Anatomically Associated Venous Thromboembolism in Patients With Peripherally Inserted Central Catheters

Travis Kimple, MD
University of Kansas Medical Center, Kansas City, KS
Niaman Nazir, MBBS, MPH
Department of Preventive Medicine and Public Health, University of Kansas Medical Center, Kansas City, KS
Chad M. Cannon, MD
Department of Emergency Medicine, University of Kansas Medical Center, Kansas City, KS

Abstract

Background: *Peripherally inserted central catheters (PICCs) are ubiquitous in modern hospitals, but are associated with venous thromboembolism (VTE), which includes deep vein thrombosis (DVT) and/or pulmonary embolism (PE). We retrospectively examined this association in hospitalized patients, highlighting anatomically associated VTEs (those with DVT in the PICC extremity).*

Methods: *Charts with an International Classification of Diseases, Ninth Revision (ICD9) code for VTE were collected from a discharge database of PICC-managed patients at a tertiary hospital. A sample (52.3%) of the VTE charts was manually reviewed to verify PICC-associated VTE (unverified charts were excluded), and determine such data as the extremity in which each DVT was diagnosed (using ultrasound reports). VTE rates were calculated using an uncorrected method (from charts with VTE ICD9 code) and a corrected method (from charts with manually verified PICC-associated VTE).*

Results: *Our uncorrected VTE rate was 3.9% (P < .0001), whereas the corrected rate was 1.5%. Among 125 charts with manually verified PICC-associated VTE, 69 (60.5%) out of 114 patients with a DVT had their DVT occur in the PICC extremity, yielding an anatomically associated VTE rate of 0.84%. The most common reason for a chart being excluded (60.2%) was a VTE occurring before PICC placement.*

Conclusions: *We found clinically significant rates of PICC-associated VTE. The majority of patients' DVT occurred in the same extremity as their PICC, lending further evidence that PICCs are an independent risk factor for VTE and require judicious use. There was also a discrepancy in VTE rate derived from ICD codes alone vs. manual chart review.*

Keywords: *deep vein thrombosis, extremity, ICD codes, PICC line catheterization, pulmonary embolism*

Background

Central venous catheters (CVCs) are defined as catheters whose tip lies in the central venous circulation, usually at or near the cavoatrial junction of the heart. Their effectiveness for long-term and/or high-volume administration of medication, fluids, and parenteral nutrition has made them an integral part of modern American hospitals.[1,2] CVCs can be classified as being centrally inserted or peripherally inserted. Centrally inserted CVCs are most commonly introduced through the internal jugular, subclavian, or femoral veins. When peripheral veins such as the basilic or cephalic veins of the upper extremities are used for insertion, the catheter is referred to as a peripherally inserted central catheter (PICC), or PICC line.[3]

Introduced in the mid-1970s, PICCs have become a highly utilized form of central venous access in hospitals.[2] The current popularity of PICCs may be due to the commonly held perception that they are safer to insert and more cost-effective than centrally inserted CVCs. Indeed, centrally inserted CVCs require a skilled placement procedure with the potential for more serious immediate complications like pneumothorax, hemothorax, and central artery puncture; however, whether or not the insertion-related complications are more frequent and/or severe than long-term PICC-associated complications remains poorly defined in the scientific literature.[4] The PICC placement procedure, which can be performed at a patient's bedside by skilled nursing teams

Correspondence concerning this article should be addressed to tkimple7@gmail.com
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instead of physicians, is a significant reason for the perceived cost-effectiveness of PICCs over centrally inserted CVCs, and this claim has traditionally been supported by the scientific literature.[5,6] However, other more recent studies that take into account the long-term costs associated with PICCs have cast doubt on this idea[4,7].

Regardless of debatable advantages, there is strong consensus among clinicians and researchers that patients with PICCs face a unique and clinically significant risk of venous thromboembolism (VTE), which refers to deep vein thrombosis (DVT) and/or pulmonary embolism (PE).[8-10] Intravenous catheters can cause endothelial trauma and venous wall inflammation, which may induce thrombosis, especially for patients in hypercoagulable states.[11,12] Consequently, most thrombotic events occurring in the upper extremities, including DVT, are due to peripheral intravenous catheters of 1 type or another.[13,14] DVT in turn can cause serious complications such as PE or postthrombotic syndrome of the upper extremity.[12,15]

Although it is well established that PICCs are associated with an increased risk of VTE, an accurate estimation of this risk and the frequency with which DVTs occur in the same extremity as the placed PICC remains to be defined in scientific literature.[8] The primary objective of this study was to examine the association between VTE and PICC use in a large hospital population, highlighting VTE involving the same extremity as the placed PICC, which we refer to as anatomically associated VTE. We also sought to investigate the degree of disparity that may exist between VTE rates derived from International Classification of Diseases (ICD) code data alone vs. rates derived from manual chart review data.

Methods

This was a retrospective chart review performed at an urban 623-bed academic tertiary care medical center, with approval from the institutional review board. Our baseline study population included all adult patients (aged 18 years or older) who had a PICC placed during their inpatient stay from 2008 to 2013. These patients were selected from the inpatient service using the ICD Ninth Revision (ICD9) procedure code for PICC through the electronic medical record discharge database. PICCs were inserted by either a member of the PICC nursing team or an interventional radiologist. Standard procedure included confirming proper positioning of the PICC tip in a patient's superior vena cava by a radiologist via chest radiograph.

From the population with a PICC, we identified all patients given an ICD9 code consistent with VTE during their stay and used this group as the focus of our study. A large, random sample (52.3%) of these charts was then manually reviewed to verify the PICC-associated VTE and quantify variables not available from ICD9 code analysis alone. We employed a standardized collection method to attain these data, as suggested by the guidelines for chart review in emergency medicine research.[16] A medical student trained in chart data extraction was the primary data abstractor, and initial charts were jointly reviewed by the primary investigator and data abstractor to ensure an understanding and correspondence of the data collection method. Following the completion of data collection from the hospital's electronic medical record into a secure REDCap (Vanderbilt University, Nashville, TN) database, all protected health information was removed. Remaining information was stored in password-protected files only accessible by study personnel.

Table 1. Reasons for Excluding 196 Manually Reviewed Charts

Reason	n	%
VTE occurred before PICC was placed (no temporal causality)	118	60.2
Chart contained insufficient evidence that a VTE occurred during the patient's hospital stay where his or her PICC was present	55	28.1
Patient had a PICC at admission from an unknown outside facility	18	9.2
Chart contained insufficient evidence that a PICC was placed during the patient's hospital stay	3	1.5
Chart contained the same hospital encounter for a patient that had been reviewed previously (duplicate chart)	1	0.5
Patient experienced a superficial venous thrombosis only[a]	1	0.5

VTE = Venous thromboembolism; PICC = Peripherally inserted central catheter.
[a]Thrombosis of superficial veins only (such as cephalic or basilic), without any extension into deeper venous regions (such as axillary or brachiocephalic), does not constitute a DVT.

The following variables, not attainable through our ICD9 code-based data extraction alone, were examined by manual chart review in the sample of PICC patients with a VTE ICD9 code. First was the date and time of VTE diagnosis, which was compared with the date and time of PICC insertion. Charts with a PICC insertion that did not precede the patient's VTE diagnosis were excluded from further analysis to avoid violating the principle of temporal causality. Additional charts were excluded due to the reasons shown in Table 1. For charts with manually verifiable PICC-associated VTE, 2 more variables were investigated. First, we determined the extremity in which any DVT was found. The location of each DVT was identified using the pertinent ultrasound reports from the hospital's radiology department. A PE was recorded if the diagnosis was established via computed tomography or abnormal ventilation-perfusion scan in a patient's radiology report. All reports were subject to the limitations of the interpreter and/or author. VTE found through manual chart review was assumed to be symptomatic because imaging is not used at this institution for routine VTE screening in asymptomatic patients.

Secondly, we determined whether any significant therapeutic intervention was initiated or indicated for a patient's VTE event. An intervention was defined as being significant if either anticoagulation therapy and/or placement of an inferior vena cava filter was initiated or indicated. This definition was created to organize and synthesize the interventions we observed, and is