

Keeping You Connected: Anti-Reflux Connectors Reduce Catheter Occlusions and Use of Alteplase

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Background

Central Venous Access Devices (CVADs) are routine in the treatment of critical care patients both in the hospital and when they return home. As the patient population ages and the prevalence of chronic diseases (eg, diabetes, heart issues, cancer) increases, the need for home infusion therapy is expected to rise accordingly.

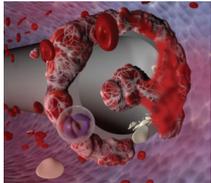


Figure A. Early formation of intraluminal thrombotic occlusion.

That trend is already underway: US home infusion and specialty providers served more than 3 million patients in 2019, a 300% increase over patients served in 2008.¹ Increasing technological advancements to ensure catheter patency are critical if home infusion is to be successful and patient outcomes are to improve.

Intraluminal thrombotic occlusions are common with CVADs, with an incidence of 28% in home infusion patients.² Occlusions often begin with blood reflux into the lumen of the catheter (Figure A). This initial step allows the blood to deposit a conditioning layer of plasma proteins inside the catheter. Once the conditioning layer is in place, subsequent reflux episodes trigger a cascade of events attracting more blood proteins to continue to layer into the site, leading to a thrombus.³ It is not currently known how long it takes for blood to coagulate inside a catheter, or how much is required to cause an occlusion, but studies are ongoing.

Reflux often results from mechanical and physiological pressure changes within the patient's vasculature caused by patient activity/movement (eg, coughing, sneezing, yawning) and catheter access management such as that which occurs when changing IV bags, clamping/unclamping, syringe connection/disconnection, or syringe plunger rebound.⁴

The recently released INS Standards⁴ recommend that infusion staff know which needleless connector (NC) is in use because the directions for use vary and can influence reflux. While reflux has been documented with all types of NCs, the

Standards note that anti-reflux devices employing a bidirectional, pressure-sensitive valve (Figure B) have the least amount of reflux.

When CVADs are blocked, alteplase is administered to clear the line. Thrombolytic use in peripherally inserted central catheter (PICC) patients is associated with a 3-fold higher risk of infection (3.59 adjusted odds ratio).⁵ Since unintentional blood reflux within the catheter is the primary cause of these occlusions, and anti-reflux needleless connectors with bidirectional flow control (ANCs) demonstrate the least amount of blood reflux,⁶ this study sought to determine if implementation of ANCs could reduce occlusions and associated cost.^{3,7}

Purpose

The purpose of this study was to measure the impact of anti-reflux needleless connector usage in preventing intraluminal thrombotic occlusions among CVADs, and whether ANC implementation will reduce occlusions, represented in alteplase usage, in this home infusion patient population.

Methods

This quality improvement initiative sought to quantify thrombolytic use and analyze the economic impact of the change in clinical practice from neutral to anti-reflux needleless connectors. This uncontrolled before/after 16-month cohort study of a single home infusion intervention compared occlusion outcomes of two types of needleless connectors, neutral needleless connector with no bidirectional flow control (NNC) (MicroClave, ICU Medical) and anti-reflux needleless connector with bidirectional flow control (ANC) (TKO-6PHV, Nexus Medical), with CVAD occlusions requiring alteplase (CathFlo, Genentech) (\$144/2mg dose) from May 2019 through December 2020. A transitional period of February–March 2020 included product changeover and staff education. Outcome parameters were nurse reported occlusion of venous central catheters that required alteplase (2mg), patient encounters, time to occlusion from hospital discharge, and unscheduled emergency room visits. Outcome parameters included patient census (PC), patient therapy days, alteplase usage (CFU), patient encounters to de clot catheters (PDE), time from discharge to occlusion in home, and ER visits (ERV).

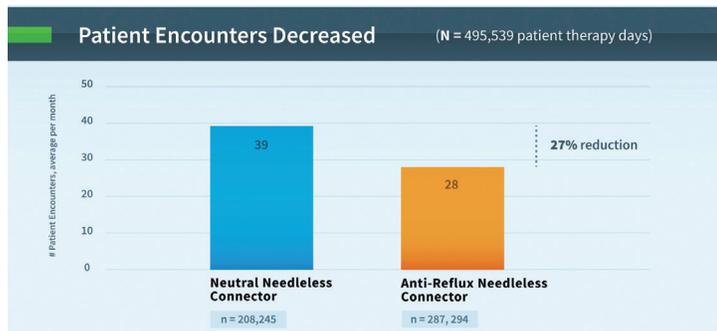


Figure 1. Average monthly number of patient encounters to de clot catheters decreased 27% after switch from neutral needleless connectors to anti-reflux needleless connector, despite increased number of patient occlusion days.

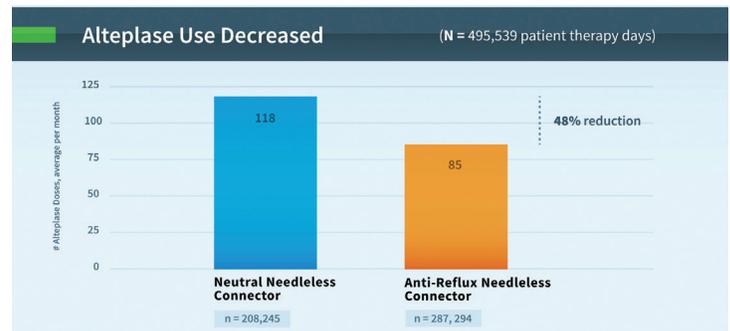


Figure 3. Average monthly alteplase usage decreased 48% per therapy days after switch from neutral needleless connectors to anti-reflux needleless connector, despite increased number of patient occlusion days.

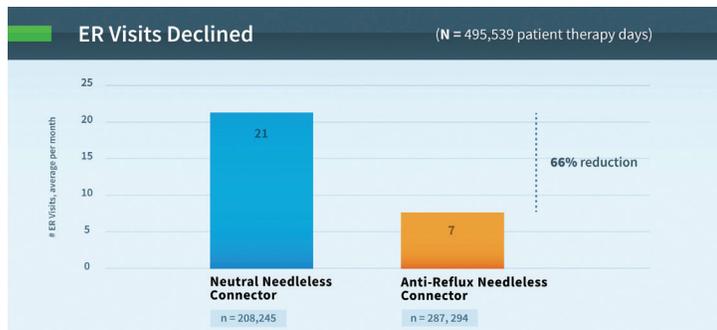


Figure 2. Average monthly number of ER visits, defined as patients requiring emergency department visits to have catheters cleared for continued use, declined after switch from neutral needleless connectors to anti-reflux needleless connector, despite increased number of patient occlusion days.

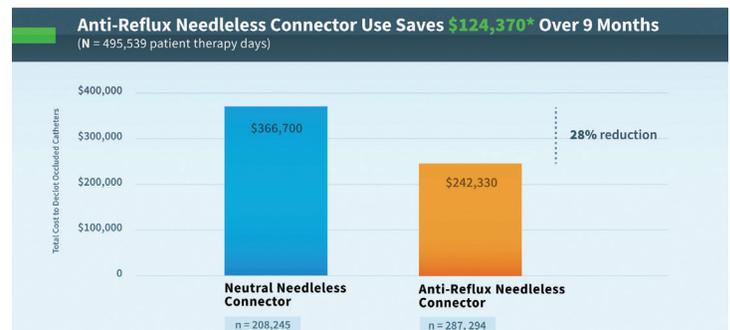


Figure 4. The switch from neutral needleless connectors to anti-reflux needleless connector reflects a fixed cost savings of \$124,370* over the study period, despite increased number of patient occlusion days. *Savings were seen in supply costs (28% reduction), nursing costs (27% reduction), and pharmacy costs (27% reductions).

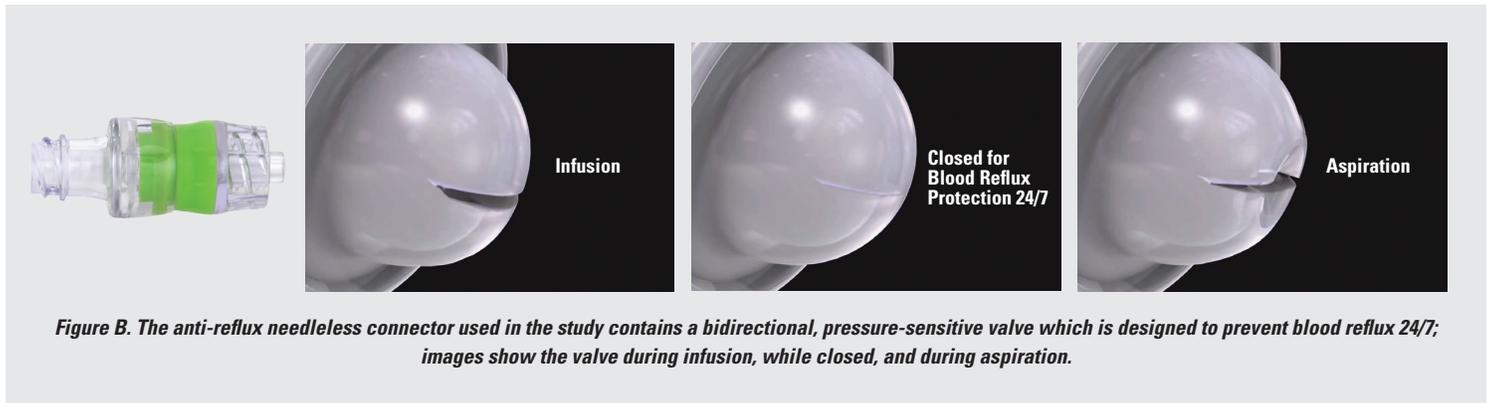


Figure B. The anti-reflux needleless connector used in the study contains a bidirectional, pressure-sensitive valve which is designed to prevent blood reflux 24/7; images show the valve during infusion, while closed, and during aspiration.

Results

The hypothesis was accepted with a total of 495,539 patient therapy days studied; 42% were NNC group (208,245) and 58% ANC (287,294) resulting in average occlusion days for NNC 26,031 (837 PC, 39 PDE, 118 CFU, 21 ERV), and for ANC 35,912 days reflecting a higher patient census (947 PC, 28 PDE, 85 CFU, 7 ERV). The reduction in patient encounters required to de clot catheters resulted in a 27% drop in nursing time (Figure 1). There was a 66% reduction in ER visits (Figure 2). Rates of alteplase usage with NNC and ANC were 4.6% vs 2.9% with median 112 (95% CI:89-169), vs 82 (95% CI:68-109) ($p < .001$). Of patients requiring alteplase, 10% were recently discharged from the hospital suggesting that signs of occlusion likely occurred during their inpatient stay. Anti-reflux intervention reduced alteplase use by 48%/therapy days (Figure 3), and by 36%/census. The ANC needleless connector intervention reflected a fixed cost savings of \$124,370 (Figure 4).

Discussion

Patients with intraluminal CVAD occlusions experience delays in treatment, increased ER visits, decreased patient satisfaction, and higher overall pharmacy costs from supplies and alteplase used to de clot catheters. While certain catheters, like small diameter PICCs, are more prone to occlusion, the blood reflux resulting from mechanical and physiologic pressure changes contribute to the overall incidence of occlusion in all CVADs. Implementation of anti-reflux connectors reduced occlusion incidence by almost half and resulted in significant cost savings. Since 10% of patient occlusions were within 7 days of home infusion admission, future research may indicate ANC placement at the time of hospital insertion to improve patient outcomes.

Previous authors have noted that reducing the incidence of thrombotic occlusion has impact well beyond the cost of the thrombolytic alone.⁹ Assessment of the device and instillation of the thrombolytic may require one to two extra nursing visits lasting 30-120 minutes for a single dose, and even more time if a second dose is required. Compromised catheter patency increases patient risk, discomfort, and inconvenience, not to mention cost, particularly if emergency department visits are necessary. Reducing these complications led to a better overall patient experience under our service.

Conclusion

There is statistical evidence that integration of anti-reflux needleless connectors on CVADs to reduce occlusions substantially reduced the need for alteplase in this home infusion study population. This quality improvement measure reduced cost associated with occlusion complications including those that required nursing and emergency room visits, while positively affecting patient satisfaction.

Disclosure: Nothing to disclose.

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