INTRODUCTION
The mortality rate for children listed for heart transplantation is 23%\(^1\). Many of these children are in need of mechanical circulatory support to bridge them to transplant. The PediaFlow\(^\text{®}\) pediatric ventricular assist device (VAD) is an implantable rotary blood pump designed to support systemic circulation by pumping blood from the left ventricle to the aorta. The selection of an appropriate outflow graft, which connects the pump outlet to the vasculature, is an important and non-trivial decision due to multiple factors. Synthetic grafts made of polyester (PET) and polytetrafluoroethylene (PTFE) derivatives are commonly used in adult VAD outflow tracts. While PET is predominately used for large diameter grafts, patency rates dramatically decrease with smaller diameter grafts making PTFE more suitable\(^2\). However, clinical studies have shown that expanded PTFE grafts can undergo plasma weeping before adequate protein deposition occurs. Although complications due to plasma weeping are infrequent, weeping can lead to decreased plasma protein levels, perigraft seromas, and additional surgeries. Significant differences in graft permeability have been seen between graft types in vivo, as well as when grafts have been treated with alcohols, oils, or antibiotics\(^3,4\). An experimental method to quantitatively measure graft permeability was develop, verified, and is being used to test to synthetic vascular grafts to select an appropriate graft to be used as a pediatric VAD outflow.

OBJECTIVE
The goal was to develop an experimental method to quantitatively measure vascular graft plasma permeability and select a synthetic vascular graft that would be an appropriate pediatric VAD outflow graft.

HYPOTHESIS
Evans blue can be used to label albumin and by measuring the absorbance of Evans blue, the concentration of albumin can be calculated and quantify plasma weeping of vascular grafts.

METHODS
Five grafts have been tested, including four Bard\(^\text{®}\) 5 mm ePTFE grafts and one Vascutek\(^\text{®}\) 6 mm SealPTFE™ graft. The first Bard\(^\text{®}\) graft was not re-sterilized and underwent mechanical manipulation while all other grafts were re-sterilized with ethylene oxide and not perturbed. Grafts were cut down to approximately 14 cm and secured inside a custom acrylic chamber. The acrylic chamber suspends the graft within a PBS bath while allowing intraluminal blood flow. The circulating blood loop consisted of a reservoir, a centrifugal pump, a pinch valve to induce pulsatility, and a throttle to adjust afterload. Temperature, flow rate and pressure drop across the graft were measured using a thermistor, a clamp-on ultrasonic flow probe, and two pressure transducers, respectively (Figure 1).

Next-day venipuncture citrated ovine blood (Lampire Inc., Pipersville, PA) was obtained, filtered, and adjusted to a hematocrit of 30±1% through the addition or removal of autologous plasma. An Evans blue solution (12.8 mg/ml), which binds to albumin, was mixed with the blood (1:10) to label the plasma proteins. Finally, two broad spectrum antibiotics gentamicin (1.0 ml/L, Gentamax® 100 Injection, Nature Vet®) and Cefazolin (1.0 ml/L) was added in the blood.

![Figure 1. Schematic of the pulsatile mock loop showing the graft submerged in the PBS bath while being perfused with blood.](image-url)
samples were measured using a spectrometer (Genesis 5, Thermo Spectronic®, Rochester, NY) at 620 nm and a micro osmometer (Precision Systems, Natick, MA), respectively. A standard curve created from the supernatant of the prepared blood suspension was used to determine the relationship between albumin concentration and absorbance.

RESULTS
Plasma weeping in the perturbed graft became visibly evident after 24 hours, predominately on the outlet side where the manipulation had occurred. Dye became visible around the strain relief of the second Bard® graft after 48 hours. No plasma weeping was observed in the third and fourth Bard® graft or the Vascutek® graft with albumin concentration negligible. The concentration of albumin in the perturbed graft increased from 0 to 0.2 g/L while the second graft increased from 0 to $4 \times 10^{-3}$ g/L (Figure 2).

DISCUSSION
Plasma weeping occurred in the first two grafts within 72 hours, consistent with clinical findings. For the perturbed graft, weeping occurred predominately on the left side where the manipulation occurred as shown in Figure 3, indicating that the localized permeance may be due to mechanical manipulation or wear.

REFERENCES

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