Section: Emergency Medicine

Original Research Article

STUDY ON EVALUATION OF SEPSIS ASSOCIATED ACUTE KIDNEY INJURY (SA-AKI) IN ICU OF A TERTIARY CARE HOSPITAL

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ABSTRACT

Background: Sepsis, a common cause of critical illness, is significantly associated with high morbidity, mortality, and often acute kidney injury (AKI), termed sepsis-associated acute kidney injury (SA-AKI) when it occurs in this context. While the link between sepsis and AKI has been explored, the absence of a reproducible and standardized consensus definition has hindered the clarity of available research.

Materials and Methods: This retrospective study was conducted in the Department of Emergency Medicine, Kamineni academy of medical sciences and research centre, L.B Nagar, Hyderabad, Telangana, India. over a period of one year, i.e. from Nov 2022-2023. The study included patients aged 18 years and above with diagnosis of sepsis with AKI. Out of the 250 patients who had been diagnosed with sepsis, 150 patients had AKI.

Results: Patients with AKI had higher serum creatinine levels than non-AKI group. Presence of septic shock, higher APACHE III score, lower mean arterial pressure, positive blood cultures for bacteria and higher in-hospital mortality are few other parameters which were found at significant levels in patients with AKI.

Conclusion: Addressing complications and identifying at-risk patients for early intervention are vital in improving survival rates and outcomes for SA-AKI.

Keywords: Sepsis, acute kidney injury, smoker, diabetic, hospital mortality, septic shock.

INTRODUCTION

Sepsis is a frequent cause of critical illness that carries significant risks of morbidity and mortality. Among its many complications, one of the most critical is acute kidney injury (AKI), commonly referred to as sepsis-associated acute kidney injury (SA-AKI) when it occurs in the setting of sepsis.[1,2] Despite the importance of this association, previous studies have been hampered by the lack of a reproducible and standardized consensus definition for SA-AKI, thereby limiting the interpretability and application of available research findings.[3,4]

Recognizing this gap, the Acute Disease Quality Initiative (ADQI) 28 Workgroup recently formulated a precise definition for SA-AKI. This definition combines the presence of sepsis, as defined by the Sepsis-3 criteria, with AKI, as defined by the Kidney Disease Improving Global Outcomes (KDIGO) criteria, occurring within seven days of sepsis diagnosis. By establishing this standardized definition, ADQI aimed to facilitate more consistent and comparable research outcomes and ultimately improve patient care.[5-7]

Despite this significant advance, the epidemiology of SA-AKI among critically ill patients remains largely unexplored. Key aspects such as its

incidence, patient characteristics, timing, trajectory, treatment modalities, and associated outcomes have not been thoroughly studied. This lack of data presents challenges for healthcare providers who need to anticipate and manage this condition effectively.

To address these gaps, we hypothesized that SA-AKI is a common condition among patients admitted to intensive care units (ICUs) and aimed to test this primary hypothesis empirically. Additionally, we aimed to test secondary hypotheses that could further illuminate the nature of SA-AKI.

MATERIAL AND METHODS

The retrospective study was conducted in the Department of Emergency Medicine, Kamineni academy of medical sciences and research centre, L.B Nagar, Hyderabad, Telangana, India. over a period of one year, i.e. from Nov 2022 to 2023.

The study included medical records of all patients aged 18 years and above who had been diagnosed with sepsis. Out of the 250 medical records studied, 150 had sepsis with AKI.

History of the patients at the time of admission was taken with special emphasis on history of presence of any co-morbidities, history of any substance abuse (drugs, NSAID's steroids, alcohol, nicotine). The vital data (heart rate, blood pressure, temperature, respiratory rate) at the time of admission were collected. Laboratory investigations done at the time of admission was collected.

The definition of sepsis was taken from the 2021 revised international consensus for sepsis and septic shock, i.e. increase in Sequential Organ Failure Assessment (SOFA) score by two points with proven or suspected infection. Sepsis is defined as a life-threatening organ failure caused by the host's inappropriate response to infection. Septic shock is defined as a subtype of sepsis with a criteria for diagnosing of: hypotension requiring vasopressor therapy to maintain MAP >65 mmHg and serum lactate levels > 2 mmol/L even after appropriate management of hypovolemia.[8]

Definition and Staging of AKI

Urine output was measured on hourly basis during the ICU stay. AKI cutoffs were established using the RIFLE criteria, which included: a decrease in GFR by at least 25% or an increase in creatinine by at least 50% (1.5 times) from baseline within a 48-hour period, or a reduction in urine output with documented oliguria of 0.5 mL/kg per hour or less for a minimum of 6 hours. Patients were classified into three groups based on the RIFLE criteria (stage 1, stage 2, and stage 3). Stage 1 AKI was defined when the above criteria were met. For more severe conditions—a decrease in GFR by 50% or greater, an increase in creatinine by 100% (2 times) from baseline within a 48-hour timeframe, or a reduction in urine output with documented oliguria of 0.5 mL/kg per hour or less for at least 12 hours—stage 2 AKI was defined. Stage 3 AKI was characterized by a decrease in GFR by 75% or more, an increase in creatinine by 200% (3 times) from baseline within a 48-hour period, a reduction in urine output with documented oliguria of 0.3 mL/kg per hour or less for at least 24 hours, or anuria for at least 12 hours. Additionally, a serum creatinine level of 4.0 mg/dL or higher with an acute increase of 0.5 mg/dL or more was also considered stage 3 AKI.

All data was analyzed using SPSS software. Comparisons were drawn using Student t- test. Categorical data was reported as proportions and comparisons were made using Fisher test. Odds ratio and 95% confidence intervals (CI) were calculated. P value of <0.05 was considered statistically significant.

RESULTS

The mean age of patients with septic AKI and patients without AKI was 64.67 ± 12.83 years and 57.24 ± 16.43 years respectively. There was significant difference in mean age between the 2 groups.

In both groups, males were involved more than females. Patients without AKI were relatively more obese than patients without AKI. Higher number of patients with AKI has history of smoking/ alcohol consumptions / diabetes / hypertension. However, there is no significant difference.

The baseline serum creatinine levels was significantly higher in patients with AKI. The baseline eGFR was significantly lower in AKI patients. [Table 1]

In present study, septic shock was predominantly seen in patients with AKI. This difference was significant. The mean APACHE III score was higher in patients with AKI. Mean arterial pressure was lower in patients with AKI.

The difference between presence of septic shock, APCACHE III score, mean arterial pressure, and presence of positive blood cultures was significant. [Table 2]

The hospital mortality and duration of hospital stay was significantly higher in AKI group than non-AKI group. [Table 3]

Table 1: Patient characteristics of Sepsis and Septic Shock

	No AKI (n=100, 40%)	AKI (n=150, 60%)	p value
Age (in years)	57.24 ± 16.43	64.67 ± 12.83	<0.005
No. of males: No. of females	85; 15	125; 25	0.054
BMI, kg/m^2	23.78 ± 3.89	21.98 ± 4.61	0.874
Smoking history	80	134	0.247
History of alcohol abuse	64	115	0.954

History of diabetes mellitus	74	161 (28.3)	0.249
History of hypertension	58	124	0.847
Baseline serum creatinine, mg/dL	0.47 ± 0.82	0.94 ±0.48	<0.005
Baseline eGFR, mL/min/1.73 m^2	124.45 ± 35.47	107.45 ± 47.20	<0.005
History of CKD	7	28	<0.005

Table 2: Physiologic and Laboratory Data on Admission

	No AKI (n = 100)	AKI (n = 150)	p value
Presence of shock	10	80	<0.001
Mean APACHE III score	48.2	58.7	<0.001
Mean arterial pressure, mm Hg	92.47 mmHg	83.33 mmHg	<0.001
Mean heart rate	84.2 beats/min	89.4 beats/min	0.514
Arterial pH	7.41	7.44	0.079
Arterial oxygen pressure, mmHg	83.4 mmHg	86.24 mmHg	0.084
Arterial carbiondioxide pressure	33.2 mmHg	32.4 mmHg	0.570
Serum bicarbonate levels	22.4 mmol/l	22.4 mmol/L	0.055
Total WBC count	11420 cells/mm^3	11980 cells/mm^3	0.052
Packed cell volume	34.9%	35.2%	0.760
Platelet count	194000	187000	0.06
Serum glucose levels	137.2 mg/dL	128.2 mg/dL	0.09
Serum blood urea nitrogen levels(BUN)	19.4 mg/dL	19.6 mg/dL	0.962
Serum total bilirubin, mg/dL	0.91 mg/dL	0.98 mg/dL	0.721
Positive blood cultures	10	35	<0.005
Gram negative bacilli	5	28	<0.005
Gram positive cocci	4	19	<0.005
Fungi	0 (0)	4	0.024

Table 3: Clinical Outcomes

	No AKI	AKI	*p* value
Hospital mortality	4	25	<0.001
Hospital LOS, days	9.11 ± 7.39	15.52 ± 18.26	<0.001
ICU LOS, days	0.59 ± 2.29	2.69 ± 8.32	<0.001

DISCUSSION

Sepsis is a severe organ dysfunction triggered by a dysregulated immune response to infection, with acute kidney injury (AKI) being a frequent and critical complication in septic shock patients. The global incidence of sepsis-associated AKI (S AKI) is estimated to be substantial, contributing significantly to mortality in affected patients.

In present study, out of the 250 patients with sepsis, 150 had AKI and 100 did not have AKI thus the prevalence of AKI in present study is 60%.

The mean age of patients with septic AKI was significantly higher than patients without AKI. Males were more affected in both groups. Patients with AKI were more likely to be smokers / alcoholics / diabetic / hypertensive.

According to study by Plataki et al,[9] which was conducted on 390 patients with sepsis, every 2 out of 3 persons had AKI. Bagshaw et al,[4] also observed a similar prevalence of AKI as in present study.

In present study the patients with AKI had significantly higher levels of serum creatinine than patients without AKI. In the study by White et al,[11] most of the patients had higher levels of serum creatinine levels.

Most of the patients with AKI had septic shock. This difference was found to statistically significant. Patients with AKI had significantly higher APACHE III score and lower mean arterial pressure. In a study conducted by Langenberg et al,[12] dysfunction of renal vascular bed is the main factor regulating AKI in sepsis rather than hypoperfusion.

In present study, patients with AKI had higher mortality and longer duration of stay. White et al,[11] observed that patients who had only low urine output without any deranged GFR had relatively lower mortality rate and shorter hospital stay than SA-AKI patients who had.

Effective management of SA-AKI includes early antibiotic therapy, fluid resuscitation with balanced crystalloids, and avoiding nephrotoxic medications. Vasoactive agents like norepinephrine are preferred over dopamine in treating septic shock, and angiotensin II has shown benefits in restoring blood pressure and renal function. Renal replacement therapy (RRT) is crucial for severe AKI, and early initiation of RRT has been associated with improved outcomes, while higher doses of continuous RRT (70 mL/kg/h) do not necessarily enhance survival.

The major limitation of the study is small sample size which is not representative of the entire population.

CONCLUSION

The study concludes that males, patients with history of smoking, alcohol abuse, diabetics, and

hypertensive are at higher risk of developing AKI in sepsis than normal patients. Large sample size based studies and further research is required to better understand the pathophysiological processes of SA-AKI and thus develop novel therapeutic strategies to mitigate kidney injury in sepsis.

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Conflicts of Interest: No conflicts of interest are declared.

REFERENCES

1. Poston JT, Koyner JL (2019) Sepsis associated acute kidney injury. BMJ 364: k4891.
2. Peerapornratana S, Manrique Caballero CL, Gómez H, Kellum JA (2019) Acute kidney injury from sepsis: current concepts, epidemiology, patho physiology, prevention and treatment. Kidney Int 96(5):1083–1099.
3. Bagshaw SM, Uchino S, Bellomo R, Morimatsu H, Morgera S, Schetz M, et al. Septic acute kidney injury in critically ill patients: clinical characteristics and outcomes. Clin J Am Soc Nephrol 2007; 2:431-9
4. Bagshaw SM, George C, Bellomo R, Committee ADM (2008) Early acute kidney injury and sepsis: a multicentre evaluation. Crit Care 12(2): R47.
5. Zarbock A, Nadim MK, Pickkers P, Gomez H, Bell S, Joannidis M et al (2023) Sepsis associated acute kidney injury: consensus report of the 28th Acute Disease Quality Initiative workgroup. Nat Rev Nephrol. https://doi.org/10.1038/s41581 023 00683 3
6. Singer M, Deutschman CS, Seymour CW, Shankar Hari M, Annane D, Bauer M et al (2016) The third international consensus definitions for sepsis and septic shock (Sepsis 3). JAMA 315(8):801–810
7. Khwaja A (2012) KDIGO clinical practice guidelines for acute kidney injury. Nephron Clin Pract 120(4):c179–c184
8. Srzić I, Nesek Adam V, Tunjić Pejak D. SEPSIS DEFINITION: WHAT'S NEW IN THE TREATMENT GUIDELINES. Acta Clin Croat. 2022 Jun;61(Suppl 1):67-72. doi: 10.20471/acc.2022.61. s1.11. PMID: 36304809; PMCID: PMC9536156.
9. Plataki M, Kashani K, Cabello-Garza J, Maldonado F, Kashyap R, Kor DJ, Gajic O, Cartin-Ceba R. Predictors of acute kidney injury in septic shock patients: an observational cohort study. Clinical Journal of the American Society of Nephrology. 2011 Jul 1;6(7):1744-51.
10. Bellomo R, Ronco C, Kellum JA, Mehta RL, Palevsky P, ADQI workgroup. Acute renal failure–definition, outcome measures, animal models, fluid therapy and information technology needs: the Second International Consensus Conference of the Acute Dialysis Quality Initiative (ADQI) Group. Critical care. 2004 Aug; 8:1-9.
11. White, K.C., Serpa-Neto, A., Hurford, R. et al. Sepsis-associated acute kidney injury in the intensive care unit: incidence, patient characteristics, timing, trajectory, treatment, and associated outcomes. A multicenter, observational study. Intensive Care Med 49, 1079–1089 (2023). https://doi.org/10.1007/s00134-023-07138-0
12. Langenberg C, Wan L, Egi M, May CN, Bellomo R. Renal blood flow and function during recovery from experimental septic acute kidney injury. Intensive care medicine. 2007 Sep; 33:1614-8.