

Comparison of Biocompatible Circuit Coatings Used in Cardiopulmonary Bypass Surgery

The use of biocompatible coatings on extracorporeal circuits (ECC) during open heart bypass surgery has increased over the past decade. Numerous surface coatings have been developed and extensively studied to show improved blood compatibility of biomaterials^{1,2}. This biocompatible surface is made to help minimize the patient's inevitable immune response to the ECC while on bypass^{3,4}. The effectiveness of four ECC coatings were compared directly by measuring protein adhesion to each circuit surface with the use of scanning electron microscope (SEM). In this study, the platelet preservation was also considered as blood samples were taken at the same time as each tubing sample.

The biocompatible circuit coatings were evaluated using bovine blood; an affordable and feasible alternative to human blood. The circuits tested were Trillium by Medtronic, Balance Biosurface by Medtronic, Cortiva Bio-Active Surface by Medtronic, and X-Coating by Terumo⁵⁻⁸. The bovine blood was circulated through each circuit for a total of 50 min; reflective of a bypass procedure. Blood samples and tubing samples were collected at three different time and temperature intervals (37°C at 10 min, 30°C at 30 min, and 37°C at 50 min). The blood samples were drawn into Monoject blood collection tubes containing EDTA, and small pieces of circuit tubing were cut and processed according to SEM protocol. The Monoject blood samples were analyzed and evaluated by a medical laboratory professional at ANTECH Diagnostics. The parameters measured included; hematocrit, hemoglobin, platelets, neutrophils, lymphocytes, monocytes, eosinophils, and basophils. Circuit tubing samples were treated for molecule fixation using varying strengths of alcohol and 4% glutaraldehyde. Tubing samples were stored within a vacuum chamber and later evaluated using the SEM. The SEM provided a visual image of the number of molecules adhered to the circuit tubing. These images were analyzed and quantified using an image software called imageJ. Percentage of molecular coverage was calculated for each image. In total 60 pictures were taken and processed.

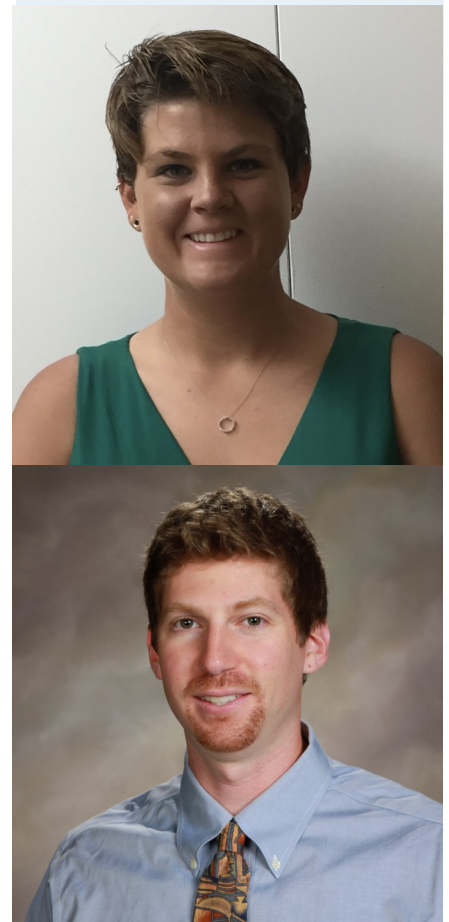
The SEM images revealed a layer of protein coverage on all tubing samples. Cortiva BioActive Surface had the highest percentage of protein adhesion with an average of 46.8% coverage across all temperature and time intervals. The remaining samples were observed to have coverage across all temperature and time intervals as follows; Trillium 25.8% coverage, Balance Biosurface 16.6% coverage, and X-coating 10.7% coverage. The blood samples showed that Balance Biosurface and Trillium had the highest platelet preservation across all temperature and time intervals, where Cortiva and X-coating platelet counts varied throughout the trial. The average adhesion across all the time and temperature intervals is consistent with the results achieved at the individual time and temperature intervals.

The results demonstrated all biocompatible tubing has the potential to be coated by protein, activate an immune response, and increase the patients' platelet count. Further research investigating the activation of platelets

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and specific antigen/antibody complexes would help provide a more detailed representation of the immune response to the ECC. This information could be used alongside previously stated results to aid in the advancement of bioactive coating strategies, helping minimize the patient's response to the ECC.

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