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ORIGINAL

Validation of the KDIGO acute kidney injury criteria in a pediatric critical care population

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Take-home message: Using the Kidney Disease: Improving Global Outcomes (KDIGO) criteria to define AKI we observed a high prevalence of AKI among critically ill children. The KDIGO criteria describe clinically relevant AKI in a broad pediatric critical care population.

Electronic supplementary material
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Abstract *Purpose:* Acute kidney injury (AKI) occurs commonly in critically ill children and has been associated with increased mortality of up to 50 %. The Kidney Disease: Improving Global Outcomes (KDIGO) AKI working group has proposed a standardized definition of AKI. Utilizing routinely available clinical data, we evaluated the KDIGO AKI criteria and the relationship of AKI with relevant outcomes in a single center tertiary pediatric intensive care (PICU) and cardiac intensive care unit (CICU) population. *Methods:* The University of Michigan Pediatric Critical Care Database was probed for all discharges from the pediatric intensive care and cardiac intensive care units between July 2011 and October 2013 ($N = 4{,}645$). The KDIGO serum creatinine (SCr)-based criteria staged AKI with the modification that a minimum SCr of greater than 0.5 mg/dL was required to be classified as AKI. Exclusion: end-stage renal disease, new renal transplant, missing PRISM III data, or no measured Cr during intensive care unit (ICU) admission ($N = 1{,}636$). *Results:* AKI occurred in 737 (24.5 %, stage 1 = 193, stage 2 = 189, and stage 3 = 355) of 3,009 discharges (PICU $N = 1{,}870$, CICU $N = 1{,}139$) that included 2,415 patients. In multivariate analysis AKI was associated with increased ICU length of stay (LOS) in hours (stage I $\beta = 42.2$, $p = 0.024$, II $\beta = 74.1$, $p = 0.003$, III $\beta = 215.8$, $p < 0.001$). Multivariate analysis showed that AKI was associated with increased odds of ICU mortality (OR 3.4, 95 % CI 2.0–6.0) and increased length of mechanical ventilation among those requiring mechanical ventilation ($\beta = 2.3$ days, $p < 0.001$). *Conclusions:* Using the KDIGO criteria to define AKI, we observed a high prevalence of AKI among critically ill children. Worsening stages of AKI were associated with increased ICU LOS, and AKI was independently associated with prolonged mechanical ventilation and increased mortality. The KDIGO criteria describe clinically relevant AKI in a broad pediatric critical care population.

Keywords Acute kidney injury · Pediatric intensive care · KDIGO · Pediatric cardiac intensive care

Introduction

Acute kidney injury (AKI) is a common problem encountered in critically ill children with an increasing incidence and evolving epidemiology [1–3]. Several studies have shown that AKI is associated with increased mortality, length of mechanical ventilation, and length of stay (LOS) in a broad spectrum of pediatric patients [1, 4–12].

In an effort to allow for the systematic study of AKI there has been an evolution of the definition of AKI. One of the first efforts to standardize the definition of AKI, the Acute Dialysis Quality Initiative Group developed the RIFLE criteria. The RIFLE criteria provided a framework based on rise in serum creatinine (SCr) or a decrease in urine output to classify AKI [13]. The *pediatric* RIFLE criteria were subsequently developed to more accurately evaluate pediatric patients by replacing the change in SCr with a change in estimated creatinine clearance [14]. Recently, it was recognized that in adults small changes in SCr (rise of 0.3 mg/dL) predicted increased mortality, leading to development of the Acute Kidney Injury Network (AKIN) definition of AKI [15]. Each of these definitions has been validated by showing an association between AKI and clinical outcomes in critically ill children including length of mechanical ventilation, LOS, and mortality [8, 11, 14].

In 2012, an updated consensus definition of AKI was put forth by the Kidney Disease: Improving Global Outcomes (KDIGO) group to reconcile subtle differences in the AKIN, RIFLE, and *pediatric* RIFLE to establish a common definition (Table 1) [16]. There have been calls to utilize the KDIGO AKI definition as the standard definition in for pediatric AKI [3], but this definition has not been validated in a broad pediatric critical care population.

The study aimed (1) to describe the incidence of AKI utilizing the KDIGO AKI definition in a combined pediatric intensive care unit (PICU) and cardiac intensive care unit (CICU) patient population and (2) to investigate the association of AKI with outcomes (length of mechanical ventilation, ICU length of stay (LOS), hospital LOS, and ICU mortality). We hypothesized that AKI defined by the KDIGO AKI criteria would be associated with increased length of mechanical ventilation, ICU LOS, hospital LOS, and mortality.

Methods

Study population

We conducted a retrospective review of all patients discharged from the PICU and CICU (each 20-bed units) at the University of Michigan Mott Children's Hospital from 1 July 2011 to 13 October 2013. All patients with ICU LOS ≥6 h were included. Exclusion criteria included end-stage renal disease, new renal transplant, missing severity of illness score (PRISM III), and those who did not have a SCr measured during their ICU stay. No patients were excluded on the basis of age. Repeat admissions to the ICU were included. The study was approved by the Institutional Review Board at the University of Michigan.

Database and data collection

The Pediatric Critical Care Database at the University of Michigan collects data on all patients discharged from the PICU and CICU beginning in July 2011. The database captures all patient data during the ICU admission. For the purposes of this study exposure to vasopressor support, mechanical ventilation, and diuretic drips were defined as a yes or no event. Severity of illness was assessed by calculating the Pediatric Risk of Mortality (PRISM) III scores at ICU admission [17]. In April 2013, the CICU stopped calculating PRISM III scores on admission and enrollment in this study was terminated for CICU patients.

Acute kidney injury

The KDIGO SCr-based AKI criteria were utilized for the staging of AKI by utilizing the peak SCr and abiding by the KDIGO time frames (Table 1) [16]. The decrease in estimated glomerular filtration rate to less than 35 ml/min per 1.73 m^2 to define stage 3 AKI was not utilized in this study (heights were available in less than 10 % of patients). The baseline SCr was defined as the lowest SCr in the 3 months before ICU admission. If a baseline SCr was not available, a baseline SCr was imputed on the basis of age and sex for all children except those younger than 1 month owing to changing kidney function. We modified the KDIGO criteria by stipulating that in order

Table 1 KDIGO acute kidney injury criteria

Stage	Change in serum creatinine	Urine output
1	Increase 0.3 mg/dL[a] or increased 150–200 %[b]	<0.5 mL/kg/h for 8 h
2	Increase ≥200–300 %	<0.5 mL/kg/h for 16 h
3	Increase ≥300 %, serum creatinine ≥4 mg/dL or dialysis or estimated glomerular filtration rate <35 mL/min/1.73 M^2 for those <18 years old	<0.5 mL/kg/h for 24 h or anuria for 12 h

[a] Increase over 48 h
[b] Increase over 7 days

to qualify as AKI a minimum SCr of greater than 0.5 mg/dL was required. That is to say if the SCr rose from 0.1 to 0.2 mg/dL or from 0.1 to 0.4 mg/dL each did not qualify as AKI (SCr was not above 0.5 mg/dL), but if the SCr rose from 0.4 to 0.6 mg/dL or from 0.3 to 0.6 mg/dL this did qualify as AKI (SCr was above 0.5 mg/dL). This was utilized to account for the precision of our assay locally and has been utilized successfully in previous reports [18–20] to prevent a bias toward classifying AKI as present in young infants [21]. A modified Jaffe reaction is utilized for SCr measurement at the University of Michigan. The urine output criteria of the KDIGO AKI definition were not utilized as the cumulative urine outputs were not reliably available.

Outcome

The outcomes of interest included length of mechanical ventilation, ICU LOS, hospital LOS, and ICU mortality.

Statistical analysis

The analytic sample was described using medians and interquartile ranges for continuous variables and frequencies and percents for categorical variables. Comparisons by AKI status were done using Chi squared tests and Wilcoxon rank sum tests. Multivariate linear and logistic regression modeling were performed for the outcomes of interest.

All multivariable modeling used the same steps: first, variables were tested as bivariate predictors of the outcome. Afterwards, any variable with a significant association at $\alpha = 0.25$ was added to a multivariable model. From this model a backwards-selection approach was used where variables were removed until all variables in the model were statistically significant at $\alpha = 0.05$.

Finally, for each outcome of interest, we tested the effects of AKI in two ways: (1) as a categorical variable and (2) as a dichotomous variable coded as AKI vs. no AKI. To adjust for the correlation of visits within patients we used generalized estimating equations with an exchangeable correlation structure for both linear and logistic regression steps. Separate sensitivity analysis including those without a measured SCr as AKI stage 0 and removing the requirement for SCr to be above 0.5 mg/dL to qualify as AKI was performed separately.

Results

Patient characteristics

During the study period there were 4,645 discharges in 3,467 patients. A total of 1,636 discharges were excluded with 1,007 of those due to no SCr drawn during ICU stay. The final analysis included 3,009 discharges in 2,415 patients. There were 1,870 discharges from the PICU and 1,139 from the CICU. A total of 594 discharges did not have a SCr measured in the 3 months prior to admission and had this imputed. Table 2 shows the baseline characteristics of the study population. Principal diagnosis were available for 2,840 patients and included cardiac in 31.1 % ($N = 883$), respiratory in 12.3 % ($N = 348$), injury/poisoning in 14.5 % ($N = 413$), neurologic 5.8 % ($N = 164$), hematologic/oncologic 8.9 % (252), and infection 4.0 % ($N = 114$).

The incidence of AKI in the study was 24.5 % ($N = 737$). The incidence of AKI was 19.1 % ($N = 358$) in the PICU and 33.2 % ($N = 379$) in the CICU. On the basis of the KDIGO AKI definition, 6.4 % of patients had stage 1 ($N = 193$), 6.3 % of patients had stage 2 ($N = 189$), and 11.8 % of patients had stage 3 ($N = 355$). A total of 87 patients received renal replacement therapy. An additional 33 cases of AKI were identified after baseline SCr imputation. Patient characteristics and outcomes stratified by the presence of AKI are presented in Table 2. In bivariate analysis, variables that differed in those with AKI compared to those without AKI included age, weight, location (PICU vs. CICU), vasopressor requirement, diuretic drip, mechanical ventilation, and PRISM III score.

Outcome

ICU mortality was 3.6 % and was significantly higher for patients with AKI as compared to those patients without AKI (11.3 versus 1.1 %, $p < 0.001$). On bivariate analysis, AKI was associated with increased length of mechanical ventilation, ICU LOS, and hospital LOS (Table 2, $p < 0.001$). Furthermore the impact of AKI on outcomes was found to vary across AKI stage (Table 3, $p < 0.001$).

Multivariate linear modeling was performed for each of the outcomes of interest (Table 4). Multivariate linear regression modeling showed that AKI, age, PRISM III score, and diuretic drip exposure predicted length of mechanical ventilation, amongst those ventilated. In this model children with AKI were ventilated for 2.3 days longer than those without evidence of AKI ($p < 0.001$). In examining the stage of AKI, those with stage 3 AKI had a significantly longer duration of mechanical ventilation than those patients without evidence of AKI (4.2 days, $p < 0.001$).

The final multivariate linear regression model for ICU LOS included AKI, mechanical ventilation, vasopressor exposure, age, diuretic drip exposure, and unit. In this model, children with any evidence of AKI had a longer ICU LOS (125.0 h, $p < 0.001$). The final multivariate linear regression model for hospital LOS included AKI,

Table 2 Patient demographics

Variable	Overall ($N = 3,009$)	Acute kidney injury		p value
		No ($N = 2,272$)	Yes ($N = 737$)	
Age (years), median (IQR)	4 (0, 13)	4 (0, 12)	2 (0, 13)	<0.001
Sex: female N (%)	1,439 (47.8)	1,101 (48.5)	338 (45.9)	0.22
Weight in kg, median (IQR), $N = 3,280$	15.0 (6.6, 40.9)	15.7 (7.6, 39.8)	11.9 (4.0, 45.0)	<0.001
Unit				
Pediatric intensive care unit, N (%)	1,870 (62.1)	1,512 (66.5)	358 (48.6)	<0.001
Cardiac intensive care unit, N (%)	1,139 (37.9)	760 (33.5)	379 (51.4)	
Vasopressor (yes), N (%)	1,073 (35.7)	581 (25.6)	492 (66.8)	<0.001
Diuretic drip (yes), N (%)	469 (15.6)	170 (7.5)	299 (40.6)	<0.001
Mechanical ventilation (yes), N (%)	1,669 (55.5)	1,079 (47.5)	590 (80.1)	<0.001
PRISM III score median (IQR)	4 (2, 8)	3 (0, 7)	9 (5, 13)	<0.001
Length of mechanical ventilation (days), median (IQR)	1 (0, 2)	0 (0, 1)	3 (1, 8)	<0.001
Intensive care unit LOS (hours), median (IQR)	69 (31, 175)	50 (26, 115)	214 (74, 417)	<0.001
Hospital LOS (hours), median (IQR)	196 (102, 455)	151 (93, 316)	475 (237, 904)	<0.001
Intensive care unit mortality, N (%)	107 (3.6)	24 (1.1)	83 (11.3)	<0.001

Table 3 Outcome by AKI stage

Outcome	Acute kidney injury			
	Stage 0 ($N = 2,272$)	Stage 1 ($N = 193$)	Stage 2 ($N = 189$)	Stage 3 ($N = 355$)
Length of mechanical ventilation (days), median (IQR)*	0 (0, 1)	1 (0, 3)	3 (1, 7)	4 (1, 11)
Intensive care unit LOS (hours), median (IQR)*	50 (26, 115)	94 (43, 235)	188 (71, 355)	309 (144, 521)
Hospital LOS (hours), median (IQR)*	151 (93, 316)	270 (137, 552)	397 (233, 689)	624 (344, 1,299)
Intensive care unit mortality N (%)*	24 (0.8)	6 (3.1)	11 (5.8)	66 (18.6)

* $p < 0.001$

mechanical ventilation, age, PRISM III score, and diuretic drip exposure. In this model children with AKI had a longer hospital LOS (299.1 h, $p < 0.001$). In each of these models each stage of AKI was associated with increased ICU LOS and increased hospital LOS with the exception of hospital LOS and stage 2 (Table 4). Further examination showed that estimates for ICU LOS increased in a dose-dependent manner: stage 1 > stage 0 ($p = 0.024$) and stage 3 > stage 2 ($p < 0.001$), but stage 2 was not statistically different than stage 1 ($p = 0.29$). Estimates for hospital LOS increased in a similar manner: stage 1 > stage 0 ($p = 0.048$) and stage 3 > stage 2 ($p < 0.001$), but AKI stage 2 was not statistically different than AKI stage 1 ($p = 0.58$).

Multivariate logistic regression analysis found that AKI, vasopressor requirement, and PRISM III score predicted survival (Table 5). In this model, AKI at any point during the ICU stay predicted increased odds of ICU mortality (OR 3.4, 95 % CI 2.0–6.0, $p < 0.001$) compared to those without AKI. In examining AKI by stage, individuals with stage 3 AKI had significantly increased odds of ICU mortality (OR 5.7, 95 % CI 3.1–10.4, $p < 0.001$) compared to those without AKI.

Children younger than 30 days ($N = 291$) were analyzed separately and had a mortality of 8.6 %. The AKI incidence was 63.9 % with 10.3 % stage 1 ($N = 30$), 20.3 % stage 2 ($N = 59$), and 33.3 % stage 3 ($N = 97$). Linear and logistic regression modeling results were similar to the entire study population. Multivariate linear regression showed that children younger than 30 days with AKI were ventilated for 3.6 days longer than those without AKI ($p = 0.006$) and those with stage 3 AKI were ventilated for 5.1 days longer than those without AKI ($p = 0.002$). In multivariate analysis any AKI was associated with increased ICU LOS in hours ($\beta = 157.0$, $p < 0.001$) and for stages 2 and 3 compared to those without AKI (stage 2 $\beta = 128.2$, $p = 0.017$; stage 3 $\beta = 204.9$, $p < 0.001$). In multivariate analysis any AKI was associated with hospital LOS in hours ($\beta = 213.1$, $p = 0.008$) and for stage 3 compared to those without AKI ($\beta = 284.3$, $p = 0.004$). Among the 25 deaths in this younger than 30 days subgroup, 24 had AKI at some point during the ICU stay. Higher mortality rates were seen in those with stage 3 AKI (21.7 % $n = 21$) compared to stage 2 (3.4 % $n = 2$) and stage 1 AKI (3.33 % $n = 1$).

A sensitivity analysis including children without a measured SCr during the ICU admission as AKI stage 0 did not show changes in the outcomes (Tables 1–3 in the electronic supplementary material). A second sensitivity

Table 4 Multivariate linear regression

Variable	Increased length of ventilation in days	SE	*p* value
Length of mechanical ventilation[a]			
Model 1: AKI categorical			
Acute kidney injury (yes)	2.3	0.6	<0.001
Age (year)	−0.1	0.02	<0.001
PRISM III score	0.2	0.1	0.005
Diuretic drip (yes)	5.4	0.8	<0.001
Model 2: AKI by stage			
Acute kidney injury stage 1	0.7	0.9	0.42
Acute kidney injury stage 2	0.5	0.8	0.48
Acute kidney injury stage 3	4.2	0.9	<0.001
Age (year)	−0.1	0.02	0.004
PRISM III score	0.2	0.1	0.007
Diuretic drip (yes)	5.1	0.8	<0.001
Variable	Increased LOS in hours	SE	*p* value
Intensive care unit length of stay[a]			
Model 1: AKI categorical			
Acute kidney injury (yes)	125.0	16.5	<0.001
Mechanical ventilation (yes)	95.6	8.8	<0.001
Vasopressor (yes)	57.7	10.8	<0.001
Age (year)	−2.1	0.6	<0.001
Unit (CICU)	−83.4	12.7	<0.001
Diuretic drip (yes)	268.0	28.9	<0.001
Model 2: AKI by stage			
Acute kidney injury stage 1	42.2	18.7	0.024
Acute kidney injury stage 2	74.1	25.3	0.003
Acute kidney injury stage 3	215.8	31.4	<0.001
Mechanical ventilation (yes)	91.6	8.8	<0.001
Vasopressor (yes)	51.1	10.9	<0.001
Age (year)	−1.6	0.6	0.008
Unit (CICU)	−73.8	12.6	<0.001
Diuretic drip (yes)	247.5	28.2	<0.001
Hospital length of stay[a]			
Model 1: AKI categorical			
Acute kidney injury (yes)	299.1	43.8	<0.001
Mechanical ventilation (yes)	63.9	26.7	0.017
Age (year)	−6.5	1.6	<0.001
PRISM III score	13.4	3.7	<0.001
Diuretic drip (yes)	314.2	56.3	<0.001
Model 2: AKI by stage			
Acute kidney injury stage 1	122.2	61.7	0.048
Acute kidney injury stage 2	81.2	51.6	0.12
Acute kidney injury stage 3	563.8	73.6	<0.001
Mechanical ventilation (yes)	60.5	26.6	0.023
Age (year)	−5.4	1.6	<0.001
PRISM III score	12.2	3.7	<0.001
Diuretic drip (yes)	264.0	55.0	<0.001

[a] Linear regression model with the reference group those without AKI

analysis was performed removing the criterion that SCr had to be above 0.5 mg/dL to qualify as AKI and the results did not change (data not shown).

Discussion

This study is the first to systematically evaluate the KDIGO AKI definition in critically ill children. We extend the previous literature on AKI by providing data on the most inclusive pediatric critical care patient population reported to date. Our study is consistent with previous reports showing an association between AKI and outcomes including increase length of mechanical ventilation, ICU LOS, hospital LOS, and mortality. Our study extends these findings by reporting on the broadest pediatric critical care population to date, including both PICU and CICU patients.

Over the last 15 years there has been an evolution of the definition of AKI. Each definition has been systematically studied and validated in varied pediatric patient

Table 5 Multivariate logistic regression

Variable	Odds ratio	95 % confidence interval	*p* value
Intensive care unit mortality[a]			
Model 1: AKI categorical			
Acute kidney injury (yes)	3.4	2.0, 6.0	<0.001
Vasopressor (yes)	2.3	1.3, 4.2	0.007
PRISM III score	1.2	1.1, 1.2	<0.001
Model 2: AKI by stage			
Acute kidney injury stage 1	1.3	0.5, 3.4	0.54
Acute kidney injury stage 2	1.5	0.6, 3.7	0.36
Acute kidney injury stage 3	5.7	3.1, 10.4	<0.001
Vasopressor (yes)	2.1	1.1, 3.8	0.022
PRISM III score	1.2	1.1, 1.2	<0.001

[a] Final logistic regression model reference group those without AKI

populations with differing incidence of AKI depending on the populations. Akcan-Arikan et al. [14] developed the *pediatric* RIFLE criteria in children requiring mechanical ventilation and reported an incidence of 82 %. Utilizing the *pediatric* RIFLE criteria, the incidence of AKI ranged from 27 to 58 % in other critically ill populations [7, 10, 22]. In 2010, Schneider et al. [8] published a study of the RIFLE criteria in a general pediatric critical care population of 3,396 children showing an incidence of AKI of 10 %. More recently Alkandari et al. [11] utilized the AKIN criteria and demonstrated an AKI incidence of 17.9 % in a population of 2,106 critically ill children. These studies frequently excluded children less than 1 month of age, which represents an important patient population as demonstrated by the median age in our study. In an effort to utilize the KDIGO AKI criteria in a manner that critical care physicians could utilize clinically we included children less than 1 month of age. Recently Blinder et al. reported an incidence of AKI in children less than 90 days old following cardiac surgery utilizing the AKIN criterion of 52 %. While our incidence of 63.9 % is slightly higher the findings are consistent with their report [23]. In this study, the first evaluating the KDIGO AKI definition in a broad pediatric patient population, the incidence of AKI of 24.5 % is similar to previous reports [11]. When the PICU population was examined separately the incidence of AKI of 19.1 % is similar to that reported by Alkandari et al. [11] and the incidence in children younger than 30 days of 63.9 % is similar to that reported by Blinder et al. [23].

The importance of AKI in critically ill children has become clear by its independent association with outcomes including prolonged length of mechanical ventilation, LOS, and mortality. Using the KDIGO AKI definition, we have demonstrated that children with AKI had a longer median length of mechanical ventilation with a stepwise increase in length of mechanical ventilation by AKI stage (Table 3). On multivariate analysis individuals with AKI had on average 2.3 days longer duration of mechanical ventilation and prolonged mechanical ventilation for stage 3 AKI consistent with previous reports utilizing the AKIN definition [11]. The associations of AKI with hospital and ICU LOS were stronger than the association between AKI and length of mechanical ventilation. On multivariate modeling children with any evidence of AKI had significantly longer hospital LOS (12.5 days) and ICU LOS (5.2 days) even after accounting for severity of illness. Multivariate modeling also showed a dose-dependent increase in ICU LOS consistent with previous reports [8, 11, 14]. The ability of the KDIGO AKI criteria to predictably demonstrate an association of AKI and clinically meaningful outcomes validates the strength of the KDIGO AKI definition.

The association of AKI with increased mortality in critically ill children has been well recognized, though reports have inconsistently included severity of illness measures in the analyses. Utilizing the KDIGO AKI definition we show that children with AKI had crude mortality rates nearly 12 times higher than those without AKI. This is consistent with previous reports in general pediatric critical care patient populations [8, 11]. We extend these observations by including an evaluation of a sizable CICU patient population. In our analysis, the association of any AKI with increased mortality persisted when accounting for severity of illness. Patients with any evidence of AKI had 3.4 times increased odds of ICU mortality in our study, consistent with previous reports put forth by Alkandari et al. (OR 3.7) [11]. Schneider et al. reported a stepwise increase in mortality with each increasing stage of AKI in their 2010 study. We were not able, however, to demonstrate a stepwise increase in mortality on multivariate modeling. This discrepancy may be due to the lower ICU mortality in our study (3.6 %) compared to the study by Schneider et al. (6.4 %). The difference in mortality likely reflects differences in inclusion criteria that broadened our patient population including ICU LOS ($\geq$6 h in our study vs. LOS $\geq$24 h in Schneider et al.) and the inclusion of children less than

30 days of age in our study. Despite this, we show an increased mortality on multivariate modeling at the highest stage of AKI consistent with previous reports [10, 11, 14, 22]. In summary, our data shows that the KDIGO criteria describe clinically relevant AKI in a broad pediatric critical care population.

Limitations of this study include the single center and retrospective nature. Another potential limitation is the utilization of only the SCr-based method of calculating AKI. At our institution the urine output data were not reliably available. We acknowledge that this likely diminishes the sensitivity of the analysis of the incidence of AKI [24, 25]. Furthermore heights were available in less than 10 % of patients, so estimated creatinine clearance could not be utilized for stage 3. For this reason we were also unable to compare various definitions of AKI including the pediatric RIFLE with the KDIGO AKI definition. Another potential limitation is the modification made to the KDIGO criteria that the SCr had to exceed a value of 0.5 mg/dL to qualify as AKI. This was utilized to account for the precision of our assay locally and to prevent a bias toward classifying AKI as present in young infants.

Conclusion

Using the KDIGO AKI criteria, we found a high incidence of AKI in the broadest pediatric critical care population reported to date including children less than 30 days of age. We show that AKI is associated with adverse outcomes including length of mechanical ventilation, ICU LOS, hospital LOS, and mortality. We show that worsening stages of AKI were associated with increased ICU LOS in a severity-dependent manner. We conclude that the KDIGO AKI criteria describe clinically relevant AKI in a broad pediatric critical care population.

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Conflicts of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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