



Association Between Intradialytic Dynamics Of Central Venous Oxygen Saturation And Ultrafiltration Volume In Chronic Hemodialysis Patients



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Background

- Cardiac disease is highly prevalent in maintenance hemodialysis (HD) patients.
- HD treatment factors such as recurrent hemodynamic stress due to high ultrafiltration rates (UFR), intradialytic cardiac stunning due to decreased myocardial perfusion, and episodes of intradialytic hypotension (IDH) may play a role in congestive heart failure pathogenesis.
- Central venous oxygen saturation (ScvO₂) is frequently clinically used as an indicator of cardiac output in non-uremic populations, and prior small studies identify an association between ScvO₂ and hemodynamic stress. We aimed to expand upon this literature in a large diverse HD cohort.

Methods

- We conducted a retrospective cohort study of maintenance outpatient hemodialysis patients with central venous catheters as dialysis access.
- We monitored intradialytic ScvO₂ in these patients for 6 months with the Critline monitor (CLM).
- The CLM measures ScvO₂ in the extracorporeal dialysis circuit.
- First we computed the slope of intradialytic ScvO₂ over time (ScvO₂ trend) for each treatment.
- We then applied linear mixed effects models to assess the association between patient-level ScvO₂ trends and ultrafiltration volumes corrected for body weight (cUFV).

Results

- We studied 6,042 dialysis sessions in 232 patients.
- Figure 1 demonstrates two different patients (A) ScvO₂ decreased during their HD treatment, and (B) ScvO₂ increased during HD treatment.
- In approximately 60% of treatments ScvO₂ decreased during dialysis (Figure 2).
- Figure 3a shows a patient with an inverse ScvO₂ trend/cUFV relationship while figure 3b demonstrates a patient with a direct ScvO₂ trend/cUFV relationship. Nearly 70% of patients had an inverse relationship between cUFV and ScvO₂ trend, indicating that higher cUFV was associated with steeper decline in ScvO₂ during dialysis.
- Figure 4 demonstrates the population ScvO₂ trend/cUFV relationship, where green lines indicate patients with a negative slope and orange lines those with a positive slope. The purple line represents the population fixed effect slope derived from the linear mixed model.

Figure 1: Changes in central venous oxygen saturation during a hemodialysis treatment for two different patients

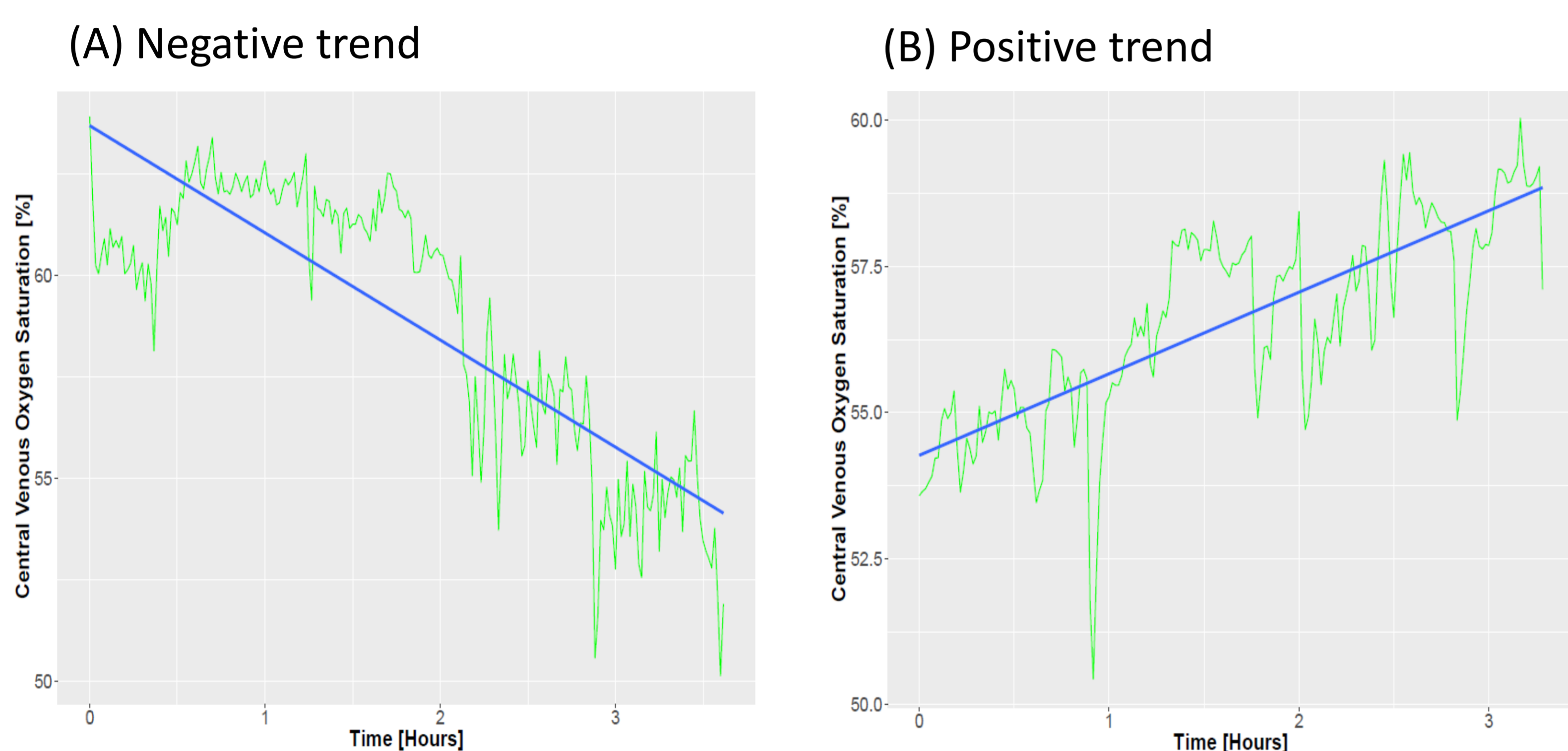


Figure 2: Distribution of central venous oxygen saturation trend on treatment level

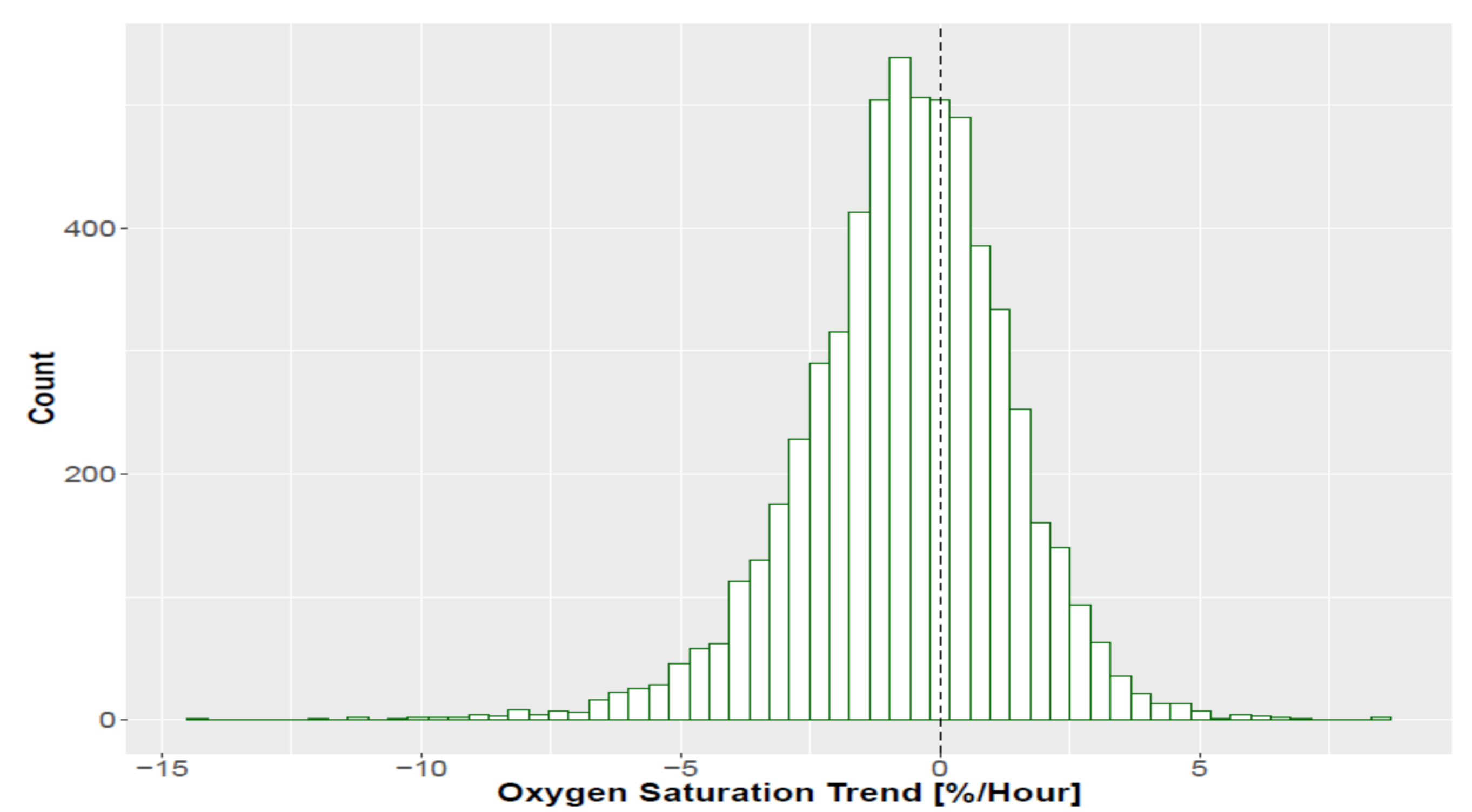


Figure 3: Distribution of central venous oxygen saturation trend on patient level

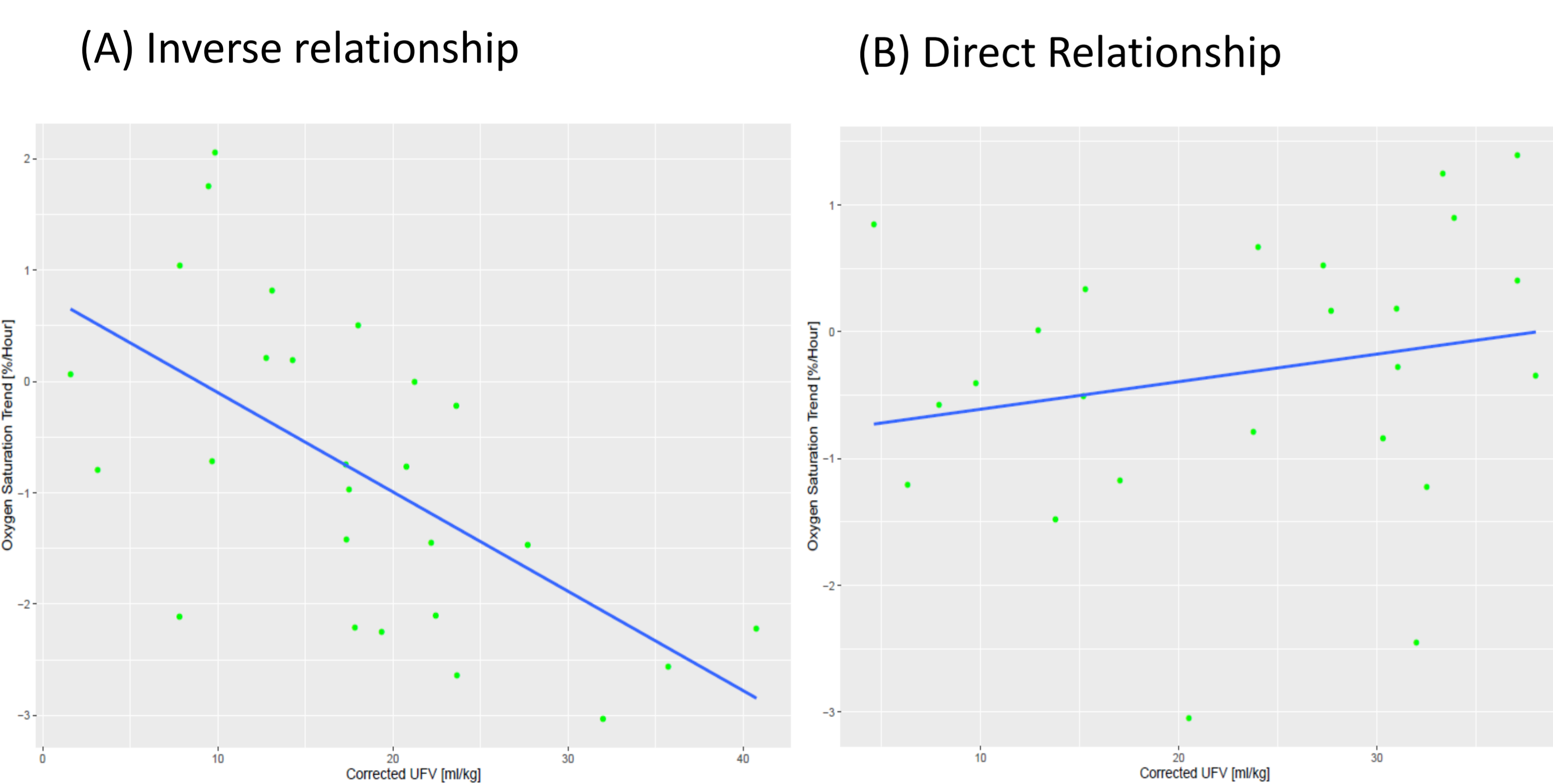
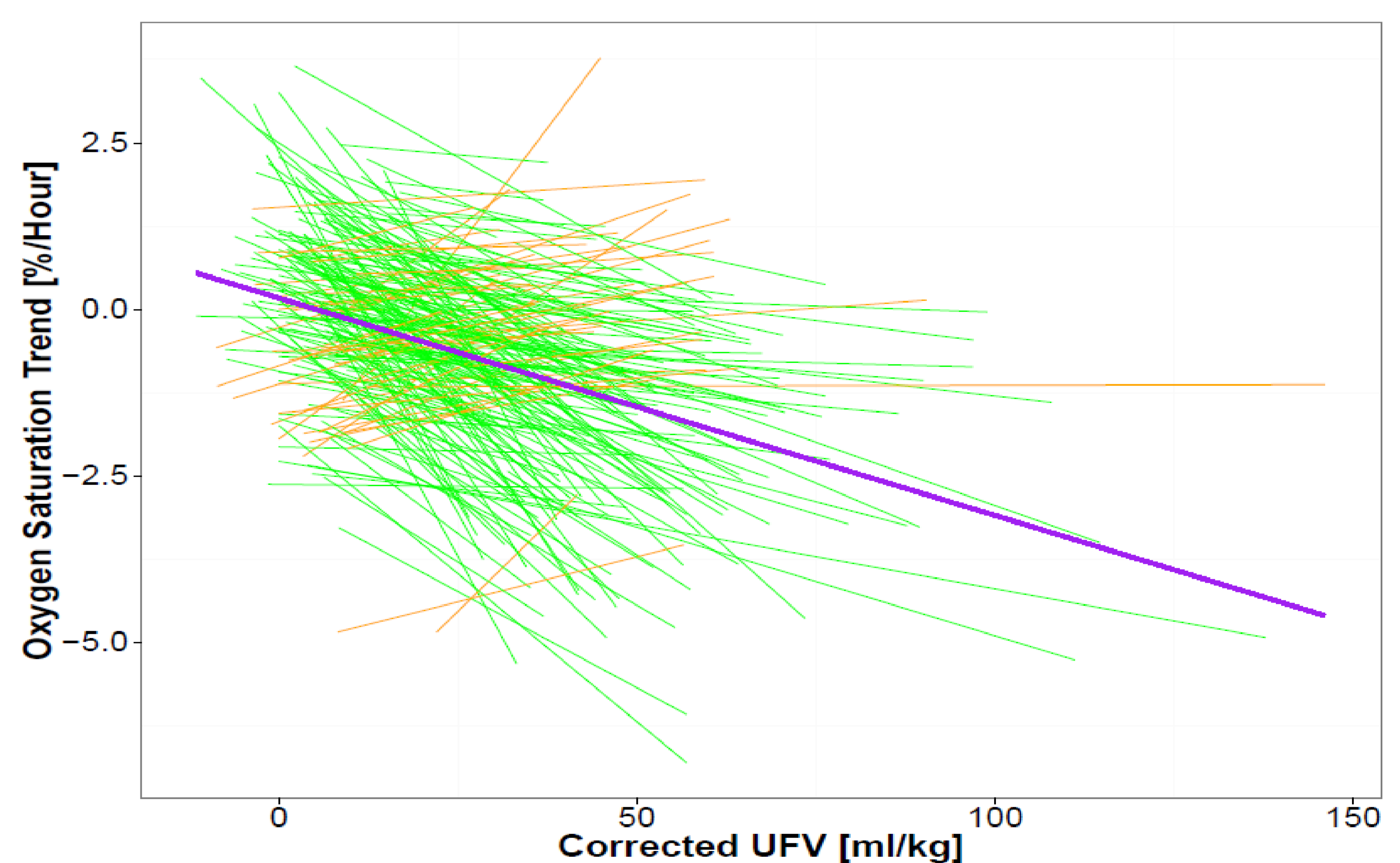


Figure 4: Linear Mixed Model of central venous oxygen saturation and corrected ultrafiltration volume



Discussion & Conclusions

- In a diverse population of chronic hemodialysis patients there is an inverse relationship between intradialytic ScvO₂ change and cUFV, meaning that most patients at high cUFV experience a more pronounced intradialytic ScvO₂ decline.
- A minority of patients showed a positive relationship between ScvO₂ trend and higher cUFV. We hypothesize that those patients may actually be well above their dry weight while being prescribed a too low UFV.
- On a population level the fixed effect derived from the linear mixed model indicates that ScvO₂ decreases once cUFV exceeds 5 mL/kg body weight. We hypothesize that this finding is driven by a decline in cardiac preload and upper body blood flow when UFR exceeds plasma refill rate. This is in line with a MRI study by Buchanan et al., where stroke volume and cardiac index fell at even smaller UFV.
- Our study suggests that ScvO₂ could evolve into a novel marker to monitor hemodynamic response to HD, especially in those with frequent episodes of intradialytic hypotension and incident HD patients who have frequent use of central venous catheter as vascular access and high morbidity and mortality.
- Future studies with direct hemodynamic measurements are warranted to further elucidate the relation between ScvO₂ dynamics and circulatory stress on dialysis, and their relation with outcome.

References

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