International Journal of Contemporary Pediatrics
Srinivasa S et al. Int J Contemp Pediatr. 2016 May;3(2):398-402
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20161022

Research Article

A comparison of pRIFLE and AKIN criteria for acute kidney injury in pediatric intensive care unit patients

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Received: 28 December 2015
Accepted: 04 February 2016

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ABSTRACT

Background: ADQI group proposed the Risk, Injury, Failure, Loss of Kidney Function, and End-stage Kidney Disease (RIFLE) criteria for defining AKI. RIFLE criteria were later modified for paediatric patients and termed as Paediatric Risk, Injury, Failure, Loss, End Stage Renal Disease (pRIFLE). The Acute Kidney Injury Network (AKIN) group proposed modification to this system. While there are studies comparing RIFLE and AKIN criteria, they are limited to adult population. This study aims to compare between the pRIFLE and AKIN criteria in critically ill children admitted to Pediatric intensive care unit (PICU).
Methods: All children admitted to PICU during December 2013 to May 2015 were included in the study. Serum creatinine was estimated on alternate days till death or discharge. The performance of pRIFLE and AKIN criteria for diagnosis and classification of AKI and its association with mortality was compared.
Results: AKI occurred in 178 (26.1%) PICU patients through pRIFLE, risk in 108(15.9%), injury in 51 (7.5%) and failure in 19 (2.8%), while by AKIN criteria, AKI occurred in 248 (36.5%) patients, with 93 (37.5%) in Stage 1, 88(35.5%) in Stage 2 and 67(27 %) in Stage 3. Mortality rates were 13 (27.65%), 7 (14.89%), 12 (25.53%) and 15 (31.91%) for patients without AKI and at stages of Risk, Injury and Failure, respectively according to pRIFLE criteria. While for AKIN criteria, mortality rates were 7 (14.89%), 14 (29.78%), 15 (31.91%) and 11 (23.4%) for patients without AKI and at stages 1, 2 and 3 respectively. For pRIFLE criteria odds ratio (OR) for mortality was 0.92, 5.22 and 73.71 for Risk, Injury and Failure stage respectively. Results for AKIN criteria were, OR of 2.98, 3.60 and 3.15 for stage 1, 2 and 3 respectively.
Conclusions: A higher incidence of AKI was diagnosed by AKIN criteria in comparison to pRIFLE criteria. Patients diagnosed with AKI had higher mortality. Both criteria had good association with mortality.

Keywords: AKI, AKIN, pRIFLE, RIFLE, PICU

INTRODUCTION

Acute kidney injury (AKI) is a common and serious complication encountered in critically ill patients. It is associated with increased mortality, especially when associated with sepsis and multiple organ dysfunctions. Patients who suffer from an episode of AKI are prone for subsequent renal dysfunction after the original injury. Children may be more susceptible to this injury. Studies in adults suggest multiple etiology of AKI but these studies cannot be extrapolated to children since adults have higher rates of co morbid illness than children.[1-4]

For long there existed widely varying definitions of AKI which limited results of studies on incidence and outcomes of AKI in critically ill patients.[5] The varying definition also created confusion in clinicians and complicated comparisons of data between studies.[6,7]

In 2004 the Acute Dialysis Quality Initiative group proposed the RIFLE classification for AKI: the Risk, Injury, Failure, Loss of Kidney Function, and End-stage Kidney Disease (RIFLE) classification, the first evidence-based consensus.[8] The classification which was includes three grades of severity of AKI (risk, injury, and failure) according to relative changes in serum creatinine (SCr) and urine output, and two outcomes (loss of kidney function and end-stage kidney disease, or ESKD). The RIFLE system includes separate criteria for creatinine and urine output. The criteria that lead to higher stage should be considered. It has been evaluated in a number of studies in critically ill patients with AKI. This criteria has shown good relevance for diagnosing and classifying the severity of AKI and for monitoring the progression, as well as comparable predictive ability for mortality.[2,9-13] This definition was modified and evaluated in critically ill pediatric patients and termed pRIFLE criteria. pRIFLE criteria is based on estimated creatinine clearance and urine output (Table 1). pRIFLE can serve well to improve understanding of AKI epidemiology and potentially optimize evaluation and treatment for AKI in children.[14-20]

Table 1: pRIFLE classification of AKI.

	Estimated CrCl	Urine output
Risk	eCrCl decrease by 25%	<0.5 ml/kg/h for 8 h
Injury	eCrC decrease by 50%	<0.5 ml/kg/h for 16 h
Failure	eCrC decrease by 75% or eCrCl<35 ml/min/1.73 m^2	<0.3 ml/kg/h for 24 h or anuric for 12 h
Loss	Persistent failure >4 weeks	
End stage	End-stage renal disease (persistent failure >3 months)	

eCrCl, estimated creatinine clearance; pRIFLE, pediatric risk, injury, failure, loss and end-stage renal disease

Table 2: AKIN classification of AKI.

	Serum creatinine criteria	Urine output
Stage 1	Increase in serum creatinine ≥0.3md/dl (≥26.4µmol/l) or increase to ≥150% to 200% (1.5 fold to 2 fold) from baseline	<0.5 ml/kg/h for >6 h
Stage 2	Increase to >200% to 300% (>2 fold to 3 fold) from baseline	<0.5 ml/kg/h for >12 h
Stage 3	Increase in serum creatinine to >300% (>3 fold) from baseline, or serum creatinine ≥4.0mg/dl (≥354µmol/l) with acute increase of atleast 0.5mg/dl	<0.3ml/kg/hr for 24 hours, or anuria for 12 hours

In 2007, the Acute Kidney Injury Network (AKIN) group proposed a modified version of the RIFLE classification, which aimed to improve the sensitivity of AKI criteria (Table 2).[21] There were several changes: in AKIN stage 1 a smaller increase in serum creatinine greater than 0.3mg/dl (26 µmol/L) was suggested as AKI threshold; patients starting with RRT were classified as stage 3, irrespectively of creatinine levels; and the change in glomerular filtration rate (GFR) and the two outcome classes were removed. AKI diagnosis was based on change between two creatinine values within a 48-hour period for AKIN classification. Only few studies that have been done to compare between the staging systems, have shown little difference between them.[22-24] But these studies are limited to comparison of criteria's in adults and not in paediatric population. Hence this study compares the efficacy of pRIFLE and AKIN criteria in studying the incidence and outcome of AKI in PICU patients.

METHODS

This was a prospective study conducted from December 2013 to May 2015. All patients aged 1 month to 18 years, admitted to PICU during the study period were included in the study. Patients with known kidney disease and post-operative patients were excluded from the study. The study was approved by the Institute Ethics Committee. Demographic, clinical and physiologic data were collected. Demographic information included age, sex and duration of ICU and hospital stay. Clinical data included diagnosis, occurrence of sepsis, shock, need for mechanical ventilation. Physiologic data included height, serum creatinine and urine output.

Serum creatinine levels were estimated by modified Jaffe method.[25] Serum creatinine was estimated on all patients admitted to PICU on the day of admission and on alternate days till discharge from PICU. Serum creatinine may be repeated frequently in children who develop shock, sepsis, need for ventilation, inotropes or diuretics. Creatinine estimation was done at daily intervals in those patients with AKI. Age related creatinine clearance was taken as the baseline CrCl. Estimated creatinine clearance (eCrCL) for pRIFLE criteria was calculated using Schwartz formula.[26]

eCrCl (GFR) = (k X Height)/ S.Cr

k = 0.45 for infants 1 to 52 weeks old

k = 0.55 for children 1 to 13 years old

k = 0.55 for adolescent females 13-18 years old

k = 0.7 for adolescent males 13-18 years old

Urine output measured and recorded as ml/kg/hour. Only patients who were catheterized were considered for urine output criteria. AKI was classified according to both pRIFLE and AKIN criteria. Either eCrCl/ serum creatinine criteria or urine output was used to diagnose and stage AKI, the criteria that led to worst classification was used. All patients were followed till death or discharge.

Statistical software

The Statistical software SPSS 15.0 was used for the analysis of the data. Student t test (two tailed, independent) has been used to find the significance of study parameters on continuous scale between two groups (Inter group analysis) on metric parameters. Chi-square/ Fisher Exact test has been used to find the significance of study parameters on categorical scale between two or more groups.

RESULTS

During the study period 680 patients met the eligibility criteria. Patient baseline characteristics are summarised in Table 3.

Table 3: Baseline characteristics and clinical features of all patients.

Features	Results
Mean age (months)	51.6 ± 22
Gender Male Female	 387 (56.9%) 293 (43.1%)
Duration of stay in PICU	4.45 ± 2.47
Duration of stay in Hospital	5.30 ± 3.25
Sepsis	91 (13.4%)
Mechanical ventilation	70 (10.3%)
Hypotension	288 (42.4%)
Nephrotoxic drugs	366 (53.8%)

AKI occurred in 178 (26.1%) PICU patients through pRIFLE, RISK in 108 (15.9%), INJURY in 51 (7.5%) and failure in 19 (2.8%). When defined by AKIN criteria, AKI occurred in 248 (36.5 %) patients in PICU, with 93 (13.7%) in Stage 1, 88 (12.9%) in Stage 2 and 67 (9.9 %) in Stage 3 (Table 4).

Table 4: Incidence of AKI stratified by the pRIFLE and AKIN definition.

pRIFLE	INCIDENCE	AKIN	INCIDENCE
No AKI	502 (73.8%)	No AKI	432(63.5%)
RISK	108 (15.9%)	Stage 1	93(13.7%)
Injury	51 (7.5%)	Stage 2	88(12.9%)
Failure	19 (2.8%)	Stage 3	67 (9.9%)

According to the pRIFLE criteria, the mortality rates were 13 (27.65%), 7 (14.89%), 12 (25.53%) and 15 (31.91%) for patients without AKI and at the stages of Risk, Injury and Failure, respectively. While for the AKIN criteria, the mortality rates were 7 (14.89%), 14 (29.78%), 15 (31.91%) and 11 (23.4%) for patients without AKI and at stages 1, 2, and 3, respectively (Table 5).

Table 5: Mortality rate stratified according to the p RIFLE and AKIN criteria.

	Total (N=680)	DEATH (N=47)	No DEATH (N=633)
pRIFLE			
No AKI	502 (73.8%)	13 (27.65)	489 (77.25)
Risk	108 (15.9%)	7 (14.89)	102 (16.11)
Injury	51 (7.5%)	12 (25.53)	51 (8.05)
Failure	19 (2.8%)	15 (31.91)	19 (3.00)
AKIN			
No AKI	432 (63.5%)	7 (14.89)	425 (67.14)
Stage 1	93 (37.5)	14 (29.78)	79 (12.48)
Stage 2	88 (35.5)	15 (31.91)	73 (11.53)
Stage 3	67 (27)	11 (23.40)	56 (8.85)

The association between mortality and the pRIFLE and AKIN criteria was tested using odds ratio. The results for the pRIFLE criteria were as follows: an odds ratio (OR) of 0.92 and a 95% confidence interval (95%CI) of 0.40 to 2.12 for the Risk stage; an OR of 5.22 with a 95%CI of 2.51 to 10.86 for the Injury stage; and an OR of 73.71 with a 95%CI of 23.14 to 234.84 for the Failure stage. The results for the AKIN criteria were as follows: an OR of 2.98 with a 95%CI of 1.53 to 5.80 for stage 1; an OR of 3.60 with a 95%CI of 1.86 to 6.96 for stage 2; and an OR of 3.15 with a 95%CI of 01.52 to 6.53 for stage 3 (Table 6).

Table 6: Association between mortality and the pRIFLE and AKIN criteria.

	ODDS Ratio (95% CI)	'Z' Score	P value of significance
pRIFLE	8.88 (4.56-17.28)	6.43	P<0.0001
Risk	0.92 (0.40-2.12)	0.19	0.85
Injury	5.22 (2.51-10.86)	4.43	P<0.0001
Failure	73.71 (23.13-234.835)	7.27	P<0.0001
AKIN	11.67 (5.14-26.50)	5.87	P<0.0001
Stage 1	2.98 (1.53-5.80)	3.19	P=0.001
Stage 2	3.60 (1.86-6.96)	3.80	P=0.0001
Stage 3	3.15 (1.52-6.53)	3.084	P=0.002

DISCUSSION

Acute kidney injury in pediatric patients confers a relatively high mortality and remains a challenge to pediatric nephrologists and intensivists. The diverse definitions of this condition caused great confusion for both clinical management and comparison of research results

The RIFLE and AKIN criteria both operate using serum creatinine, creatinine or creatinine based measurements and urine output measurements to stage acute kidney injury. Thus, any bias that may compromise the accuracy of the values will alter all the indices, thereby reducing any particular influence on the outcome.

Most of studies comparing RIFLE and AKIN criteria are done in adult population. Bagshaw et al conducted the first study in 2008 to compare the RIFLE and AKIN criteria and relate them to AKI in an ICU setting. According to this study AKIN criteria, which were derived from the renowned RIFLE criteria, was not significant in bringing substantial benefits to improve sensitivity and predictive ability.[23] Lopes et al compared AKIN and RIFLE staging system and found that AKIN classification had superior sensitivity to AKI but was inferior for outcome prediction in critically ill patients.[22]

However there are only a few studies have compared the incidence and mortality of AKI in PICU patients using pRIFLE and AKIN criteria. Sutherland et al compared AKI incidence and mortality according to pRIFLE, AKIN and KDIGO and opined that all three definition demonstrated excellent interstage discrimination.[27]

In this study AKI incidences according to pRIFLE and AKIN were 26.1% and 35.5% respectively. This was comparable to Krishnamurthy and Mehta et al which found the incidence of AKI to be 25.1 and 36.1% respectively.[28,29] AKIN criteria was more sensitive than pRIFLE in our study as it detected 9.4% higher cases than pRIFLE.

Among the AKI patients, stage 1 (13.7%) or RISK (15.9%) comprised the maximum AKI cases, followed by stage 2 (12.9%) or INJURY (7.5%) and last being stage 3 (9.9%) or FAILURE (2.8%).

Mortality was higher among patients with AKI by both definitions (pRIFLE, 72.3%; AKIN, 85.1%). The number of cases decreased with progression of disease but mortality increased. Odds ratio for mortality by pRIFLE criteria was 8.88 with 95% CI 4.56 to17.28 and by AKIN criteria was 11.67 with 95% CI of 5.14 to 26.50; with both being significant ($p<0.0001$). pRIFLE staging demonstrated progressively higher mortality at each AKI severity stage among PICU patients.

CONCLUSION

In conclusion, AKIN criteria are more sensitive than pRIFLE in identification of AKI cases is more sensitive. Patients diagnosed as AKI had significantly higher mortality rate than non AKI patients irrespective of the criteria used. While both the criteria were good predictors of mortality in PICU patients.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Srinivasa S, Reshmavathi V, Srividya GS. A comparison of pRIFLE and AKIN criteria for acute kidney injury in pediatric intensive care unit patients. Int J Contemp Pediatr 2016;3:398-402.