We sought to reproduce this failure mode using different infusion rates and different combinations of fluids for blood product reconstitution in the reservoir” Gopinath et al (2016).

Abstract:

BACKGROUND: Electromagnetic coil overheating, deformation, occlusion, and rupture during rapid infuser use have been previously reported. Although the etiology is unclear, prolonged machine use and reconstitution of citrated blood components with crystalloid solutions in the reservoir have been implicated. Lactated Ringer’s (LR) solution is of particular concern as a diluent because of its calcium content. We sought to reproduce this failure mode using different infusion rates and different combinations of fluids for blood product reconstitution in the reservoir. We also introduced calcium chloride (CaCl2) to the mix to determine its role in macroscopic clot formation.

METHODS: In this in vitro study, we conducted 2 series of experiments using the Belmont FMS 2000 rapid infuser and a reservoir. In series I, we submitted a mix of 1 U fresh thawed plasma (FTP) and 1 U red blood cells (RBC) with 500 mL of LR solution, normal saline, Plasma-Lyte A, or albumin 5% to a specific pump flow sequence. If neither a pump failure mode or self-shutoff (primary outcome) nor macroscopic clot (secondary outcome) was observed during a pump flow sequence, the sequences were repeated after first adding an additional 500 mL of the initially used crystalloid or albumin and then CaCl2 beginning with 200 mg and up to 1 g to the reservoir. In series II, 7 different crystalloid-blood product combinations were tested by using a variety of pump flow sequences with the same end points. Descriptive statistics and analysis of variance were used, and data were reported as means ± SD.

RESULTS: We did not observe a Belmont pump failure mode (coil deformation, occlusion, or rupture) as previously described. In series I, the addition of CaCl2 200 mg resulted in macroscopic clots in 9 of 10 experiments (95% confidence interval, 0.55-0.99). The time to clot formation was 9.1 ± 2.3 minutes (99% confidence interval, 6.74-11.46) and did not differ
between solutions used for component reconstitution. In series II, adding variable amounts of CaCl2 to 4 different combinations of FTP/RBC with Plasma-Lyte A or LR solution led to clot formation. The use of only FTP in 2 experiments with either LR solution or normal saline resulted in formation of a fibrin clot. In 1 experiment of LR solution mixed with RBCs alone, no clot was observed even after addition of 1 g CaCl2. After the observation of clot in the reservoir, the fluid empty alarm occurred once in series I, the overheating alarm occurred once in series II, and the high-pressure alarms occurred 3 times in each series, all accompanied by self-shutoff.

CONCLUSIONS: In this in vitro study, we were unable to reproduce the failure mode characterized by coil overheating, deformation, and rupture previously reported with use of the FMS 2000. Addition of CaCl2 in the range of 200 mg caused macroscopic coagulation in the reservoir when added to crystalloids or albumin mixed with different combinations of blood products containing FTP.

Reference:


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