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ACUTE KIDNEY INJURY IN COMMUNITY ACQUIRED PNEUMONIA AND ITS PROGNOSTIC IMPACT

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Abstract

Objectives: To identify risk factors for the development of Acute Kidney Injury (AKI) in CAP and to estimate the incidence and assess the prognostic impact of AKI in Community Acquired Pneumonia (CAP) patients.

Methods: This was the observational study conducted in emergency department of Isra University Hospital with from February 2025 to September 2025. Patients aged ≥ 18yrs, with clinical and radiological diagnosis of CAP were included in the study. Continuous variables were presented as mean and medians. To compare categorical variables, Fisher's exact test or chi-square tests were utilized, while Mann–Whitney U or Student's t tests were employed for continuous variables.

Results: The total sample size was 360. The mean age of participants was 57.98 ± 13.51 years. AKI was present in 107 (29.7%) patients. The AKI group had significantly higher median CRP, lactate, CURB-65 scores, and hospital stay duration (all $p < 0.05$). On univariable logistic regression, the CRP (OR = 1.7; $p = 0.001$), lactate (OR = 11.64; $p < 0.001$), diabetes (OR = 3.15; $p < 0.001$), and hypertension (OR = 3.16; $p < 0.001$) were significantly associated with AKI.

Conclusion: AKI increases the length of hospital stay, ICU admission and in hospital mortality in CAP patients.

Keywords: ICU admission; Acute Kidney Injury; Lactate; Community Acquired Pneumonia; CRP

INTRODUCTION

Community-acquired pneumonia (CAP) ranks as a leading cause of infectious mortality globally. In 2020, the number of hospitalized CAP patients in the USA rose by 1 million [1], and it is responsible for 3 million deaths worldwide each year [2]. CAP is characterized as an acute infection of the lung parenchyma in individuals who contract the infection outside of a hospital setting [3]. CAP that necessitates ICU admission accounts for 9% to 14% of all CAP cases requiring hospitalization [4]. While the mortality rate for CAP is less than 1% in outpatient settings1 and ranges from 8% to 10.6% among various hospitalized patient groups [5], a recent report indicated a 24% mortality rate for those admitted to the ICU [6]. Even if ICU patients with CAP are discharged from the hospital, they often face enduring effects from the pneumonia and exhibit a higher long-term mortality rate compared to other hospitalized patient groups [7].

CAP is a prevalent infection that is frequently misdiagnosed and improperly managed. Although it can sometimes manifest as a relatively mild condition, it continues to be a significant cause of illness and death. Several factors influence the outcome of CAP, including the patient's age, overall health, and whether treatment is administered in an outpatient or inpatient setting. The range of cases spans from young, healthy individuals who can be treated at home to older patients with additional health issues who need intensive care unit admission [8].

Acute Kidney Injury (AKI) is a common complication associated with CAP. The definition of AKI used in clinical and epidemiological research is based on specific criteria that have been progressively developed. According to the Kidney Disease Improving Global Outcomes (KDIGO) guidelines, AKI is defined as an increase in serum creatinine by ≥ 0.3 mg/dL (≥26.5 mmol/L) within 48 hours, or an increase in serum creatinine to ≥ 1.5 times the baseline level, which is known or presumed to have occurred within the previous seven days, or urine output of less than 0.5 mL/kg/hour for six hours [9,10]. The baseline serum creatinine level is defined as the serum creatinine value at admission or within six months prior to admission [11].

In patients with CAP, AKI is a crucial indicator of the severity of the illness. AKI patients typically have a more complex clinical course. They frequently exhibit more severe hemodynamic instability and systemic inflammation, which lengthens hospital stays [12]. Due to multiorgan involvement, the development of AKI is also linked to increased rates of ICU admission and a greater need for invasive mechanical ventilation [1]. Above all, AKI is a strong predictor of poor outcomes in CAP because it dramatically increases in-hospital mortality [13].

The majority of the evidence that is currently available comes from Western and East Asian populations, despite the fact that the relationship between CAP and AKI has been investigated in various international contexts. These results might not be entirely applicable to South Asian nations like Pakistan, where there are significant differences in comorbidity patterns, healthcare-seeking behavior, presentation delays, and resource availability. The frequency of AKI in CAP and its impact on clinical outcomes in our population have not been extensively studied locally. In order to better understand risk factors and enhance disease management, this gap emphasizes the need for region-specific data. This study aims to identify the risk factors for developing AKI in patients with CAP and to evaluate the prognostic impact of AKI on clinical outcomes, including ICU admission, length of hospital stay, and in-hospital mortality.

MATERIALS AND METHODS

This was the observational descriptive longitudinal study conducted in emergency department of Isra University Hospital from February 2025 to September 2025. Ethical approval for the study was taken from Ethics Review Committee (ERC) of Isra University Hospital. Written informed consent was taken from patients or their guardians. Participant confidentiality was ensured by assigning unique identification codes in place of personal information. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. The sampling technique was purposive nonprobability sampling.

Patients aged ≥ 18yrs, with clinical and radiological diagnosis of CAP were included in the study. Patients with hospital acquired pneumonia, end stage renal disease, dialysis dependent, malignancy or immunocompromised state, HIV, tuberculosis, renal diseases such as glomerulonephritis, nephrotic syndrome, and chronic inflammatory diseases such as Rheumatoid arthritis, SLE were excluded from the study.

After the approval of ERC, 360 patients diagnosed as CAP were enrolled. Severity of Pneumonia was assessed by using CURB 65, PSI and IDSA/ATS (Infectious disease society of America/ American thoracic society) consensus guidelines. Serum urea and creatinine were measured by using Principal photometric method and spectrophotometric method. Arterial blood gases were measured by using blood gas analyzer and chest X ray (CXR) were performed within one hour of arrival. Patients were followed by health care professional to observe the outcomes.

Data analysis was conducted using SPSS version 22.0. Continuous variables with non-normal distribution were reported as medians and interquartile ranges, while those with normal distribution were shown as mean ± standard deviation (SD). To compare categorical variables, Fisher's exact test or chi-square tests were utilized, and for continuous variables, Mann–Whitney U or Student's t tests were applied. Univariate logistic regression analysis was employed to pinpoint potential risk factors for AKI. Additionally, variables with p values < 0.05 from the univariable analysis were further examined using multivariable logistic regression to determine independent risk factors for AKI. The area under the curve (AUC) with a 95% confidence interval (CI) was used to assess discrimination.

RESULTS

The total number of participants included in the study was 360. The mean age of participants was 57.98 ± 13.51 years. Among the participants, 60.8% were male and 39.2% were female. AKI was present in 107 (29.7%) patients. The mean urea levels were 49.83 ± 20.72 mg/dL. The mean creatinine and BUN levels were 1.329 ± 0.58 and 23.28 ± 9.68 mg/dL, respectively. The mean PSI score was 84.17 ± 23.10. The mean length of stay in hospital was 6.15 ± 2.91 days (Table 1).

Indicators of disease severity were considerably higher in patients who experienced AKI. The AKI group had significantly higher median CRP, lactate, CURB-65 scores, and hospital stay duration (all $p < 0.05$). Patients with AKI also had significantly higher levels of creatinine and urea. Age differences between the two groups were not statistically significant ($p = 0.553$). Univariate analysis revealed that patients with AKI had significantly higher rates of comorbidities like diabetes and hypertension ($p < 0.05$). AKI was also substantially correlated with the use of inotropes and the requirement for ventilatory support.

On univariable logistic regression, the CRP (OR = 1.7; p = 0.001), lactate (OR = 11.64; p < 0.001), diabetes (OR = 3.15; p < 0.001), and hypertension (OR = 3.16; p < 0.001) were significantly associated with AKI. Age (OR = 1.01; p = 0.55), CKD (OR = 0.49; p = 0.27) and albumin (OR = 0.90; p = 0.60) were not associated with AKI. Variables with clinical relevance in univariable analysis were entered into a multivariable logistic regression model. After adjustment, the CRP (adjusted OR = 1.07, 95% CI 1.052 – 1.098, p < 0.001) and lactate (adjusted OR = 10.06, 95% CI 3.91 – 25.90, p < 0.001) remained independent predictors of AKI. Age, diabetes, and hypertension were not independently associated with AKI after adjustment (Table 2). The predictive performance of the final multivariable model was evaluated using ROC analysis. The model demonstrated excellent discrimination with an AUC of 0.98 (95% CI 0.996 – 1.00). Patients with AKI had a significantly longer hospital stay (p < 0.001). Rates of inotrope use (64.5%, p < 0.001) and mechanical ventilation (16.6%, p < 0.001) were also significantly higher among AKI patients.

DISCUSSION

Our results corroborate the idea that renal dysfunction plays a significant role in the clinical course of community-acquired pneumonia, which is becoming more widely recognized as a systemic illness. In line with earlier research, the pattern observed suggests that AKI in CAP is more driven by acute inflammatory and hemodynamic disturbances than by baseline comorbidities. These findings highlight the importance of evaluating CAP as a multisystem disorder where patient outcomes may be impacted by early identification of renal vulnerability.

The incidence of AKI in this study of hospitalized patients with CAP was 29.7%, which is within the range previously reported in CAP cohorts, where AKI occurs in roughly 20–40% of hospitalized patients [14,15]. Organ dysfunction, including AKI, is a common complication in severe pneumonia and significantly increases morbidity [16,17]. Our results underline the importance of early identification of high-risk patients and support the clinical significance of renal involvement in CAP. The correlation between systemic inflammation and renal damage is among the most consistent findings in earlier research. Even after controlling for comorbidities, higher CRP levels were independently linked to AKI in our cohort. This is consistent with research by Manrique-Caballero et al. [18] and Tinti et al. [19], which showed that increased inflammatory markers are a reflection of the microcirculatory dysfunction and systemic inflammatory response that put patients at risk for AKI.

It is interesting to note that, despite having a strong univariate association with AKI, diabetes and hypertension were not independent predictors after adjustment. This pattern has also been seen in earlier research where, once multivariable modeling is used, the contribution of chronic comorbidities is superseded by severity-of-illness markers [20]. This implies that acute physiological disturbances (inflammation, hypoperfusion) may be more significant predictors of AKI in the context of CAP than baseline metabolic disease alone [21]. Marzuillo et al. [22] reported similar results, pointing out that although chronic illness raises susceptibility, the effect diminishes when acute severity markers are taken into consideration.

Additionally, our findings show that AKI was linked to considerably worse clinical outcomes, such as longer hospital stays, increased ventilatory needs, and a greater need for inotropic support. Prior research has demonstrated that AKI increases the risk of multi-organ dysfunction [23], lengthens hospital stays [24], and uses more resources in both CAP and sepsis populations [25]. Our study's correlation between AKI and increased supportive care is in line with this known pattern and highlights the prognostic significance of renal injury in respiratory infections.

There are a few limitations. Similar to the majority of observational analyses, residual confounding may occur and causality cannot be deduced. Additionally, external validation would be required to validate the identified markers' predictive performance. Notwithstanding these drawbacks, our results support previous research and advance our knowledge of AKI risk stratification in CAP.

In conclusion, this study demonstrates that AKI is a frequent and clinically important CAP complication. Strong early indicators of AKI include elevated CRP and lactate levels, whereas comorbid conditions like diabetes and hypertension seem to have less of an impact once the severity of the illness is taken into consideration. Early intervention and better patient outcomes may result from the identification of these risk factors.

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Table 1: Baseline Characteristics of the Study Population (n = 360)

Variable	Overall Mean ± SD
Age (years)	57.99 ± 13.51
Urea (mg/dL)	49.83 ± 20.72
Creatinine (mg/dL)	1.33 ± 0.58
BUN (mg/dL)	23.28 ± 9.69
PSI Score	84.17 ± 23.10
Length of Stay (days)	6.15 ± 2.91

Table 2: Multivariable Logistic Regression Identifying Independent Predictors of AKI

Variable	Adjusted OR	95% CI	p-value
Age	1.012	0.975 – 1.050	0.545
CRP	1.075	1.052 – 1.098	<0.001
Lactate	10.065	3.91 – 25.90	<0.001
Diabetes	0.208	0.068 – 0.637	0.006
Hypertension	0.255	0.085 – 0.767	0.015