

Utilizing the Neutron™ Catheter Patency Device to Reduce the Clinical Costs Associated with Central Line Catheter Occlusion

BACKGROUND

Central venous access devices (CVADs) are a standard and integral part of care for critically ill and long-term IV therapy patients. It is estimated that well over 7 million CVADs are placed each year in the United States.¹ The proper care, maintenance, and avoidance of complications in these indwelling devices is essential for viable mid- and long-term IV access for therapeutic modalities such as chemotherapy, antibiotic therapy, total parenteral nutrition, and the infusion of blood and blood products.

Catheter occlusion is the most common non-infectious complication in long-term use of CVADs, with the majority of occlusions occurring as a direct result of thrombosis² (clotting blood.) Thrombosis induced by central venous catheters is frequent, affecting 33% to 59% of indwelling catheters, although clinical symptoms develop in a relatively smaller percentage of patients.³ As much as 25% of all central venous catheter usage ends in occlusion.^{4,5}

Thrombus formation is linked to increased risk of catheter-related bloodstream infection (CRBSI) for patients. Fibrin, blood components, and biofilm can amass,⁶ creating a rich culture medium for bacterial growth that has been shown to directly result in microorganisms entering the bloodstream.⁷

While the economic costs of CRBSIs are known to range from \$34,508 to \$56,000,^{8,9} the additional economic burdens that are associated with catheter occlusions are not nearly as well documented.

COSTS ASSOCIATED WITH CVAD PATENCY SALVAGE OR REPLACEMENT

Notwithstanding potentially significant clinical complications, which may increase patient length of stay and require costly therapeutic treatment, the direct economic costs of routine occlusions can be significant. Once a nurse has identified an occlusion and has ruled out mechanical or chemical causes, treatment with a thrombolytic agent is usually attempted. A very common catheter patency restoration treatment involves a rather complex and time consuming protocol in which a thrombolytic agent is instilled into the blocked catheter and allowed to dwell for a specified time (up to 2 hours - depending on institutional protocol.) The thrombolytic is removed after the dwell period and the catheter checked for patency. In many instances, this procedure is repeated in further attempt to clear the catheter. Each attempt to restore catheter patency using a de-clotting agent such as tissue plasminogen activator (tPA) can cost \$120¹⁰, but the true operational cost is much higher. Considering supply costs and time spent reconstituting the therapeutics, the cost to address an occlusion can quickly reach \$206 per treatment.¹¹

Patency restoration utilizing tPA is successful in 73.9% to 89.9% of cases.¹² When tPA is unsuccessful, the cost of device replacement greatly exceeds that of salvage and can include costs for interventional radiology, diagnostic imaging, nursing, supplies, and, of course, a new access device.

Catheter occlusion is the most common non-infectious complication in long-term use of central venous access devices (CVADs). As much as 25% of all central venous catheter usage ends in occlusion.^{4,5}

Total published cost estimates of central venous catheter (CVC) and peripheral inserted central catheter (PICC) replacement varies widely from \$850–\$1,500, depending on the type of CVC.^{10,13} to \$200–\$3,000 for PICC lines, depending on the care setting and need for interventional radiology.⁸

In addition, interruption of clinically necessary therapies and medication administration during the patency restoration process has been shown to compromise patient care and lead to an increased length of stay.^{7, 10, 14-17} Hospital-adjusted expenses per inpatient day in the United States range between \$985 in South Dakota to \$2,696 in Washington State, with the national average cost per inpatient day being \$1,853 per day.¹⁸

The Neutron catheter patency device has been shown to contribute to a 50.7% reduction in occlusions, which has the potential to save an average high-volume hospital nearly a quarter million dollars per year.

COMBATING CATHETER REFLUX USING THE NEUTRON CATHETER PATENCY DEVICE

A common cause of catheter occlusion is the clotting of blood that has refluxed into the catheter lumen.⁶ Reflux occurs in several circumstances: when catheters are not flushed properly, when negative pressure builds in the catheter, when there is an increase in intra-thoracic venous pressure, when an IV fluid container is allowed to run dry, or when venous pressure exceeds the infusion pressure.^{19, 20, 21}

To date, catheter technologies have had limited ability to effectively address all causes of reflux. Positive displacement needlefree IV connectors, for example, reduce reflux caused by connecting and disconnecting a syringe or an administration set, but do not address the other sources of reflux.

The Neutron™ catheter patency device (ICU Medical, Inc., San Clemente, CA) is a microbiologically and mechanically closed needlefree connector that permits access to the catheter via use of a luer lock connection.

Additionally, the Neutron is the first and only FDA-cleared device with the ability to prevent fluid displacement (reflux) resulting from internal and external causes, including the connection or disconnection of a luer; syringe plunger compression; patient vascular pressure changes, such as coughing or sneezing; and IV solution container run-dry.

With a reduced risk of catheter occlusions, there is decreased need for expensive declotting agents such as tPA. In testing, clinicians reported a 1:1 relationship between the use of tPA to restore and maintain catheter patency and the reduction of catheter occlusions. Accordingly, the Neutron was able to contribute to a 50.7% reduction rates occlusions along with a 50.7% reduction in the use of tPA with this patient population.²² Additionally, reducing catheter occlusions may provide real-time clinical benefits by helping to avoid critical delays in patient care as well as patient discomfort and pain.



POTENTIAL CLINICAL COST SAVINGS WITH NEUTRON CATHETER PATENCY DEVICE

The scenario (Figure 1) illustrates the potential cost savings associated with switching to the Neutron catheter patency device for a hospital placing 2,000 central lines per year. The calculations assume a cost of \$206 per tPA dose, an occlusion reduction of 50% using the Neutron, an average tPA success rate of 82%, a device replacement cost of \$1,388, and a per-day inpatient cost of \$1,853.

FIGURE 1: POTENTIAL CLINICAL COST SAVINGS USING NEUTRON COMPARED TO MAXPLUS

Patency Restoration and Device Replacement Cost Savings Comparison		
	MaxPlus	Neutron
Cost of tPA Administration	\$103,000	\$51,500
Device cost @ 7 per Line (21 days)	\$8.75	\$29.75
Total device cost	\$17,500	\$59,500
Total Cost	\$120,500	\$111,000
tPA Cost Savings/Year Using Neutron		\$9,500

Additional Clinical Costs of Catheter Occlusion		
	Without Neutron	With Neutron
Number of central lines placed/year	2000	2000
Occlusion rate/tPA usage	25%	25%
Occlusion rate reduction using Neutron	-	50%
Total number of occlusions	500	250
tPA success rate	82%	82%
Number of catheter replacements	90	45
PICC/CVC replacement cost each	\$1,388	\$1,388
Yearly cost of catheter replacement	\$124,920	\$62,460
Increase LOS (2 days/replaced catheter)	\$3,706	\$3,706
Yearly cost of increased LOS	\$333,540	\$166,770
Savings on additional clinical costs with Neutron	-	\$229,230
Savings on tPA using Neutron	-	\$9,500
Total savings/Year Using Neutron		\$238,730

The model compares a cost-per-connector for a CareFusion® MaxPlus® at \$1.25 and a Neutron at \$4.25. Even with the price differential between the two connectors, switching to the Neutron has the potential to save nearly one-quarter of a million dollars per year as compared to using the MaxPlus.

CONCLUSION

Blood reflux is a key cause of catheter thrombotic occlusions that risk patient safety, clinical outcomes, and cost-efficient care. The Neutron catheter patency device is unique in its ability to significantly reduce all types of reflux into a catheter, and may help to significantly reduce costs associated with tPA treatments and catheter replacements.

References

1. Richardson DK. Vascular access nursing-practice, standards of care, and strategies to prevent infection: a review of flushing solutions and injection caps (part 3 of a 3-part series). *J Assoc Vasc Access.* 2007;12(2):74-84.
2. Stephens LC, Haire WD, Kotulak GD. Are clinical signs accurate indicators of the cause of central venous catheter occlusion? *J Parenter Enteral Nutr.* 1995;19(1): 75-79.
3. Mughal MM. Complications of intravenous feeding catheters. *Br J Surg.* 1989;76:15-21.
4. Haire WD, Atkinson JB, Stephen LC, Kotulak GD, et al. Urokinase versus recombinant tissue plasminogen activator in thrombosed central venous catheters: a double-blinded, randomized trial. *Thromb Haemost.* 1994;72(4):543-7.
5. Deitcher S, et al. Safety and efficacy of alteplase for restoring function in occluded central venous catheters: results of the cardiovascular thrombolytic to open occluded lines trial. *J Clin Oncol.* 2002;20(1): 317-24.
6. Gorski, Lisa A MS, RN, CS, CRNI. Central Venous Access Device Occlusions: Part 1: Thrombotic causes and treatment. *Home Healthcare Nurse.* 21:2;115-121, February 2003.
7. Ryder M. The role of biofilm in vascular catheter-related infections. *N Dev Vasc Dis.* 2001;2:15-25.
8. O'Grady NP, Alexander M, Dellinger EP, et al. Guidelines for the prevention of intravascular catheter-related infections. *MMWR Recomm Rep.* 2002;51(RR-10):1-26.
9. Maki DG, Mermel LA, Kluger D, Narins L, Knasinski V, Parenteau S. The Efficacy of a Chlorhexidine-Impregnated Sponge (Biopatch™) for the Prevention of Intravascular Catheter-Related Infection: A Prospective, Randomized, Controlled, Multicenter Study. Washington, DC: American Society for Microbiology; 2000.
10. Kokotis K. Cost containment and infusion services. *Journal of Infusion Nursing.* (2005) 28(3 Suppl), S22-S32.
11. Timoney JP, Malkin MG, Leone DM, Groeger JS, Heaney ML, Keefe DL, Klang M, Lucarelli CD, Muller RJ, Eng SL, Connor M, Small TN, Brown AE, Saltz LB. Safe and cost effective use of alteplase for the clearance of occluded central venous access devices, *JCO.* Apr 1, 2002;19:18-1922; DOI:10.1200/JCO.2002.07.131.
12. Ponec D, Irwin D, Haire WD, Hill PA, Li X, McCluskey ER; COOL Investigators. Recombinant tissue plasminogen activator (alteplase) for restoration of flow in occluded central venous access devices: a double-blind placebo-controlled trial—the Cardiovascular Thrombolytic to Open Occluded Lines (COOL) efficacy trial. *J Vasc Interv Radiol.* 2001 Aug;12(8):951-5.
13. Cummings-Winfield C, Mushani-Kanji T. Restoring patency to central venous access devices. *Clin J Oncol Nurs.* 2008; 12(6):925-934.
14. Wingerter L. Vascular access device thrombosis. *Clin J Oncol Nurs.* 2003;7(3):345-348.
15. Camp-Sorrell D, ed. *Access Device Guidelines: Recommendations for Nursing Practice and Education.* 2nd ed. Pittsburgh, PA: Oncology Nursing Society; 2004.
16. Hadaway L. Reopen the pipeline for IV therapy. *Nursing.* 2005; 35(8):54-61.
17. Infusion Nurses Society. *Infusion nursing standards of practice.* *J Infus Nurs.* 2006;29(suppl 1):S1-S92.
18. The Kaiser Family Foundation statehealthfacts.org. "Hospital Adjusted Expenses per Inpatient Day, 2009." Data Source: AHA Annual Surveys. © 2011 by Health Forum LLC, an affiliate of the American Hospital Association.
19. Farjo L. Blood collection from peripherally inserted central venous catheters. *Journal of Infusion Nursing,* 26 (6), 374-379. 2003.
20. Hadaway L. Heparin locking for central venous catheters. *Journal of the Association for Vascular Access,* 11 (4) 224-231. 2006.
21. Kerner J, Garcia-Careaga, M., Fisher, A., Poole, R. Treatment of catheter occlusions in pediatric patients. *Journal of Parenteral and Enteral Nutrition,* 30 (1), S73-S81. 2006.
22. Observational in-vivo evaluation of the Neutron™ needlefree catheter patency device and its effects on catheter occlusions in a home care setting. Study Summary. ICU Medical.