Metabolic Acidosis is an Independent Predictor of Adverse Renal Outcomes and Higher Costs in Patients with Chronic Kidney Disease

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BACKGROUND
Metabolic acidosis is a risk factor for chronic kidney disease (CKD) progression,1 but less is known about its effect on healthcare costs and resource utilization. We describe the association between metabolic acidosis and adverse renal outcomes and costs in non-dialysis patients with CKD stages 3-5.6

OBJECTIVE
To investigate the impact of metabolic acidosis on healthcare outcomes and direct costs in the non-dialysis CKD population.

METHODS
To the Electronic Medical Records database (Optum® EMR) spanning the years 2007 to 2017, we identified non-dialysis CKD patients (N=51,558) with 2 serum bicarbonate tests 28–365 days apart, ≥ 3 eGFR values < 60 mL/min/1.73 m² and who did not have any of the following: acute kidney injury, hospitalization for acute kidney injury, or eGFR decline ≥ 40%, excluding such declines during an episode of acute kidney injury.

We assessed the independent effect of serum bicarbonate on death, adverse kidney outcomes (DD40), and healthcare costs in patients with metabolic acidosis and normal serum bicarbonate within CKD stage and in total for a 2-year post-index outcome period.

Serum bicarbonate was a strong independent predictor of a DD40 outcome after controlling for age, sex, race, eGFR, pre-existing diabetes, hypertension, heart failure, Charlson comorbidity score (as index of comorbidity burden), and log albumin-to-creatinine ratio with logistic and linear regression models.

RESULTS
Figure 1. 2-Year Incidence Rates of DD40 and Per Patient Per Year Cost, Metabolic Acidosis vs. Normal Serum Bicarbonate

Figure 2. All-Cause Costs Per Patient Per Year (PPPY), Metabolic Acidosis vs. Normal Serum Bicarbonate, with and without DD40 Outcome (Unadjusted)

Table 1. Demographic and Baseline Characteristics

Conclusions
• Serum bicarbonate was a significant independent predictor of a DD40 outcome after controlling for age, sex, race, eGFR, pre-existing diabetes, hypertension, heart failure, Charlson comorbidity score, and log albumin-to-creatinine ratio with logistic and linear regression models.

• At each stage of CKD, among patients with and without a DD40 outcome, patients with metabolic acidosis had higher per patient per year costs compared to patients with normal serum bicarbonate at baseline (Figure 2).

In this analysis of 51,558 non-dialysis CKD patients followed for two years, patients with metabolic acidosis had higher rates of death and adverse kidney outcomes (DD40) and higher costs compared to those with normal serum bicarbonate. Each 1 mEq/L increase in serum bicarbonate was associated with a 13% decrease in the 2-year composite endpoint of death, dialysis, kidney transplant or a ≥40% eGFR decline and a 7% decrease in monthly costs.

CONCLUSION

Figure 3. Odds Ratios for 2-Year Incidence of DD40 Outcome

Figure 4. Predicted Cost Per Month per 1 mEq/L Increment in Serum Bicarbonate

Table 2. Clinical Characteristics at Baseline

Table 3. Baseline Bicarbonate Levels by Race

Table 4. Relative Risk for Death

Figure 5. Pooled Predicted Cost Model Based on the Need for End-Stage Kidney Disease and the Required Renal Replacement Therapy per $1,000 of Serum Bicarbonate

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