RESEARCH ARTICLE

Acute Kidney Injury in Children Hospitalized With Diarrheal Illness in the United States

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ABSTRACT

OBJECTIVES: To determine the incidence, correlates, and consequences of acute kidney injury (AKI) among children hospitalized with diarrheal illness in the United States.

METHODS: Using data from Kids' Inpatient Database in 2009 and 2012, we studied children hospitalized with a primary diagnosis of diarrheal illness (weighted $N = 113\,195$). We used the *International Classification of Diseases, Ninth Revision, Clinical Modification*, diagnosis codes 584.5 to 584.9 to capture AKI. We calculated the incidence, correlates, and consequences (mortality, length of stay [LOS], and costs) of AKI associated with hospitalized diarrheal illness using stepwise logistic regression and generalized linear models.

RESULTS: The average incidence of AKI in children hospitalized with diarrheal illness was 0.8%. Hospital location and teaching status were associated with the odds of AKI, as were older age, solid organ transplant, hypertension, chronic kidney disease, and rheumatologic and hematologic conditions. The development of AKI in hospitalized diarrheal illness was associated with an eightfold increase in the odds of in-hospital mortality (odds ratio 8.0; 95% confidence interval [CI] 4.2–15.4). AKI was associated with prolonged LOS (mean increase 3.0 days; 95% CI 2.3–3.8) and higher hospital cost (mean increase $9241; 95% CI $4661–$13 820).

CONCLUSIONS: Several demographic factors and comorbid conditions are associated with the risk of AKI in children hospitalized with diarrheal illness. Although rare, development of AKI in this common pediatric condition is associated with increased mortality, LOS, and hospital cost.

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Diarrheal illness is 1 of the most common causes of morbidity and mortality among children worldwide; diarrheal illness is the fourth leading cause of death for children <5 years and the fifth leading cause of years of life lost globally.[1–4] In the United States, although rates of admissions nearly halved after the implementation of the rotavirus vaccine,[5] diarrheal illness remains a leading cause for hospital admission, particularly among young children.[6–8] Notably, mortality attributable to diarrheal illness is higher in the United States than that observed in other high-income countries (1.5 per 100 000 in the United States compared to 0.7–0.8 per 100 000 in Canada and the United Kingdom).[4]

One of the most significant complications of severe diarrheal illness is hypovolemic acute kidney injury (AKI). Hospitalized children who develop AKI experience longer hospital stays and higher mortality.[9] Furthermore, studies have revealed long-term implications for kidney health, as children who experience AKI are at increased risk for chronic kidney disease (CKD), hypertension, and proteinuria.[10,11] Despite the ubiquity of diarrheal illness, risk factors for developing AKI are poorly understood. Identifying and increasing awareness of such risk factors could mitigate or even prevent AKI.

Using data from the Kids' Inpatient Database (KID), we assessed the incidence, correlates, and short-term consequences of AKI in children hospitalized with diarrheal illness in the United States in 2009 and 2012.

METHODS

Data Sources

We drew our study population from the KID, a nationally representative database of pediatric hospitalizations created by the Agency for Healthcare Research and Quality as part of the Healthcare Cost and Utilization Project.[12] KID is the largest public all-payer pediatric inpatient care database in the United States and has been produced approximately every 3 years since 1997. Each entry contains discharge information for a single hospitalization, including data on demographics, primary and secondary discharge diagnoses, procedures. and length and cost of hospital stay. Hospital characteristics, such as location, teaching status, and bed size, are also available. All years before 2016 use the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) coding system for diagnoses; KID 2016 uses the *International Classification of Diseases, 10th Revision, Clinical Modification* (ICD-10-CM). We pooled KID data from 2009 and 2012, rather than 2016, to increase statistical power and ensure uniformity of diagnosis and procedure codes.

Primary Exposure: Infectious and Noninfectious Diarrhea

In assembling our cohort (Fig 1), we included all hospitalized children with a primary discharge diagnosis of diarrheal illness. We stratified our analyses by type of diarrheal illness (infectious or noninfectious) because we hypothesized that risk factors for development of AKI would differ on the basis of the underlying pathology.[13] For infectious diarrhea, we used the following ICD-9-CM diagnosis codes: 001, 002, 003.0, 004, 005, 006.0 to 006.2, 006.8 to 006.9, 007, 008, 009, 112.85, and 487.8. For noninfectious diarrhea, ICD-9-CM diagnosis codes included 271.3, 306.4, 536.8, 555, 556, 557, 558, 562.01, 562.03, 562.11, 562.13, 564.1 to 564.2, 564.4 to 564.5, 564.9, and 579; we excluded the code for diarrhea not otherwise specified (787.91) because it comprised <5% of all admissions for diarrheal illness. The diarrhea diagnosis codes and definitions are presented in Supplemental Table 4. Finally, we excluded anyone with a diagnosis code for end-stage kidney disease who received dialysis during the hospital stay. We refined our included ICD-9-CM diagnoses codes using existing literature.[14–16]

Primary Outcome: AKI

We used ICD-9-CM diagnosis code 584.x (comprised by codes 584.5–584.9) to define an episode of AKI.[9] In adults, this administrative code has low sensitivity, but its specificity nears 99%, and it has been shown to represent a more severe spectrum of AKI compared to serum creatinine criteria.[17,18] We required the AKI diagnosis to be present as a secondary, rather than primary, diagnosis on discharge in an effort to minimize uncertainty around temporality.

We calculated the average incidence (or incidence proportion) of AKI in hospitalized diarrheal illness over 2 nonconsecutive years by computing the proportion of total diarrhea hospitalizations that were complicated by AKI for each year and then averaging the results.

Secondary Outcomes

To describe the consequences of AKI in hospitalized diarrheal illness, we compared in-hospital mortality, length of stay (LOS), and costs for children with diarrheal illness with and without AKI. We also tested for "effect" modification by age and diarrhea type.

Covariates

We selected a priori comorbidities of interest using ICD-9-CM diagnosis codes and grouping by organ system.[8,13,19] In Supplemental Table 5, we provide the ICD-9-CM, codes used to create comorbidity definitions as well as grouping of comorbidities into an organ system. Hospital-level variables included geographic region, bed number, and teaching status by using predetermined KID definitions.

Statistical Analysis

We summarized baseline characteristics of the study participants using descriptive statistics, stratifying by diarrhea type (infectious versus noninfectious). Continuous variables were expressed as mean (SD) or if not normally distributed, as median (interquartile range [IQR]) when appropriate. Categorical variables were expressed as proportions. When examining correlates of AKI associated with diarrheal illness, we considered an array of demographic, clinical, and hospital characteristics as presented in Table 1. We used logistic regression with backward variable selection (entry P value criterion <.05 and retention P value criterion <.01, which are stricter than the usual criteria to account for the large sample size) to determine correlates associated with AKI. We ran separate models by diarrhea type (infectious versus noninfectious) and all

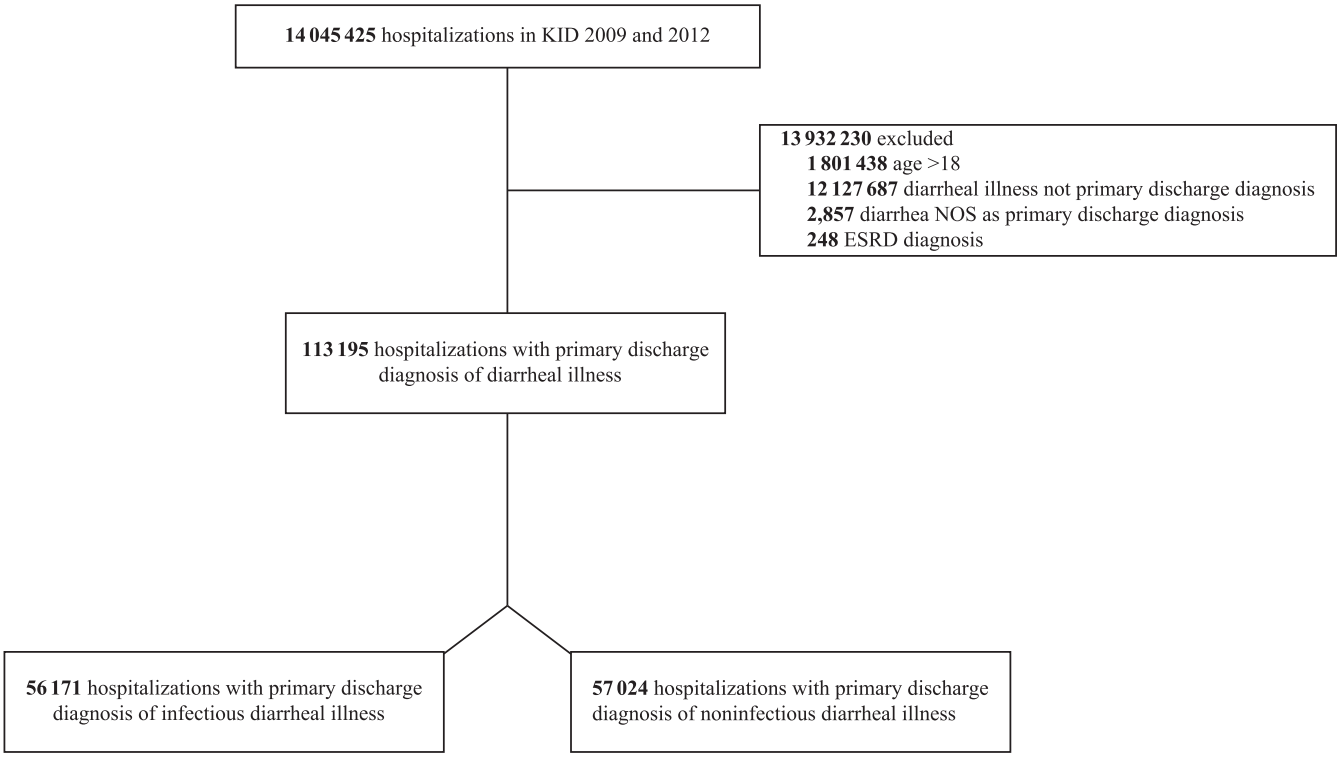

FIGURE 1 Cohort development. ESRD, end-stage renal disease; NOS, not otherwise specified.

diarrhea. We calculated odds ratios (ORs) and 95% confidence intervals (CIs) of the associated correlates and ranked them by their absolute standardized β-coefficient to determine their relative contribution to the risk of developing our primary outcome: AKI in hospitalized diarrheal illness. To explore the consequences of AKI in this cohort, we determined the association of AKI with in-hospital mortality, length of hospital stay, and hospital cost also using backward selection methods. We calculated ORs and 95% CIs to show the association between AKI versus no AKI in infectious, noninfectious, and all diarrheal illness and mortality rates. Because of the skewness of LOS and cost data, we used a generalized linear model with a γ distribution and a log link to obtain the adjusted mean increase in LOS and cost attributable to AKI for each diarrhea subgroup and all diarrhea, adjusting for demographic, clinical, and hospital characteristics.[20,21]

All analyses presented account for the KID survey design (weighting and stratification) and subpopulation measurements to generate national estimates. We created the cohort and conducted the analyses using SAS software, version 9.4 (SAS Institute, Inc, Cary, NC), and StataMP, version 14.0 (Stata Corp, College Station, TX).

RESULTS

Baseline characteristics of the cohort by diarrhea etiology are shown in Table 1; cohort characteristics stratified by AKI status are presented in Supplemental Table 6. Children hospitalized with infectious diarrhea were younger than those admitted with noninfectious diarrhea and were more likely to have neuromuscular and/or neurologic disorders, genitourinary abnormalities, and a history of solid organ transplant. In contrast, children in the noninfectious diarrhea group were more likely to have inflammatory bowel disease (IBD) and rheumatologic and hematologic conditions. The proportions of children with CKD and hypertension were similar between the infectious and noninfectious diarrheal illness groups. Treatment in the ICU was required in 2.2% of diarrhea admissions overall (2.6% for infectious diarrhea and 1.9% for noninfectious diarrhea).

Correlates of AKI

The average incidence of AKI in children hospitalized with diarrheal illness was 1.0%, 0.6%, and 0.8% for infectious, noninfectious, and all diarrhea, respectively. There was a higher incidence of dialysis-requiring AKI in patients with infectious diarrhea (0.04% vs 0.01% for infectious versus noninfectious diarrhea, respectively; P value $=$ .02 in unadjusted analyses). Correlates of AKI by diarrhea type are shown in Table 2. The odds of developing AKI increased with older age in both infectious and noninfectious diarrheal illnesses. As compared to noninfectious diarrheal illness, infectious diarrheal illness was associated with higher odds of AKI (OR 2.1; 95% CI 1.7–2.7).

In infectious diarrheal illness, hospitalization at an urban teaching hospital was associated with a marked increase in the odds of developing AKI when compared to hospitalization at rural facilities. To test the hypothesis that this association reflected greater case complexity at urban teaching hospitals, we compared All Patient Refined Diagnosis Related Groups scores[22] for severity of

TABLE 1 Demographics, Comorbidities, and Hospital Characteristics of Children Admitted With Diarrheal Illness, by Diarrhea Etiology

	Infectious Diarrhea	Noninfectious Diarrhea	All Diarrhea
	$n = 56\,171$	$n = 57\,024$	$N = 113\,195$
	Weighted %	Weighted %	Weighted %
Demographics			
Age, y, mean ± SD	4.56 ± 0.04	7.49 ± 0.08	6.03 ± 0.06
0–1	37.3	27.0	32.1
>1–5	30.9	19.0	24.9
>5–10	15.5	15.4	15.5
>10–15	10.5	22.9	16.7
>15–18	5.8	15.7	10.8
Sex			
Female	44.9	46.9	45.9
Race			
White	47.3	49.3	48.3
African American	11.6	12.1	11.8
Hispanic	21.0	20.0	20.5
Asian American or Pacific Islander	2.4	2.1	2.2
Native American	0.8	0.7	0.7
Other	4.5	4.7	4.6
Missing	12.4	11.2	11.8
Household income[a]			
<39 000	32.6	31.5	32.1
39 000–47 999	25.0	23.6	24.3
48 000–62 999	22.0	21.4	21.7
>63 000	18.3	21.1	19.7
Hospital details			
Hospital ownership			
Government, nonfederal	12.6	13.1	12.8
Private, nonprofit	71.7	71.6	71.6
Private, investor-owned	10.9	11.3	11.1
Expected primary payer			
Medicare	0.3	0.2	0.2
Medicaid	50.3	46.1	48.2
Private, HMO	42.6	46.7	44.7
Self-pay	2.7	2.6	2.6
No charge	0.1	0.1	0.1
Other	3.8	4.2	4.0
Region			
Northeast	17.4	21.8	19.6
Midwest	20.6	18.4	19.5
South	42.2	39.8	41.0
West	19.8	20.0	19.9
Location, teaching status			
Rural	11.7	12.5	12.1
Urban nonteaching	25.0	23.0	24.0
Urban teaching	58.5	60.5	59.5

illness and risk of mortality among patients admitted to urban teaching and rural hospitals; indeed, All Patient Refined Diagnosis Related Groups scores were higher at urban or teaching hospitals ($P < .001$).

Figure 2 reveals the comorbid conditions associated with AKI in hospitalized diarrheal illness, ranked by standardized β-coefficients. Irrespective of diarrhea type, hematologic and rheumatologic conditions, solid organ transplant, CKD, and hypertension were associated with higher odds of developing AKI. AKI in infectious diarrheal illness was additionally associated with other renal or genitourinary abnormalities, whereas AKI in noninfectious diarrheal illness was additionally associated with diabetes and cardiovascular and neurologic conditions.

AKI Complicating Diarrheal Illness: Mortality, LOS, and Cost

When compared to diarrheal illness hospitalizations without AKI, hospitalizations for diarrheal illness complicated by AKI were associated with higher mortality, prolonged LOS, and higher hospital cost (Table 3). The development of AKI in hospitalized diarrheal illness was associated with an up to 11-fold increase in the odds of in-hospital mortality (mortality OR 10.8; [95% CI 3.4–34.3] and OR 7.0; [95% CI 3.1–15.7] for infectious and noninfectious diarrheal illness, respectively).

Age did not modify the association between AKI and mortality. Older age was associated with a lower mean increase in LOS and hospital cost in all and noninfectious diarrheal illness complicated by AKI, but not in infectious diarrheal illness.

DISCUSSION

AKI is a relatively uncommon complication in children hospitalized with diarrheal illness, occurring in less than 1% of admissions. Despite its rarity, the clinical consequences of AKI in this setting are dire: the odds of death are increased by eightfold, mean hospital stay is prolonged by ~3 days, and costs are increased by >$9000 per hospital stay. We found that several comorbid conditions, including type of diarrhea (infectious versus noninfectious), previous solid organ transplant, hypertension, CKD, and rheumatologic and hematologic conditions

TABLE 1 Continued

	Infectious Diarrhea	Noninfectious Diarrhea	All Diarrhea
	n = 56 171	*n* = 57 024	*N* = 113 195
	Weighted %	Weighted %	Weighted %
Bed size			
Small	10.0	10.6	10.3
Medium	22.9	24.7	23.8
Large	62.2	60.7	61.5
Comorbidities			
CKD	0.4	0.2	0.3
Hypertension	1.0	0.9	0.9
Other renal and genitourinary	1.3	0.9	1.1
Cardiovascular	3.1	3.0	3.0
Weight			
Overweight	0.7	1.3	1.0
Underweight	5.8	9.2	7.5
Low birth weight	0.2	0.3	0.3
Pulmonary	8.1	7.7	7.9
Diabetes	0.7	0.8	0.8
Other endocrine	0.6	0.7	0.7
IBD	1.1	27.6	14.5
Other gastrointestinal	2.5	8.5	5.6
Neurologic and/or neuromuscular	4.6	3.3	3.9
Rheumatologic and/or immunologic	1.6	3.3	2.5
Hematologic, BMT	7.5	14.1	10.8
Solid organ transplant	1.3	0.6	0.9
Solid tumors	1.0	0.6	0.8
Admission details			
Elective	9.6	15.8	12.7
Nonelective	90.2	84.0	87.1
ICU stay	2.2	2.6	1.9
Hospitalization outcomes			
Cost of stay, $, median (IQR)	2564 (1595–4333)	3253 (1720–7480)	2829 (1649–5515)
LOS, d, median (IQR)	1.6 (0.8–2.7)	1.8 (0.8–3.7)	1.7 (0.8–3.0)
Mortality	0.1	0.1	0.1

BMT, bone marrow transplant; HMO, health maintenance organization; IQR, interquartile range.
[a] Combined 2009 and 2012 income quartiles.

were associated with AKI. Although our analysis does not evaluate nor support broadening the demographic for AKI testing in diarrheal illness, it does support heightened vigilance for AKI in specific at-risk populations and the appropriate interpretation of test results in patient groups for whom testing is already being pursued. Increased awareness of these associations could help clinicians identify and proactively manage hospitalized children who are at higher risk for developing AKI in the setting of diarrheal illness.

When compared with adults, AKI complicating pediatric hospitalized diarrheal illness in the United States is much less common (incidence of <1% vs 10% in children and adults, respectively),[13] although the incidence of AKI in our study is consistent with published findings on the national incidence of AKI in pediatric hospitalizations.[9,23,24] AKI had more pronounced effects on in-hospital mortality, LOS, and hospital costs for children hospitalized with diarrheal illness than it did in adults.[13] In previous studies, authors note worse AKI-related health outcomes in younger, compared with older, patients experiencing AKI.[13,25,26] It is theorized that AKI, which develops in individuals with better baseline renal reserve, may reflect more severe underlying illness.[25,26]

Although younger age has been associated with worse AKI-related hospital outcomes, we found that older children experienced a higher likelihood of developing AKI in hospitalized diarrheal illness. A potential explanation for this finding could be that parents and guardians of older children may be less likely to seek medical evaluation for milder forms of diarrheal illness than are parents and guardians of younger children. Thus, when older children are hospitalized, they may present later in the course of the disease which, in turn, leads to greater likelihood of developing AKI. Alternatively, younger children may be more likely to be hospitalized rather than sent home given difficulty in ensuring adequate hydration and prevention of volume depletion. Physician recognition of AKI may also differ with patient age; small but significant rises in serum creatinine that fall within the population reference range may be overlooked in small children whose serum creatinine concentrations tend to be lower than those of older children and adolescents.[27]

Hospitalization at an urban teaching facility was associated with higher odds of AKI than hospitalization at a rural facility. We hypothesized (and our supplementary analyses supported) that this finding may represent varying case complexity across hospitals. For example, parents or guardians might decide to take a child who is more severely ill to a larger, urban teaching hospital rather than a local rural institution because the former is perceived to be better equipped to manage serious illnesses. It is also possible that emergency department physicians and pediatricians from various settings practice differently on the basis of ambulatory resource availability; providers in nonurban settings may be more likely to admit children to the hospital than providers in urban settings.[28] This difference in practice could lead to a

TABLE 2 Correlates of AKI by Diarrhea Type

	Infectious Diarrhea	Noninfectious Diarrhea	All Diarrhea
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Demographics			
Age group, y			
0–1	1.0	1.0	1.0
>1–5	1.3 (0.9–1.9)	0.7 (0.4–1.3)	1.1 (0.8–1.6)
>5–10	2.0 (1.3–2.9)	0.8 (0.5–1.5)	1.5 (1.1–2.1)
>10–15	2.0 (1.4–3.1)	1.2 (0.7–2.0)	1.6 (1.2–2.3)
>15–18	2.9 (1.9–4.5)	2.1 (1.3–3.4)	2.6 (1.9–3.6)
Hospital details			
Teaching status			
Rural	1.0	N/A	1.0
Urban nonteaching	3.3 (1.3–8.6)	N/A	2.7 (1.3–5.5)
Urban teaching	7.4 (3.1–17.6)	N/A	5.2 (2.7–10.1)
Chronic conditions			
Diarrhea type, infectious versus noninfectious	N/A	N/A	2.1 (1.7–2.7)
CKD	16.9 (9.7–29.4)	6.5 (1.7–24.4)	13.8 (8.2–23.1)
Hypertension	3.6 (2.2–6.1)	5.0 (2.7–9.3)	4.1 (2.7–6.3)
Other renal and genitourinary	2.4 (1.4–4.1)	N/A	2.2 (1.4–3.4)
Cardiovascular disorders	N/A	3.8 (2.4–6.2)	1.9 (1.3–2.8)
Diabetes	N/A	5.2 (2.2–12.0)	N/A
Solid organ transplant	3.2 (2.0–5.4)	8.6 (3.8–19.6)	3.9 (2.6–5.9)
Neurologic and/or neuromuscular	N/A	3.8 (2.4–6.2)	1.8 (1.3–2.6)
Rheumatologic and/or immunologic disorders	2.5 (1.4–4.1)	4.0 (2.4–6.7)	3.0 (2.1–4.5)
Hematologic, BMT	2.0 (1.4–2.7)	1.9 (1.3–2.7)	1.8 (1.4–2.3)

Variables presented are those that met the retention criterion of $P < .01$ by using stepwise backward selection. The top 3 diagnosis groups under other renal and genitourinary, cardiovascular, neurologic and/or neuromuscular, rheumatologic and/or immunologic, and hematologic disorders were as follows: congenital abnormalities (eg, renal agenesis), vesicoureteral reflux and/or obstructive anomalies, and nephritis; dysrhythmias, septal defects, and congenital abnormalities; epilepsy, cerebral palsy, and chromosomal abnormalities; disorders of protein metabolism, immune system deficiencies, and lupus; anemias, neutropenias, and acute lymphoblastic leukemia. BMT, bone marrow transplant; N/A, not applicable; also designates that the correlate was not chosen by backward selection to be included in the final multivariable model (eg, cardiovascular disorders in infectious diarrhea).

lower severity of diarrheal disease in nonurban settings, with a resultant lower odds of AKI.

Several of the comorbid conditions associated with the odds of AKI in our cohort may also reflect severity of illness. For example, we found a higher risk of AKI in rheumatologic and hematologic conditions; the rheumatologic and hematologic diagnosis codes included entities such as hypoalbuminemia and anemia, which can be surrogates for severity of illness or could represent malnutrition from chronic, persistent diarrhea.[29,30] Chronic immunosuppression in children with a history of transplant adds another layer of disease complexity during a hospitalization for diarrheal illness because it impairs the immune response and increases vulnerability to hospital-acquired infections. Furthermore, calcineurin inhibitors, a cornerstone of immunosuppressive therapy, are known to cause renal arterial vasoconstriction, accentuating any hypovolemic insults.[31]

Hypertension, a common risk factor for AKI in adults hospitalized with any type of diarrheal illness,[13] was also associated with the development of AKI in children hospitalized with diarrheal illness. However, unlike in adults, the prevalence of hypertension in children is low, and among those who are diagnosed, a minority are prescribed antihypertensive medications; thus, the hypothesized contributing factors in adults (ie, therapy with renin-angiotensin-aldosterone system blockers or diuretics) are less likely to be explanatory in children.[32] Of note, when compared with adults, pediatric hypertension is more likely to be secondary in nature[33,34]; this suggests that our finding may reflect the possibility that hypertension diagnoses tend to be a consequence, rather than a cause, of AKI in children admitted with diarrheal illness or that hypertension is a reflection of CKD, even when laboratory parameters commonly used to assess kidney function (ie, serum creatinine and blood urea nitrogen) are normal or near normal.

We found that CKD, another risk factor for AKI in adults, was associated with the odds of AKI in any hospitalized diarrheal illness, although the odds of AKI in children with CKD admitted with infectious diarrhea tended to be higher than that of their counterparts with noninfectious diarrhea. A potential explanation for this finding could be that infectious diarrhea, given its acute nature and more rapid fluid losses, may result in abrupt declines in intravascular volume. Children (like adults) with CKD are more vulnerable to hypovolemia caused by reduced renal reserve, as well as impaired renal autoregulation related to common pharmacologic treatments (eg, angiotensin-converting enzyme inhibitors, angiotensin receptor blockers or diuretics).[35,36] In addition, children with CKD and other congenital genitourinary abnormalities commonly have defects in urinary concentrating ability and polyuria, which can exacerbate the hypovolemia accompanying diarrheal illness, further predisposing them to AKI.[37]

Cardiovascular and neurologic conditions were associated with the odds of developing AKI in noninfectious diarrheal illness. Common diagnosis codes within these categories included congenital heart disease, epilepsy, and cerebral palsy. In a

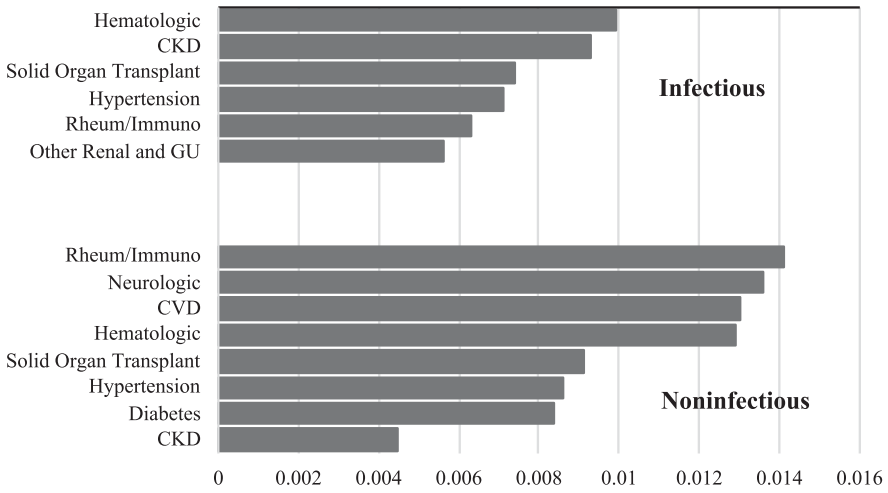

FIGURE 2 Comorbid conditions associated with increased odds of AKI in hospitalized infectious and noninfectious diarrheal illness. The bar length represents relative importance score based on the absolute standardized coefficient (x-axis). CVD, cardiovascular disorders; other renal and GU, other renal and genitourinary abnormalities; rheum/immuno, rheumatologic and/or immunologic disorders.

study of children admitted to the PICU, cardiovascular and neurologic conditions were more common in patients with AKI than in demographically similar controls.[38] Children with these conditions may have poor nutritional status,[39,40] increasing their risk for AKI during diarrheal illness. AKI in congenital heart disease is common in the perioperative setting, and risk factors include periprocedural hemodynamic instability and nephrotoxic medications.[41,42]

Although our study has important strengths, including broad representation of hospitals caring for children across the United States, the study also has several limitations. As with any use of ICD-9 diagnosis codes, there is potential for misclassification of exposure and outcome, although the performance of the ICD-9 code for AKI has been validated previously.[17,18] Given that we did not have access to laboratory data, we may have missed milder forms of AKI and thus underestimated AKI incidence, which is likely to be underrecognized in pediatric populations in which a rise in serum creatinine may not always accompany significant renal injury.[43,44] The availability of only discharge data in the KID made determining the temporality of our associations difficult; however, we attempted to minimize this uncertainty by requiring that diarrhea be the primary, rather than secondary, diagnosis on discharge. In addition, because our study is focused on diarrheal illness requiring hospitalization, caution must be used in generalizing our findings to milder forms of diarrheal illness in the community. Still, knowledge of the conditions associated with complications in diarrheal illness can be helpful to outpatient providers when managing and counseling affected patients and families on the importance of oral hydration during acute diarrheal illness. Finally, our findings do not provide evidence that identifying AKI can in itself improve outcomes for patients with diarrheal illness. Rather than advocating for empirical kidney function testing in all patients with acute diarrheal illness requiring hospitalization, our findings argue for close attention to AKI in patients with certain serious comorbid illnesses, particularly when interpreting laboratory tests conducted as part of routine workup. Future areas for research may include assessing if implementation of intravenous fluid protocols for acute diarrheal illness in patients with select preexisting comorbidities (eg, solid organ transplant, rheumatologic conditions such as lupus) reduces the odds of AKI.

TABLE 3 Effects of AKI in Hospitalized Diarrheal Illness on Death, LOS, and Cost of Stay

	Infectious Diarrhea	Noninfectious Diarrhea	All Diarrhea
Death, OR (95% CI)[a]	10.8 (3.4–34.3)	7.0 (3.1–15.7)	8.0 (4.2–15.4)
LOS, d[a,b]	2.3 (1.8–2.8)	3.6 (2.1–5.2)	3.0 (2.3–3.8)
Cost of stay, $[b]	5472 (3388–7555)	12 330 (2971–21 689)	9241 (4661–13 820)

The reference group is patients with hospitalized diarrheal illness who did not develop AKI.

[a] Separate backward stepwise selection models were run for the 3 outcomes: death, LOS, and cost of stay. We adjusted for the Table 1 correlates that were below the *P* value cutoff of .01, including ICU status (full models available in Supplemental Table 7).

[b] Mean change (95% CI) versus hospitalizations for diarrheal illness without AKI.

CONCLUSIONS

AKI complicating hospitalized diarrheal illness in children, although rare, is consequential, being associated with higher mortality, prolonged LOS, and higher hospital costs. Knowledge of the risk factors for AKI in children with this common condition can help facilitate proactive management by physician and nonphysician primary care providers and potentially reduce the incidence of AKI and associated complications.

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