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Study of Acute Kidney Injury in Patients with Severe Respiratory Infections

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ABSTRACT

Background: Severe respiratory infections can affect organs beyond the lungs, and acute kidney injury is one of the important complications seen in hospitalized patients. Its presence can worsen the clinical course and increase the risk of adverse outcomes.

Objectives: To assess the occurrence of acute kidney injury in patients admitted with severe respiratory infections and to examine the factors associated with its development and outcome.

Materials and Methods: This hospital-based observational study was conducted among adult patients admitted with severe respiratory infections at a tertiary care centre. Demographic details, clinical features, comorbid illnesses, laboratory findings, and treatment requirements were recorded. Acute kidney injury was identified using standard KDIGO criteria based on serum creatinine changes and urine output. Patients were further evaluated for severity of illness, need for intensive care, ventilatory support, vasopressor requirement, duration of hospital stay, and in-hospital outcome. Statistical analysis was performed to compare patients with and without acute kidney injury and to identify significant associations.

Results: A total of 120 patients with severe respiratory infections were included in the study. Of them, 34 patients (28.3%) developed acute kidney injury during hospitalization. AKI was more frequent among patients aged more than 60 years (41.2% vs. 24.4%), and among those with diabetes mellitus (47.1% vs. 26.7%) and hypertension (52.9% vs. 30.2%). The mean serum creatinine at admission was higher in the AKI group (1.9 ± 0.6 mg/dL) compared to the non-AKI group (0.9 ± 0.3 mg/dL). Patients who developed AKI had higher C-reactive protein levels (68.4 ± 18.2 mg/L vs. 39.7 ± 14.5 mg/L) and lower oxygen saturation at presentation (86.3 ± 5.4% vs. 91.8 ± 3.9%). Intensive care unit admission was required in 23 patients (67.6%) in the AKI group, compared to 21 patients (24.4%) in the non-AKI group. Mechanical ventilation was needed in 16 patients (47.1%) with AKI and 12 patients (14.0%) without AKI. The mean duration of hospital stay was longer in patients with AKI (11.8 ± 3.6 days) than in those without AKI (7.2 ± 2.8 days). In-hospital mortality was markedly higher in the AKI group (29.4%) compared to the non-AKI group (8.1%).

Conclusion: Acute kidney injury was observed in more than one-fourth of patients admitted with severe respiratory infections and was associated with older age, comorbid conditions, greater inflammatory response, higher need for critical care support, and poorer outcome. Careful renal monitoring and early supportive management may help reduce complications in these patients.

Keywords: *Acute kidney injury; severe respiratory infections; renal dysfunction; intensive care; mechanical ventilation; mortality.*

INTRODUCTION

Severe respiratory infections remain a leading cause of hospitalisation and mortality across the world, particularly in low- and middle-income countries. Conditions such as severe community-acquired pneumonia, viral pneumonitis, influenza, and more recently coronavirus infections, are frequently associated with systemic involvement beyond the lungs [1,2].

While respiratory compromise is the primary concern, it is now well recognised that these infections can trigger a cascade of inflammatory and haemodynamic changes affecting multiple organ systems, including the kidneys [3,4].

Acute kidney injury (AKI) is one of the most important extra-pulmonary complications observed in patients with severe respiratory illness. It is characterised by an abrupt decline in renal function, reflected by a rise in serum creatinine and/or reduction in urine output [5]. The reported incidence of AKI in patients with severe respiratory infections varies widely depending on disease severity, patient profile, and healthcare setting, ranging from 10% in general ward admissions to over 40% in critically ill patients [6,7]. The occurrence of AKI in this context is clinically significant, as it is associated with prolonged hospital stay, increased need for renal replacement therapy, and higher mortality [8,9].

The pathophysiology of AKI in severe respiratory infections is multifactorial. Hypoxaemia resulting from impaired gas exchange can lead to renal tubular injury due to reduced oxygen delivery [10]. In addition, systemic inflammatory response and cytokine release contribute to endothelial dysfunction, microvascular injury, and altered renal perfusion [11]. Haemodynamic instability, especially in patients requiring vasopressor support, further compromises renal blood flow [12]. Sepsis-associated mechanisms, including immune dysregulation and direct cellular injury, also play a crucial role in the development of AKI [13].

Another contributing factor is the use of potentially nephrotoxic medications such as antibiotics, antivirals, and contrast agents, which are often required in the management of severe infections [14]. Mechanical ventilation, particularly with high positive end-expiratory pressure, can affect renal perfusion by altering intrathoracic pressure and cardiac output [15]. Furthermore, underlying comorbid conditions such as diabetes mellitus, hypertension, and chronic kidney disease predispose patients to a higher risk of renal injury during acute illness [16,17].

In recent years, the burden of AKI in respiratory infections has gained renewed attention, especially during the COVID-19 pandemic, where a significant proportion of hospitalised patients developed renal complications [18,19]. Studies have demonstrated that AKI in such patients is not merely a secondary finding but an independent predictor of poor prognosis [20]. Despite increasing awareness, there is still a need for region-specific data to better understand the incidence, risk factors, and outcomes of AKI in patients with severe respiratory infections.

Early identification of patients at risk of AKI is crucial, as timely intervention may prevent progression to severe stages and reduce complications. Monitoring renal function, optimising haemodynamic status, avoiding nephrotoxic agents when possible, and ensuring appropriate supportive care are essential components of management [21,22]. However, clinical data from many tertiary care settings in India remain limited, particularly regarding the interplay between respiratory severity and renal dysfunction.

In this context, the present study was undertaken to evaluate the occurrence of acute kidney injury in patients admitted with severe respiratory infections, to analyse associated clinical and laboratory factors, and to assess its impact on patient outcomes.

MATERIALS AND METHODS

Study Design and Setting

This investigation was carried out as a hospital-based observational study in the Departments of General Medicine and Pulmonary Medicine at Government Medical College, Mahabubnagar, Telangana. The institution serves as a tertiary care referral centre for surrounding districts, receiving a wide spectrum of respiratory illnesses, including severe and complicated cases. The study was conducted over a period of 15 months, from January 2025 to March 2026. This duration allowed inclusion of patients across different seasonal variations, which is relevant for respiratory infections that often show temporal trends. The observational design was chosen to assess real-world clinical patterns and outcomes without altering routine patient management.

Study Population

The study population comprised adult patients admitted with clinical features suggestive of severe respiratory infections. These included conditions such as severe community-acquired pneumonia, viral pneumonitis, and acute respiratory distress syndrome. Only patients aged 18 years and above were considered, as the disease profile and renal response differ significantly in paediatric populations. Both male and female patients were included to ensure a representative sample. Patients were enrolled consecutively during the study period to minimise selection bias and to reflect the actual burden of disease encountered in the hospital.

Inclusion Criteria

Patients were included if they met predefined criteria to ensure uniformity in diagnosis. Eligible participants were those aged 18 years or older with clinical features of severe respiratory infection, including fever, cough, breathlessness, and hypoxia requiring hospital admission. Radiological evidence of lung involvement, confirmed by chest X-ray or computed tomography, was mandatory for inclusion. Patients who required inpatient care due to the severity of their illness were considered appropriate for evaluating systemic complications such as acute kidney injury.

Exclusion Criteria
Certain categories of patients were excluded to avoid confounding factors that could independently influence renal function. Individuals with known chronic kidney disease, those already on dialysis, or those with documented renal impairment at the time of admission were not included. Patients with primary renal diseases or obstructive uropathy were also excluded to ensure that any renal dysfunction observed during the study was attributable to the acute illness. Additionally, patients who were discharged or expired within 24 hours of admission were excluded, as adequate evaluation of renal parameters over time was not feasible in such cases. Cases with incomplete clinical or laboratory data were also omitted to maintain data integrity.

Sample Size and Sampling Method
A convenient sampling method was adopted, wherein all eligible patients admitted during the study period were included. This approach was practical given the hospital-based setting and ensured continuous enrolment without selective inclusion. A total of 120 patients fulfilling the inclusion criteria were enrolled in the study. The sample size was considered adequate to provide meaningful insights into the occurrence of acute kidney injury and its associated factors in this clinical setting.

Data Collection
Data were collected using a structured and predesigned proforma to ensure consistency and completeness. Baseline demographic details such as age and gender were recorded, along with clinical information including presenting symptoms, duration of illness, and relevant medical history. Particular attention was given to comorbid conditions such as diabetes mellitus, hypertension, and cardiovascular diseases, as these are known to influence both respiratory severity and renal outcomes.

On admission, vital parameters including blood pressure, pulse rate, respiratory rate, and oxygen saturation were documented. Laboratory investigations were performed as part of routine clinical care and included complete blood count, renal function tests, serum electrolytes, and liver function tests. Inflammatory markers such as C-reactive protein were also measured to assess the degree of systemic inflammation. Radiological findings were evaluated based on chest X-ray or CT scan reports, which helped confirm the diagnosis and assess the extent of lung involvement. Patients were followed throughout their hospital stay, and relevant clinical events were recorded systematically.

Assessment of Acute Kidney Injury
Renal function was assessed using serial measurements of serum creatinine and monitoring of urine output. Acute kidney injury was defined according to the Kidney Disease Improving Global Outcomes (KDIGO) criteria, which provide a standardised framework for diagnosis and staging. Patients were categorised into different stages of AKI based on the magnitude of increase in serum creatinine and the degree of reduction in urine output. This classification enabled objective comparison of renal involvement across the study population and helped in assessing the severity of kidney injury.

Assessment of Disease Severity
The severity of respiratory illness was evaluated using a combination of clinical findings and supportive investigations. Parameters such as the degree of breathlessness, oxygen saturation levels, and requirement for supplemental oxygen were considered. Patients requiring admission to the intensive care unit, mechanical ventilation, or vasopressor support were classified as having severe disease. Arterial blood gas analysis, where available, was used to assess the extent of hypoxia and respiratory compromise. This stratification helped in correlating disease severity with the occurrence of acute kidney injury.

Treatment and Monitoring
All patients were managed according to standard treatment protocols followed at the institution. Treatment modalities included oxygen therapy, appropriate antimicrobial agents, antiviral drugs when indicated, corticosteroids, and general supportive care. Fluid management was carefully monitored to maintain adequate hydration while avoiding fluid overload, particularly in patients with respiratory compromise. The use of potentially nephrotoxic medications was noted, and efforts were made to minimise their impact wherever possible. Patients were regularly monitored for changes in renal function, urine output, and haemodynamic status. The need for renal replacement therapy, such as dialysis, was documented in patients who developed severe kidney injury.

Outcome Measures
The primary outcome of interest was the development of acute kidney injury during the course of hospitalisation. Secondary outcomes included duration of hospital stay, requirement for intensive care unit admission, need for mechanical ventilation, and in-hospital mortality. These outcomes were chosen to understand the clinical impact of AKI on disease progression and patient prognosis.

Statistical Analysis
All collected data were entered into Microsoft Excel and analysed using appropriate statistical software. Continuous variables were expressed as mean with standard deviation, while categorical variables were presented as frequencies and percentages. Comparative analysis between patients with and without acute kidney injury was performed using the chi-

square test for categorical variables and the independent t-test for continuous variables. Associations between clinical variables and the occurrence of AKI were assessed, and a p-value of less than 0.05 was considered statistically significant.

Ethical Considerations

The study was conducted after obtaining approval from the Institutional Ethics Committee of Government Medical College, Mahabubnagar. Written informed consent was obtained from all participants or their legally authorised representatives prior to enrolment. Patient confidentiality was maintained throughout the study by anonymising data and restricting access to authorised personnel only. The study adhered to standard ethical principles for biomedical research involving human participants.

RESULTS:

Baseline Characteristics of Study Population

A total of 120 patients with severe respiratory infections were analysed. Among them, 34 patients developed acute kidney injury, giving an overall incidence of 28.3%. The remaining 86 patients did not show any evidence of renal involvement during their hospital stay (Table 1).

Patients who developed AKI were noticeably older. The mean age in the AKI group was around 62 years, whereas those without AKI had a mean age just above 50 years. This difference was statistically significant, indicating that advancing age played an important role in susceptibility to renal injury.

Gender distribution did not show any meaningful difference between the two groups. Although males were slightly more in both groups, this variation was not statistically significant.

Comorbid conditions, however, showed a clear association. Nearly half of the patients with AKI were diabetics, compared to about one-fourth in the non-AKI group. Similarly, hypertension was present in more than half of the AKI group, while it was seen in less than one-third of those without AKI. Both these associations reached statistical significance, suggesting that underlying metabolic and vascular conditions increase the risk of renal complications in severe respiratory illness. Smoking history did not show a significant difference between the groups.

Table 1: Demographic and Clinical Characteristics

Parameter	AKI (n = 34)	Non-AKI (n = 86)	χ^2 / t-value	p-value
Age (years)	61.8 ± 14.2	51.3 ± 17.1	t = 3.01	0.003*
Male (%)	22 (64.7%)	50 (58.1%)	χ^2 = 0.45	0.50
Diabetes Mellitus	16 (47.1%)	23 (26.7%)	χ^2 = 4.63	0.03*
Hypertension	18 (52.9%)	26 (30.2%)	χ^2 = 5.24	0.02*
Smoking History	14 (41.2%)	29 (33.7%)	χ^2 = 0.62	0.43

*Values expressed as mean ± SEM or frequency (%). *p < 0.05 considered statistically significant.*

Clinical Presentation and Severity Indicators

Clinical presentation at admission differed markedly between patients who developed AKI and those who did not. Oxygen saturation levels were significantly lower in the AKI group, reflecting more severe hypoxia. On average, patients with AKI presented with oxygen saturation in the mid-80s, while those without AKI maintained levels above 90% (Table 2).

Respiratory rate was also higher among patients with AKI, indicating greater respiratory distress at presentation. This difference was statistically significant and supports the observation that more severe lung involvement is linked with renal dysfunction.

The need for intensive care support further highlighted the severity of illness. More than two-thirds of patients with AKI required ICU admission, whereas only about one-fourth of non-AKI patients needed such care (Figure 1). Similarly, mechanical ventilation was required in nearly half of the AKI group compared to a small proportion in the non-AKI group. These differences were highly significant, emphasising that AKI tends to occur in patients with more severe respiratory compromise.

Table 2: Clinical Severity Parameters

Parameter	AKI (n = 34)	Non-AKI (n = 86)	t-value	p-value
SpO_2 (%)	86.3 ± 5.4	91.8 ± 3.9	5.87	<0.001*
Respiratory Rate (/min)	28.6 ± 4.8	23.9 ± 3.7	5.21	<0.001*
ICU Admission	23 (67.6%)	21 (24.4%)	χ^2 = 18.2	<0.001*
Mechanical Ventilation	16 (47.1%)	12 (14.0%)	χ^2 = 14.6	<0.001*

*Values expressed as mean ± SEM or frequency (%). *Statistically significant.*

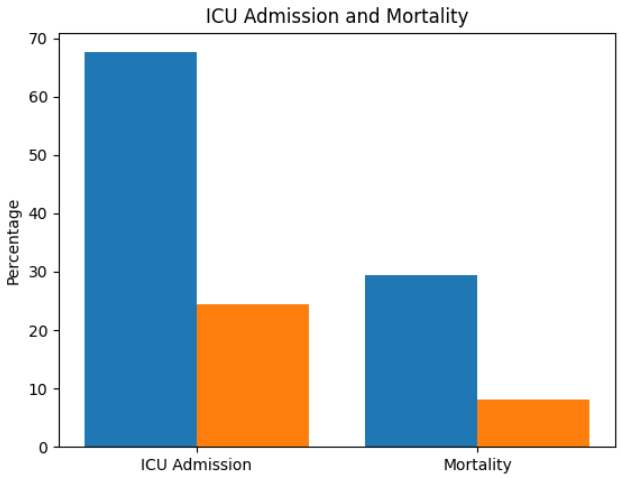

Figure 1: ICU Admission and Mortality in AKI versus Non-AKI Patients

Laboratory Parameters

Laboratory parameters revealed clear differences between the two groups. Patients who developed AKI had significantly higher serum creatinine levels, indicating impaired renal function. Blood urea levels were also markedly elevated in this group, further supporting the presence of renal dysfunction (Table 3).

Inflammatory markers such as C-reactive protein were considerably higher in patients with AKI. This suggests that a heightened inflammatory response may contribute to the development of kidney injury (Figure 2 & 3).

Haemoglobin levels were slightly lower in the AKI group compared to the non-AKI group, and this difference was statistically significant. Although the reduction was modest, it may reflect the overall severity of illness and underlying comorbid conditions.

Table 3: Laboratory Findings

Parameter	AKI (n = 34)	Non-AKI (n = 86)	t-value	p-value
Serum Creatinine (mg/dL)	1.9 ± 0.6	0.9 ± 0.3	9.12	<0.001*
Blood Urea (mg/dL)	64.3 ± 18.5	32.7 ± 12.1	8.21	<0.001*
CRP (mg/L)	68.4 ± 18.2	39.7 ± 14.5	7.01	<0.001*
Hemoglobin (g/dL)	10.8 ± 1.6	11.6 ± 1.4	2.64	0.009*

Values expressed as mean ± SEM. *p < 0.05 significant.

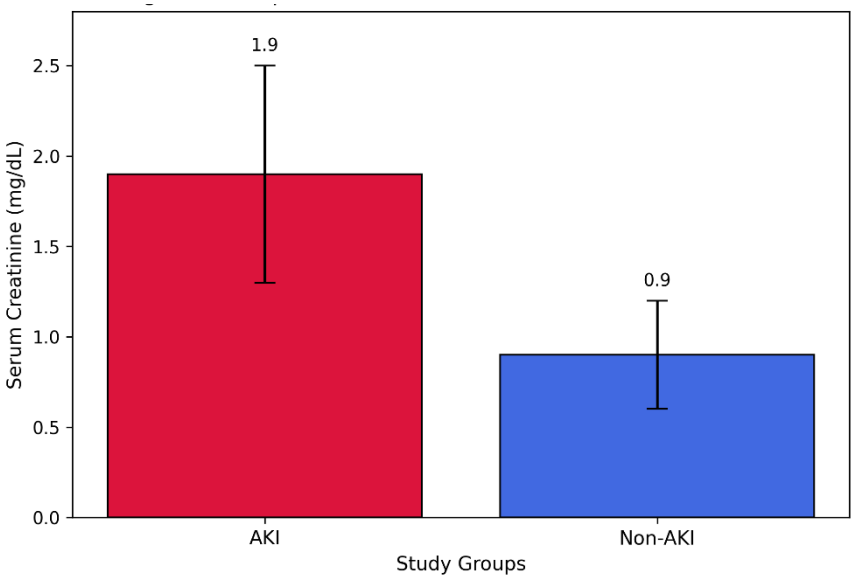

Figure 2: Comparison of Serum Creatinine Levels between AKI and Non-AKI Groups

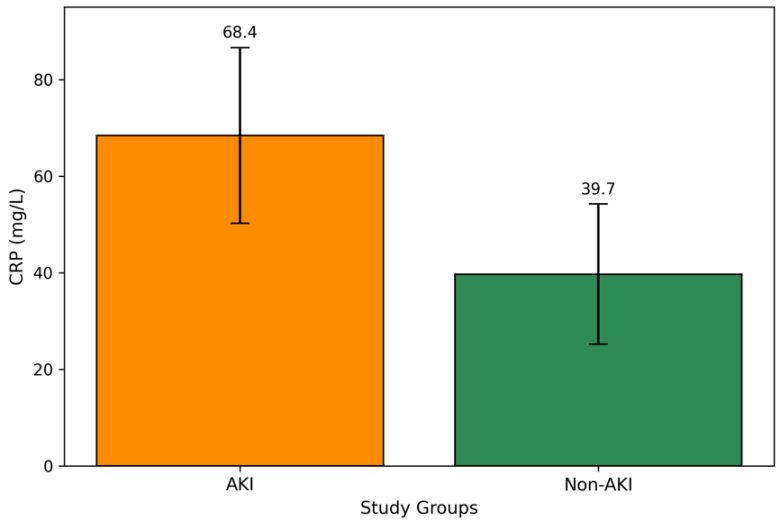

Figure 3: Comparison of C-Reactive Protein (CRP) Levels between AKI and Non-AKI Groups

Staging of Acute Kidney Injury

Among the patients who developed AKI, the majority were in the early stage of the disease. Stage 1 AKI accounted for just over 40% of cases, making it the most common presentation. Stage 2 was seen in about one-third of patients, while approximately one-fourth progressed to Stage 3 (Figure 4).

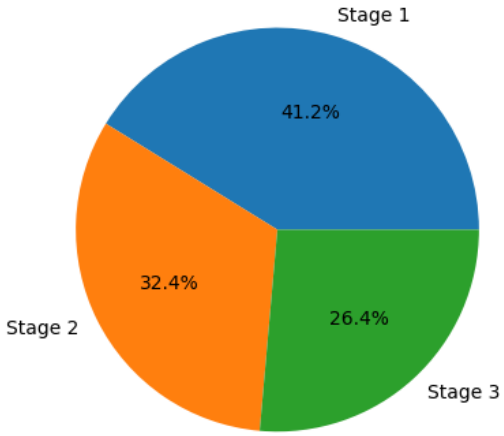

Figure 4: Distribution of Acute Kidney Injury Stages among Affected Patients

Patients in the higher stages of AKI showed more severe clinical course, including increased need for dialysis and poorer outcomes. This pattern indicates that progression of AKI severity is closely linked to worsening prognosis.

Treatment and Clinical Outcomes

The development of AKI had a significant impact on clinical outcomes. Patients with AKI had a longer duration of hospital stay, averaging nearly 12 days, compared to just over 7 days in those without AKI. This difference was statistically significant and reflects increased complexity of management (Table 4).

Renal replacement therapy was required only in the AKI group, with nearly one-fourth of these patients undergoing dialysis. None of the patients in the non-AKI group required such intervention, highlighting the severity of renal involvement.

Mortality rates were also substantially higher among patients with AKI. Nearly one-third of patients in the AKI group did not survive, compared to less than 10% in the non-AKI group. This difference was statistically significant and indicates that AKI is a strong predictor of poor outcome in patients with severe respiratory infections.

Table 4: Outcome Measures

Outcome	AKI (n = 34)	Non-AKI (n = 86)	χ^2 / t-value	p-value
Hospital Stay (days)	11.8 ± 3.6	7.2 ± 2.8	t = 7.21	<0.001*
Dialysis Required	8 (23.5%)	0 (0%)	χ^2 = 21.3	<0.001*
Mortality	10 (29.4%)	7 (8.1%)	χ^2 = 9.72	0.002*

Values expressed as mean ± SEM or frequency (%). *Statistically significant.

The findings clearly show that acute kidney injury is not an isolated complication but is closely linked with the severity of respiratory illness. Older age, presence of comorbid conditions, greater hypoxia, and higher inflammatory response were all associated with the development of AKI.

Patients with AKI required more intensive care, had longer hospital stays, and experienced significantly higher mortality. These observations underline the importance of early recognition and careful monitoring of renal function in patients admitted with severe respiratory infections.

DISCUSSION:

The present study evaluated the occurrence and clinical implications of acute kidney injury in patients admitted with severe respiratory infections. A considerable proportion of patients, nearly one-third of the study population, developed AKI during hospitalisation. This finding aligns with earlier reports indicating that renal involvement is a frequent complication in patients with severe pulmonary infections, particularly in those requiring hospital or intensive care support [1,2].

One of the important observations in this study was the higher age among patients who developed AKI. Elderly individuals are known to have reduced renal reserve and are more vulnerable to haemodynamic fluctuations and hypoxic injury during acute illness. Previous studies have also shown that advancing age is a significant risk factor for AKI in critically ill patients [3,4]. The present findings reinforce the need for closer monitoring of renal function in older patients admitted with severe respiratory disease.

Comorbid conditions such as diabetes mellitus and hypertension were significantly associated with the development of AKI. These conditions are known to cause chronic microvascular changes, which may predispose the kidneys to injury during acute stress. Similar associations have been reported in earlier studies, where metabolic and vascular comorbidities increased susceptibility to renal dysfunction in both infectious and non-infectious critical illness [5,6]. The presence of these comorbidities may therefore serve as an early indicator of risk in clinical practice.

The severity of respiratory illness appeared to have a strong relationship with the occurrence of AKI. Patients who developed renal injury had lower oxygen saturation levels and higher respiratory rates at presentation, indicating more severe hypoxia. Hypoxaemia can directly affect renal tubular cells by reducing oxygen delivery and promoting cellular injury [7]. In addition, a greater proportion of patients with AKI required intensive care admission and mechanical ventilation. This observation is consistent with earlier studies where AKI was more common among patients with severe respiratory compromise and those requiring advanced life support [8,9].

Inflammation seems to play a central role in the development of AKI in this setting. In the present study, patients with AKI had significantly higher levels of C-reactive protein, suggesting an exaggerated inflammatory response. Systemic inflammation can lead to endothelial dysfunction, microcirculatory impairment, and altered renal perfusion, all of which contribute to kidney injury [10,11]. Similar findings have been reported in sepsis-related AKI and in viral respiratory infections, where cytokine-mediated injury is a key mechanism [12].

Laboratory findings further supported the presence of renal dysfunction, with higher serum creatinine and blood urea levels in the AKI group. These changes reflect impaired glomerular filtration and accumulation of nitrogenous waste products. The observation of lower haemoglobin levels in patients with AKI may be related to the severity of illness, underlying comorbidities, or haemodilution due to fluid therapy. Although modest, this difference was statistically significant and may have clinical relevance.

The staging of AKI revealed that most patients were in the early stage at diagnosis, with Stage 1 being the most common. However, a substantial number progressed to more advanced stages. This progression highlights the dynamic nature of AKI and the importance of early identification. Patients in higher stages of AKI had worse outcomes, including increased need for dialysis and higher mortality. This pattern is consistent with established literature, where severity of AKI correlates directly with prognosis [13,14].

The impact of AKI on clinical outcomes was clearly evident in this study. Patients with AKI had significantly longer hospital stays, reflecting the added complexity in management and recovery. The requirement for renal replacement therapy in a subset of patients further indicates the severity of renal involvement. Importantly, mortality was markedly higher among patients who developed AKI. This finding supports previous evidence that AKI is not merely a secondary complication but an independent predictor of poor outcome in critically ill patients [15,16].

The interplay between lung and kidney dysfunction, often referred to as lung–kidney cross-talk, may explain the high incidence of AKI in severe respiratory infections. Factors such as hypoxia, systemic inflammation, mechanical ventilation, and haemodynamic instability interact in a complex manner to affect renal function [17]. Understanding this relationship is essential for improving patient care, as early interventions targeting these pathways may help prevent progression of organ dysfunction.

From a clinical perspective, the findings of this study emphasise the importance of routine renal monitoring in patients admitted with severe respiratory infections. Early detection of AKI, careful fluid management, avoidance of nephrotoxic drugs, and timely supportive care can potentially improve outcomes. Identifying high-risk groups, particularly elderly patients and those with comorbidities, may allow for more targeted interventions.

However, certain limitations should be acknowledged. The study was conducted in a single centre with a relatively moderate sample size, which may limit generalisability. Additionally, long-term renal outcomes were not assessed. Despite these limitations, the study provides valuable insight into the burden and clinical significance of AKI in severe respiratory infections in a tertiary care setting.

Overall, the present study highlights that acute kidney injury is a frequent and serious complication in patients with severe respiratory infections. Its occurrence is closely linked with disease severity, systemic inflammation, and underlying comorbid conditions, and it significantly influences patient outcomes. These findings underline the need for an integrated approach in managing such patients, with equal attention to both respiratory and renal aspects of care.

CONCLUSION

The present study demonstrates that acute kidney injury is a frequent and clinically important complication in patients admitted with severe respiratory infections. Nearly one-third of the patients developed renal involvement, highlighting the need to look beyond pulmonary manifestations in such cases.

AKI was found to be more common in older individuals and in those with underlying conditions such as diabetes and hypertension. It was also closely linked with the severity of respiratory illness, particularly in patients presenting with marked hypoxia and those requiring intensive care support. Elevated inflammatory markers further indicated that systemic response to infection plays a key role in the development of renal injury.

Importantly, the presence of AKI had a significant impact on patient outcomes. It was associated with longer hospital stay, increased need for advanced interventions such as dialysis, and higher mortality. These findings suggest that AKI is not just a coincidental finding but an indicator of worsening clinical status.

Early recognition and close monitoring of renal function in patients with severe respiratory infections are therefore essential. Timely supportive measures, along with careful management of comorbid conditions and avoidance of nephrotoxic agents, may help in reducing complications and improving overall outcomes.

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