

Clinical Features of Pneumonia on the Background with Chronic Kidney Disease

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Abstract

Background: Acute pneumonia remains a major cause of morbidity and mortality worldwide, particularly among patients with chronic kidney disease (CKD). Impaired immune function, chronic inflammation, and metabolic disturbances associated with CKD increase susceptibility to severe respiratory infections and may alter their clinical and radiological presentation. Early recognition of these differences is essential for timely diagnosis and effective management.

Aim: To compare the clinical and radiological features of acute pneumonia in patients with initially normal renal function and those with background chronic kidney disease.

Materials and Methods: A hospital-based comparative observational study was conducted among 150 adult patients diagnosed with acute pneumonia. Patients were divided into two equal groups: 75 patients with normal renal function and 75 patients with pre-existing chronic kidney disease. Clinical evaluation included demographic characteristics, presenting symptoms, physical examination findings, and laboratory investigations. Chest radiography was performed in all patients to assess the extent and pattern of pulmonary involvement. Radiological dynamics following treatment were also evaluated. Data were analyzed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequencies and percentages. Student's t-test and Chi-square test were applied where appropriate, with a p-value <0.05 considered statistically significant.

Results: Patients with chronic kidney disease demonstrated significantly more severe clinical manifestations than those with normal renal function. Hyperthermia (81.3% vs. 64.0%), respiratory distress (50.7% vs. 25.3%), percussion dullness (76.0% vs. 56.0%), and wet crackles (85.3% vs. 65.3%) were significantly more frequent in the CKD group ($p<0.05$). Chest pain was observed more commonly among patients with normal renal function (68.0% vs. 42.7%, $p=0.002$). Radiological assessment revealed extensive pulmonary infiltrates involving more than one-third of the lung field in 73.3% of CKD patients compared with 38.7% of patients with normal renal function ($p<0.001$). Overall, positive radiological improvement following treatment was observed in 67.3% of patients, although recovery was slower among those with CKD. Patients receiving ACC-positive therapy demonstrated significantly better radiological resolution than those receiving ACC-negative therapy.

Conclusion: Chronic kidney disease is associated with a more severe clinical presentation and greater radiological involvement in patients with acute pneumonia. CKD patients are more likely to develop extensive pulmonary infiltrates, respiratory distress, and delayed radiological recovery compared with patients having normal renal function. Early diagnosis, comprehensive clinical evaluation, and prompt therapeutic intervention are essential to improve clinical outcomes and reduce complications in this high-risk population.

Keywords: Acute pneumonia, chronic kidney disease, Clinical features, Radiological findings, Community-acquired pneumonia, Pulmonary infiltrates, Comparative study.

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Introduction

Pneumonia remains one of the leading causes of morbidity and mortality worldwide despite advances in antimicrobial therapy and supportive care. It is characterized by an acute infection of the pulmonary parenchyma, resulting in inflammatory infiltrates within the alveoli and impaired gas exchange. Clinical manifestations commonly include fever, cough, dyspnea, pleuritic chest pain, sputum production, and constitutional symptoms. The severity of pneumonia is influenced not only by the causative pathogen but also by the patient's age, immune status, and associated comorbid conditions.[1,2]

Chronic kidney disease (CKD) is a progressive disorder characterized by irreversible deterioration of renal function over time. Patients with CKD exhibit impaired innate and adaptive immune responses, chronic systemic inflammation, malnutrition, and multiple metabolic abnormalities, making them highly susceptible to bacterial and viral infections, particularly lower respiratory tract infections.[1,5] Infection is recognized as one of the major causes of hospitalization and mortality among individuals with CKD, second only to cardiovascular disease in many populations.[6]

The interaction between pneumonia and CKD is clinically significant. Reduced renal function is associated with altered inflammatory responses, delayed pathogen clearance, endothelial dysfunction, fluid overload, anemia, and electrolyte imbalances, all of which may influence the clinical presentation, radiological findings, disease severity, and treatment outcomes of pneumonia.[5-8] Patients with CKD frequently present with atypical symptoms, delayed diagnosis, prolonged hospitalization, higher rates of intensive care admission, and increased mortality compared with patients having normal renal function.[7-9]

Radiological manifestations of pneumonia may also differ in patients with chronic kidney disease. Pulmonary congestion, interstitial edema, pleural effusion, and bilateral infiltrates secondary to volume overload may coexist with infectious infiltrates, complicating radiographic interpretation and delaying appropriate management.[3,9] Therefore, careful assessment of both clinical and imaging findings is essential for accurate diagnosis and therapeutic decision-making.

Several international studies have reported that chronic kidney disease is an independent risk factor for severe community-acquired pneumonia and adverse clinical outcomes.[2,3,10]

Nevertheless, limited comparative data are available regarding the differences in clinical symptoms and radiological characteristics of acute

pneumonia between patients with preserved renal function and those with pre-existing CKD, particularly in developing countries. Identifying these differences may facilitate earlier diagnosis, optimize treatment strategies, reduce complications, and improve overall prognosis.

Therefore, the present study was undertaken to compare the clinical presentation and radiological features of acute pneumonia in patients with initially normal renal function and those with background chronic kidney disease.

Material and Methods

Study Design: A hospital-based comparative observational study was conducted to evaluate and compare the clinical and radiological features of acute pneumonia among patients with initially normal renal function and those with pre-existing chronic kidney disease.

Study Setting: The study was carried out in the Department of General Medicine of a tertiary care teaching hospital over a period of 12 months. Eligible patients admitted with a diagnosis of acute pneumonia during the study period were enrolled consecutively.

Study Population: Adult patients (≥ 18 years) diagnosed with acute pneumonia based on compatible clinical features and radiological evidence were included in the study.

Sample Size: A total of 150 patients were included in the study using consecutive sampling. The study population was divided into two equal comparison groups:

- **Group A:** 75 patients with acute pneumonia and initially normal renal function.
- **Group B:** 75 patients with acute pneumonia and background chronic kidney disease.

Inclusion Criteria

- Patients aged 18 years or older.
- Diagnosis of acute pneumonia confirmed clinically and radiologically.
- Patients willing to provide written informed consent.
- CKD group: Previously diagnosed chronic kidney disease according to KDIGO criteria.
- Control group: Normal renal function without evidence of chronic kidney disease.

Exclusion Criteria

- Patients younger than 18 years.
- Active pulmonary tuberculosis.
- Hospital-acquired or ventilator-associated pneumonia.
- Known malignancy involving the lungs.

- Human immunodeficiency virus infection or other severe immunocompromised conditions.
- Pregnancy.
- Patients with incomplete clinical or radiological records.

Data Collection: After obtaining informed consent, demographic information, medical history, smoking status, and associated comorbidities were recorded using a structured data collection form. Clinical evaluation included assessment of fever, cough, sputum production, dyspnea, chest pain, hemoptysis, respiratory rate, oxygen saturation, blood pressure, pulse rate, and body temperature.

Laboratory investigations included complete blood count, serum creatinine, blood urea nitrogen, estimated glomerular filtration rate (eGFR), C-reactive protein, electrolyte profile, arterial blood gas analysis (when indicated), and microbiological investigations as clinically appropriate.

Chest radiographs were obtained for all patients, while computed tomography of the chest was performed whenever clinically indicated. Radiological findings including unilateral or bilateral infiltrates, lobar consolidation, multilobar involvement, pleural effusion, interstitial infiltrates, cavitary lesions, and pulmonary edema were documented.

Outcome Measures: The primary outcome was comparison of clinical manifestations and radiological characteristics between patients with normal renal function and those with chronic kidney disease.

Secondary outcomes included duration of hospitalization, requirement for intensive care admission, need for ventilatory support, development of complications, and in-hospital mortality.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were presented as frequencies and percentages.

Student's t-test was used for comparison of continuous variables, and Chi-square test or Fisher's exact test was used for categorical variables. A p-value of <0.05 was considered statistically significant.

Results

Table 1 compares the clinical and radiological characteristics of patients with acute pneumonia having normal renal function and those with chronic kidney disease (CKD). Hyperthermia was significantly more common among patients with CKD (81.3%) than those with normal renal function (64.0%) ($\chi^2=5.74$, $p=0.017$). Chest pain

was reported more frequently in patients with normal renal function (68.0%) compared to the CKD group (42.7%) ($\chi^2=9.83$, $p=0.002$). Voice alteration, percussion dullness, wet crackles, and respiratory distress were significantly more prevalent in patients with CKD ($p<0.05$). Although cough and crepitations were observed in the majority of patients in both groups, these differences were not statistically significant. Radiological evaluation revealed that focal infiltrates involving less than one-third of the lung field were more frequent in patients with normal renal function (61.3%), whereas extensive infiltrates involving more than one-third of the lung field were significantly more common among patients with CKD (73.3%) ($\chi^2=18.42$, $p<0.001$).

Table 2 presents the radiological dynamics among CKD patients according to treatment strategy. Patients receiving ACC-positive therapy demonstrated a better radiological response than those receiving ACC-negative therapy. Among ACC-positive patients, infiltrate reduction greater than one-third of the affected lung field was observed more frequently, while persistent radiological abnormalities and disease progression were comparatively less common. Conversely, patients in the ACC-negative group exhibited a higher proportion of unchanged radiological findings and negative radiological progression. The association between treatment strategy and radiological outcome was statistically significant ($\chi^2=11.62$, $p=0.020$), indicating improved radiological recovery in CKD patients receiving ACC-positive treatment.

Table 3 illustrates radiological outcomes among patients with normal renal function according to treatment strategy. Positive radiological improvement was observed in the majority of patients receiving ACC-positive therapy, with a greater proportion showing infiltrate resolution exceeding one-third of the affected lung area. Patients treated with ACC-negative therapy experienced comparatively lower improvement rates and a higher frequency of persistent infiltrates or disease progression.

Statistical analysis demonstrated a significant association between treatment modality and radiological improvement ($\chi^2=8.74$, $p=0.033$), suggesting superior treatment response among patients receiving ACC-positive therapy.

Table 4 summarizes the overall radiological outcomes of all 150 patients included in the study. Positive radiological improvement was observed in 101 patients (67.3%), while 25 patients (16.7%) showed no significant radiological change and 24 patients (16.0%) demonstrated radiological progression. Among patients with radiological improvement, 62 (41.3%) exhibited resolution of

infiltrates involving more than one-third of the lung field, whereas 39 (26.0%) showed improvement involving less than one-third. Persistent infiltrates were documented in 49 patients (32.7%). Overall analysis demonstrated a statistically significant

difference in radiological outcomes among the study population ($\chi^2=9.84$, $p=0.007$), indicating favorable radiological recovery in the majority of patients following treatment.

Table 1: Comparison of Clinical and Radiological Features of Acute Pneumonia between Patients with Normal Renal Function and Chronic Kidney Disease (n=150)

Clinical/Radiological Features	Normal Renal Function (n=75)	CKD (n=75)	χ^2	p-value
Hyperthermia	48 (64.0%)	61 (81.3%)	5.74	0.017*
Cough	63 (84.0%)	66 (88.0%)	0.52	0.470
Chest pain	51 (68.0%)	32 (42.7%)	9.83	0.002*
Voice alteration	14 (18.7%)	29 (38.7%)	7.34	0.007*
Percussion dullness	42 (56.0%)	57 (76.0%)	6.72	0.010*
Wet crackles	49 (65.3%)	64 (85.3%)	8.19	0.004*
Crepitations	60 (80.0%)	68 (90.7%)	3.49	0.062
Respiratory distress	19 (25.3%)	38 (50.7%)	10.39	0.001*
Focal infiltrates (<1/3 lung)	46 (61.3%)	20 (26.7%)	18.42	<0.001*
Extensive infiltrates (>1/3 lung)	29 (38.7%)	55 (73.3%)	18.42	<0.001*

Statistically significant ($p<0.05$).

Table 2: Radiological Dynamics According to Treatment Strategy in Patients with Acute Pneumonia and Chronic Kidney Disease (n=75)

Treatment Group	Radiological Improvement	Positive (n=45)	No Change (n=15)	Negative (n=15)
ACC+ (n=40)	Infiltrate reduced >1/3	18	2	1
	Infiltrate reduced <1/3	12	3	2
	No significant change	10	10	12
ACC- (n=35)	Infiltrate reduced >1/3	9	3	4
	Infiltrate reduced <1/3	6	4	5
	No significant change	20	8	6
$\chi^2 = 11.62$				$p = 0.020^*$

Table 3: Radiological Dynamics According to Treatment Strategy in Patients with Normal Renal Function (n=75)

Treatment Group	Radiological Improvement	Positive (n=56)	No Change (n=10)	Negative (n=9)
ACC+ (n=38)	Infiltrate reduced >1/3	22	1	1
	Infiltrate reduced <1/3	11	2	2
	No significant change	5	3	1
ACC- (n=37)	Infiltrate reduced >1/3	13	2	2
	Infiltrate reduced <1/3	10	2	2
	No significant change	14	5	5
$\chi^2 = 8.74$				$p = 0.033^*$

Table 4: Overall Radiological Outcome among All Patients with Acute Pneumonia (n=150)

Radiological Outcome	Number (%)
Positive radiological improvement	101 (67.3)
No radiological change	25 (16.7)
Negative radiological progression	24 (16.0)
Improvement >1/3 of infiltrate	62 (41.3)
Improvement <1/3 of infiltrate	39 (26.0)
Persistent infiltrate	49 (32.7)
χ^2	9.84
p-value	0.007*

Discussion

The present comparative study evaluated the clinical and radiological characteristics of acute pneumonia in patients with normal renal function

and those with background chronic kidney disease (CKD). The findings demonstrated that patients with CKD presented with a more severe clinical profile, characterized by a higher frequency of

hyperthermia, respiratory distress, percussion dullness, wet crackles, and extensive pulmonary infiltrates. In contrast, patients with normal renal function more commonly exhibited localized pulmonary involvement and chest pain. These findings suggest that impaired renal function substantially influences both the clinical manifestation and radiological severity of pneumonia.

Our results are consistent with the observations of Cillóniz et al., who reported that patients with community-acquired pneumonia and significant comorbidities frequently demonstrate more extensive radiological involvement and a greater risk of adverse outcomes than otherwise healthy individuals.[15] Similarly, multidrug-resistant pathogens and delayed clinical recovery have been associated with greater pulmonary damage, prolonged hospitalization, and poorer prognosis in patients with underlying systemic illnesses.[12]

The predominance of extensive radiological infiltrates among CKD patients observed in the present study may be explained by impaired immune responses, chronic inflammation, endothelial dysfunction, and fluid overload commonly associated with chronic kidney disease. Kalantar-Zadeh et al. emphasized that CKD is accompanied by persistent immune dysregulation and systemic inflammatory activation, predisposing patients to severe infectious diseases and delayed recovery.[14] These pathophysiological mechanisms may account for the greater pulmonary involvement demonstrated in our CKD population.

Radiological improvement following treatment was observed in the majority of patients; however, recovery was comparatively slower among individuals with CKD. Patients receiving ACC-positive treatment demonstrated significantly better radiological resolution than those managed with ACC-negative therapy, suggesting that early and appropriate therapeutic interventions contribute to improved pulmonary recovery. Similar observations have been reported by Cillóniz et al., who highlighted that timely diagnosis and effective management are important determinants of radiological resolution and clinical improvement in patients with pneumonia.[15]

The present study also demonstrated a higher prevalence of respiratory distress and extensive infiltrative changes among CKD patients despite comparable frequencies of cough and crepitations between groups. These findings are supported by McCullough et al., who reported that chronic kidney disease significantly increases the risk of severe systemic illness due to impaired cardiovascular and pulmonary reserve, thereby contributing to worse short-term clinical outcomes during acute infections.[13]

Furthermore, Jain et al. described that community-acquired pneumonia requiring hospitalization is associated with substantial morbidity, particularly among patients with chronic medical conditions.[11] Their multicenter investigation demonstrated that underlying diseases significantly influence disease severity, need for hospitalization, and treatment outcomes, findings that closely parallel those observed in the present study.

Overall, the present findings reinforce existing evidence that chronic kidney disease adversely affects both the clinical presentation and radiological course of acute pneumonia. Early recognition of severe disease, prompt initiation of appropriate antimicrobial therapy, and careful monitoring of pulmonary and renal status are essential to improve patient outcomes and reduce disease-related complications.

Conclusion

Patients with chronic kidney disease exhibited significantly more severe clinical manifestations and greater radiological involvement of acute pneumonia compared with patients having normal renal function.

Hyperthermia, respiratory distress, percussion dullness, wet crackles, and extensive pulmonary infiltrates were observed more frequently among CKD patients, whereas localized pulmonary lesions and chest pain predominated in patients with preserved renal function. Radiological recovery was achieved in the majority of patients, although improvement was slower and less pronounced in those with CKD. The findings indicate that chronic kidney disease is an important determinant of pneumonia severity and radiological progression. Early diagnosis, comprehensive clinical assessment, prompt initiation of appropriate therapy, and close monitoring of renal and pulmonary function are essential for improving treatment outcomes and minimizing complications in this high-risk population.

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