STUDY SUMMARY

Comparison of Bacterial Transfer and Biofilm Formation on Intraluminal Catheter Surfaces Among Eight Connectors in a Clinically Simulated in vitro Model

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PURPOSE

The purpose of this study was to compare eight needlefree connectors in terms of bacterial transfer and colonization over a 96-hour period. This study measured the difference among connectors in the passage rate of bacteria from the connector surface through the catheter and into the bloodstream over time, and compared biofilm formation within the connectors, catheter hub, and catheter lumen.

MATERIALS AND METHODS

A total of eight needlefree connectors (see table 1) were inoculated twice a day with 10^6 CFU *Staphylococcus aureus* ATCC #6538, with the MicroClave® connector serving as the matched control. The inoculated connector was allowed to dry for 30 minutes before being attached to a catheter. Each connector-catheter set was flushed with 3.0 mL of sterile saline and plated (First Flush). The connector-catheter sets were flushed two more times with sterile normal saline, locked with sterile Brain Heart Infusion (BHI) for one hour, and then flushed three more times with normal saline. The last flush was also collected and plated (Last Flush). Following the sixth flush, the connector-catheter sets were inoculated a second time, followed by a second round of flushing, plating, and locking for a total of 18 connector accesses daily, considered to be a routine number of accesses in an intensive care unit.

The entire procedure was repeated each day for 5 days. On days 4 and 5, two connector-catheter sets were destructively sampled for bacterial counts and microscopy. Statistical analyses were performed to determine significant mean differences of log density of bacteria in the flush, hub, catheter, or connector amongst the different needlefree connectors.

RESULTS

The risk of transfer of bacteria from a contaminated connector surface through the hub and catheter lumen and into the bloodstream is dependent on the type of connector used. The MicroClave had a statistically lower bacterial transfer rate than all other connectors as measured in both the daily least square mean densities in the flush (See Table 1) as well as the least square mean for all flushes for all days (See Table 2).

TABLE 1

Daily Least Square Mean Bacterial Densities In The Flush

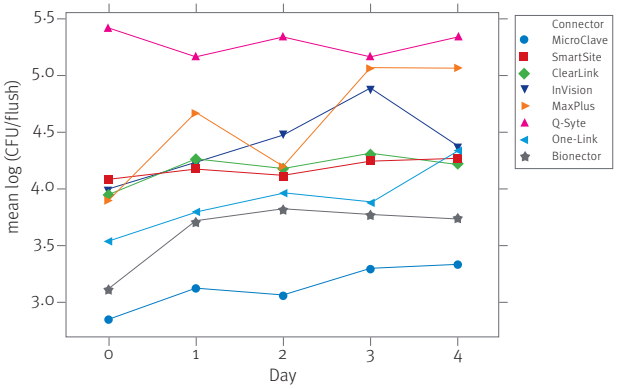

TABLE 2

Least Square Mean Flush For All Days And All Flushes

Connector	Significant Groups*	Overall Mean Log (CFU/Flush)**
MicroClave® (ICU Medical Inc.)	A	3.128
Bionector® (Vygon Inc.)	B	3.637
One-Link® (Baxter Inc.	B C	3.907
ClearLink® (Baxter Inc.)	C D	4.176
SmartSite® (CareFusion Corp.)	C D	4.176
Invision® (Rymed Technologies Inc.)	D E	4.368
MaxPlus® (CareFusion Corp.)	E	4.573
Q-Syte™ (BD and Co.)	F	5.276

*color scheme indicates significant groups ($p<0.05$)

**calculated as the Least Squares Mean For All Days and All Flushes

Tests also showed that the MicroClave had the lowest mean bacteria density within the connector, catheter hub, and catheter lumen for days 3 and 4 combined (see Table 3).

TABLE 3

Connector	Connector Log Density	Hub Log Density	Catheter Log Density
MicroClave	2.544	1.594	0.845
One-Link	2.592	1.694	1.14
ClearLink	3.005	1.853	1.194
MaxPlus	3.902	2.101	1.426
SmartSite	3.274	2.095	1.58
Q-Syte	3.936	2.925	1.797
Bionector	3.481	2.905	1.646
Invision	3.79	3.14	1.541

CONCLUSION

The risk of transfer of bacteria from a contaminated connector surface through the hub and catheter lumen and into the bloodstream is dependent on the type of connector used. The MicroClave connector's statistically lower amount of bacterial transfer may be attributed to minimal swabbing surfaces or seals that "become" part of the fluid path when accessed by a mating cannula. However, the common classification of split septum and mechanical valve is an over simplification and an unreliable approach for device selection based on infection risk.

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