

# Serum Potassium and Clinical Outcomes among Hemodialysis Patients: Impact of the Long Interdialytic Interval

### Introduction

- The paradigm of thrice weekly dialysis implies two short (1-day) breaks and one long (2-day) break.
- Among dialysis patients, hospitalizations and mortality peak after the long break.<sup>1-3</sup>
- This phenomenon might be explained by the accumulation of fluid, toxins, potassium ( $K^+$ ), or a combination thereof.
- The role of serum K<sup>+</sup> in mediating this weekend effect has not been empirically studied.

#### Objective

To determine the independent relationship between serum K<sup>+</sup> and outcomes overall, and to understand how these relationships are or are not impacted based on the day of the week that K<sup>+</sup> is measured

#### Methods

- Study data were derived from the electronic health records of a large dialysis organization (LDO) and the United States Renal Data System database.
- Patients considered were adult Medicare Parts A & B beneficiaries receiving in-center hemodialysis at the LDO on a Monday/Wednesday/Friday schedule who received routine (non-stat) serum K<sup>+</sup> measurements during the period 2010-2011 and had not missed a treatment in the 7 days prior to the measurement.
- This analysis was done at the interval level, with each interval defined by a qualifying serum K<sup>+</sup> measurement and characterized by the day of the week of the measurement. Patients could contribute multiple intervals; analyses were corrected for multiple observations.
- K<sup>+</sup> was characterized as 4.0-<4.5, 4.5-<5.0, 5.0-<5.5, 5.5-<6.0, 6.0-<6.5, 6.5-<7.0 and ≥7.0 mEq/L (measurements <4.0 were excluded).
- Outcomes (deaths, hospitalizations, emergency department [ED] visits) were considered on the day of the  $K^+$  measurement and the next 3 days (Figure 1).
- Causes of hospitalizations were ascribed based on the primary ICD-9 code in the claim, applying the Agency for Healthcare Research and Quality major group classifiers.
- Associations between serum K<sup>+</sup> category and outcomes were estimated using logistic models, and were adjusted for age, sex, race, vintage, vascular access, etiology of ESRD, target weight, diabetes, congestive heart failure, coronary artery disease, cerebrovascular disease, peripheral vascular disease, malignancy, Charlson Comorbidity Index, albumin, creatinine, normalized protein catabolic rate, systolic blood pressure, intradialytic hypotension, and ultrafiltration rate. The impact of the day of the week was estimated using two-way cross product terms and likelihood ratio testing. If no effect modification was observed, estimates were collapsed across days of the week.

#### Figure 1: Study Schematic

Example interval (Monday measurement): K<sup>+</sup> measurement Outcome window Mon Tue Wed Thu Fri Sat Sun Mon

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## Steven M. Brunelli, MD, MSCE;<sup>1</sup> Charles Du Mond, PhD;<sup>2</sup> Nina Oestreicher, PhD;<sup>2,3</sup> Viatcheslav Rakov, MD;<sup>4</sup> David M. Spiegel, MD<sup>2</sup>

<sup>1</sup>DaVita Clinical Research, Minneapolis, MN, USA; <sup>2</sup>Relypsa Inc, Redwood City, CA, USA; <sup>3</sup>University of California San Francisco, San Francisco, CA, USA; <sup>4</sup>Vifor Pharma, Glattbrugg, Switzerland

### Results

#### Patient Characteristics, Dialysate K<sup>+</sup>, and Serum K<sup>+</sup>

- The distribution of 533,889 qualifying serum K<sup>+</sup> measurements across serum K<sup>+</sup> strata was similar on Monday, Wednesday, and Friday (Table 1).
- Higher serum K<sup>+</sup> was associated with younger age, greater weight, greater likelihood of central venous catheter use for dialysis access, longer dialysis vintage, lower Charlson Comorbidity Index scores, and higher ultrafiltration rate. All analyses were corrected for these differences.

#### Table 1: Distribution of Serum K<sup>+</sup> Concentration by Day of Week

<b>Serum K<sup>+</sup> Category</b> , mEq/L, n (%)	<b>Monday</b> N = 230,634	<b>Wednesday</b> N = 285,522	<b>Friday</b> N = 17,733	<b>Total</b> N = 533,889
4.0-<4.5	49,739 (21.6)	79,870 (28.0)	4798 (27.1)	134,407 (25.2)
4.5-<5.0	67,839 (29.4)	94,034 (32.9)	5376 (30.3)	167,249 (31.3)
5.0-<5.5	57,883 (25.1)	66,108 (23.2)	4024 (22.7)	128,015 (24.0)
5.5-<6.0	33,660 (14.6)	30,764 (10.8)	2222 (12.5)	66,646 (12.5)
6.0-<6.5	14,563 (6.3)	10,723 (3.8)	846 (4.8)	26,132 (4.9)
6.5-<7.0	5267 (2.3)	3193 (1.1)	348 (2.0)	8808 (1.7)
≥7.0	1683 (0.7)	830 (0.3)	119 (0.7)	2632 (0.5)

- Within each serum K<sup>+</sup> stratum, the proportion of patients using a given dialysate K<sup>+</sup> concentration was similar across Monday, Wednesday and Friday (Figure 2).
- None of the outcome data that follow were impacted by dialysate K<sup>+</sup> concentration (ie there was no effect modification).



#### Figure 2: Dialysate K<sup>+</sup> by Serum K<sup>+</sup> and Day of Week

#### Hospitalizations

- The association between higher serum K<sup>+</sup> and hospitalization was significantly more potent when K<sup>+</sup> was measured on Friday vs other days of the week P-interaction = 0.008 (Figure 3).
- Higher serum K<sup>+</sup> was associated with greater risk of hospitalization for many causes, particularly endocrine; nutritional; and metabolic disorders and immunity disorders, which includes the diagnosis code for hyperkalemia (Figure 4). Due to sample size limitations, causes of hospitalization could not be analyzed separately on each day of the week.

#### Figure 3: Adjusted Probability of Hospitalization by Serum K<sup>+</sup> Category and Day of Week



Significantly different than the referent category (4.0-<4.5mEq/L) on the same day of the week (P<0.05)





\* Significantly different than the referent category (4.0-<4.5mEq/L), P<0.05

#### **Death and ED Visits**

- For death and ED visits, the association between serum K<sup>+</sup> category and outcome was not significantly different based on day of week (*P*-interaction 0.86) and 0.14 respectively), so data were aggregated across days of the week.
- Risk of death or ED visit was significantly greater in the highest 3 serum K<sup>+</sup> categories compared to the referent (Figure 4).

#### Figure 5: Adjusted risk of Death or ED Visit by Serum K<sup>+</sup> Category



#### Conclusions

- Higher serum K<sup>+</sup> is associated with greater risk of hospitalization. Consistent with the hypothesis that accumulation of K<sup>+</sup> contributes to adverse outcomes following the long interdialytic interval, the association is more potent when the K<sup>+</sup> measurement occurs on Friday vs Monday or Wednesday.
- Higher serum K<sup>+</sup> is associated with greater risk of death and ED visit; this association is not modified by day of week.
- Further work is needed to determine whether directed hyperkalemia management strategies ameliorate these risks.

#### References

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\*Correspondence: steven.brunelli@davita.com Poster available at www.davitaclinicalresearch.com

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