Serum potassium levels and mortality in hemodialysis patients

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Introduction

• Hyperkalemia is associated with risk of renovascular amyotrophy and sudden cardiac arrest.  
• It is quite prevalent in dialysis patients due to imbalance in potassium (K) homeostasis.  
• 90%-100% of hemodialysis (HD) patients have high K in any given month.  
• 40%-50% of ESRD patients require emergency HD at some time for treatment of high K.
• Mortality due to high K among HD patients has been estimated at 3.1 per 1000 patient-years.  

Methods

DATA AND STUDY COHORT

The retrospective cohort study used the linked USRDS/UIA Clinical Data Warehouse database. Included patients met the following modifications:  
• Prevalent HD patients aged 18 years on a thrice-weekly schedule.  
• Alike and continuously enrolled in five-fee-for-service Medicare HD plan with at least one year of participation in an NDD from July 1, 2009, through January 31, 2010.  
• Received ≥ 6 dialysis sessions in December 2009.  
• No missing K dialysis bath records for dialysis treatments received in December 2009.  
• Serum K record in January 2010.  

STUDY MEASURES

• For each patient, a time-varying exposure variable with 2 levels of K (high vs. normal) was defined using weekly measured serum K.  
• High K was successively defined by serum K levels ≥ 5.5 mEq/L, ≥ 5.6 mEq/L, ≥ 5.7 mEq/L, ≥ 5.8 mEq/L, ≥ 5.9 mEq/L, and ≥ 6.0 mEq/L.  
• HD schedule was defined as Monday–Wednesday–Friday or Tuesday–Thursday–Saturday.  
• Comorbid conditions were defined from the Medicare diagnosis claims data (CMR-273) and from claims prior to index date, we required >1 hospitalization for the outpatient claims with relevant diagnosis codes.

While there is no universal clinical definition for hyperkalemia, high K has been variously defined as serum K ≥ 5.5, ≥ 5.6, ≥ 5.7, ≥ 5.8, ≥ 5.9, and ≥ 6.0 mEq/L.  

We examined the association between high K defined by varying thresholds of serum K, and mortality in HD patients.  

Each patient was followed for any time for treatment of high K.  

A serum K of 5.7 mEq/L was used to define hyperkalemia, defined as serum K ≥ 5.7 mEq/L.  

After receiving ≥ 6 dialysis sessions in December 2009, while there is no universal clinical definition for the hyperkalemia, defined as serum K ≥ 5.7 mEq/L.  

We examined the association between high K, mortality, and cardiovascular events.

Results

COHORT CHARACTERISTICS

• Figure 1 shows the inclusion criteria flowchart.  
• Patient demographics and baseline characteristics are shown in Table 1.  
• A total of 36,888 HD patients with Medicare as primary payer were included (mean age 62.9 ± 16.6 years; 51.7% white; 44.0% females).  
• Dialysis K bath was between 2 and 3 mEq/L, (incluively) for 77.7%.

MORTALITY OUTCOMES

• During follow-up, 10.2% of patients (n = 3753) died of any cause; 4.4% (n = 1604; 42.7%) died of cardiovascular causes.
• Hyperkalemia, defined as serum K ≥ 5.7 mEq/L was associated with all-cause mortality (adjusted hazard ratio [HR] 1.05, 95% CI 1.01–1.08, P = 0.017, Table 2).  
• The pattern of the point estimates was similar for cardiovascular mortality, although the results did not reach statistical significance (adjusted HRs 1.09 for K ≥ 5.7 mEq/L, 1.13 for K ≥ 5.8 mEq/L, 1.28 for K ≥ 5.9 mEq/L, and 1.35 for K ≥ 6.0 mEq/L).

Table 1. Characteristics of patients included in the study cohort

<table>
<thead>
<tr>
<th>Variable</th>
<th>Unadjusted analysis</th>
<th>Adjusted analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>High K</td>
<td>n (%)</td>
<td>HR (95% CI)</td>
</tr>
<tr>
<td>K &lt; 5.7 mEq/L</td>
<td>27,585 (75.0)</td>
<td>Reference</td>
</tr>
<tr>
<td>K ≥ 5.7 mEq/L</td>
<td>6,258 (17.0)</td>
<td>1.05 (1.01–1.09)</td>
</tr>
<tr>
<td>K ≥ 5.8 mEq/L</td>
<td>3,744 (10.2)</td>
<td>1.11 (1.06–1.16)</td>
</tr>
<tr>
<td>K ≥ 5.9 mEq/L</td>
<td>2,261 (6.2)</td>
<td>1.17 (1.11–1.23)</td>
</tr>
<tr>
<td>K ≥ 6.0 mEq/L</td>
<td>1,346 (3.7)</td>
<td>1.22 (1.16–1.29)</td>
</tr>
</tbody>
</table>

Figure 2. Hazard ratios and 95% CI for risk of all-cause mortality in hemodialysis patients using varying serum potassium cut-offs for the definition of hyperkalemia.

Conclusions

• This analysis showed that, relative to normal serum K concentrations, elevated serum K was associated with increased risk of death.  
• Risk of adverse events increased with increasing degree ("severity") of hyperkalemia.  
• A serum K of 5.7 mEq/L, may be the threshold at which hyperkalemia becomes overtly dangerous, suggesting a clinically relevant value that may warrant focused intervention.