search was done using the key words 'Epidemiology of DVT in surgery', 'DVT', 'Virchow's triad', 'Diagnosis and management of DVT' and 'DVT complications'. Articles were chosen based on their title, and whether the abstract indicated that the article provided information answering the research questions. Articles published prior to 2015, those for which full text was not available, and those that included DVT in non-surgical departments were excluded. A total of 28 articles, with a combined sample size of 10 694, were selected based on the inclusion and exclusion criteria.

Results and discussion

Incidence of DVT in surgical departments

Globally, VTE is the third most common CVD, and its estimated incidence is ~2 per 1 000 persons per year.[7] Surgery is an independent risk factor in the development of VTE, and various aspects of the surgical procedure influence the risk it poses. For example, Yang *et al.*[8]

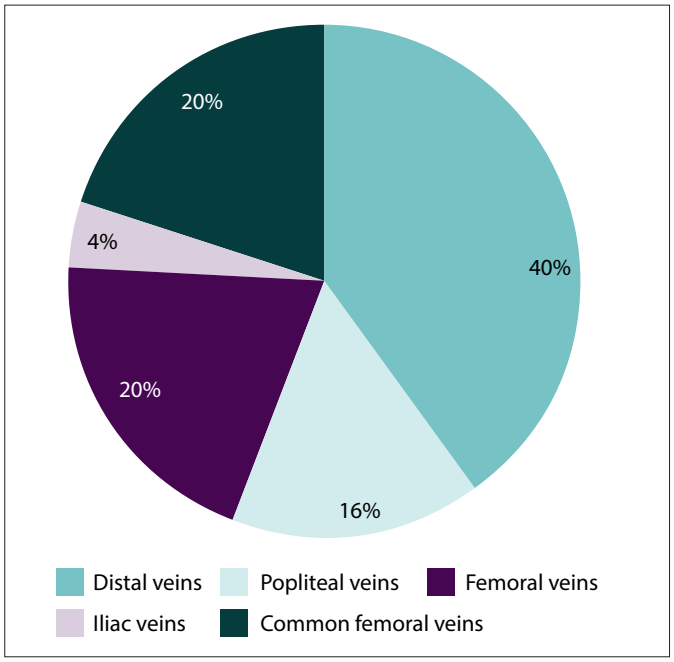

Fig. 1. The most common sites for formation of deep-vein thrombosis.

Table 1. Factors increasing the risk of development of deep-vein thrombosis[10]

Stasis	• Immobility (prolonged travel, postoperative recovery) • Trauma • Atrial fibrillation • Obesity
Endothelial damage	• Smoking • Surgery • Hypertension • Artificial valves • Infection
Hypercoagulability	• Cancer • Chemotherapeutic agents • Pregnancy • Oral contraceptives • Clotting disorders • Trauma

found that in patients undergoing spinal surgery, the duration of surgery, blood loss, need for blood transfusion during or after surgery, and average hospital stay after surgery all affected the risk of DVT development. Danwang *et al*.[9] reported that the prevalence of DVT in sub-Saharan Africa and North Africa ranged between 2.4% and 9.6% in surgical patients, and in South Africa (SA), the burden of DVT was estimated to be >200 000 cases per year.[10] Geographical location, gender and individual comorbidities contribute to the risk posed by surgery for the development of DVT, as seen in SA, where tuberculosis and HIV were the main risk factors for the development of VTE.[10] In the USA, the

Table 2. American College of Chest Physicians guideline based on the Caprini risk assessment score[17]

Score	Risk category	Management
0	Very low	• Prophylaxis is not necessary • Early mobilisation
1 - 2	Low	• Mechanical prophylaxis (compression stockings/pneumatic compression)
3 - 4	Moderate	• Low-molecular-weight heparin OR • Low-dose unfractionated heparin OR • Mechanical prophylaxis
≥5	High	• High-dose low-molecular-weight heparin OR • Low-dose unfractionated heparin with or without mechanical prophylaxis

incidence of VTE is higher in African Americans than in Asians and Native Americans, and among African Americans, an increased incidence was found in women during pregnancy, immediately after giving birth and on contraception, and in men aged >45 years.[3] We could find no recent data on the incidence outside Europe and the USA.

Factors increasing the risk of DVT

Rudolf Virchow in 1856 identified three factors predisposing individuals to developing VTE, namely endothelial damage, venous stasis, and hypercoagulability. Vessel injury exposes tissue factor on the damaged cells, allowing von Willebrand factor to bind, venous stasis causes a concentration of clotting factors in that region, and the hypercoagulable state increases the ability of the blood to clot when stimulated.[11] The mechanism of the formation of a thrombus is described as pooling of blood in the veins due to their increased diameter, resulting in impairment of venous return to the heart. Since the valves in the veins are prone to backflow, there is an increased likelihood of a thrombus forming. After the clot forms, it may dislodge and travel to the lungs, where it causes a PE.[12] Risk factors associated with an increase in the development of DVT and their mechanism based on Virchow's triad are summarised in Table 1. A basic understanding of these factors and their involvement in clot formation directs various clinical decisions regarding level of risk as well as management of the thrombus.

Diagnosis and management

DVT is usually nonspecific in its presentation, so the patient's history, clinical signs and symptoms, together with objective diagnostic tests, are imperative in making a correct diagnosis. Conditions such as cellulitis, chronic venous insufficiency, lymphoedema or a Baker cyst may present similarly.[13,14] The most common signs and symptoms of DVT of the leg include pain, swelling, heaviness, and discoloration of the affected area. D-dimer testing is used as a diagnostic modality because its levels rise in patients with DVT; however, this test is not specific to DVT.[14-16] The gold standard tests for the presence of DVT are venography and pulmonary angiography. Doppler ultrasound scans have become an alternative imaging modality, effectively assisting in the diagnosis and exclusion of DVT.[13] The Caprini score remains the most commonly used tool to ascertain the likelihood of DVT, but some studies suggest that this tool is

not sufficient and should be superseded by the 9th American College of Chest Physicians guideline (ACCP-9).[17]

After the diagnosis of DVT has been established, anticoagulation therapy is usually indicated to manage the symptoms, decrease the chances of progression, and reduce the risk of complications. Direct-acting oral anticoagulants, heparin, warfarin and aspirin remain the drugs of choice in the management of DVT.[18] Non-pharmacological regimens for treating DVT such as surgery and inferior vena cava filters also exist, and analgesics are used to reduce pain and inflammation caused by the thrombus.[18] Devis and Knuttinen[19] noted that the level of the risk of DVT development in patients should be assessed, as it also drives treatment. One tool used for this purpose is the ACCP-9 guideline based on the Caprini risk assessment score (Table 2).[17] This tool considers a patient's age, sex and body mass index, and other individual factors, and provides a score that categorises patients into different risk classes, which is then used to determine what kind of therapy patients will receive.[17,20]

DVT can result in long-term morbidity and a decreased quality of life, and can be fatal (up to 60%).[16] The main complications of DVT are recurring DVT, PE and PTS. The incidence of recurrent DVT after an initial episode is 9.6%.[21] Hansrani *et al.*[22] reported that PE occurs as an acute complication of DVT in up to 33.3% of patients. Signs and symptoms include shortness of breath, chest pain, tachycardia, dizziness, loss of consciousness and cyanosis. Danwang *et al.*[9] found the prevalence of PE in medical patients in Africa to range from 0.14% to 61.5%, with a mortality rate of up to 69.5%. PTS, a long-term complication of DVT, is characterised by slight discomfort, chronic pain, oedema, chronic itching and ulcer formation. It occurs in 20 - 50% of patients who have had a DVT.[23-25] Khan *et al.*[26] found that the best approach to avoid DVT complications is preventing primary and recurrent thrombosis, use of compression stockings, and administering thrombolytic agents.

Gaps in existing knowledge and study limitations

Other than in SA, where a study found that prophylaxis for DVT could be vastly improved,[27] no new information could be found on the implementation of recent recommendations for the management and prevention of DVT,[6] especially in the African setting. Limited data are also available on risk factors that contribute the most to the incidence of DVT in different settings, and what the incidence of DVT is in each surgical department, regardless of the treatment.[23] While the present review provided information on recently available data on the incidence of DVT in surgical departments, it did not focus on how and why the major contributors to DVT development affect the number of DVT cases, discuss the use and efficacy of DVT prophylaxis, or explore additional possible screening tools with the potential to limit complications. Finally, limited access to certain research articles and the limited amount of available research, especially in the African context, are also shortcomings of the review.

Conclusion

DVT is common in surgical departments, and its incidence is influenced by various factors. The diagnosis of DVT involves a multifaceted approach, but the definitive diagnosis is made by Doppler ultrasonography or venography. Management of DVT revolves around prevention of the initial episode, preventing recurrence, managing symptoms, and minimising complications.

We could find only two recent articles reporting on DVT in Africa. Furthermore, other than from Europe and the USA, no recent articles on DVT were found globally. Most of the data found were from studies done during 2015 and earlier, with only six studies reported after 2018. Based on these factors, and observed gaps in knowledge, there is a need to undertake studies on the occurrence, complications and adequacy of treatment of DVT in different surgical departments. In Africa, the effect of common comorbidities as well as adequate prophylactic treatment should be evaluated further. Globally, additional studies on the prevalence in different ethnic groups should also be considered.

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