

Modelling hypovolemia during blood donation

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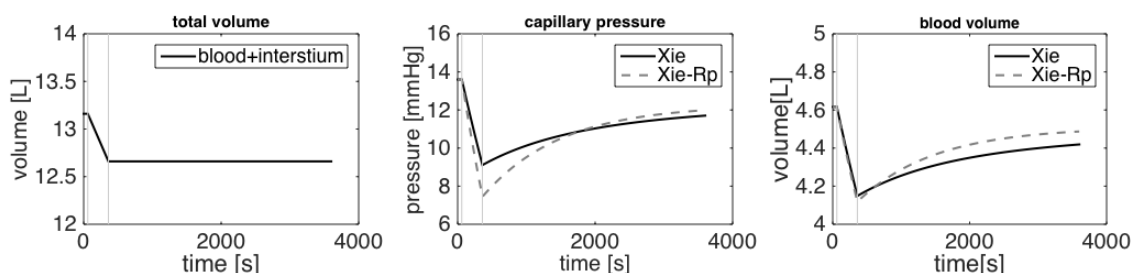
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Introduction

Major surgery is often associated with severe blood loss, compensated by intravenous fluid administration during and after surgery. This is necessary to prevent hypovolemia, which carries the risk of hypoperfusion and multi-organ failure [1]. Especially elderly patients are sensitive to fluid balance disruptions due to their compromised regulatory system. It has become clear that hypervolemia can also cause complications, such as edema, high blood pressure and kidney failure [2]. The optimal fluid balance is hard to estimate, since there are no non-invasive techniques available to directly measure volume status. In this study we take the first step by modeling hypovolemia in a controlled environment, namely during blood donation. This is regulated first by the baroreflex, while on a longer timescale fluid redistribution takes over [3].

Methods

To model the effects of blood donation, we have developed a combined cardiovascular fluid responsiveness model. The fluid model is based on the work of Xie [4]. Fluid exchange between plasma and interstitium depends on capillary pressure, derived from a systemic circulation model with baroregulation [5,6].



Preliminary results

Blood donation of 500 ml in 5 minutes was modeled. In the isolated fluid exchange model ('Xie'), capillary pressure drops by about 5 mmHg after 5 minutes, and increases again by about 3 mmHg after 1 hour, due to restoration of capillary volume from interstitial volume. In the combined model, with a baroreflex acting only upon peripheral resistance ('Xie-Rp'), decrease of capillary pressure is increased, causing increased inflow from interstitium to plasma. This causes dilution of the full blood, causing the hematocrit to change after blood donation. The results are qualitatively comparable to literature [3].

Conclusion

These preliminary results suggest that the baroreflex contributes to restoration of blood volume upon hypovolemia. This is a critical first step in the effort to model fluid balance in critical elderly patients during and after major abdominal surgery.

References

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