

Blood Flow Rates and Ultrafiltration Accuracy in a Manual Single Lumen Alternating Micro-Batch Dialysis Circuit

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Purpose: Electrolyte derangements and volume overload remain life threatening emergencies in low resource settings. The manual Single Lumen Alternating Micro-Batch (mSLAMB) dialysis system is envisioned to treat severe acute kidney injury (AKI) and its sequelae when a standard dialysis machine or peritoneal dialysis are not available. Blood is drawn in small batches from the patient into a sterile tubing circuit, and a hemofilter provides a diffusive surface for clearance, while syringes can pull fluid off for ultrafiltration. Through this closed loop system, we believe clearance and volume removal is not only possible, but efficient and volumetrically accurate. We sought to determine blood flow rates (Q_b) and ultrafiltration accuracy using mSLAMB to dialyze human blood *in vitro*.

Methods: We used units of expired packed red blood cells diluted with 0.9% NaCl to a final hematocrit of 30-35% and anticoagulated with heparin to simulate the pediatric patient blood volume. The duration of each cycle was timed to determine Q_b , using a 2x2 factorial design to assess the effect of the height difference between reservoirs and volume on Q_b . Differences in height between reservoirs (35cm vs 45cm) and crystalloid hemofiltration fluid volumes (aliquots of 50mL of blood added to either 50mL or 150mL of crystalloid) were tested. Student's T-test was used to compare groups. Effluent volumes were recorded after each run and compared to prescribed volume to assess ultrafiltration accuracy.

Results: 6 runs of 8 cycles each were time recorded. Mean (+/- SD) Q_b of the 100mL vs. 200mL volume group was 80.3 +/- 5.1 vs 90.2 +/- 7.0 mL/min ($p=0.03$). Mean (+/- SD) Q_b of the 35cm vs. 45cm height difference was 79.7 +/- 4.4 vs 90.8 +/- 6.5 mL/min ($p=0.01$). Higher volume and greater height difference improved Q_b (Figure). Mean difference between volume prescribed and measured was 11.4mL for prescription volumes of 800-2400mL. Percent absolute difference between volume prescribed and measured ranged from 0 to 2.4% and did not increase with increasing volumes.

Conclusion: We consistently and precisely achieved blood flow rates comparable to an automated continuous dialysis machine with accurate ultrafiltration volume. Increasing height between reservoirs and volume dialyzed synergistically improved Q_b without sacrificing ultrafiltration accuracy.

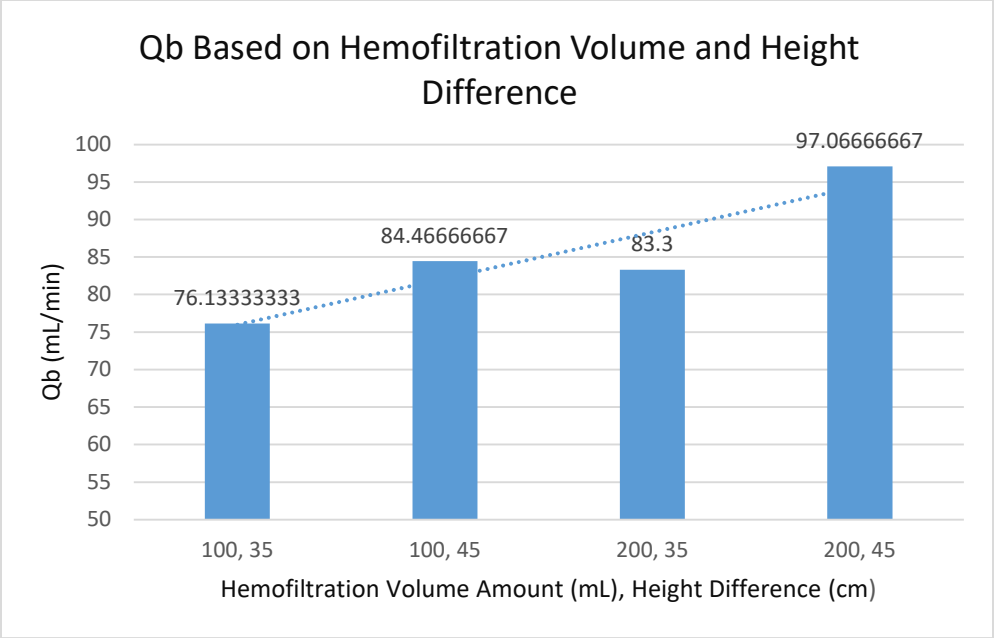


Figure legend: Blood flow rates based on hemofiltration volume and height difference, 2-way ANOVA p=0.11. Qb-blood flow rate.