

Low Volume Flush Characteristics of Unique NeedleFree Connectors

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Background



Needlefree connectors (NC) are routinely used in IV therapy to protect the hubs of vascular access devices. In order to reduce manipulation and the subsequent risk of bacterial hub contamination¹⁻³, NCs must be used for all types of IV infusions in addition to blood infusion or sampling. Due to the enhanced risk of catheter sepsis which might result from residual blood in the NC, it is desirable to flush NCs after blood sampling or infusion. Subsequently, the ability to flush a NC free of blood residual is important for maintaining the catheter. For volume restricted patients, such as pediatric or neonatal patients, the volume of flush must be carefully limited so as not to injure the patient⁴⁻⁷.



In this study, two types of NCs were investigated for their ability to flush clear of blood at low volumes. The MicroCLAVE (ICU Medical, Inc) which is constructed using a straight, internal fluid path having a relatively low residual volume (0.04mL), was compared to the MaxPlus (Medegen, Inc) which uses an external fluid path with corrugations, having a large residual volume (0.32mL). Results show that the MicroCLAVE was able to be flushed with significantly less volume than the MaxPlus, indicating that a straight, internal fluid path and low residual volume is advantageous for blood clearance. Studies have shown that non-linear fluid paths, or ones with corrugations may harbor bacteria which have resulted in increased catheter sepsis.⁸ Furthermore, at flush volumes in excess of 4.0mL the MaxPlus NC was not able to be cleared of blood and would therefore not be appropriate for use on volume restricted patients.

Materials and Methods

Studies were conducted at Westcliff Medical Labs, Santa Ana, California, USA. A MicroCLAVE with a clear housing was manufactured specifically for this study for visualization purposes. A MaxPlus (MP1000-C) with clear housing was used to represent the MaxPlus NC. Two consenting, healthy male patients were accessed using a 21G butterfly with the NC attached to the distal tube. Each patient was accessed once using a MicroCLAVE assembly and once using a Medegen assembly. A Vacutainer[®] adapter (Becton Dickinson) and a purple top tube were then used to aspirate blood through the butterfly until the NC was filled with blood.

Each NC was then removed from the assembly and a 1mL syringe filled with normal saline (Hospira) was attached to the female luer. Using increments of ½mL, flush solution was pushed through each of the connector samples and captured in a test tube.

Flush captures were then analyzed for residual Hb measured in g/dL by spectrophotometer, in order to quantify at what point the NC was flushed clear of blood. The amount of Hb present in all samples was determined by lysing the blood with a Siemens lysing agent present in Coulter CBC Counter. Results are shown in g/dL in the table below.

Table 1.

	0.5mL flush g/dL	1.0mL flush g/dL	1.5mL flush g/dL	2.0mL flush g/dL	2.5mL flush g/dL	3.0mL flush g/dL	3.5mL flush g/dL	4.0mL flush g/dL
MicroCLAVE	0.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MaxPlus	9.05	1.05	0.50	0.20	0.15	0.15	0.00	0.10

Results:

The initial flush capture which represents the volume of blood to be found in each NC following a blood draw was 0.95g/dL and 9.05g/dL for the MicroCLAVE and MaxPlus respectively. Figures 3-5 and Table 1 demonstrate that the MicroCLAVE is both visibly clear of blood and has no blood residuals after 0.5mL of flush. Figures 6-10 and Table 1, demonstrate residual blood in the MaxPlus at various volumes. With as much as 4.0mL of flush the MaxPlus was still harboring blood components.

Discussion:

The MicroCLAVE has a straight fluid path with a smaller deadspace when compared to the MaxPlus. This design proves to have a significant impact on the ability to clear the device of blood. The corrugated design and outside fluid path of the MaxPlus appears to contribute to the harboring of blood and fluids. As noted in Table 1, the MaxPlus flush at 3.5mL contained no blood components, but then at 4.0mL blood components appeared again suggesting that blood had been trapped in the connector and then released. It is therefore unclear that even though the device appears clear, IV fluids including blood and drug precipitate, may be getting trapped in the device.

Furthermore, trapped fluids and blood could potentially support the development of bacteria and biofilm. Results of this study would indicate that the flush volumes to clear a MaxPlus would exceed the maximum requirements for volume restricted patients and the NC should be changed following drug infusions or blood draw. Increased exchange of the NC may introduce the risk of bacterial contamination through manipulation. In contrast, results for the MicroCLAVE would indicate that it is appropriate, using a minimal flush volume, for use with volume restricted patients and would not require exchange following drug infusion or blood draw.

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* MaxPlus is a registered trademark of Medegen Inc.

