Alteplase Use in Surface-Modified Peripherally Inserted Central Catheters in a National Cancer Institute-Designated Comprehensive Cancer Center: A Pharmacoeconomic Analysis

Eric R. Musial, PharmD
Lamya Hamad, MPH
Chong Wang, MA
Ryan Hare, PharmD
Roswell Park Cancer Institute, Buffalo, NY

Abstract

Background: *One of the most common complications of a peripherally inserted central catheter (PICC) is loss of line patency due to platelet adhesion to the device. A new technology called Endexo (Interface Biologics Inc, Toronto, ON, Canada) has been developed that has been shown to reduce platelet adhesion (in bench studies). The purpose of our study was to determine if the use of PICC lines manufactured with Endexo technology would use fewer alteplase doses such that the increased expense of these lines could be offset by a corresponding reduction in alteplase expense.*

Methods: *The control group received our standard-of-care PICC, the study group received the Endexo PICC, and all patients were followed for a maximum of 60 days postinsertion. Statistical and economic analyses were performed to determine whether a significant reduction in alteplase use was observed, and whether the increased cost of the new novel PICCs could be offset by a reduction in alteplase-related expense.*

Results: *Our study enrolled patients who underwent 157 PICC insertions in the control group and 145 PICC insertions in the study group. We found no statistical difference in average alteplase doses per line, number of PICCs requiring an alteplase dose, or time to first dose of alteplase between study groups. An economic analysis revealed that at our institution, adopting PICCs with Endexo technology would result in increased expenses.*

Conclusions: *In our patient population we were unable to observe a reduction in alteplase use to offset the increased costs of this novel PICC when catheters were followed for a maximum of 60 days postinsertion.*

Keywords: *Bioflow, Endexo, peripherally inserted central catheter*

Introduction

Peripherally inserted central catheters (PICCs), once viewed as a last resort, have seen increasing use since their introduction in the mid-20th century. Today, PICCs have been determined to be a safe and reliable vascular access methodology for situations requiring short-, intermediate-, or long-term vascular access.[1-3] Due to their safety profile, ease of insertion, and relative costs, PICCs have become a popular choice for central venous access for many patients requiring administration of vesicant drugs, long-term antibiotics, chemotherapeutic agents, blood, or nutrition.[1,4-6] Despite the advantages of using PICCs for central venous access, there are notable complications that can arise with these devices.

One group of well-documented complications associated with PICCs are those related to thrombosis formation on the device itself causing occlusions, or dislodging of a thrombosis that results in venous thromboembolism.[1,2,5,7-9] Risk factors

Correspondence concerning this article should be addressed to ermusial@hotmail.com
http://dx.doi.org/10.1016/j.java.2015.11.003

for the development of a venous thromboembolism have long been identified by Virchow's Triad.[7] Damage to the endothelium of a blood vessel caused by the PICC device or the insertion process, blood stasis due to the obstruction or change of blood flow patterns around the PICC device, and platelet aggregation around the PICC device are all contributing factors for a patient to develop a thrombotic complication related to a PICC device.

There is wide variability in reports of complication rates of PICCs in the medical literature. Sriskandarajah et al[2] and Seckold et al[10] describe an overall rate of complications of PICCs to be 12%-60% and 8%-50%, respectively. Additional data provided by Bartock[9] indicate that a specific complication—occlusion—was observed at a rate of 7% to 25% and Walshe et al[5] evaluated complication rates in a specific oncologic population and found that 32.8% of PICC lines had to be removed due to complications; however, only 7.4% required removal due to thrombosis or occlusion. Ming et al[6] reported a higher incidence of occlusion occurring in a population with leukemia. In that study,[6] occlusion occurred in 48.2% of lines. However, removal of the PICC due to overall complications was only 4.7% in the study by Ming et al,[6] compared with 32.8% in the Walshe study.[5] These data suggest that there is a high risk of complication with PICC lines, chiefly thrombotic complications; however, those complications do not often require line removal. Nevertheless, the loss of line patency due to a thrombotic complication is not without concern. PICC occlusion can result in life-threatening delays in treatment, patient discomfort, infection, and the possibility of line removal and replacement.[8]

Currently, alteplase (Cathflo Activase, Genentec Inc, San Francisco, CA) is the only thrombolytic agent approved by the US Food and Drug Administration to restore the function of central venous access devices due to thrombotic occlusion. Alteplase administration, although effective, does have specific limitations—chiefly the cost per dose and the administration technique, which requires a specific in-dwell time.[11]

Until recently, alteplase, along with standard line maintenance practices and PICCs coated with heparin or a lubricant material, was a clinician's only defense against PICC line occlusion due to thrombosis formation. In 2012, the US Food and Drug Administration approved the incorporation of Endexo polymer technology into PICCs (BioFlow PICC, AngioDynamics Inc, New York, NY). Endexo technology (Interface Biologics Inc, Toronto, ON, Canada) introduces surface-modifying molecules to the base polymer during the PICC line manufacturing process. The Endexo surface-modifying molecules self-locate to the air/device interface creating a passive surface that has shown a significant reduction in platelet adhesion and thrombus formation.[12,13]

Laboratory results indicate that a PICC with modified-surface technology demonstrates an average of 75%-87% less thrombus accumulation on its surface when compared with traditional PICCs.[12,13] Surface-modifying technology is described as "A permanent and non-eluting integral low molecular weight fluoro-oligomer that is blended into the polyurethane of the catheter shaft. These low molecular weight molecules orient themselves to the air/device interface creating a passive surface that provides a catheter material more resistance to the accumulation of blood components."[5]

Benchtop results of this new technology appear promising. This new tool may prevent thrombosis-related occlusions and help maintain line patency. We hypothesized that a PICC manufactured with modified-surface technology would require fewer alteplase administrations to restore line patency than a traditional PICC without such technology. The goal of our study was to evaluate if the increased cost of PICCs with modified-surface technology would be offset by a reduction in alteplase use and expense.

Methods

A retrospective chart review was performed on patients who received our organization's standard-of-care PICC (the valveless Bard PowerPICC, Bark Access Systems, Salt Lake City, UT) (control group) compared with a study group of patients who received the valveless Bioflow PICC with Endexo technology (ie, the surface-modified PICC).

The observational control group study period consisted of any PICC insertion over a 2-month period from August 1, 2014, to September 30, 2014. During this period, our organization used the valveless Bard PowerPICC as its standard-of-care PICC. The study period consisted of any PICC insertion also over a 2-month period from November 17, 2014, through January 17, 2015. During this period, our organization used the valveless Bioflow PICC with Endexo technology as its standard-of-care PICC. Patients included in the study were both inpatients and outpatients, aged $\geq$ 18 years, had received $\geq$ 1 PICC line at Roswell Park Cancer Institute, and did not have active clotting disease at the time of PICC placement.

Patients receiving prophylaxis anticoagulation medications were not excluded from the study to increase external validity. Information collected for both the control and study groups included the PICC line placement date, PICC line removal date (if removed by the end of the observation period), age of the patient, baseline platelet count at time of PICC placement, whether the patient was receiving anticoagulation medication at the time of PICC placement, whether tissue plasminogen activator or administration of alteplase was required to restore PICC patency (if so, the date of alteplase administration and number of alteplase doses per PICC line were recorded). Anticoagulation medication was considered to be warfarin, platelet inhibitors (such as clopidogrel), direct thrombin inhibitors (such as dabigatran and rivaroxaban), or therapeutic aspirin.

The differences in demographic characteristics (ie, average patient age, sex, and taking an anticoagulant agent at time of insertion) between study group and control group were compared by Fisher exact test for categorical variables, and Kruskal-Wallis Test for continuous variables.

The outcomes evaluated included the number of PICCs receiving alteplase, average time to first alteplase dose (days), and number of alteplase doses administered per line. The differences of the outcomes between study group and control group were compared by Fisher exact test (for categorical