Estimating Absolute Blood Volume in Hemodialysis Patients

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Objective

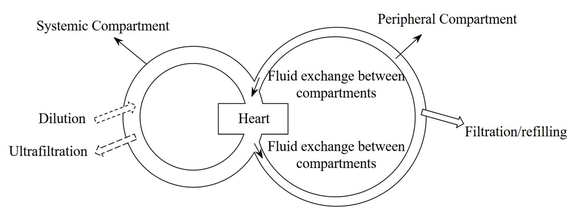
Improve precision of absolute blood volume (ABV) estimates from online dialysate dilution test.

Background

- Intradialytic hypotension is a common hemodialysis (HD) complication associated with adverse outcomes.
- ABV data is likely to improve HD treatment outcomes.
- Gold standard ABV measurements are invasive, expensive, and impractical for routine care.
- Relative blood volume sensors offer only indirect information about ABV.
- Recently, an on-line bolus dialysate dilution protocol has been shown to produce reliable ABV estimates. This protocol can be readily incorporated into current HD machine technology.
- Previous ABV estimates from dilution protocols were based on the fixed-volume, mono-exponential, back-extrapolation algorithm (BEXP).

Methods

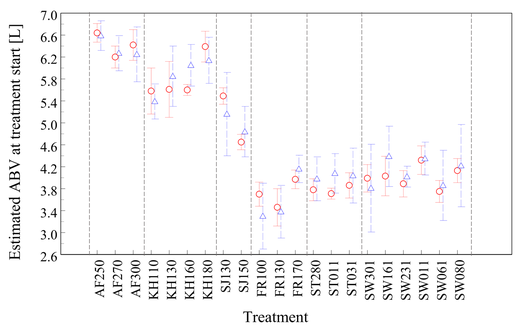
- Fresenius 4008H hemodiafiltration machine with online dialysate infusion capability equipped with a blood volume monitor (BVM) and dedicated data acquisition software.
- 3 arteriovenous (AV) and 3 central venous (CV) access patients. Repeated, intra-treatment, online bolus dialysate dilution tests (3-5), over several (2-6) HD treatments.
- Variable-volume, two-compartment blood volume and water content kinetic model vs. the BEXP algorithm.



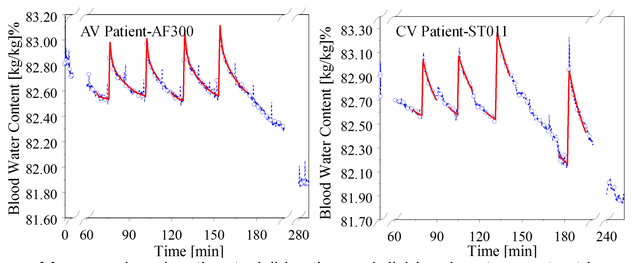
Schematic of the kinetic model

Results

- Bland-Altman plots shows good agreement between kinetic model and BEXP algorithm.
- Kinetic model results in 53% and 42% lower SD for AV and CV access, respectively.



Intra-treatment variability of ABV estimates (mean+/-SD) using the kinetic model (red) and BEXP algorithm (blue)



Measured and estimated (kinetic model) blood water content in repeated dilution tests

- The kinetic model *is not observable* in CV access. It must be reduced to a single compartment model.
- Sensitivity analysis confirms the *identifiability* of ABV from the kinetic model.

Conclusions

- The kinetic model successfully describes BWC dynamics during an online dialysate dilution protocol in AV and CV access patients.
- ABV estimates based on the kinetic model have significantly improved precision compared with estimates obtained from the BEXP algorithm.

References

Schneditz, D., et al., Online dialysate infusion to estimate absolute blood volume in dialysis patients. ASAIO Journal, 2014. 60(4): p. 436-442.

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