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 hemodialfiltration 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.

Results

- Variable-volume, two-compartment blood volume and water content kinetic model vs. the BEXP algorithm.
- Bland-Altman plots show good agreement between kinetic model and BEXP algorithm.
- Kinetic model results in 53% and 42% lower SD for AV and CV access, respectively.

Conclusions

- 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.

References