

The Impact of Positive Pressure versus Simple Valve Needleless Connector on Occlusion in Central Venous Catheters in Children: A Prospective Trial

Background:

In the days when needles were used for administration of intravenous medications, flushing the catheter was performed mainly to clear the line of any residual medication, thus preventing possible drug to drug interaction. Since the needle took up very little space when inserted into the injection site, removal of the needle created very little backflow of blood to fill that empty space. Occlusion from blood reflux was relatively unknown.

When blunt cannula systems appeared in the marketplace, blood reflux became a more common cause of catheter occlusion. The larger cannula left more empty space when withdrawn and that space filled with reflux blood. Occlusion resulted which led to the development of new procedures to address the issue. Most new procedures called for Heparin to be infused as the last flush to fill the catheter and keep any reflux blood for clotting. (SASH Method)

In an effort to comply with OSHA requirements for Needlestick Safety, the use of valve activated devices became more prevalent in the hospital. Proportionate to the growth in use of valve activated devices came the growth in occurrence of reflux related occlusions, leading to increase in costs associated with declotting drugs and catheter replacement. Once again, methods were created to combat the reflux occlusion. The “Manual Positive Pressure Flush” method is very well known but varied in effectiveness due to nursing technique. The purpose of this procedure is to fill the back space left from the withdrawn cannula or luer so that blood could not backflow into the catheter. For the first time, “positive pressure flush” became an important nursing procedure.

More recently, “automatic” positive fluid displacement devices have appeared in the clinical setting. These devices do not depend on proper nursing technique to perform an effective positive displacement flush. The device itself automatically injects some retained flush solution in the catheter locking the catheter against blood reflux. With out blood in the catheter tip, it is hypothesized thrombus formation due to blood reflux is dramatically reduced.

Research:

Cincinnati Children’s Hospital Medical Center’s (CCHMC) Central Venous Catheter Resource Team is responsible for the oversight of all catheter related issues for the institution. The study restricted patients hospitalized in the Pediatric Intensive Care,

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Neonatal Intensive Care, Bone Marrow Transplant Unit, and Adolescent Unit. No exclusions were made according to gender, ethnic background, or health status. The study

was conducted in two (2) phases in sequential design. In the first phase all central venous catheter (CVC) lumens not receiving continuous fluid infusions were capped with a standard device (*SmartSite*, *Alaris Medical, San Diego, CA*). In phase two, all CVC lumens were capped with a positive pressure device (*MaxPlus™*, *Medegen Medical, Ontario, CA*). Data was tracked relative to the occlusions encountered with each device.

Comparison of Occlusion Rates

	SmartSite (n=154)	MaxPlus (n=172)
M/F	81/73	91/81
Average Age (months)	88.2	81
Mean # Catheter Lumens	1.5	1.6
Mean # of Catheter Days	11.6	10.9
Total # Catheter Days in Study	1790	1879
# of Cap Days in Study	2231	2117
# of Complete Occlusions	17 (11%)	12 (6.9%)

Results: The occlusion rate was approximately 11% with the standard (non positive displacement valve). After conversion the positive displacement device (MaxPlus) the occlusion rate dropped to 6.9%, or a 40% reduction.

Conclusion: This study demonstrates that the MaxPlus™ positive displacement valve reduces the occurrence of thrombus formation resulting from reflux. This has a positive impact on the patient and the hospital as it reduces the need to treat clots with anti-clotting drugs and other rigorous techniques. In addition, invitro studies on Bio-Film formation have strongly implicated the association between thrombus and infection as blood components on the catheter surface can facilitate adhesion and colonization of microorganisms. If positive displacement can reduce the occurrence of thrombus formation, it may have a positive influence reducing infection rates. Future research is needed to confirm this theory.

