Acute Kidney Injury in Critically Ill Children at Pediatric Intensive Care Unit

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ABSTRACT

Background: Recognition of acute kidney injury (AKI) requires use and selection of easily measured criteria that can be applied widely across age groups and clinical situations. Modified pediatric RIFLE (pRIFLE) has been used for diagnosis and grading of AKI (acute kidney injury) in children. Objective: To investigate AKI in children aged 1-14 years hospitalized at PICU (pediatric intensive care unit), Wahidin Sudirohusodo Hospital, Makassar. Methods: A cross-sectional study was done based on medical records from 2009 until 2011. The records were screened for demographic data, serum creatinine level and estimated creatinine clearance by Schwartz formula. AKI was grouped according to pRIFLE formula. Results: There were 77 patients, 58.4% boys and 41.6% girls. Majority were above 5 year-old (76.6%), have increased serum creatinine level (80.05%) and decreased eCC/estimated creatinine clearance (80.05%). Underlying diseases as the cause of AKI consists of AGN/acute glomerulonephritis (41.6%), NS/nephrotic syndrome (9.1%), UTI/urinary tract infections (9.1%), and others (40.3%) including DSS (dengue shock syndrome), dehydration due to diarrhea, and septic shock. pRIFLE-R was more frequent in patients above five years old (33.8%), in boys (27.3%), well-nourished patients (13.0%), and in patients with increased creatinine serum level or decreased eCC (49.9%) compared to pRIFLE-I and pRIFLE-F groups. No significant difference of pRIFLE grading in different groups of underlying diseases (p=0.126), age (p=0.075), sex (p=0.817), and nutritional status (p=0.102). The difference of creatinine serum level and eCC was significant (p <0.001) among different pRIFLE grading.

Conclusion: Early diagnosis of AKI should be based on pRIFLE grading and adequate preventive measures should be instituted as early as possible to reduce the morbidity and mortality rates at PICU.

Key words: children, acute kidney injury, pRIFLE

INTRODUCTION

Acute renal failure (ARF) is defined as a rapid decline in glomerular filtration rate (GFR), resulting in disturbance of physiological renal functions including impairment of nitrogenous waste product excretion, loss of water and electrolyte regulation and loss of acid-base regulation. Although the incidence of ARF varies with geographical localization.
and countries, it has been reported in 2-5% of hospitalized children and in 4.5-30% of children in pediatric intensive care units (PICU). Mortality rates of 35 to 80% have been reported in patients developing ARF.1-3 An acute decline of kidney function is secondary to tubular (or more extensive) injury that leads to functional or structural damage in the kidney. ARF actually includes a spectrum of conditions, the term acute kidney injury (AKI) has been recently proposed to reflect the entire spectrum of the syndrome.4-6

The exact incidence and causes of AKI in children is unknown; recent studies suggest that incidence of AKI in hospitalized children is increasing. Previous studies in Nigeria and North India showed 11.7 and 20 AKI cases admitted per year per 1000 pediatric admissions, respectively7 and in New Zealand children, 4.0 per 100,000 total population under 15 year of age.8 No study reported incidence of AKI in Indonesia. This study retrospectively investigated AKI in children hospitalized at PICU in Wahidin Sudirohusodo Hospital, Makassar.

METHOD
This survey was a retrospective cross-sectional study to investigate AKI in hospitalized children at Wahidin Sudirohusodo Hospital Makassar. Data were based on a review of standard medical records of all patients aged 1-14 years hospitalized at PICU of Wahidin Sudirohusodo Hospital, Makassar from 2009 until 2011. Study approval was obtained from the Ethical Committee of Wahidin Sudirohusodo Hospital, Makassar.

We enrolled all patients who had been hospitalized at PICU of the hospital with complete medical records. Patient records were retrospectively analyzed for age, sex, nutritional status, underlying diseases, whole blood count, urinary analysis, duration of renal failure, blood urea, serum creatinine, and estimated creatinine clearance (eCC). Systolic and/or diastolic blood pressure levels equal or greater than 95 percentile was defined as hypertension whereas systolic blood pressure <70 mmHg + 2 x Age(yr) defined as hypotension.8 Patients with a history of chronic renal failure and incomplete medical records were excluded from the study. The medical records were screened for creatinine serum level and estimated GFR, and patients with GFR of 75 ml/min/1.73 m2 or less were selected for additional analysis. GFR was assessed by Schwartz formula.9 AKI was defined according to the modified pediatric RIFLE (pRIFLE) and graded into “pRIFLE-R” (risk for reduced kidney function), “pRIFLE-I” (injury of kidney function), “pRIFLE-F (failure of kidney), “pRIFLE-L” (loss of kidney function), and “pRIFLE-E” (End Stage Renal Disease). pRIFLE-L and pRIFLE-F define the outcome of AKI. pRIFLE grading uses estimated creatinine clearance estimation (eCC) to assess renal function based on Schwartz’ formula’s (0.55 x height (cm) / serum creatinine (mg/dL) in mL/ minute/1.73 m2)5,6 (Table 1).

Baseline of normal eCC used in this study was 120 ml/min/1.73 m2.6 Underlying diseases as the cause of AKI were grouped into acute glomerulonephritis (AGN), nephrotic syndrome (NS), urinary tract infection (UTI), and others including any shock conditions such as dengue shock syndrome (DSS), dehydration caused by diarrhea, and any cause of septic shock. Data were analyzed using SPSS v.15.00 (SPSS, Inc, Chicago). Pearson chi-square was used to compare characteristic data and p <0.05 was considered as significant.

RESULTS
There were 77 patients enrolled in this study, consisting of 58.4% boys and 41.6% girls with a boy to girl ratio of 1.4:1. Mean age of subjects was 8.483 years ranging from 1.10 to 13.50 years. Majority of subjects was above 5 years (76.6%) and undernourished (53.2%). Increased serum creatinine level or decreased eCC occurred in 80.05% cases (Table 2).

Table 2 Characteristics of subjects

<table>
<thead>
<tr>
<th>Parameters</th>
<th>n (77) / (100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean: 8.483 [1.83 - 13.5])</td>
<td>18/23.4%</td>
</tr>
<tr>
<td>&lt; 5 yr</td>
<td>59/76.6%</td>
</tr>
<tr>
<td>&gt; 5 yr</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>45/58.4%</td>
</tr>
<tr>
<td>Boy</td>
<td>32/41.6%</td>
</tr>
<tr>
<td>Girl</td>
<td></td>
</tr>
<tr>
<td>Nutritional status</td>
<td>36/46.8%</td>
</tr>
<tr>
<td>Well-nourished</td>
<td>41/53.2%</td>
</tr>
<tr>
<td>Undernourished</td>
<td></td>
</tr>
<tr>
<td>Serum creatinine (mean: 1.553)</td>
<td>15/19.05 %</td>
</tr>
<tr>
<td>Normal</td>
<td>62/80.05 %</td>
</tr>
<tr>
<td>High</td>
<td></td>
</tr>
<tr>
<td>eCC (mean: 40.920 [0.45-127.00])</td>
<td>15/19.05 %</td>
</tr>
<tr>
<td>Normal</td>
<td>62/80.05 %</td>
</tr>
<tr>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

Table 3 shows that underlying diseases as the cause of AKI consist of AGN (41.6%), NS (9.1%), UTI (9.1%), or others (40.3%) including DSS, dehydration due to diarrhea, and septic shock.
There was no significant difference of pRIFLE grading among different underlying diseases (p=0.126). pRIFLE-R was more frequent in patients aged under and above five years old (9.1%/33.8%), in boys (27.3%), well-nourished patients (13.0%), and patients with increased creatinine serum level and decreased eCC (49.9%) compared to those with pRIFLE-I and pRIFLE-F (Table 4).

Table 4 shows no significant differences of pRIFLE grading among distribution of age (p=0.075), sex (p=0.817), and nutritional status (p=0.102) but very significant difference among different pRIFLE grading, creatinine serum level (p <0.001) and eCC (p <0.001).

DISCUSSION
AKI is defined as functional or structural abnormalities or markers of kidney damage including abnormalities in blood, urine or tissue tests or imaging studies present for less than three months. AKI is an abrupt or less than 48 hours reduction in kidney function confirmed by an absolute increase in serum creatinine of either >0.3 mg/dL or a percentage increase of 50% or reduction in urine output or documented oliguria of <0.5 mL/kg/hr for >6 hr. The heterogenous cause of AKI has been associated with increased morbidity and mortality by increasing dialysis need as well as further subsequent development of chronic kidney disease and its progression to dialysis dependency. Recognition of AKI requires selection and use of easily measured criteria that can be applied widely, across age groups and clinical situations. Modified pRIFLE has been used for diagnosis and grading of AKI in children.

The reported incidences of AKI in children and adolescents hospitalized at PICU ranged from 8% to 30%. The present study found that pRIFLE-R, pRIFLE-I, and pRIFLE-F in children hospitalized at PICU in Wahidin Sudirohusodo Makassar was 49.9%, 27.3%, and 10.4%, respectively. This result is similar to other studies.

The common cause of childhood AKI reported in New Zealand was post cardiac surgery (58%), HUS (17%), sepsis (13%), and AGN (4%). In Houston Texas, the cause of AKI in children were renal ischemia (21%), nephrotoxic agents (16%), sepsis (11%), and primary renal disease (7%). The present study showed that
the cause of AKI in children was AGN (41.6%), NS (9.1%), UTI (9.1%), and others (40.3%) including any shock conditions such as dengue shock syndrome (DSS), dehydration caused by diarrhea, and any cause of septic shock. This result was similar to a study from Anatolia, Turkey that AGN caused more than 60% of AKI in children.

A limitation of this study is that data analysis based on a retrospective and cross-sectional design. A prospective cohort study should be done further to confirm the results from this study. Early diagnosis of AKI in all children hospitalized at PICU should be established based on the pRIFLE criteria using Schwartz formula. Since children hospitalized in PICU are at high risk of AKI, early diagnosis and adequate preventive measures should be instituted as early as possible to decrease the need for RRT (renal replacement therapy) and subsequently to reduce morbidity and mortality rates.

CONCLUSION
Early diagnosis of AKI should be based on pRIFLE grading and adequate preventive measures should be instituted as early as possible to reduce the morbidity and mortality rates at PICU.

REFERENCES