PRESCRIPTIONS OF DIALYSATE POTASSIUM CONCENTRATIONS DURING SHORT DAILY AND LONG NOCTURNAL (HIGH DOSE) HAEMODIALYSIS

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Introduction and Objective

Dialysate potassium concentrations are prescribed to provide adequate dialytic removal while maintaining serum potassium levels within normal limits, and such prescriptions during thrice weekly haemodialysis (HD) are based largely on clinical experience. The prescription of dialysate potassium concentrations during short daily and long nocturnal (high dose) HD are challenging due to limited clinical experience with such modalities.

The objective of this study was to describe a quantitative approach for prescribing dialysate potassium concentrations during short daily and long nocturnal HD based on a model of potassium kinetics.

Methods

Data Analysis

Data for these retrospective analyses were obtained during kinetic modeling sessions from months 4 and 36 of the HEMO Study, as described previously (Agar et al, ERA-EDTA Congress 2013 & Agar et al, ASN Congress 2013). Kinetic modeling sessions were performed by collection of blood samples predialysis, 60 minutes after starting the treatment, 20 seconds after stopping the treatment using a slow flow technique, and 30 minutes after the end of treatment; serum potassium concentration was measured in each sample. The dependence of serum potassium concentration on time was analyzed using a pseudo one-compartment model (Agar et al, Clin J Am Soc Nephrol 2011) to estimate potassium mobilization clearance and volume of the central compartment for each patient using nonlinear regression:

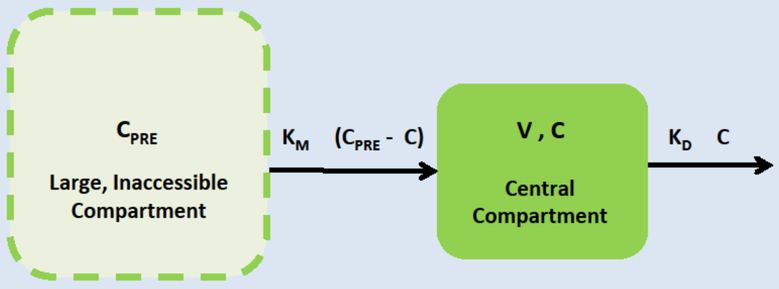

Figure 1: Pseudo one-compartment model

C_{PRE}: Predialysis serum potassium concentration
C: Serum potassium concentration
K_M: Potassium mobilization clearance
V: Volume of central compartment
K_D: Dialyzer potassium clearance

Predictions for High Dose HD

Dialysate potassium concentrations during high dose HD prescriptions were determined using a mass balance model (Leypoldt et al, Int J Artif Organs 2012) and the relationship between C_{PRE} and the removal or generation rate (G)

$$C_{PRE} = \frac{G \times (T + \theta) + D \times C_d \times T}{D \times \hat{C}_T \times T}$$

where T is treatment time, θ is the interdialytic interval, D is the dialyser potassium dialysance, C_d is the dialysate potassium concentration and $\hat{C}_T$ is the normalized, average serum potassium concentration during the treatment. The latter variable is a complex function of treatment variables and kinetic parameters (K_M and V). The above equation was solved for the dialysate potassium concentration during high dose HD to maintain the identical C_{PRE} and removal rate as during thrice weekly HD as during the HEMO Study.

Short daily HD was assumed to be performed 6 times per week with treatment times one-half that during the HEMO Study, all other conditions identical. Long nocturnal HD was assumed to be performed 5 times per week with a treatment time of 420 minutes, blood flow rate of 280 mL/min, and dialysate flow rate of 320 mL/min. Under those conditions, the dialyser potassium dialysance was calculated to be 148 5 mL/min.

Results

Table 1: HEMO Study patient characteristics and measured parameters during kinetic modeling sessions.

Characteristic	Dialysate Potassium Category			
	Total	1K	2K	3K
N	547	60	437	50
Age (years)	58.8 ± 14.4	54.5 ± 15.6	59.3 ± 14.2	59.7 ± 14.5
Female Sex (N, %)	304, 56	38, 63	242, 55	23, 46
Black Race (N, %)	335, 61	16, 27	288, 66	31, 62
Treatment Time (min)	206± 29	206 ± 27	206 ± 29	208 ± 30
Blood Flow Rate (ml/min)	343 ± 61	327 ± 67	345 ± 60	351 ± 63
Dialysate Flow Rate (ml/min)	688 ± 129	642 ± 139	693 ± 127	700 ± 128
Dialyser Potassium Dialysance (ml/min)	179 ± 27	170 ± 29	180 ± 26	184 ± 29
Dialysate Potassium Concentration (mEq/L)	1.99 ± 0.45	1.01 ± 0.05	2.01 ± 0.05	3.01 ± 0.07

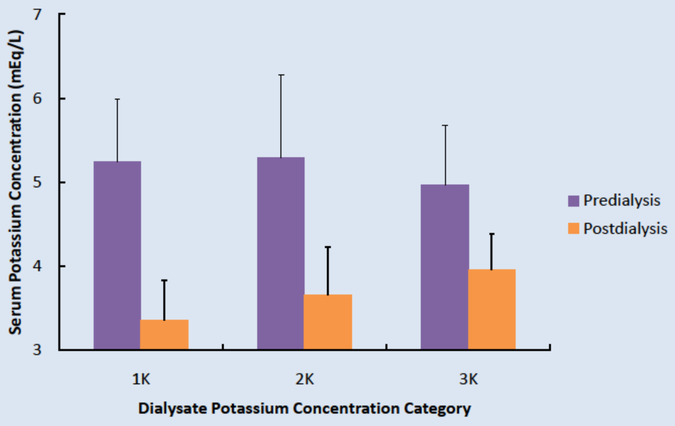

Figure 2: Measured potassium concentrations during kinetic modeling sessions of the HEMO Study.

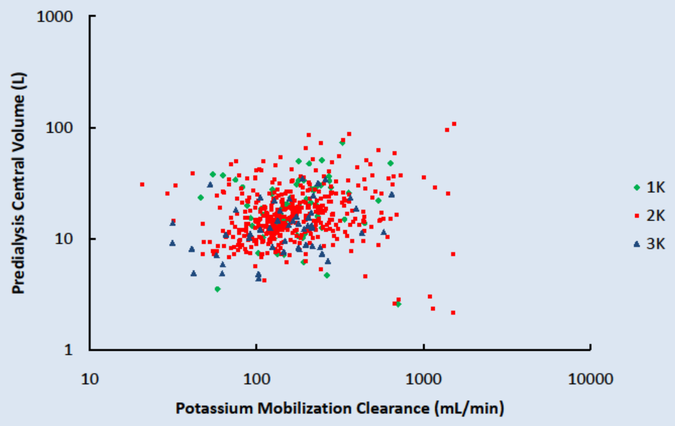

Figure 3: Kinetic model parameters for potassium determined from kinetic modeling sessions of the HEMO Study.

Table 2: Recorded or Prescribed dialysate potassium concentration by the kinetic model (mEq/L).

Haemodialysis Modality	Dialysate Potassium Category		
	1K	2K	3K
HEMO Study (Recorded)	1.01 ± 0.05	2.01 ± 0.05	3.01 ± 0.07
Short Daily Haemodialysis (Predicted)	1.46 ± 0.23	2.37 ± 0.24	3.19 ± 0.17
Long Nocturnal Haemodialysis (Predicted)	3.72 ± 0.56	4.10 ± 0.68	4.26 ± 0.48

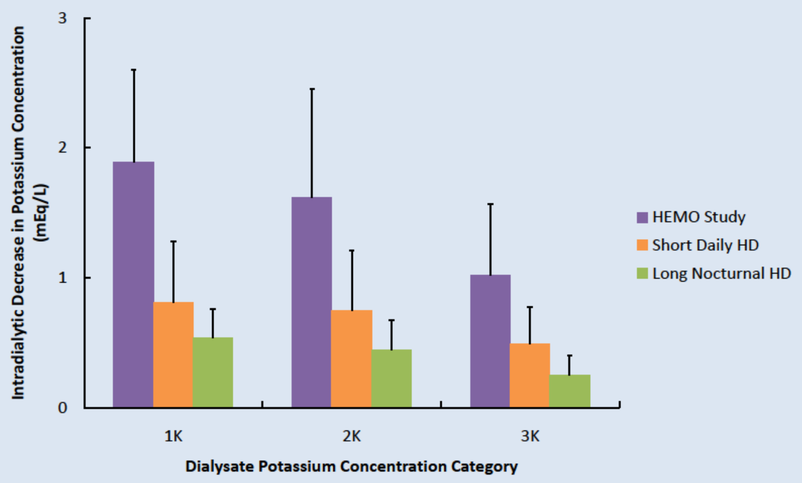

Figure 4: Measured or predicted intradialytic decreases in serum potassium concentration. These predictions suggest that the intradialytic decrease in serum potassium concentration will be reduced by more than one-half during short daily and by approximately three-quarters during long nocturnal HD of that during thrice weekly HD, i.e. as prescribed in the HEMO Study.

Conclusions

- We conclude that dialysate potassium concentrations during high dose HD modalities can be quantitatively predicted using a potassium kinetic model.
- High dose HD modalities may improve clinical outcomes by reducing intradialytic decreases in serum potassium concentration.

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