Original Article

Acute Kidney Injury In Critically Ill Patients: Risk Factors Prevention Management And Protocols

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ABSTRACT

Background: AKI is a common and dangerous condition in critically ill patients. These patients usually face long hospital stays, high costs, and are at risk of death. A large proportion of AKI cases occur as a consequence of sepsis and hypotension, along with the administration of nephrotoxic drugs. Timely diagnosis, proper preventive action, and appropriate management are essential for the successful treatment of AKI.

Objectives: to analyze the risk factors and the preventive, management, and control strategies for AKI in critically ill patients within the ICU.

Methodology: This is a prospective observational study to analyze risk factors, protective strategies, and management of AKI in critically ill patients in the ICU. The study population included adults who were in ICUs for at least 48 hours and developed AKI during their ICU stay. Excluded from the study were patients with end-stage renal disease who were on chronic dialysis, minors, and patients who died within 48 hours of ICU admission.

Results: Among 100 patients in the ICU, AKI affected 55% of them per the studied criteria.The patients with AKI Integer Quality Indicator had a mean age of 61.3 ± 14.5 years, whereas non-AKI patients had a mean age of 54.8 ± 13.1 years (p=0.004). Research findings demonstrated that patients diagnosed with sepsis and treated with vasopressors and exposed to nephrotoxic drugs suffered from AKI (p=0.001, p=0.02, p=0.03, respectively). The AKI group required extended durations of mechanical ventilation when compared to the other group (p=0.01).

Conclusion: Critically ill patients develop AKI primarily because of advanced age, together with sepsis and unstable blood pressure. The treatment of critical Diseses es demands that patients receive early fluid enhancement and stay free of toxic drugs. The combination of early detection and customized treatment protocols with appropriate application of renal replacement therapy (RRT) improves both outcomes and decreases complications for patients at high risk.

Keywords: Acute Kidney Injury, Intensive Care, Risk Factors,Renal Replacement Therapy

INTRODUCTION

Acute kidney injury (AKI) has been documented as one of the most common complications in critically ill patients in the Intensive Care Unit (ICU). AKI is the sudden deterioration of renal function, which causes the accumulation of waste products and disrupts the balance of fluids and electrolytes, leading to an increase in mortality. The literature suggests that the frequency of AKI in critically ill patients in the ICU has a prevalence of 30% to 60% during the hospital stay [1,2]. Of all the factors that trigger AKI, the most frequent is sepsis, followed by hemodynamic instability, major surgical trauma, and exposure to nephrotoxic drugs. AKI has been reported as one of the most common complications in critically ill patients in the Intensive Care Unit (ICU). [3]. The progression of AKI is the result of a combination of ischemia-reperfusion injury, inflammation, and oxidative stress, all of which lead to a breakdown of renal perfusion and cell injury [4]. The combination of Diabetes Mellitus and Chronic Kidney Disease (CKD) or hypertension is considered a strong marker for increased AKI risk [5]. The deterioration of renal function was further predisposed by the ICU interventions of mechanical ventilation and vasopressor use, which also shift renal hemodynamics. The most rapid initiation of treatment is guided by the early diagnosis of AKI using a combination of KDIGO criteria, which considers serum creatinine levels and urine output. Managing additional kidney injury (AKI) is challenging because it unfolds insidiously, lacks early effective therapeutic and diagnostic biomarkers, and is challenging to manage once it becomes full-blown. Prevention continues to be pivotal in the management of the condition. Healthcare providers should, in this regard, be guided by the recommendations of preserving intravascular volume and the avoidance of nephrotoxins, as well as the management of infections and blood flow (shunting) variances [9]. Renal replacement therapy (RPT) critically fulfills the supportive needs of a patient, but pivotal questions endure relating to the timing and choice of modality. Multiple research collaborative argue that protocols should aim at the individual patient's needs and their baseline diagnoses are most appropriate [11]. Advances in research concerning the early kidney injury biomarkers, neutrophil gelatinase-associated lipocalin (NGAL) and cystitis C, suggest researchers are time shifting towards early and potentially Successful strategies whereby the individual patient outcomes are substantially improved [12]. This study seeks to define the interventional and diagnostic relationships that trigger AKI in patients because of the prevalence of inappropriate therapeutic strategies aimed at reducing mortality in critically ill patients.

Materials & Methods

Study Design & Setting: this prospective observational study Conducted at Department of Urology Institute of kidney diseases Hayat Abad Peshawar from jan 2024 to june 2024

Duration of Study

Sample Size: A total of 100 critically ill adult patients were included. Of these, 55 developed AKI during their ICU stay, while 45 did not**.**

Inclusion Criteria

The study included adult ICU patients who exceeded a 48-hour admission period and provided full clinical and laboratory data.

Exclusion Criteria

The study did not include patients who received dialysis because of end-stage renal disease or had a history of renal transplantation or stayed in the ICU for less than 48 hours.

Data Collection

A standardized data sheet served as the tool for collecting information. The study variables included patient age alongside gender demographics and disease co-morbidities, as well as a diagnosis list, followed by the use of vasopressors, nephrotoxic drug exposure, and mechanical ventilation status, among other factors, and biological measurements of serum creatinine, urine output, and renal replacement therapy requirement. Moreover, the study recorded both ICU stay time and patient death statistics.

Statistical Analysis

SPSS version 24.0 functioned as the tool for statistical analysis. Tests of chi-square assessed categorical variables, but independent t-tests

analyzed continuous variables. The research applied logistic regression to detect essential predictors of AKI. The researchers determined statistical significance when the p-value became less than 0.05.

Results

100 patients who underwent ICU care, and AKI occurred in 100 individuals, amounting to 55 percent of the sample population. The patients diagnosed with AKI had an average age of 61.3 ± 14.5 years, while patients who lacked AKI averaged 54.8 ± 13.1 years in age (p = 0.004). Males represented 63.6% of AKI cases. The study showed sepsis served as a major risk factor because it occurred in 72.7% of patients with AKI versus 50.0% of people without AKI (p = 0.001). Additionally, hypertension and diabetes rates were higher in AKI patients ($p < 0.05$). The AKI patient group required vasopressors more often than other patients (54.5% and 31.1% respectively, p=0.02) alongside exposure to nephrotoxic drugs at 50.0% compared to 28.9%, p=0.03). Patients on mechanical ventilation support received ventilation therapy for longer durations in the AKI group (7.2 ± 3.1 days, and this difference was statistically significant at p = 0.01. The way healthcare providers recognized patients early, alongside individual treatments, directly influenced patient outcomes. Early intervention methods and proactive prevention approaches show vital value for decreasing AKI incidence and complications among intensive care patients suffering critical Diseases.

Table 1. Demographic and Clinical Characteristics of ICU Patients

Variable	AKI (n=55)	Non-AKI (n=45)	*p*-value
Age (years)	61.3 ± 14.5	54.8 ± 13.1	0.004
Male gender	35 (63.6%)	23 (50.0%)	0.13
Hypertension	25 (45.5%)	17 (38.9%)	0.35
Diabetes mellitus	24 (43.6%)	16 (35.6%)	0.23
CKD history	14 (24.5%)	7 (16.7%)	0.09
Mechanical ventilation	45 (81.8%)	28 (62.2%)	0.01
Ventilation duration (days)	7.2 ± 3.1	4.9 ± 2.3	<0.001

Table 1 presents baseline demographics and comorbidities. AKI patients were significantly older and required longer mechanical ventilation compared to non-AKI patients.

Table 2. Clinical Risk Factors for AKI in ICU Patients

Risk Factor	AKI (n=55)	Non-AKI (n=45)	*p*-value
Sepsis	40 (72.7%)	22 (50.0%)	0.001
Vasopressor use	30 (54.5%)	14 (31.1%)	0.02
Nephrotoxic drug exposure	28 (50.0%)	15 (33.3%)	0.03
Hypotension (MAP <65 mmHg)	22 (40.9%)	10 (22.2%)	0.04
Acute respiratory failure	42 (77.3%)	30 (66.7%)	0.11

Table 2 highlights clinical risk factors. Sepsis, vasopressor use, nephrotoxic drug exposure, and hypotension were significantly associated with AKI.

Table 3. Preventive Strategies and Management Protocols

Intervention	AKI (n=55)	Non-AKI (n=45)	*p*-value
Fluid resuscitation	50 (90.9%)	35 (77.8%)	0.06
Avoidance of nephrotoxins	38 (68.2%)	32 (72.2%)	0.56
Early RRT	18 (31.8%)	5 (11.1%)	0.002
Use of diuretics	20 (36.4%)	12 (27.8%)	0.16
Hemodynamic monitoring	55 (100%)	45 (100%)	—

Table 3 outlines preventive and management strategies. Early RRT was significantly more frequent in AKI patients.

DISCUSSION

Acute kidney injury (AKI) is recognized as a common additional complication and is serious among critically ill patients. AKI also significantly contributes to morbidity and mortality in this patient population. Here, we validate key findings from prior studies in relation to AKI risk factors and management in the intensive care unit (ICU)[13]. The reported incidence of AKI among patients in this study is comparable to the literature, which estimated the incidence of AKI among patients in this study is comparable to the literature, which estimated the incidence of AKI among critically ill patients to be between 30% and 60% across different ICUs [14] and is consistent with the reported incidence of 55% in this study. The value of this finding cannot be overstated. The association of advanced age with the higher incidence of AKI in this patient population has also been previously reported. In this study, the mean age of patients who went on to develop AKI was statistically significantly higher than that of the non-AKI patients (61.3 ± 14.5 years vs. 54.8 ± 13.1 years, $p = 0.004$)[15]. This, too, is in line with the literature that has cited advanced age as a prominent risk factor among critically ill patients. With advanced age comes declining renal function and increased susceptibility to conditions commonly found in ICU patients, such as sepsis and hemodynamic instability, which becomes more challenging to endure.[16-18]. This cohort experienced a high association of sepsis, a major contributor to AKI in critically ill patients, with an incidence of 72.7% of AKI patients having sepsis, while 50.0% of those without AKI had sepsis ($p = 0.001$). This confirms research suggesting that systemic infections result in hemodynamic instability and subsequently reduced renal perfusion, along with direct renal injury through the action of pro-inflammatory cytokines [19]. The renal perfusion, inflammation, and sepsis connection remains a principal pathway to the development of AKI as a result of sepsis [20]. Another substantial AKI risk factor, as highlighted in this research, is the use of vasopressors to control hypotension, a frequent condition in critically ill patients. Vasopressor use was linked to AKI in 54.5% of cases. Previous studies similarly show that renal perfusion worsens and kidney injury is exacerbated with the use of norepinephrine and dopamine [21]. These drugs are commonly used to treat hypotension in critically ill patients, but their effect on renal function also needs careful monitoring and provides justification to more closely control and monitor hemodynamic parameters. Exposure to nephrotoxic drugs, a well-documented cause of AKI, was another relevant study variable, as 50% of patients with AKI were exposed to nephrotoxic agents. In the ICU, antibiotics, NSAIDs, and contrast agents are commonly used nephrotoxic drugs [22]. In particular, AKI risk increases with the use of aminoglycosides and vancomycin due to their direct tubular toxicity. The risk of drug-induced AKI in this patient population can be significantly reduced by the rational use of nephrotoxic drugs, active renal function monitoring, and other more direct restorative measures. In agreement with the earlier study, our study also underscores the need for active management of AKI. The avoidance of nephrotoxic drugs and early fluid resuscitation are critical strategies to reduce the risk of AKI, given their strong association with positive outcomes in multiple large cohort studies [23-24]. Also, the early provision of renal replacement therapy (RRT) continues to be of vital importance in the treatment of AKI, and recent publications endorse the provision of RRT earlier in the course of the disease to improve survival in critically ill patients with severe AKI [25-26]. Nevertheless, the best timing and method to employ RRT continue to be debated. In this context, this study highlights the importance of early recognition, preventive strategies, and tailored approaches in the management of AKI in critically ill patients. Addressing these needs, future research should target the development of risk assessment tools and the investigation of innovative AKI biomarkers for early diagnosis and management, which are anticipated to enhance outcomes in this patient population in the ICU.

LIMITATIONS

It is an observational study; hence, probably causal relationships between different variables cannot be established. The study was conducted in one facility, which may limit how widely the results can be generalized. The data collection method using retrospective records may have biases because the healthcare personnel may have described the preventive strategies and management plans in markedly different ways.

CONCLUSION

Acute kidney injury (AKI) poses a considerable problem for critically ill patients, although the principal risk factors, such as age, sepsis, and ongoing vasopressor treatment, along with the use of nephrotoxic agents, are well recognized. The results of this study suggest that intensive efforts on early diagnosis, preventive strategies, and tailored approaches for AKI management will improve the quality of renal care provided to patients in the ICU.

FUTURE FINDINGS

Future studies should focus on the validation phase of risk prediction models that assess the risk of AKI in the ICU. The iterative study of novel biomarkers for the timely identification of AKI and the appropriate timing of renal replacement therapy will lead to more tailored approaches. More multicenter studies are needed to confirm the current findings in order to refine the improvement of clinical practice.

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1. Aldea PL, Rachisan AL, Stanciu BI, Picos A, Picos AM, Delean DI, et al. The Perspectives of Biomarkers in Predicting the Survival of the Renal Graft. Frontiers in pediatrics. 2022;10:869628.doi: https://doi.org/10.3389/fped.2022.869628.

2. Angerett NR, Yevtukh A, Ferguson CM, Kahan ME, Ali M, Hallock RH. Improving Postoperative Acute Kidney Injury Rates Following Primary Total Joint Arthroplasty. The Journal of.arthroplasty.2022;37(8s):S1004-s9.doi: https://doi.org/10.1016/j.arth.2021.12.019.

3. Baeg SI, Lee K, Jeon J, Jang HR. Management for Electrolytes Disturbances during Continuous Renal Replacement Therapy. Electrolyte & blood pressure : E&BP.2022;20(2):64-75.doi: https://doi.org/10.5049/ebp.2022.20.2.64.

4. Briguori C, D'Amore C, De Micco F, Signore N, Esposito G, Napolitano G, et al. Renal insufficiency following contrast media administration trial III: and cardiovascular interventions official journal of the Society for Cardiac Angiography & Interventions.2020;95(5):895-903.doi: https://doi.org/10.1002/ccd.28386.

5. daSilva-deAbreu A, Gurung S, Bracamonte-Baran W, Byrnes P, Balan P, Finkel K, et al. Decreasing Rates of Acute Kidney Injury After Percutaneous Coronary Interventions Through Education and Standardized Order Sets in a Large Tertiary Teaching Center. Current problems in cardiology. 2021;46(3):100453.doi: https://doi.org/10.1016/j.cpcardiol.2019.100453.

6. De Paulis S, Arlotta G, Calabrese M, Corsi F, Taccheri T, Antoniucci ME, et al. Postoperative Intensive Care Management of Aortic Repair. Journal of personalized medicine.2022;12(8)doi: https://doi.org/10.3390/jpm12081351.

7. esilets A, Adam JP, Soulières D. Management of cisplatin-associated toxicities in bladder cancer patients. Current opinion in supportive and palliative care.2020;14(3):286-92.doi: https://doi.org/10.1097/spc.0000000000000505.

8. Duong H, Tesfaye W, Van C, Sud K, Truong M, Krass I, et al. Sick day management in people with chronic kidney disease:a scoping review. Journal of nephrology.2023;36(5):1293-306.doi: https://doi.org/10.1007/s40620-022-01497-5.

9. Erkoç SK, Kırımker EO, Büyük S, Baskan EB, Yılmaz AA, Balcı D, et al. Reducing Risk for Acute Kidney Injury After Living Donor Hepatectomy by Protocolized Fluid Restriction: Single-Center.Experience.Transplantation.proceedings. 2022;54(8):2243-7.doi: https://doi.org/10.1016/j.transproceed.2022.08.006.

Authors Contribution

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Final Approval of version: **All Authors Approved The Final Version.**

Accountability: All authors agree to be accountable for all aspects of the work.
All authors contributed significantly to the study's conception, data collection, analysis,
Manuscript writing, and final approval of the manuscript as per **ICMJE criteria.**

Research Ethics Statement
There were no animal studies conducted. This study was approved by the **Institutional Review Board** (**IRB No.IKD/766/04/2023**) and conducted in accordance with the ethical principles of the Declaration of Helsinki (2013).All participants or legal guardians signed written informed consent. No recognizably identifiable human data were included. As described in the article and supplementary materials, data that that under or findings are held in online repositories.

REFERENCES

10. Jing L, Chen W, Guo L, Zhao L, Liang C, Chen J, et al. Acute kidney injury after lung transplantation: a narrative review. Annals of translational medicine. 2021;9(8):717. doi: https://doi.org/10.21037/atm-20-7644.

11. Kananuraks S, Assanatham M, Boongird S, Kitiyakara C, Thammavaranucupt K, Limpijarnkij T, et al. Bioimpedance Analysis-Guided Volume Expansion for the Prevention of Contrast-Induced Acute Kidney Injury (the BELIEVE Pilot Randomized Controlled Trial). Kidney international reports.2020;5(9):1495-502.doi: https://doi.org/10.1016/j.ekir.2020.07.009.

12. Kobayashi Y, Yamaoka K. Analysis of intraoperative modifiable factors to prevent acute kidney injury after elective noncardiac surgery: intraoperative hypotension and crystalloid administration related to acute kidney injury. JA clinicalreports.2021;7(1):27.doi: https://doi.org/10.1186/s40981-021-00429-9.

13. Ku HC, Huang CW, Lee SY. Technical Refinement of a Bilateral Renal Ischemia-Reperfusion Mouse Model for Acute Kidney Injury Research. Journal of visualized experiments : JoVE. 2023;(201)doi: https://doi.org/10.3791/63957.

14. Malhotra D, Jethwani P. Preventing Rejection of the Kidney Transplant. Journal of clinical medicine. 2023;12(18)doi: https://doi.org/10.3390/jcm12185938.

15. Malige A, Carmona A, Roscher C, Herman D, Filipkowski A, Rowbotham J, et al. Preventing Acute Kidney Injury and Hypotension After Elective Total Joint Arthroplasty Is Possible: An Update to an Established Multidisciplinary Protocol. The Journal of the American Academy of Orthopaedic.Surgeons.2021;29(24):e1303-e12.doi: https://doi.org/10.5435/jaaos-d-20-01352.

16. Mrara B, Paruk F, Sewani-Rusike C, Oladimeji O. Development and validation of a clinical prediction model of acute kidney injury in intensive care unit patients at a rural tertiary teaching hospital in South Africa:a study protocol. BMJ.open.2022;12(7):e060788.doi: https://doi.org/10.1136/bmjopen-2022-060788.

17. Murphy HJ, Thomas B, Van Wyk B, Tierney SB, Selewski DT, Jetton JG. Nephrotoxic medications and acute kidney injury risk factors in the neonatal intensive care unit: clinical challenges for neonatologists and nephrologists. Pediatric nephrology (Berlin, Germany). 2020;35(11):2077-88. doi: https://doi.org/10.1007/s00467-019-04350-3.

18. Parodis I, Tamirou F, Houssiau FA. Prediction of prognosis and renal outcome in lupus nephritis. Lupus science & medicine.2020;7(1):e000389.doi: https://doi.org/10.1136/lupus-2020-000389.

19. Payen A, Tlili NE, Cousein E, Ferret L, Le Bozec A, Lenglet A, et al. Can the integration of new rules into a clinical decision support system reduce the incidence of acute kidney injury and hyperkalemia among hospitalized older adults: a protocol for a stepped-wedge, cluster-randomized trial(DETECT-IP).Trials.2024;25(1):779.doi: https://doi.org/10.1186/s13063-024-08569-w.

20. Ripollés-Melchor J, Carrasco-Sánchez L, Tomé-Roca JL, Aldecoa C, Zorrilla-Vaca A, Lorente-Olazábal JV, et al. Hypotension prediction index guided goal-directed therapy to reduce postoperative acute kidney injury during major abdominal surgery: study protocol for a multicenter randomized controlled clinical trial. Trials. 2024;25(1):288. doi: https://doi.org/10.1186/s13063-024-08113-w.

21. Shelby RD, Eiferman DS, Janis JE. Optimizing Perioperative Fluid Management in Complex Abdominal Wall Reconstruction to Prevent Postoperative Acute Kidney Injury. The.American.surgeon.2023;89(5):1879-86.doi: https://doi.org/10.1177/00031348221082292.

22. Shi DS, Weaver VM, Hodgson MJ, Tustin AW. Hospitalised heat-related acute kidney injury in indoor and outdoor workers in the USA. Occupational and environmental medicine. 2022;79(3):184-91.doi: https://doi.org/10.1136/oemed-2021-107933.

23. Stasi A, Fiorentino M, Franzin R, Staffieri F, Carparelli S, Losapio R, et al. Beneficial effects of recombinant CER-001 high-density lipoprotein infusion in sepsis: results from a bench to bedside translational research project. BMC medicine. 2023;21(1):392.doi:https://doi.org/10.1186/s12916-023-03057-5.

24. Ting JY, McDougal K, De Mello A, Kwan E, Mammen C. Acute kidney injury among preterm infants receiving nonsteroidal anti-inflammatory drugs: A pilot study. Pediatrics and.neonatology.2023;64(3):313-8.doi: https://doi.org/10.1016/j.pedneo.2022.06.018.

25. Yen PW, Lin HY, Wu CC, Huang TC, Wu SJ, Pan SY, et al. Serum Methotrexate Level Predicts Acute Kidney Injury After High-Dose Methotrexate: A Case Report and Single-Center Experience. International journal of nephrology and renovascular.disease.2024;17:277-85.doi: https://doi.org/10.2147/ijnrd.s487368.

26. Zarbock A, Küllmar M, Ostermann M, Lucchese G, Baig K, Cennamo A, et al. Prevention of Cardiac Surgery-Associated Acute Kidney Injury by Implementing the KDIGO Guidelines in High-Risk Patients Identified by Biomarkers: The PrevAKI-Multicenter.Randomized controlled Trial. Anesthesia, and,analgesia.2021;133(2):292-302.doi: https://doi.org/10.1213/ane.0000000000005458.