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Potassium Status in Pediatric Chronic Kidney Disease:
A Report from the Chronic Kidney Disease in Children (CKiD) Study

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Background

- Hyperkalemia is associated with increased disease progression, cardiovascular events, morbidity, and mortality in patients with chronic kidney disease (CKD).
- There are few large-scale studies evaluating potassium levels and the prevalence of hyperkalemia in pediatric CKD.

Objectives

- Characterize median serum potassium levels and prevalence of hyperkalemia in subjects with CKD Stage (1-5)
- Evaluate the relationship of serum potassium and hyperkalemia with respect to CKD etiology, CO2 level, and degree of proteinuria
- Evaluate the prevalence of hyperkalemia with respect to medication use when controlling for subject factors

Methods

- 5183 study visits with laboratory data from 1050 subjects from the CKiD Study
- Evaluated median serum potassium level (mmol/L) and percentage of patients with hyperkalemia (K > 5.5 mmol/L) with respect to the following features:
  - **CKD Stage** (CKiD U25 eGFR)
  - **CKD Etiology** (glomerular v. nonglomerular)
  - **Acid-Base Status** (CO2 level: low, medium, high)
  - **Level of proteinuria** (none, non-nephrotic, nephrotic)
  - **Self-Reported Therapy Use**

Statistical Analysis

Kruskal-Wallis tests: compare median potassium levels across groups
Repeated Measures Logistic Regression, Generalized Estimating Equations: estimate/compare proportion of hyperkalemia (K > 5.5 mmol/L) within groups

Univariate/Multivariate Logistic Regression: assess association between presence of hyperkalemia (K > 5.5 mmol/L) and concurrent use of the following:
- ACEi/ARB, Beta Blocker, Diuretic, Potassium Binder

Models adjusted for the following covariates:
- Age, sex, race, ethnicity, low socioeconomic status (public insurance, annual household income <$36k, or maternal education < college), eGFR, log2 based proteinuria, CKD etiology, CO2 category, concurrent alkali therapy

Results

Table 1. Median serum potassium levels and percentage of assessments with hyperkalemia by CKD stage.

Stage (eGFR, mL/min/1.73m^2)	1/2 (60+)	3a (45-59)	3b (30-44)	4/5 (<30)	p-value
Overall, N (# of visits)	1492	1353	1368	970	
Potassium, mmol/L	4.2	4.3	4.4	4.5	<0.001
[IQR]	[4.0, 4.5]	[4.1, 4.6]	[4.1, 4.7]	[4.1, 5.0]	
Hyperkalemia, % (n)	0.6 (9)	0.8 (11)	2.3 (32)	6.6 (64)	<0.001
[95% CI]	[0.3, 1.2]	[0.5, 1.5]	[1.6, 3.4]	[4.8, 8.2]	
Glomerular, n*	538	290	227	154	
Potassium, mmol/L	4.3	4.4	4.5	4.9	<0.001
[IQR]	[4.0, 4.5]	[4.1, 4.8]	[4.2, 4.9]	[4.3, 5.3]	
Hyperkalemia, % (n)	1.1 (6)	1.0 (3)	2.2 (5)	14.3 (22)	
[95% CI]	[0.5, 2.5]	[0.3, 3.1]	[0.9, 5.1]	[9.4, 21.1]	0.002
Non-glomerular, n*	954	1063	1141	816	
Potassium, mmol/L	4.2	4.3	4.4	4.5	<0.001
[IQR]	[4.0, 4.5]	[4.1, 4.6]	[4.1, 4.7]	[4.1, 4.9]	
Hyperkalemia, % (n)	0.3 (3)	0.8 (8)	2.4 (27)	5.1 (42)	
[95% CI]	[0.1, 1.0]	[0.4, 1.5]	[1.6, 3.5]	[3.5, 6.8]	<0.001

* Glomerular or nonglomerular etiology of CKD, # of study visits

Table 2. Median serum potassium levels and percentage of assessments with hyperkalemia by CO2 level and level of proteinuria.

CO2 mmol/L	High >26	Normal 22-26	Low <22	p-value
N (# of visits)	1407	2333	1304	
Potassium, mmol/L	4.3 [4.0, 4.5]	4.3 [4.1, 4.6]	4.5 [4.1, 4.9]	<0.001
Hyperkalemia*, % (n)	0.4 (5)	1.9 (45)	4.8 (63)	<0.001

Level of proteinuria UPCR, g/g	None <0.2	Non-nephrotic 0.2-2.0	Nephrotic >2.0	p-value
N (# of visits)	1825	2611	608	
Potassium, mmol/L [IQR]	4.3 [4.1, 4.6]	4.4 [4.1, 4.7]	4.4 [4.0, 4.8]	<0.001
Hyperkalemia*, % (n)	1.3 (24)	2.6 (69)	3.3 (20)	0.002

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Table 3. Self-reported medication use in the study population.

Medication	Overall n (%)
ACEi/ARB	2809 (54.2)
Beta Blocker	292 (5.6)
Diuretic	300 (5.8)
Potassium Binder	67 (1.3)

Table 4. Association between self-reported medication use and the presence of hyperkalemia.

Medication Used	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
At Concurrent Study Visit		
ACEi/ARB	5.36 (2.09, 13.73)	**3.16 (1.33, 7.53)**
Beta Blocker	2.29 (1.18, 4.46)	1.34 (0.71, 2.52)
Diuretic	1.97 (1.04, 3.73)	1.15 (0.60, 2.20)
Potassium Binder	2.26 (1.45, 3.51)	**2.40 (1.49, 3.89)**
At Previous Study Visit*		
ACEi/ARB	3.07 (1.79, 5.27)	**3.06 (1.69, 5.54)**
Beta Blocker	0.83 (0.31, 2.27)	0.45 (0.16, 1.26)
Diuretic	2.29 (1.20, 4.38)	1.65 (0.86, 3.17)
Potassium Binder	2.84 (0.83, 9.75)	2.16 (0.68, 6.84)

* Subjects medication use at 2 or more study visits

Conclusions

- Subjects with advanced CKD stage, low CO2 level, and nephrotic-range proteinuria had significantly higher median serum potassium levels and a greater percentage of laboratory assessments with hyperkalemia irrespective of CKD etiology
- The odds of hyperkalemia is 3.16 times higher with concurrent ACEi/ARB use
- This information can help identify patients at greatest risk for substantial elevations in potassium who may benefit from dietary modification and/or potassium-lowering medication.

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CKiD Chronic Kidney Disease in Children

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