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Original Article

# Using pRIFLE criteria for acute kidney injury in critically ill children

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## Abstract

***Background*** Incidence of acute kidney injury (AKI) in critically ill children and its mortality rate is high. The lack of a uniform definition for AKI leads to failure in determining kidney injury, delayed treatment, and the inability to generalize research results.

***Objectives*** To evaluate the pediatric RIFLE (pRIFLE) criteria (risk for renal dysfunction, injury to the kidney, failure of kidney function, loss of kidney function, and end-stage renal disease) for diagnosing and following the clinical course of AKI in critically ill children. We also aimed to compare AKI severity on days 1 and 3 of pediatric intensive care unit (PICU) stay in critically ill pediatric patients.

***Methods*** This prospective cohort study was performed in PICU patients. Urine output (UOP), serum creatinine (SCr), and glomerular filtration rate on days 1 and 3 of PICU stay were recorded. Classification of AKI was determined according to pRIFLE criteria. We also recorded subjects' immune status, pediatric logistic organ dysfunction (PELOD) score, admission diagnosis, the use of vasoactive medications, diuretics, and ventilators, as well as PICU length of stay and mortality.

***Results*** Forty patients were enrolled in this study. AKI was found in 13 patients (33%). A comparison of AKI severity on day 1 and day 3 revealed no statistically significant differences for attainment of pRIFLE criteria by urine output only ($pRIFLE_{UOP}$; P=0.087) and by both UOP and SCr ($pRIFLE_{Cr+UOP}$; P=0.577). However, attainment of pRIFLE criteria by SCr only ($pRIFLE_{Cr}$) was significantly improved between days 1 and 3 (P=0.026). There was no statistically significant difference in mortality or length of stay between subjects with AKI and those without AKI.

***Conclusion*** The pRIFLE criteria is feasible for use in diagnosing and following the clinical course of AKI in critically ill children. **[Paediatr Indones. 2013;53:32-6.]**

***Keywords*****:** *acute kidney injury, pRIFLE, critically ill children*

Acute kidney injury (AKI), previously called acute renal failure, is characterized by a reversible increase in the blood concentration of creatinine and nitrogenous waste products and by the inability of the kidney to appropriately regulate fluid and electrolyte homeostasis.[1] Incidence and mortality of AKI in critically ill children is high.[2,3] An epidemiological study of AKI showed its incidence to range from 12 - 87.8%, depending on the definition used.[4] There are more than 30 definitions of AKI. This lack of a uniform and multidimensional definition may lead to failure in determining kidney injury, delayed treatment, and the inability to generalize research results.[5,6]

The Acute Dialysis Quality Initiative group has proposed a new classification system to be used in critically ill adult patients, namely the RIFLE criteria, which is the acronym for risk of renal dysfunction, injury to the kidney, failure of kidney function, loss of kidney function, and end-stage renal disease.[4] A

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modified version of this RIFLE criteria, pRIFLE, has been used in pediatric patients. This criteria classifies the severity of AKI based on changes in serum creatinine (SCr) or estimated creatinine clearance (eCCl) and urine output (UOP).[3] Studies on adult patients have shown the RIFLE criteria to have clinical relevance for AKI diagnosis, severity and progression, as well as predictive value for mortality.[7,8]

There have been few pediatric studies using the pRIFLE criteria. A previous study showed that AKI was commonly found in the first seven days after PICU admission, and patients without improvement of kidney function in 48 hours after PICU admission had a greater risk for renal replacement therapy (RRT).[3] The purpose of this study was to evaluate the usefulness of pRIFLE criteria for determining AKI and its clinical course in critically ill children, as well as to compare AKI severity in our subjects on days 1 and 3 after PICU admission.

## Methods

This prospective, cohort study was performed in the PICU at Cipto Mangunkusumo Hospital, Jakarta from May 2010 to April 2011. The inclusion criteria were patients aged 1 month – 18 years and using a urine catheter. We excluded patients with a history of kidney disease, diabetes insipidus, diabetes mellitus and syndrome of inappropriate antidiuretic hormone secretion (SIADH). Urine output, serum creatinine and glomerular filtration rate (GFR) on days 1 and 3 of admission were recorded, and the classification of AKI was determined according to pRIFLE criteria **(Table 1)**.

We also recorded the immune status, PELOD score, admission diagnosis, the need for vasoactive medication, diuretics, and ventilator, as well as PICU length of stay and mortality.

Wilcoxon test was used to analyze the difference in AKI severity between days 1 and 3. The characteristics

**Table 1.** Pediatric RIFLE criteria (pRIFLE)

| | Estimated creatinine clearance (eCCl) | Urine output (UOP) |
|---|---|---|
| Risk (R) | eCCl decreased 25% | < 0.5 mL/kg/h for 8 h |
| Injury (I) | eCCl decreased 50% | < 0.5 mL/kg/h for 16 h |
| Failure (F) | eCCl decreased 75% or <35mL/min/1.73m$^2$ | < 0.3 mL/kg/h for 24 h or anuric for 12 h |
| Loss (L) | Persistent failure > 4 weeks | |
| End-stage (E) | End-stage renal disease (persistent failure > 3months) | |

**Table 2.** Patient characteristics with and without AKI according to pRIFLE criteria

| Characteristics | AKI (n=13) | Without AKI (n=27) | P value |
|---|---|---|---|
| Mean age (SD), months | 62.3 (45.39) | 50.8 (51.59) | 0.316 |
| Immunocompromised, n (%) | 5 (38.5) | 12 (44.4) | 0.944 |
| Severe malnutrition | 2 (15.4) | 6 (22.2) | |
| Malignancy | 2 (15.4) | 3 (11.1) | |
| Severe malnutrition and malignancy | 1 (7.7) | 2 (7.4) | |
| HIV | 0 | 0 | |
| Other | 0 | 1 (3.7)* | |
| Mean PELOD score (SD) | 12 (7.84) | 7.2 (7.42) | 0.216 |
| Admission diagnosis | | | |
| Post-operative | 1 (7.7) | 16 (59.3) | 0.004 |
| Respiratory failure | 5 (38.5) | 6 (22.6) | 0.704 |
| Neurological causes | 4 (30.8) | 5 (18.5) | 1.000 |
| Sepsis | 6 (46.2) | 8 (29.6) | 0.720 |
| Trauma | 0 | 1 (3.7) | 1.000 |
| Heart disease | 0 | 1 (3.7) | 1.000 |
| Hypovolemic shock | 7 (53.8) | 1 (3.7) | 0.005 |
| Other | 0 | 2 (7.4) | 1.000 |
| Need for ventilator, n (%) | 9 (69.2) | 15 (55.6) | 0.729 |
| Need for vasoactive medication, n (%) | 8 (61.5) | 9 (33.3) | 0.185 |
| Need for diuretics, n (%) | 8 (61.5) | 11 (40.7) | 0.369 |
| Mean PICU length of stay (SD), hours | 238.5 (166.01) | 230.5 (208.16) | 0.515 |
| Mortality, n (%) | 4 (30.8) | 8 (29.6) | 1.000 |

*Down syndrome

of subjects with AKI and those without AKI were analyzed using independent t-test, Mann-Whitney test, chi square test and Fisher's exact test. Statistical analysis was performed using SPSS 15.0.

## Results

Forty critically ill pediatric patients were enrolled. Acute kidney injury was found in 13 patients (33%), according to pRIFLE criteria during the first 3 days after PICU admission. Renal replacement therapy was performed on two patients. A comparison of characteristics of subjects with AKI and without AKI is shown in **Table 2**. **Figure 1** shows the clinical course of AKI.

A comparison of AKI severity revealed no statistically significant difference between days 1 and 3 for $pRIFLE_{UOP}$ (P=0.087) and $pRIFLE_{Cr+UOP}$ (P=0.577), but $pRIFLE_{Cr}$ showed statistically significant difference (P=0.026). **Table 3** shows the comparison of $pRIFLE_{Cr+UOP}$ on day 1 and day 3 of PICU admission.

**Table 3.** The severity of AKI according to $pRIFLE_{Cr+UOP}$ on day 1 and 3 of admission.

| Day 1 (n) | Day 3 (n) | | | | |
|---|---|---|---|---|---|
| | No AKI | R | I | F | Total |
| No AKI | 27 | 0 | 1 | 0 | 28 |
| R | 4 | 2 | 0 | 0 | 6 |
| I | 1 | 0 | 0 | 0 | 1 |
| F | 1 | 1 | 0 | 3 | 5 |
| Total | 33 | 3 | 1 | 3 | 40 |

## Discussion

Akcan-Arikan *et al*. showed a mean time to onset of the first pRIFLE stratum of 3.3±3.1 days after PICU admission,[3] while Plőtz *et al*. showed a mean time to attainment of the first RIFLE stratum of 1.9 ± 1.6 days.[2] Another study of PICU patients using RIFLE criteria with creatinine only, without UOP data, showed that almost half of patients with AKI had a maximum RIFLE score in the first 24 hours after admission.[9] In our study, we monitored renal function on days 1 and 3, and found the incidence of AKI to be 32.5%. It was lower than that of previous studies which monitored renal function for 7 days. Acute kidney injury incidences were reported to be 82% by Akcan-Arikan *et al*.[3] and 58% by Plőtz *et al*.[2]

Acute kidney injury may be the primary cause of PICU admission or a secondary cause due to underlying diseases.[10] The etiologies have been classified as pre-renal, renal, and post–renal, and are often multifactorial in critically ill patients.[1] Sepsis is the main etiology, with 45-70% of AKI in critically ill patients considered to be related to sepsis.[11,12] A multinational study on AKI in critically ill patients reported that septic shock was the main

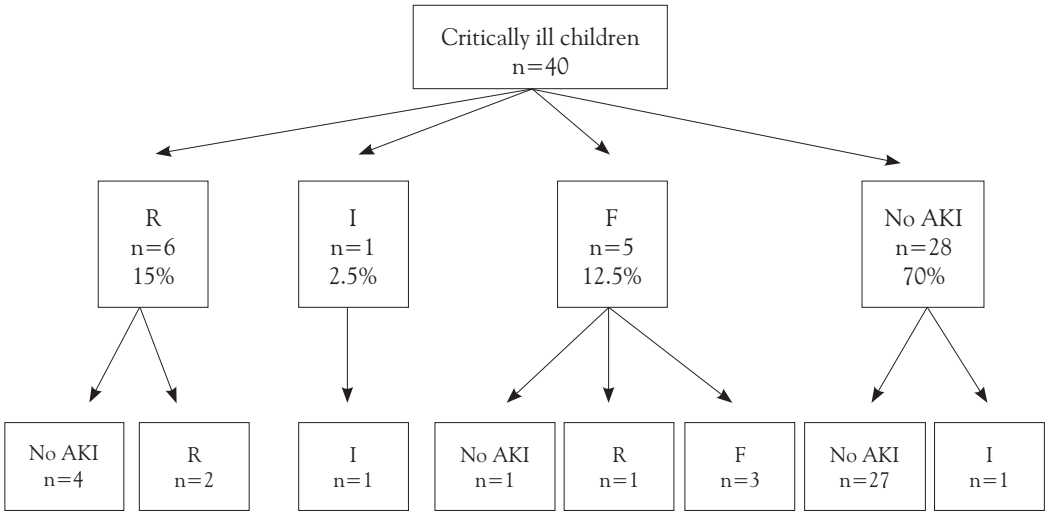


**Figure 1.** Flow diagram of the course of AKI according to $pRIFLE_{Cr+UOP}$; R: risk; I: injury; F: failure

etiology (47.5%), followed by major surgery (34%), cardiogenic shock (27%), hypovolemia (26%), and drugs (19%), and in many cases more than one factor was involved.[12] We found statistically significant differences between subjects with and without AKI in patients with hypovolemia and those who were admitted to the PICU post-operatively. However, there was no significant difference in sepsis patients or those with other admission diagnoses. A limitation of our study was that our sample size was too small for sub-group analysis.

A systematic review reports that RIFLE classification was a good predictor of outcomes, with a progressive increase in mortality with worsening RIFLE classification, and even mild degrees of kidney dysfunction having a negative impact on outcomes.[8] Similarly, Ackan-Arickan *et al*. report a statistically significant difference between subjects with and without AKI in length of stay, but no significant difference in mortality.[3] In our study, we found no significant difference in mortality or length of stay between subjects with and without AKI.

Akcan-Arikan *et al*. found that renal function substantially improved (as defined by a decrease in pRIFLE stratum) within 48 hours of PICU admission in 46% of patients with AKI. Furthermore, patients who did not show improving renal function within 48 hours of PICU admission had a greater risk for renal replacement therapy.[3] In our study, 6 out of 12 patients with AKI showed renal function improvement on day 3 after PICU admission. There were no statistically significant differences between day 1 and 3 in $pRIFLE_{Cr+UOP}$ (P=0.577) and $pRIFLE_{UOP}$ (P=0.087). However, there was a significant difference in $pRIFLE_{Cr}$ between days 1 and 3 (P=0.026).

Limitations of this study were the relatively small sample size and the fact that we assumed the baseline creatinine value to be 100 mL/min/1.73m$^2$ since the baseline data was unknown. The potential pitfall of this assumption was misdiagnosis of a patient with AKI based on a relative decrease in eCCl, if in fact, the patient had previous underlying chronic kidney disease. Whether or not such a misdiagnosis would lead to unnecessary evaluation or treatment is currently unknown, but clinicians should take caution when classifying patients with AKI using pRIFLE, or any system using eCCl change as an input, when the baseline creatinine level is unknown.[3]

In conclusion, pRIFLE criteria is feasible for use in determining the diagnosis and clinical course of AKI in critically ill children. There are no significant differences in $pRIFLE_{Cr+UOP}$ and $pRIFLE_{UOP}$ between days 1 and 3. However, $pRIFLE_{Cr}$ is significantly different between days 1 and 3. Further study with a larger sample size is needed.

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