



The Indonesian Journal of General Medicine

The Analysis Study of Prevalence, Management and Outcome of Renal Trauma in Pediatrics: A Comprehensive Systematic Review

¹Rizal Mustaqim Kaloka, ²Gita Tanbao Suselin

¹dr. Sobirin Regional General Hospital, Lubuklinggau, South Sumatera,
Indonesia

²Besemah Regional General Hospital, Pagar Alam, South Sumatera,
Indonesia

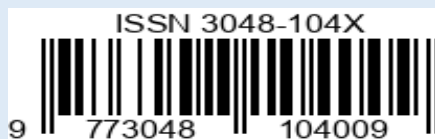
Correspondence : rizalkaloka28@gmail.com

Article History :

Received date : 2024/01/15
Revised date : 2024/03/23
Accepted date : 2024/04/25
Published date : 2024/07/12



Copyright: © 2024 by the
authors. Submitted for possible
open access publication under
the terms and conditions of the
Creative Commons Attribution
(BY NC) license
(<https://creativecommons.org/licenses/by-nc/4.0/>).



ABSTRACT

Background: Acute kidney injury (AKI) in children is a critical condition influenced by diverse factors, including surgery, critical illness, and nephrotoxin exposure. It affects up to 50% of pediatric ICU admissions and has significant mortality implications, especially post-heart surgery and in the presence of inotropes or ventilation. **Methods:** The study adhered to PRISMA 2020 standards, examining English literature from 2014 to 2024. **Result:** Initially retrieving 360 articles from online databases (PubMed, SagePub, SpringerLink and Google Scholar) eight relevant papers were selected after three rounds of screening for full-text analysis. **Conclusion:** Pediatric renal injury, including acute kidney injury (AKI) and its long-term implications, presents a significant clinical challenge across diverse settings. Recent studies highlight varying AKI incidences and outcomes, underscoring the need for effective management strategies and long-term renal surveillance to mitigate mortality and chronic kidney disease risks.

Keyword: acute kidney injury, pediatric, outcome, management, outcome

INTRODUCTION

Renal trauma or Acute kidney injury (AKI) is a serious condition that can arise in children and adolescents due to a variety of factors. AKI can quickly develop into chronic renal disease and require dialysis if it is not identified and treated right once. AKI affects about 10% of children hospitalized to the critical care unit, which has a substantial effect on their mortality rates.^{1,2}

Awareness of the severity and frequency of AKI in children is growing. AKI occurs in babies and children 30% to 50% of the time after heart surgery, and in pediatric intensive care units (ICUs) 10% to 35% of the time.³ For children who require inotropes or are ventilated, the danger is significantly higher. AKI is also frequently seen in hospital wards, particularly in children who are given aminoglycosides and many nephrotoxins while they are there.⁴

A comprehensive retrospective research on neonates, the AWAKEN study comprised more than two thousand babies from four different nations. According to research done in 2017, AKI affected 30% of babies in the neonatal ICU, with a higher frequency in very preterm babies. Even when confounding variables were taken into account, AKI in newborns was linked to higher mortality and longer hospital admissions.^{5,6}

After trauma, rhabdomyolysis, direct kidney damage, shock, and the use of nephrotoxic drugs in trauma care all raise the risk of AKI in both adults and children. Research indicates that children with AKI who have experienced trauma have a 3.6 times greater chance of dying. Nonetheless, there is a great

deal of heterogeneity between research.⁷

Between industrialized and developing nations, there are notable differences in the causes of AKI. AKI is frequently obtained in hospitals in developed areas and is linked to nephrotoxins, critical illnesses, surgery, transplants, and cancer. In contrast, the causes that are more prevalent in rural parts of poor countries are hemolytic uremic syndrome, sepsis, and dehydration.^{8,9}

Because serum creatinine (SCr) measurements, which do not always adequately reflect kidney function in unwell children, have been used to define AKI in children, this has historically been a challenge. Clinical studies have employed over thirty-five distinct definitions, which has resulted in a wide variety of reported epidemiology, morbidity, and death rates and made it difficult to compare data.^{10,11}

While numerous studies in the past two decades have provided acceptable findings on AKI following trauma in adults, the extent of the problem and its impact on mortality in children remain unclear.¹² Thus, this systematic review aims to analyze current evidence on the prevalence, management and outcome of renal injury in pediatric patients based on literatures of the last 10 years.

METHODS

Protocol

The author carefully followed the rules laid out in the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020. This was done to make sure the study met all its standards. The selection of this

methodological approach was specifically aimed at ensuring the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review investigate existing evidence on prevalence, management and outcome of renal injury in pediatric patients based on literatures of the last 10 years. This study meticulously analyzed data on literatures to provide insights and enhance patient treatment strategies. The primary objective of this paper is to highlight the collective significance of the identified key points.

Inclusion criteria for this study entail: 1) Papers must be in English, and 2) Papers must have been published between 2014 and 2024. Exclusion criteria comprise: 1) Editorials; 2) Submissions without a DOI; 3) Previously published review articles; and 4) Duplicate entries in journals.

Search Strategy

The keywords used for this research are acute kidney injury, pediatric, outcome, management, prevalence. The Boolean MeSH keywords inputted on databases for this research are: *Search: (((acute kidney injury) AND (pediatric)) AND (outcome)) OR (management)) OR (prevalence) Filters: Clinical Trial, in the last 10 years (((acute kidney injury)[MeSH Terms] OR ("acute"[All Fields] AND "kidney"[All Fields] AND "injury"[All Fields]) OR "acute kidney injury"[All Fields]) AND ("paediatrics"[All Fields] OR "pediatrics"[MeSH Terms] OR "pediatrics"[All Fields] OR*

"paediatric"[All Fields] OR "pediatric"[All Fields]) AND ("outcome"[All Fields] OR "outcomes"[All Fields]) OR ("manage"[All Fields] OR "managed"[All Fields] OR "management s"[All Fields] OR "managements"[All Fields] OR "manager"[All Fields] OR "managers"[All Fields] OR "manages"[All Fields] OR "managing"[All Fields] OR "managment"[All Fields] OR "organization and administration"[MeSH Terms] OR ("organization"[All Fields] AND "administration"[All Fields]) OR "organization and administration"[All Fields] OR "management"[All Fields] OR "disease management"[MeSH Terms] OR ("disease"[All Fields] AND "management"[All Fields]) OR "disease management"[All Fields]) OR ("epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "prevalence"[All Fields] OR "prevalence"[MeSH Terms] OR "prevalance"[All Fields] OR "prevalences"[All Fields] OR "prevalence s"[All Fields] OR "prevalent"[All Fields] OR "prevalently"[All Fields] OR "prevalents"[All Fields])) AND ((y_10[Filter]) AND (clinicaltrial[Filter]))

Data retrieval

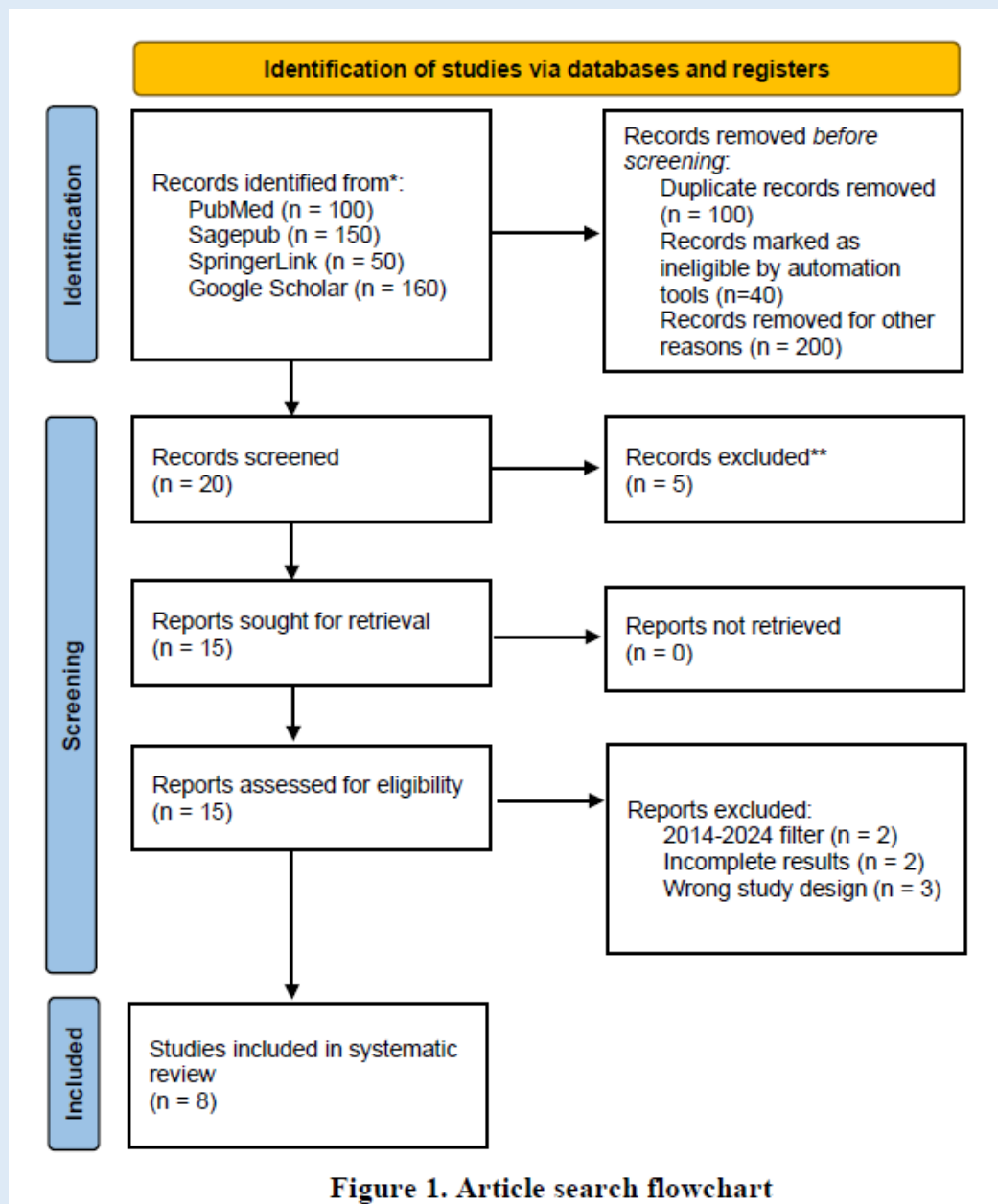
The authors assessed the studies by reviewing their abstracts and titles to determine their eligibility, selecting relevant ones based on their adherence to the inclusion criteria, which aligned with the article's objectives. A consistent trend observed across multiple studies led to a conclusive result. The chosen submissions had to meet the

eligibility criteria of being in English and a full-text.

This systematic review exclusively incorporated literature that met all predefined inclusion criteria and directly pertained to the investigated topic. Studies failing to meet these criteria were systematically excluded, and their findings were not considered. Subsequent analysis examined various details uncovered during the research process, including titles, authors, publication dates, locations, study methodologies, and parameters.

Quality Assessment and Data Synthesis

Each author independently evaluated the research presented in the title and abstract of the publication to determine which ones merited further exploration. The subsequent stage involved assessing all articles that met the predefined criteria for inclusion in the review. Decisions on including articles in the review were based on the findings uncovered during this evaluation process.



RESULT

The initial number of articles retrieved from online databases (PubMed, SagePub, SpringerLink, and Google Scholar) is 360 articles. After conducting three levels of screening, eight articles that directly relate to the current systematic review have been chosen for further assessment through full-text reading and analysis. Table 1 presents the selected literature included in this analysis.

Table 1. The literature included in this study

N o.	Author	Origin	Method	Sample	Result
1.	Bjornstad, et al. ¹³ (2020)	Malawi	Prospective observational study	114 patients	Nearly one in ten children died during hospitalization, and those with AKI (n=4) had a significantly higher risk of death compared to those without AKI, with a mortality rate of 40.0% versus 6.2% (relative risk 6.5, 95% CI 2.2–19.1).
2.	Van den Eynde, et al. ¹⁴ (2022)	Belgium	Prospective cohort study	571 patients	Out of 571 patients who underwent surgery over a four-year period, 113 (19.7%) developed AKI, and 15 (13.3%) of these patients died within a median of 31 days after surgery. Sixty-six patients participated in the follow-up kidney assessment at a median of 4.8 years after the AKI episode. Of these, 59.1% had at least one marker of kidney injury, including reduced eGFR in 13.6%, proteinuria in 40.9%, α 1-microglobulinuria in 7.6%, hypertension in 19.7%, and ultrasound abnormalities in 13.6%. Chronic kidney disease (CKD) stages 1 to 5 were present in 27.3% of patients, with CKD more likely in those with associated syndromes (55.6% vs. 20.8%, P=0.015). At a median follow-up of 13.1 years, 36.7% of 49 patients had eGFR <90

					mL/min per 1.73 m ² , indicating an average eGFR decline rate of -1.81 mL/min per 1.73 m ² per year.
3.	Vivek, et al. ¹⁵ (2023)	India	Retrospective cohort study	362 patients	In a study involving 362 patients, divided into a furosemide group (n=182) and a no-furosemide group (n=180), the median pediatric risk of mortality-III scores were similar between groups. The primary outcome occurred in 28% of the furosemide group and 20% of the no-furosemide group, a difference that was not statistically significant. The furosemide group had a significantly higher mean urine output compared to the no-furosemide group. However, the furosemide group also had higher organ dysfunction scores, longer durations of mechanical ventilation and hospital stays, and lower kidney recovery rates at discharge.
4.	Hirano, et al. ¹⁶ (2020)	Japan	Retrospective cohort study	43 patients	In a study of 43 patients, acute kidney injury (AKI) developed in 21 patients (49%) within 100 days following hematopoietic stem cell transplantation (HSCT). After adjusting for potential confounders, posttransplant AKI was significantly associated with the use of matched unrelated donors (MUD) (HR, 6.26; P = 0.042), but not with total body irradiation (TBI). Among the 37 patients who were followed up for two years, 7 died, but none developed chronic kidney

					disease (CKD) during this period.
5.	Kanazawa, et al. ¹⁷ (2024)	Japan	Retrospective cohort study	118 patients	In a study examining risk factors for developing acute kidney injury (AKI) in pediatric patients receiving vancomycin (VCM), the area under the curve (AUC) threshold for AKI risk was determined to be 583.0 $\mu\text{g} \cdot \text{h/mL}$, with an AUC-ROC curve of 0.873 (sensitivity 0.930, specificity 0.750). Univariate analysis identified the duration of VCM administration, ICU admission, and AUC as factors associated with AKI incidence. Concomitant medications that increased AKI risk included tazobactam/piperacillin, liposomal amphotericin B, calcineurin inhibitors, contrast agents, and H2-receptor blockers. Multivariate analysis revealed that an AUC $\geq 583.0 \mu\text{g} \cdot \text{h/mL}$ (odds ratio 20.14, 95% CI 3.52–115.22, $p < 0.001$) and the use of H2-receptor blockers (odds ratio 8.70, 95% CI 1.38–54.87, $p = 0.02$) were independent factors for AKI incidence.
6.	Stotter, et al. ¹⁸ (2023)	USA	Retrospective cohort study	49 patients	In a study of 59 patients with a mean age of 14.3 years, of whom 84.7% were female, the most common indications for kidney replacement therapy (KRT) were fluid overload (86.4%) and elevated blood urea nitrogen/creatinine (74.6%). The mean follow-up duration was 3.9 years. AKI recovery without progression to kidney failure

					occurred in 37.3% of patients, while 25.4% experienced AKI recovery with later progression to kidney failure, and 35.6% did not recover from AKI. Factors associated with kidney failure included older age, severe tubular atrophy and interstitial fibrosis (>50%), and an NIH chronicity index score >4 on kidney biopsy.
7.	Gist, et al. ¹⁹ (2022)	USA	Retrospective cohort study	131 patients	In a study of 131 patients (median age 29 days, 51% male, 82% with underlying cardiac disease), the primary outcomes were mortality and hospital length of stay (LOS) among survivors. The hospital discharge survival rate was 45.8%. Fluid overload (FO+) at the time of ECMO discontinuation, but not acute kidney injury (AKI), was associated with increased mortality (adjusted odds ratio [aOR] = 2.3; 95% CI: 1.07–4.91). Patients with FO+ had twice the LOS compared to FO– patients, regardless of AKI status (FO+/AKI+: 60 days vs. FO–/AKI+: 30 days; P = 0.01).
8.	Safdar, et al. ²⁰ (2021)	UAE	Retrospective cohort study	1581 patients	In a study involving 1581 out of 6038 patients, acute kidney injury (AKI) occurred in 135 cases (8.5%), with 57% in stage 1, 31.1% in stage 2, and 11.9% in stage 3. Mortality was significantly higher in the AKI group (4.4%) compared to the non-AKI group (0.2%, P < 0.01). During long-term follow-up, 14.8% of patients did not return for

					assessment, while 58.5% of survivors fully recovered and 22.2% progressed to chronic kidney disease. Infants aged 1 month to 2 years were the most affected age group (26%). Common causes of admission included chemotherapy-induced AKI (31.9%) and pneumonia (10.4%). There was a significant inverse relationship between AKI occurrence and age group ($P < 0.001$) and a positive association between AKI and mortality ($P < 0.001$). However, no clear association was found between AKI stages and patient outcomes.
--	--	--	--	--	--

Bjornstad, et al.¹³ (2020) showed that AKI occurs in up to 10% of admitted pediatric trauma patients in Malawi and increases the risk of death sevenfold compared to those without AKI. Burn injuries were most commonly associated with AKI, occurring in 63.6% of cases, while other potential risk factors included multiple injuries, trunk or facial injuries, and recent consumption of herbal remedies.

Van den Eynde, et al.¹⁴ (2022) concluded that children who developed AKI after cardiac surgery had persistent kidney injury markers, highlighting the need for long-term kidney follow-up due to the risk of cardiovascular comorbidities associated with CKD.

Vivek, et al.¹⁵ (2023) showed that there was no difference between the groups in terms of all-cause mortality, fluid balance, and the need for kidney replacement therapy. The study concluded that furosemide infusion in AKI management did not reduce the progression to more severe AKI stages but was associated with higher morbidity.

Hirano, et al.¹⁶ (2020) found that posttransplant AKI is strongly associated with HSCT from MUD. Despite a high incidence of AKI, the incidence of posttransplant CKD was lower than previously reported in adults. To avoid late renal dysfunction after HSCT in children, it is necessary to reduce TBI doses, minimize graft-versus-host disease (GVHD), and prevent infections, as these factors may contribute to the occurrence of AKI.

Kanazawa, et al.¹⁷ (2024) showed that in pediatric patients receiving VCM, the risk of AKI increases with higher AUC, and the concurrent use of VCM and H2-

receptor blockers further elevates this risk. Univariate analysis identified the duration of VCM administration, ICU admission, and AUC as factors associated with AKI incidence.

Stotter, et al.¹⁸ (2023) concluded that children with lupus nephritis (LN) and stage 3D AKI have a high long-term risk of kidney failure, with severe tubular atrophy and interstitial fibrosis being predictive of disease progression, regardless of AKI duration.

Gist, et al.¹⁹ (2022) showed that FO+ at both ECMO initiation and discontinuation was associated with a significantly longer LOS, by 66% and 50% respectively. The study highlights the need for prospective research on the timing and strategies for fluid management, including fluid removal, in children undergoing extracorporeal cardiopulmonary resuscitation (ECPR).

Safdar, et al.²⁰ (2021) concluded that community-acquired AKI remains prevalent among pediatric patients, with higher mortality rates observed. Infants are particularly vulnerable, and a notable proportion of AKI cases progress to chronic kidney disease.

DISCUSSION

Pediatric renal injury, encompassing acute kidney injury (AKI) and its long-term consequences, represents a significant clinical challenge across diverse clinical settings. This systematic review synthesizes findings from recent studies exploring the prevalence, management strategies, and outcomes associated with pediatric renal injury.⁵

AKI incidence varies widely across different pediatric populations, highlighting its multifactorial

etiology and varying clinical contexts. Studies such as Bjornstad et al. (2020) underscore the severity of AKI in pediatric trauma patients, where up to 10% experience AKI, significantly increasing the risk of mortality compared to non-AKI counterparts. This underscores the critical need for effective triage and management strategies in trauma care settings.¹³

Following pediatric cardiac surgery, Van den Eynde et al. (2022) demonstrated that nearly one-fifth of patients developed AKI, with persistent kidney injury markers observed in a substantial proportion during long-term follow-up. The high prevalence of chronic kidney disease (CKD) stages 1 to 5 in these patients emphasizes the necessity of prolonged renal monitoring to mitigate long-term cardiovascular risks associated with CKD.¹⁴

In contrast, interventions like furosemide infusion in AKI management, as explored by Vivek et al. (2023), did not significantly alter the progression of AKI stages but were associated with prolonged hospital stays and higher rates of organ dysfunction. This highlights the complexity of pharmacological interventions in pediatric AKI management and calls for cautious implementation guided by robust clinical evidence.¹⁵

Posttransplant AKI remains a critical concern, particularly in hematopoietic stem cell transplantation (HSCT) recipients from matched unrelated donors (MUD), as evidenced by Hirano et al. (2020). Despite the high incidence of AKI post-transplantation, the lower-than-expected prevalence of posttransplant CKD suggests potential strategies focusing on

optimizing transplant protocols to mitigate renal complications.¹⁶

The pharmacokinetic dynamics of nephrotoxic medications, such as vancomycin (VCM), significantly contribute to AKI risk in pediatric populations, as highlighted by Kanazawa et al. (2024). Elevated area under the curve (AUC) of VCM and concurrent use of H2-receptor blockers were identified as independent risk factors for AKI, emphasizing the importance of tailored dosing and monitoring strategies in nephrotoxic drug administration.¹⁷

Long-term outcomes of pediatric AKI, particularly in conditions like lupus nephritis (LN), underscore the high risk of progression to kidney failure in severe AKI stages, as indicated by Stotter et al. (2023). Severe tubular atrophy and interstitial fibrosis serve as critical prognostic indicators, necessitating early intervention strategies to mitigate disease progression and improve renal outcomes.¹⁸

Fluid overload (FO) management in pediatric patients undergoing extracorporeal membrane oxygenation (ECMO) poses unique challenges, as highlighted by Gist et al. (2022). FO at ECMO discontinuation, rather than AKI itself, was associated with increased mortality and prolonged hospital stays, underscoring the critical role of fluid balance optimization in improving outcomes in this vulnerable population.¹⁹

Community-acquired AKI in pediatric patients, as observed by Safdar et al. (2021), remains a prevalent condition with substantial mortality rates, particularly among infants. The significant association between AKI and mortality

underscores the need for early recognition, prompt intervention, and ongoing surveillance to mitigate long-term renal complications.²⁰

Advances in understanding pediatric renal injury continue, but challenges remain in optimizing management and outcomes. Early detection, personalized protocols, and long-term surveillance are crucial. Future research should emphasize prospective studies to refine interventions and establish tailored guidelines for pediatric AKI management.

CONCLUSION

Pediatric renal injury, including acute kidney injury (AKI) and its long-term implications, presents a significant clinical challenge across diverse settings. Recent studies highlight varying AKI incidences and outcomes, underscoring the need for effective management strategies and long-term renal surveillance to mitigate mortality and chronic kidney disease risks.

REFERENCES

1. Harrois A, Libert N, Duranteau J. Acute kidney injury in trauma patients. *Curr Opin Crit Care*. 2017;23(6):447-456. doi:10.1097/MCC.00000000000000463
2. Yousefifard M, Toloui A, Forouzannia SA, et al. Prevalence and Mortality of Post-traumatic Acute Kidney Injury in Children; a Systematic Review and Meta-analysis. *Arch Acad Emerg Med*. 2022;10(1):e89. doi:10.22037/aaem.v10i1.1660
3. Haines RW, Fowler AJ, Kirwan CJ, Prowle JR. The incidence and associations of acute kidney injury in trauma patients admitted to critical care: A systematic review and meta-analysis. *J Trauma Acute Care Surg*. 2019;86(1):141-147. doi:10.1097/TA.0000000000002085
4. Burmeister DM, Gómez BI, Dubick MA. Molecular mechanisms of trauma-induced acute kidney injury: Inflammatory and metabolic insights from animal models. *Biochim Biophys Acta Mol Basis Dis*. 2017;1863(10 Pt B):2661-2671. doi:10.1016/j.bbadis.2017.04.011
5. Sethi SK, Bunchman T, Chakraborty R, Raina R. Pediatric acute kidney injury: new advances in the last

- decade. *Kidney Res Clin Pract.* 2021;40(1):40-51.
doi:10.23876/j.krcp.20.074
6. Jetton JG, Boohaker LJ, Sethi SK, et al. Incidence and outcomes of neonatal acute kidney injury (AWAKEN): a multicentre, multinational, observational cohort study. *Lancet Child Adolesc Health.* 2017;1(3):184-194.
doi:10.1016/S2352-4642(17)30069-X
7. Sanchez-Pinto LN, Goldstein SL, Schneider JB, Khemani RG. Association Between Progression and Improvement of Acute Kidney Injury and Mortality in Critically Ill Children. *Pediatr Crit Care Med J Soc Crit Care Med World Fed Pediatr Intensive Crit Care Soc.* 2015;16(8):703-710.
doi:10.1097/PCC.0000000000000461
8. Coleman C, Tambay Perez A, Selewski DT, Steflik HJ. Neonatal Acute Kidney Injury. *Front Pediatr.* 2022;10:842544.
doi:10.3389/fped.2022.842544
9. Kaddourah A, Basu RK, Bagshaw SM, Goldstein SL, AWARE Investigators. Epidemiology of Acute Kidney Injury in Critically Ill Children and Young Adults. *N Engl J Med.* 2017;376(1):11-20.
doi:10.1056/NEJMoA1611391
10. Cabral FC, Ramos Garcia PC, Mattiello R, et al. Influence of Acute Kidney Injury Defined by the Pediatric Risk, Injury, Failure, Loss, End-Stage Renal Disease Score on the Clinical Course of PICU Patients. *Pediatr Crit Care Med J Soc Crit Care Med World Fed Pediatr Intensive Crit Care Soc.* 2015;16(8):e275-282.
doi:10.1097/PCC.0000000000000516
11. Wang HY, Li YH, Zhang SS, et al. Application of Extracorporeal Membrane Oxygenation in Patients With Severe Acute Respiratory Distress Syndrome Caused by *Pneumocystis jirovecii* Pneumonia Following Kidney Transplantation: A Case Series. *Front Physiol.* 2022;13.

- doi:10.3389/fphys.2022.902465
12. Macedo E, Cerdá J, Hingorani S, et al. Recognition and management of acute kidney injury in children: The ISN 0by25 Global Snapshot study. *PloS One*. 2018;13(5):e0196586. doi:10.1371/journal.pone.0196586
13. Bjornstad EC, Muronya W, Smith ZH, et al. Incidence and epidemiology of acute kidney injury in a pediatric Malawian trauma cohort: a prospective observational study. *BMC Nephrol*. 2020;21(1):98. doi:10.1186/s12882-020-01755-3
14. Van den Eynde J, Salaets T, Louw JJ, et al. Persistent Markers of Kidney Injury in Children Who Developed Acute Kidney Injury After Pediatric Cardiac Surgery: A Prospective Cohort Study. *J Am Heart Assoc*. 2022;11(7):e024266. doi:10.1161/JAHA.121.024266
15. Vivek S, Rameshkumar R, Muthu M, et al. Furosemide in the management of acute kidney injury in the pediatric intensive care unit—retrospective cohort study. *Intensive Care Med – Paediatr Neonatal*. 2023;1(1):6. doi:10.1007/s44253-023-00010-5
16. Hirano D, Kakegawa D, Miwa S, et al. Independent risk factors and long-term outcomes for acute kidney injury in pediatric patients undergoing hematopoietic stem cell transplantation: a retrospective cohort study. *BMC Nephrol*. 2020;21(1):373. doi:10.1186/s12882-020-02045-8
17. Kanazawa N, Shigemi A, Amadatsu N, et al. A cohort study of the risk factors and the target AUC to avoid vancomycin-associated acute kidney injury in pediatric patients. *J Infect Chemother*. 2024;30(4):323-328. doi:10.1016/j.jiac.2023.10.025
18. Stotter BR, Cody E, Gu H, et al. Acute kidney injury

- requiring kidney replacement therapy in childhood lupus nephritis: a cohort study of the Pediatric Nephrology Research Consortium and Childhood Arthritis and Rheumatology Research Alliance. *Pediatr Nephrol.* 2023;38(5):1653-1665. doi:10.1007/s00467-022-05775-z
19. Gist KM, Misfeldt A, Sahay RD, et al. Acute Kidney Injury and Fluid Overload in Pediatric Extracorporeal Cardio-Pulmonary Resuscitation: A Multicenter Retrospective Cohort Study. *ASAIO J.* 2022;68(7):956. doi:10.1097/MAT.00000000000001601
20. Safdar O, Alaydarous SA, Arafsha Y, et al. Incidence and Outcome of Community-Acquired Acute Kidney Injury in Pediatric Patients Seen at an Emergency Department: A Retrospective Cohort Study. *Pediatr Emerg Care.* 2021;37(12):e1429. doi:10.1097/PEC.00000000000002065