CLINICAL RESEARCH STUDY

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Peripherally Inserted Central Catheter-associated Deep Vein Thrombosis: A Narrative Review

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ABSTRACT

BACKGROUND: Although common, little is known about factors associated with peripherally inserted central catheter-related deep vein thrombosis (PICC-DVT). To better guide clinicians, we performed a comprehensive literature review to summarize best practices for this condition.

METHODS: A systematic search of the literature for studies reporting epidemiology, diagnosis, treatment, and prevention of PICC-DVT was conducted. Algorithms for diagnosis and management were compiled using available evidence.

RESULTS: The incidence of PICC-DVT varied between 2% and 75% according to study population, testing modality and threshold for diagnosis. Studies evaluating the diagnostic utility of clinical symptoms suggested that these were neither sensitive nor specific for PICC-DVT; conversely, ultrasonography had excellent sensitivity and specificity and is recommended as the initial diagnostic test. Although more specific, contrast venography should be reserved for cases with high clinical probability and negative ultrasound findings. Centrally positioned, otherwise functional and clinically necessary PICCs need not be removed despite concomitant DVT. Anticoagulation with low-molecular-weight heparin or warfarin for at least 3 months represents the mainstay of treatment. The role of pharmacologic prophylaxis and screening for PICC-DVT in the absence of clinical symptoms is unclear at this time.

CONCLUSIONS: PICC-DVT is common, costly and morbid. Available evidence provides guidance for diagnosis, treatment and prevention of this condition.

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KEYWORDS: Deep vein thrombosis; Diagnosis; DVT; Peripherally inserted central catheter; PICC; Prevention; Thrombosis; Treatment

Over the past decade, use of peripherally inserted central catheters (PICCs) to achieve nonpermanent yet durable venous access has grown dramatically.[1,2] Originally developed in 1975 for delivering total parenteral nutrition,[3] PICCs today serve roles spanning delivery of short- and long-term intravenous antibiotics to invasive hemodynamic monitoring. However, PICCs are also associated with complications, including upper-extremity deep vein thrombosis.[4,5] Peripherally inserted central catheter-related deep vein thrombosis (PICC-DVT) is important because it interrupts venous therapy, increases cost of care, and often leads to sequelae such as phlebitis, vein stenosis, and pulmonary embolism.[5-10]

Despite these facts, little is known about risk factors, diagnostic strategies, treatment, and prevention of PICC-DVT. While a recently published meta-analysis reported that PICCs were associated with a greater risk of thrombosis compared with central venous catheters,[11] factors that may drive this increased risk are not well defined. An overview incorporating the myriad scientific and technical aspects of diagnosis, management, and prevention of PICC-DVT is thus needed. Therefore, we reviewed the literature and synthesized available data to develop evidence-based algorithms for evaluation and treatment of PICC-DVT.

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METHODS

With a medical research librarian, we searched MEDLINE (via PubMed), CINAHL, Embase, and the Cochrane CENTRAL registry for English-language articles with the following keywords: "peripherally inserted central catheter," "PICC," "deep vein thrombosis," and "thrombosis" (Appendix). Boolean operators and medical subject heading terms were used to enhance electronic searches. Additional studies of interest were identified by hand searches of bibliographies. Studies that involved patients <18 years of age, or that were case reports, editorials, or conference proceedings were excluded. The search was last updated August 1, 2014.

Using the retrieved articles, we summarized findings to develop evidence-based algorithms for decision-making in PICC-DVT. To create such algorithms, we first categorized studies by patient-, provider-, and device-related domains according to a published conceptual model (Figure 1).[12] Two authors (VC and NF) then developed workflows in each domain to develop an organizational framework. By determining which factors were modifiable (and consequently, targetable), we developed recommendations for testing and treatment.

CLINICAL SIGNIFICANCE

- Despite increasing recognition, little is known about patient-, provider-, and device-specific risk factors associated with peripherally inserted central catheter-related deep vein thrombosis (PICC-DVT).
- Novel algorithms utilizing these data to guide clinicians in diagnosis and treatment of PICC-DVT are presented.

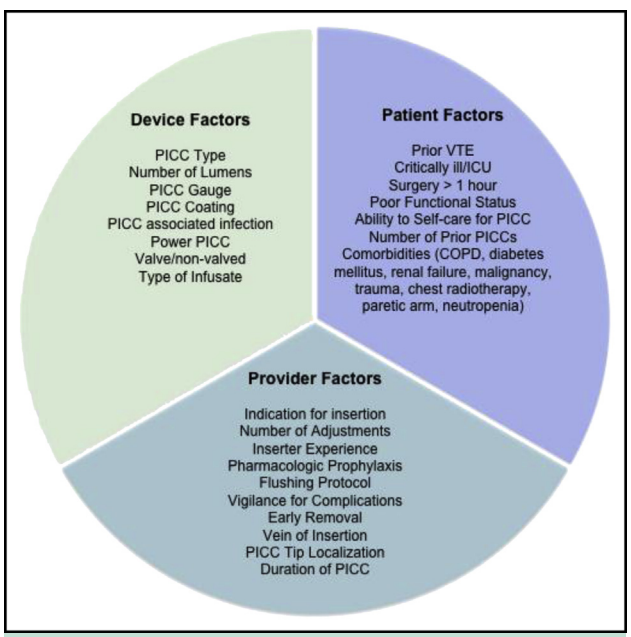

Figure 1 Conceptual model For PICC-DVT. A conceptual model, adapted from a prior submission,[16] displaying patient-, provider-, and device-related characteristics associated with PICC-DVT. COPD = chronic obstructive pulmonary disease; ICU = intensive care unit; PICC = peripherally inserted central catheter; VTE = venous thromboembolism.

RESULTS

A total of 83 articles were included in our review (Figure 2). Studies are presented as follows: (a) epidemiology and risk factors; (b) clinical signs and symptoms; (c) diagnosis, treatment, and prevention of PICC-DVT.

Epidemiology and Risk Factors for PICC-DVT

The incidence of PICC-DVT varies by patient population. Studies involving critically ill populations, those with cancer, and hospitalized patients report higher rates of PICC-DVT (5%-15%) than ambulatory populations (2%-5%).[4,5,11,13,14] Correspondingly, estimates of the frequency of PICC-DVT often relate to epiphenomena such as population studied, method of diagnosis, and diagnostic testing thresholds.[11] Studies that utilize screening techniques (eg, testing in the absence of clinical signs or symptoms) demonstrate a pooled frequency of PICC-DVT that is substantially greater than studies where testing is prompted by clinical symptoms (24.2%; 95% confidence interval [CI], 17.9-50.4 vs 4.3%; 95% CI, 3.4-5.2).[11] In a recent study, screening for PICC-DVT was associated with thrombosis in 75% of devices, with the majority of these being asymptomatic.[15]

Patient-related Risk Factors. Several patient-specific characteristics influence the risk of PICC-DVT. For instance, prior venous thromboembolism is associated with greater risk of PICC-DVT.[7,16,17] Critically ill patients and those with a cancer diagnosis are also at a substantially greater risk of PICC-DVT.[4,18,19] Additionally, higher rates of PICC-DVT have been reported in patients with end-stage renal disease, potentially due to the prothrombotic state associated with this condition.[20] Inherited thrombophilias such as protein C or protein S deficiency also fall into this category.[21] Specific comorbidities (eg, diabetes mellitus, obesity, and chronic obstructive pulmonary disease) may be associated with greater risk of PICC-DVT according to a number of observational studies.[4,14,20,22,23] Notably, surgery with a PICC in situ is an important factor associated with this outcome and should be avoided whenever clinically feasible.[7]

Device-related Risk Factors. Blood flow in peripheral veins is hampered by PICC placement; the caliber of the catheter and degree of cross-sectional area occupied by the PICC correlates with reduction in venous flow.[24] In a retrospective cohort study of 966 unique PICC placements, 5- and 6-French PICCs were more likely to develop PICC-DVT compared with 4-French PICCs (hazard ratio [HR] 3.56; 95% CI, 1.31-9.66, and HR 2.21; 95% CI,