Comparison of Bacterial Transfer and Biofilm Formation on Intraluminal Catheter Surfaces Among Fourteen Connectors in a Clinically Simulated in vitro Model
Ryder M1, deLancy Pulcini E2, Parker A2, James G2
(1) Ryder Science, Inc., Escondido, CA (2) Center for Biofilm Engineering Montana State University-Bozeman

INTRODUCTION
The use of needleless connectors is an important strategy in the prevention of needlestick injuries for healthcare workers and caregivers of patients with vascular access devices. The design components of the connector influence the potential for bacteria to pass from the connector surface into the flow path of the connector, catheter hub and catheter lumen. Intraluminal biofilm is a predominant source of catheter-related bloodstream infection (CRBSI) during the maintenance phase of catheterization.

PURPOSE
The purpose of this study was to compare the bacterial transfer rate of fourteen needleless connectors through the connector-catheter system and to compare biofilm formation within the connectors, catheter hubs, and catheter lumens.

METHODS
A total of 14 needleless connector designs were evaluated in this study. Three of each connector type were evaluated in three replicate runs (n=9) with the MicroClave® serving as the matched control for every run in a total of 21 runs.

RESULTS
The MicroClave and Neutron connectors had statistically significantly smaller mean log densities (LD) of bacteria in the flush, when pooled over all flushes, inoculations, days, and runs, compared to any other of the connector types (p < 0.0023). The MicroClave and Neutron were not statistically significantly different (p = 1.0).

DISCUSSION
The risk of transfer of bacteria from a contaminated connector surface was dependent on the type of connector used. The results of this study validate that biofilm formation in the catheter hub and internal lumen can result from bacterial transfer through a needleless connector. It further demonstrates that detached or planktonic bacteria shed from the biofilm are subsequently flushed into the bloodstream with infusion. Regression analysis indicates that biofilm formation within the connector was the best predictor of the number of bacteria flushed into the bloodstream (R-squared=95%). Thus the use of a connector with a low microbial transfer rate may minimize the risk of bloodstream infection. It also points to the use of consistent and effective disinfection methods of the connector and catheter hub prior to access as a critical strategy for prevention of CRBSI. The data also suggests that the common classification related to features of connectors such as split septum and mechanical valve is an unreliable approach for device selection based on infection risk.

CONCLUSIONS
• 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 and Neutron had a significantly lower bacterial transfer rate than any of the other connectors.
• Biofilm formation in the catheter hub and internal lumen can result from bacteria transferred through a needleless connector.
• Biofilm formation within the connector is a good predictor of the number of bacteria flushed into the bloodstream.
• The frequency of connector exchange may be dependent on the bacterial transfer potential of each device design.
• The common classification of split septum and mechanical valve is an over-simplification and an unreliable approach for device selection based on infection risk.