

Incidence and risk Factor of Acute Kidney Injury post open Heart Surgery in Paediatric Patients



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ABSTRACT

Introduction: Acute kidney injury (AKI) was a frequent complication after open heart surgery, especially in paediatric patients < 2 years old and had been related with increased mortality and adverse renal outcomes. This study aimed to determine the incidence of AKI post open heart surgery in paediatric patients and its relation with duration of cardiopulmonary bypass (CPB) and patient's age in Indonesia's tertiary national hospital.

Methods: This was a cohort retrospective study, using medical records and cardiac ICU chart data of 195 paediatric patients who underwent open heart surgery from June 2014 - June 2015 in Integrated Cardiovascular Center Cipto Mangunkusumo hospital. After ethical approval from Research Ethics Committee, data was collected and sorted by inclusion and exclusion criteria. AKI was diagnosed based

on RIFLE criteria. Data was analyzed by chi-square and multivariate analysis (SPSS software 22.0 version).

Results: Incidence of AKI post open heart surgery in paediatric patients was 36.4%. Duration of CPB > 60 min had a significant correlation with increased incidence of AKI (p 0.043; RR 1.248). Patient's age (\leq 2 years old) also had a significant correlation with increased incidence of AKI (p<0.001; RR 2.431). Multivariate analysis results showed that both the duration of CPB and the patient's age were significant risk factors of AKI (OR 2.951, OR 5.371).

Conclusion: Incidence of AKI post open heart surgery in paediatric patients was 36.4%. Duration of CPB duration (> 60 min) and patient's age (< 2 years old) were significant risk factors of AKI.

Keywords: Acute kidney injury, cardiopulmonary bypass, open heart surgery, paediatric

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INTRODUCTION

Acute kidney injury (AKI) is a complication that occurs frequently post open heart surgery with cardiopulmonary bypass (CPB) and is related to increased mortality and adverse renal outcome. Previous studies showed that 5-33% of paediatric patients who underwent open heart surgery with CPB had AKI within 3 days postoperative.¹ Five percent of patients who had been diagnosed with AKI would suffer from prolonged AKI, undergo dialysis treatment and have a high mortality rate (80%).² Kidneys in paediatric patients were not functioning properly making it more likely to suffer from AKI postoperatively, especially in paediatric patients that are < 2 years old. The duration of CPB was also thought to be linearly associated with an increased risk of AKI, due to ischemic and progressive inflammation of the kidney during CPB.¹ This study aimed to determine the incidence of AKI post open heart surgery in paediatric patients and its relation to the duration of cardiopulmonary bypass (CPB) and patient's age in Indonesia's tertiary national hospital.

DESIGN AND METHODS

This was a cohort retrospective study on 195 paediatric patients who had undergone open heart surgery with CPB at the Integrated Cardiovascular Center in Indonesia's tertiary national hospital, Cipto Mangunkusumo Hospital from June 2014 until June 2015. Sample size was estimated with sample size calculation of two independent groups, based on proportion difference. After approval from Research Ethics Committee Universitas Indonesia, medical records and cardiac ICU chart data were sorted and analyzed. Patient's with incomplete medical records, history of AKI preoperatively, and patient's who died intraoperatively were excluded from this study.

The duration of CPB were divided into two groups: CPB > 60 min and CPB \leq 60 min. Patients were diagnosed with AKI postoperatively based on RIFLE criteria, ie urine output < 0.5 cc/kg/hour in first 6 hours after surgery. Age was divided into two groups: \leq 2 years and > 2 years. After data was collected, the data was analyzed by SPSS software 22.0 version with chi-square test and multivariate analysis.

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Table 1 Characteristics of subjects

| Variables | CPB duration > 60 min (n=122) | CPB duration ≤60 min (n=73) |
|---------------------------------|-------------------------------|-----------------------------|
| Age | | |
| ≤ 2 years (n) | 46 (37.7%) | 41 (56.2%) |
| > 2 years (n) | 76 (62.3%) | 32 (43.8%) |
| Sex | | |
| Male (n) | 62 (50.8%) | 30 (41.1%) |
| Female (n) | 60 (49.2%) | 43 (58.9%) |
| Body weight (kg) | 12 (3.1-56) | 8 (3.25-34) |
| Preoperative creatinine (mg/dL) | 0.4 (0.1-0.9) | 0.3 (0.2-0.8) |

Table 2 Characteristics of postoperative

| Characteristics | Results |
|-----------------------------|-------------|
| AKI postoperative incidence | |
| AKI (n) | 71 (36.4%) |
| Non-AKI (n) | 124 (63.6%) |
| Length of stay (days) | 6 (1-45) |

Table 3 Statistical analysis results of the subjects

| Variables | AKI (n=71) | Non-AKI (n=124) | p-value | RR (IK 95%) |
|---------------|------------|-----------------|---------|-------------|
| CPB duration | | | | |
| > 60 min (n) | 51 (41.8%) | 71 (58.2%) | 0.043 | 1.248 |
| ≤ 60 min (n) | 20 (27.4%) | 53 (72.6%) | | |
| Age | | | | |
| ≤ 2 years (n) | 47 (54%) | 40 (46%) | 0.000 | 2.431 |
| > 2 years (n) | 24 (22.2%) | 84 (77.8%) | | |

Table 4 Association of AKI and length of stay

| | Length of stay | | p-value | RR (IK 95%) |
|-------------|------------------|-----------------|---------|-------------|
| | ≤ 6 days (n=109) | > 6 days (n=86) | | |
| AKI (n) | 28 (39.4%) | 43 (60.6%) | 0.000 | 1.656 |
| Non AKI (n) | 81 (65.3%) | 43 (34.7%) | | |

RESULTS

There were 122 subjects who underwent open heart surgery with CPB duration > 60 min and 73 subjects with CPB duration ≤ 60 min. Characteristics of subjects were presented in Table 1 while AKI incidence and length of hospitalization postoperatively were presented in Table 2. In this study, incidence of AKI in paediatric patients underwent open heart surgery was 36.4%.

There was a significant association between CPB duration > 60 min and increased incidence of AKI

(p 0.043; RR 1.248). Paediatric patients with duration of CPB > 60 min were 1.248 times more likely to suffer from AKI postoperatively compared to paediatric patients with duration of CPB ≤ 60 min (RR 1.248, IK 95%). Significant association between age ≤ 2 years old and increased incidence of AKI was also found (p<0.001). Paediatric patients ≤ 2 years old were 2.431 times more likely to suffer from AKI postoperatively compared to paediatric patients > 2 years old (RR 2.431, IK 95%).

Multivariate analysis was done in this study with the Hosmer and Lemeshow test. The results showed that CPB duration > 60 min and age ≤ 2 years old was significant risk factors of AKI postoperative (OR 2.951, OR 5.371, respectively). There was a significant association between incidence of AKI postoperatively and length of stay (p<0.001; RR 1.656).

DISCUSSION

In this study, the duration CPB > 60 min was a risk factor of post open heart surgery AKI in paediatric patients. This results were similar with Sethi et al. that found that AKI incidence was higher in populations with longer duration of CPB.³

Using CPB would trigger the coagulation cascade and haemolysis due to cell damage induced by CPB mechanical force. Heme in blood cells would enter the circulation, and large quantities of iron would trigger oxidative reactions that subsequently would damage end organ tissues, including in this case, the renal tubules.⁴ Using CPB would also trigger systemic inflammatory response due to activation of proinflammatory cytokines and coagulation factors, which can lead to more severe injury to the kidneys. In addition, there was also fluid accumulation due to increased vasopressin postoperatively, which usually continued for 48-72 hours after surgery.⁵ Activation of the renin-angiotensin-aldosterone system would increase potassium excretion. Hypothermia, that usually occurred postoperatively, could also cause decreased renal perfusion. Limiting the duration of CPB would decrease the post open heart surgery AKI incidence in paediatric patients.

In this study, we also found that age ≤ 2 years old was a significant risk factor for post open heart surgery AKI. Renal blood flow and glomerular filtration is low in the first 2 years of life due to high renal vascular resistance. Renal tubular function is immature until 8 months therefore infants are unable to excrete a large sodium load. Acid-base balance and the mechanism of concentration and urinary dilution are also not fully developed.⁵ Therefore, children younger than 2 years

old become more susceptible to ischemia and an inflammatory response that eventually leads to AKI symptoms. Patients that will undergo congenital heart surgery tend to be younger nowadays, and in the future it becomes a challenge to avoid AKI occurrence postoperatively.

The preoperative renal function may become a risk factor for postoperative AKI. Preoperative kidney function also affects outcomes, as impaired renal function before surgery causes worse outcomes with longer duration of hospitalization and higher mortality. In this study, all of the subjects had normal creatinine levels so we couldn't evaluate the association between preoperative kidney function and post open heart surgery AKI.

Post open heart surgery AKI was related with longer length of hospital stay (Table 4). Kumar AB et al⁶ also found that AKI post open heart surgery was related with longer length of stay and increased mortality.⁶ Therefore recognizing the risk factors of AKI and avoiding matters that may increase the risk of AKI is a must to reduce length of hospital stay and mortality.

CONCLUSION

Incidence of AKI post open heart surgery in paediatric patients was 36.4%. The duration of

CPB duration > 60 min and patient's age ≤ 2 years old were significant risk factors of AKI.

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