

Economics of Acute Kidney Injury in the Critical Care Setting: Kidneys Need More Time and Money!

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Abstract

Background: Acute kidney injury (AKI) is a frequent complication among critically ill patients, contributing significantly to morbidity, mortality, and healthcare costs. Despite its impact, limited studies exist on the economic burden of AKI, particularly in the Indian healthcare context.

Methods: From January to April 2021, we conducted a single-center, cross-sectional observational study at Kasturba Medical College, Manipal. The study included 132 patients directly admitted to the medical intensive care unit (ICU). Demographic and clinical data, including AKI etiology, healthcare costs, and insurance coverage, were collected and analyzed.

Results: Of the 132 patients, 57.6% developed AKI, with sepsis identified as the leading cause (78%). Patients with AKI incurred significantly higher total healthcare costs (US\$ 2452.4 vs. US\$ 1556.8, $P < 0.001$) and experienced longer ICU stays (8 days vs. 4 days, $P < 0.001$) compared to those without AKI. Among AKI patients, 85.5% required hemodialysis. While 61% of patients had some form of health insurance, predominantly government-sponsored plans, coverage was limited, with a median reimbursement rate of 35.8%.

Conclusion: AKI represents a substantial economic burden for critically ill patients, marked by higher costs and prolonged ICU stays. A deeper understanding of these financial implications is essential for guiding resource allocation and shaping healthcare policies to mitigate the economic impact of AKI.

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Introduction

Acute kidney injury (AKI) is a prevalent condition in intensive care units (ICUs), often occurring as a complication of various systemic diseases, including infections.¹ AKI significantly contributes to patient morbidity and mortality, but its impact extends beyond clinical outcomes. The condition imposes a substantial economic burden, significantly increasing hospitalization costs. These expenses are primarily driven by the need for advanced renal replacement therapies (RRT) and

prolonged hospital stays required to manage AKI.²

Despite its considerable financial implications, studies on the economic burden of AKI remain limited, both globally and in India. Investigating the costs associated with AKI in critically ill patients can provide valuable insights with both short-term and long-term benefits. In the short term, such research can help healthcare providers counsel patients' families, enabling them to better prepare for the financial challenges of treatment. In the long term, studies like ours can highlight the economic impact of AKI, informing policy

changes and aiding government and insurance agencies in designing more effective healthcare schemes. These schemes can allocate resources more efficiently to address the management of AKI.

Methods

This was a single-center, cross-sectional observational study conducted at Kasturba Medical College, Manipal, between January 2021 and April 2021. After obtaining informed consent, all patients directly admitted to the medical intensive care unit (ICU) during the study period were included. Patients were excluded if they received treatment in ICUs at other hospitals before admission at our institution or had an ICU stay of less than 48 hours. The institutional ethics committee approved the study and registered prospectively in the Clinical Trials Registry-India (CTRI) under reference number REF/2021/08/046028.

Demographic details of the patients, including age, gender, monthly income, and funding source, were collected. Clinical information such as co-morbid conditions, clinical diagnosis, and the presence or absence of AKI was also documented. AKI was defined according to the KDIGO criteria. For patients without a baseline estimated GFR (eGFR) before hospitalization, inclusion required an absolute increase in serum creatinine of 0.3 mg/dL after the onset of illness.

Additional data specific to AKI, including etiology, staging, and the requirement for hemodialysis, were collected. Hospitalization costs, including expenses related to AKI management, were recorded and analyzed. Direct costs associated with nephrology services, such as nephrology consultations, hemodialysis catheter insertion, and hemodialysis sessions, were included. The total cost was calculated from the day of ICU admission until discharge or death.

Insurance coverage details, including the extent of coverage, were also obtained and analyzed. Costs were initially calculated in Indian Rupees and converted to US Dollars based on the average prevailing exchange rate during the study period.

Statistical Analysis

Demographic data and baseline characteristics were summarized using mean (\pm standard deviation), median (interquartile range), or numbers with percentages, as appropriate. The etiology of AKI was illustrated using pie charts created with Microsoft Excel 2019.

Patients were categorized into two groups based on the presence or absence of AKI. Variables between these groups were compared using the Mann-Whitney U or unpaired t-test for continuous variables and the chi-square test for categorical variables. A P value of

<0.05 was considered statistically significant.

All statistical analyses were performed using SPSS software, version 19.

Results

The study included 132 patients. The baseline characteristics of the study population are detailed in Table 1. The mean age of the participants was 58.17 years (± 15.03). Among the study population, 76 patients (57.6%) developed AKI.

Table 1: Baseline Characteristics of Patients in the Cohort of Critically Ill Patients

Baseline Characteristics	Overall (n=132)
Age (years)*	58.17 (± 15.03)
Males (n,%)	97 (73.5)
Availability of health insurance (n,%)	81 (61.3)
Acute Kidney Injury (n,%)	76 (57.6)
Diabetes Mellitus (n,%)	54 (40.9)
Hypertension (n,%)	55 (41.7)
Chronic Kidney Disease (n,%)	15 (11.4)
Number of ICU days (n)#	6 (3-11)
Total days of hospitalization	9 (5-16)
Cost of hospitalization (US\$)#	1803.3 (1188.3-3064.2)

ICU: Intensive care unit; *Expressed as mean and standard deviation; #Expressed as median with inter-quartile range

The median duration of an ICU stay was 6 days, and the median cost of hospitalization was US\$1803.3 (IQR: 1188.3–3064.2). Approximately 60% of patients had health insurance to cover hospitalization costs.

Sepsis was identified as the leading cause of AKI, accounting for 78% of cases (Figure 1).

AKI versus No AKI

Among the 132 patients included in the study, 76 (57.6%) were diagnosed with AKI. The total cost of care was significantly higher for patients with AKI, with a median price of US\$ 2452.4 (IQR 1371.8–3747.2) compared to US\$ 1556.8 (IQR 995.8–1993.4) for those without AKI ($P < 0.001$) (Table 2). Notably, costs directly related to nephrology services accounted for a median of 8.87% (IQR 5.54–13.06) of the total care expenses.

Additionally, ICU stay duration was markedly more prolonged in patients with AKI, with a median of 8 days (IQR 4–15) compared to 4 days (IQR 3–8) for patients without AKI ($P < 0.001$). Among the AKI patients, 65 (85.5%) required hemodialysis, with a median of 3 sessions (IQR 2–5).

Availability of Health Insurance

Overall, approximately 61% of patients had some form of health insurance. Among those with insurance, government-sponsored insurance was the most commonly availed (42%).

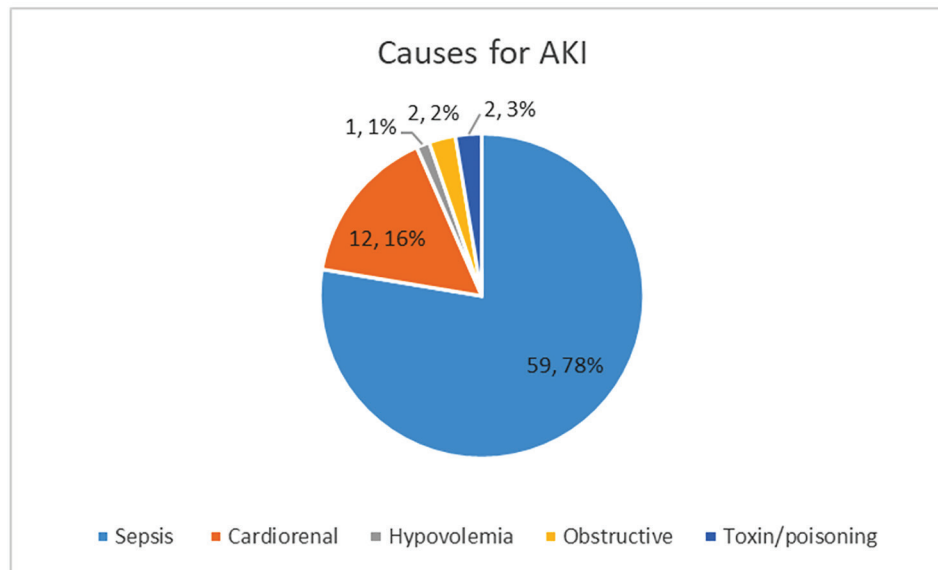


Figure 1: Etiological Factors Associated with Acute Kidney Injury

Table 2: Comparison of characteristics between AKI and non-AKI groups

Variable	AKI (n=76)	Non AKI (n=56)	P value
Age (years)*	59.5 (±12.27)	58.12(±14.92)	0.218
Health insurance (n,%)	44 (57.8)	37 (66)	0.152
Overall cost of hospitalization (US\$)	2452.4 (1371.8-3747.2)	1556.8 (995.8-1993.4)	<0.001
Direct cost related to Nephrology services (US\$)	210.2 (143.4-378.6)	NA	NA
% cost due to Nephrology [#]	8.87 (5.54-13.06)	NA	NA
ICU days [#]	8 (4-15)	4 (3-8)	<0.001
Total days of hospitalization	12 (6-16)	8 (5-13)	<0.001

AKI: Acute kidney injury; *Expressed as mean and standard deviation; [#]Expressed as median with inter-quartile range; ICU: Intensive care unit; NA: Not applicable

However, despite health insurance, only a median of 35.8% (IQR 23.4–57.6) of the overall bill was covered, with the remaining amount needing to be paid out-of-pocket by the patients.

Discussion

Our study has shed light on the underexplored economic implications of acute kidney injury (AKI) in the ICU. While the clinical consequences of AKI, particularly its contribution to morbidity and mortality, are well-established, our research aims to look beyond these clinical implications to reveal the profound economic burden that often goes unnoticed.

Our study was not explicitly designed to examine the epidemiological aspects of acute kidney injury (AKI) in the ICU; however, there were some notable findings. More than 50% of our patients developed AKI during their ICU stay. This is similar to the study by Mo et al., where AKI was observed in 53.5% of ICU patients.³ The more extensive multicenter AKI-EPI study also reported an AKI incidence of 57%, as defined by the KDIGO criteria.⁴ Data from Indian studies are primarily from single centers, with AKI incidence varying from 16.1% to 33% in critical care units.⁵⁻⁷ This highlights the relevance of AKI in

managing patients in the ICU. The etiology of AKI in the ICU setting is always multifactorial, but, as in existing studies, sepsis continues to be a significant contributing factor in our cohort. This is in agreement with sizeable international cohort studies,⁸⁻¹⁰ as well as Indian studies.^{11, 12}

Patients admitted with AKI had significantly higher hospitalization costs in our study. This finding is consistent with a study by Samuel et al., which examined a large database of inpatients in the United States.² The study showed an increase in the number of days hospitalized for patients with AKI, which was similar to our study.² Possible reasons for the increased costs associated with AKI in patients may include prolonged hospital stays,¹³ additional expenses related to dialysis,¹⁴ or AKI indicating a multiorgan illness that necessitates a higher level of care.¹⁵

With the increasing cost of hospitalization due to AKI in the critical care setting, the economic burden either falls on individuals and their families or insurance companies. Very few studies have examined insurance coverage for hospitalization, especially in private-sector hospitals in India. In our cohort of critically ill patients, nearly 40% had to bear the burden of costs individually due to the

absence of insurance. Despite 60% of patients having some form of insurance, our data reveals that only a median of 35.8% of the total costs were covered. This finding underscores a critical concern—the gap between insurance coverage and the remaining out-of-pocket patient expenses. In developed countries like the United States and the United Kingdom, extensive nationwide studies have estimated the costs associated with AKI to be around \$24 billion and \$1.8 billion, respectively.^{2, 16} The stark revelation that AKI escalates overall hospitalization expenditure cannot be understated.

Our findings demonstrate that acute kidney injury (AKI) is not merely an affliction of physiological derangement but a formidable financial challenge. In the short term, these findings may help healthcare professionals counsel and prepare patients' families for the economic challenges that lie ahead. In the long term, they should prompt healthcare professionals and policymakers to approach AKI as a medical concern and a significant fiscal challenge that warrants targeted interventions. Our findings also highlight the need for comprehensive insurance coverage that effectively safeguards patients from financial hardship.

However, our study has its limitations. It is a single-center study with a relatively small sample size. Therefore, it may not capture the full economic implications across diverse patient populations. A larger and more diverse sample could provide a more comprehensive picture of the economic burden of AKI.

Conclusion

Acute kidney injury (AKI) is associated with significant hospitalization costs, especially in patients with critical illness. On the one hand, insurance needs to be more comprehensive and universal; on the other, measures are required to prevent AKI and reduce overall healthcare spending.

Conflict of Interest: None declared.

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