Treatment outcomes and predictors of clinical response in patients with community-acquired pneumonia at Hai Phong International Hospital: A retrospective cohort study

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ABSTRACT

Background: Community-acquired pneumonia (CAP) remains a leading cause of morbidity and mortality worldwide, with antimicrobial resistance (AMR) posing a critical challenge in low- and middle-income countries, including Vietnam. Local data on antibiotic use, resistance, and treatment outcomes are essential to guide empirical therapy and stewardship. ***Methods:*** We conducted a retrospective study of 1,418 adult patients hospitalized with CAP at Hai Phong International Hospital, Vietnam, from 2020 to 2024. Clinical characteristics, inflammatory markers, CURB-65 severity scores, antibiotic regimens, and outcomes were extracted from medical records. Microbiological culture and susceptibility data were analyzed according to CLSI/EUCAST standards. Treatment response was assessed by clinical symptoms, biomarkers, and hospital outcomes. ***Results:*** The majority of patients were elderly (≥60 years: 76.0%) and male (53.1%). Frequent comorbidities included hypertension (53.4%) and diabetes (37.8%). At admission, 72.6% had elevated CRP and 65.7% had elevated procalcitonin. Most patients presented with cough (51.2%) and fever (43.8%). CURB-65 scores indicated low-to-moderate risk in 85.5% of cases. Fluoroquinolone monotherapy was the most common initial regimen (48.8%), followed by carbapenem monotherapy (11.6%). Combination therapy accounted for 25.1% of cases, though de-escalation was applied in only 9.4%. Clinical improvement was observed in 75.3% and cure in 20.5% of patients, with significant reductions in WBC ($p<0.0001$) and CRP ($p<0.0001$). However, high resistance rates were found in *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, and *Klebsiella pneumoniae*. ***Conclusion:*** CAP patients in this Vietnamese cohort were predominantly elderly with multiple comorbidities and frequent use of broad-spectrum antibiotics. Despite overall favorable outcomes, inappropriate reliance on fluoroquinolones and carbapenems, coupled with high AMR rates, underscores the urgent need for hospital-based antimicrobial stewardship, adherence to evidence-based guidelines, and expansion of local resistance surveillance to optimize CAP management.

Keywords: *Community-acquired pneumonia, antimicrobial resistance, antibiotic utilization, treatment outcome, Vietnam*

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Received: September 29, 2025
Reviewed: October 2 , 2025
Accepted: December 3, 2025

INTRODUCTION

Community-acquired pneumonia (CAP) is one of the most frequent and serious infectious diseases worldwide, contributing significantly to morbidity, mortality, and healthcare costs. According to the Global

Burden of Disease Study, lower respiratory tract infections, including CAP, caused an estimated 2.4 million deaths in 2019, ranking among the top ten causes of death globally [1]. The burden is disproportionately high in low- and middle-income countries (LMICs), where limited access to timely diagnosis, effective antibiotics, and intensive care support worsens clinical outcomes [2].

Despite the availability of effective antibiotics and evidence-based treatment guidelines, the prognosis of hospitalized patients with CAP remains concerning. In high-income countries, in-hospital mortality rates are estimated at 5–15% for general ward patients and may reach 30–40% among those admitted to intensive care units (ICUs) [3]. Mortality is particularly elevated in patients with advanced age, multiple comorbidities, or delayed initiation of appropriate therapy.

Risk stratification tools such as the Pneumonia Severity Index (PSI) and CURB-65 score are widely recommended to assess disease severity and guide site-of-care decisions [4]. Both scores incorporate clinical, laboratory, and demographic parameters and have been validated in large cohorts. However, their predictive value may vary across populations, especially in LMICs where resource limitations and high prevalence of antimicrobial resistance (AMR) complicate management. Moreover, comorbid conditions such as diabetes mellitus, chronic kidney disease, chronic obstructive pulmonary disease (COPD), and cardiovascular disease have been consistently identified as independent predictors of poor outcomes, including treatment failure, prolonged hospitalization, and mortality [5].

In Vietnam, CAP remains a major cause of hospital admission, particularly among older adults and patients with chronic illnesses. Previous studies have mostly concentrated on microbiological etiology and resistance patterns[6]. While these are essential for informing empirical antibiotic policies, there is a paucity of large-scale investigations examining clinical outcomes and prognostic factors in Vietnamese CAP cohorts. Real-world evidence on treatment response, duration of hospital stay, and predictors of unfavorable outcomes is crucial for optimizing patient management and resource allocation.

Given this context, the present study was conducted to evaluate treatment outcomes and identify independent predictors of prognosis in hospitalized patients with CAP at Hai Phong International Hospital over a five-year period (2020–2024). The findings are expected to contribute to improved risk stratification, inform local clinical practice, and support antimicrobial stewardship strategies in Vietnam.

METHODS

Study Design and Setting

This was a retrospective cohort study conducted at Hai Phong International Hospital, Vietnam. Data were extracted from the hospital's electronic medical records (EMR) covering the period January 1, 2020, to December 31, 2024. Statistical analysis was performed between January and May 2025.

Study Population

Eligible participants were adults (≥18 years) hospitalized with a diagnosis of CAP identified by ICD-10 codes J12–J18. Patients were included if they received antibiotic therapy during admission, had a hospital stay of at least 24 hours, and

possessed complete clinical and treatment data. Exclusion criteria comprised hospital-acquired pneumonia (HAP), ventilator-associated pneumonia (VAP), SARS-CoV-2 pneumonia, and incomplete medical records. A total of 1,418 patients met the eligibility criteria and were included in the analysis.

Data Collection

Data were collected using a structured form and included (1) demographics and baseline characteristics such as age, sex, comorbidities, and CURB-65 score on admission; (2) clinical presentation at admission, including fever, cough, dyspnea, chest pain, and vital signs; (3) laboratory and imaging findings such as white blood cell count (WBC), C-reactive protein (CRP), procalcitonin (where available), and chest X-ray results; and (4) treatment-related information, including empirical antibiotic regimen, adjustments according to clinical or microbiological response, route of administration, number of agents used (monotherapy vs. combination), and treatment duration.

Outcomes

Treatment outcomes were evaluated based on resolution of symptoms (fever, cough, dyspnea, chest pain), improvement in laboratory biomarkers (WBC, CRP), length of hospital stay, and final clinical status categorized as cured, improved, not improved, or death.

Data Analysis

Data cleaning was performed to exclude duplicates and incomplete records. Continuous variables were summarized as mean ± standard deviation (SD) or median with interquartile range (IQR), while categorical variables were expressed as frequencies and percentages. Differences in laboratory values before and after treatment were assessed using the Wilcoxon signed-rank test, and changes in symptoms were analyzed using McNemar's test. Associations between treatment outcomes and potential predictors (e.g., CURB-65 score, comorbidities, antibiotic regimen) were examined with the Chi-square or Fisher's exact test. Multinomial logistic regression was used to identify independent predictors of unfavorable outcomes. Candidate variables included age, sex, comorbidities, CURB-65 score, baseline WBC and CRP, antibiotic regimen, and admission symptoms (fever, dyspnea, chest pain). Results were expressed as odds ratios (OR) with 95% confidence intervals (95% CI), and a two-tailed $p < 0.05$ was considered statistically significant.

Ethical Considerations

This study was conducted as part of an academic research project by medical students at Hai Phong University of Medicine and Pharmacy. As a retrospective analysis using anonymized electronic medical record data, the study involved no direct patient contact and posed minimal risk; therefore, the requirement for individual informed consent was waived.

RESULTS

A total of 1,418 patients with CAP were included from 2020–2024. The cohort was slightly male predominant (53.1%) and elderly patients (≥60 years) accounted for the majority (76.0%). Only 0.3% were adolescents (10–19 years). The most frequent presenting symptom was cough (51.2%), followed by fever (43.8%), dyspnea (29.8%), and chest pain (14.8%). Laboratory investigations showed a median WBC count of 8.7 G/L (min–max: 0.1–38.4) and a median

neutrophil count of 6.4 G/L (min–max: 0.3–32.1). Elevated CRP was found in 72.6% of patients, while leukocytosis was present in 35.7%. Procalcitonin levels (available in 201 cases) were elevated in 65.7%. Chest radiographs revealed pneumonic lesions in 85.8%, while respiratory cultures were positive in 22.6% (Table 1).

***Table 1**. Baseline symptoms and initial investigations (n = 1,418)*

Domain	Metric	Value
Sex		
Male	753	53.14
Female	665	46.86
Age group		
10–19 years	4	0.28
20–59 years	336	23.68
≥60 years	1,078	76.04
Presenting symptoms, n (%)	Cough	727 (51.23)
	Fever	622 (43.83)
	Dyspnea	423 (29.81)
	Chest pain	210 (14.80)
Inflammatory markers	WBC (G/L), mean ± SD	9.73 ± 4.71
	WBC, median [min–max]	8.7 [0.1–38.4]
	Neutrophils (G/L), median [min–max]	6.4 [0.3–32.1]
	CRP (mg/L), mean ± SD	73.92 ± 85.97
	CRP, median [min–max]	41.7 [0.2–581.8]
	Procalcitonin (ng/mL), mean ± SD	11.86 ± 24.63
	Procalcitonin, median [min–max]	1.03 [0.04–121.48]
Categorical labs, n (%)	WBC: normal / high / low	880 (62.09) / 506 (35.66) / 32 (2.26)
	CRP elevated (≥10 mg/L)	1,030 (72.59)
	Procalcitonin elevated (≥0.5 ng/mL)	132 / 201 (65.67)
Imaging & microbiology, n (%)	Chest X-ray pneumonic lesion	1,218 (85.83)
	Positive respiratory culture	321 (22.64)

Although radiographic lesions were detected in most patients, the low rate of positive respiratory cultures (22.6%) suggests limited microbiological yield, which is consistent with CAP studies in similar settings.

Severity assessment using CURB-65 showed that most patients had low (48.9%) or moderate (36.6%) scores, while 14.5% were in the high-risk group (≥3). There was a modest correlation between CURB-65 and WBC (r=0.10, p=0.0003) and a stronger correlation with CRP (r=0.33,

p<0.0001). Procalcitonin did not show significant correlation (r=0.05, p=0.496). These findings highlight the utility of CRP as a marker of severity in CAP, in line with previous studies demonstrating its prognostic value compared to other inflammatory markers (Table 2).

Table 2. *Disease severity by CURB-65 and correlations with inflammatory markers*

A. CURB-65 distribution (n = 1,418)		
Score	**n**	**%**
0	164	11.57
1	530	37.38
2	519	36.6
3	184	12.98
4	18	1.27
5	3	0.21
Risk group		
Low (0–1)	694	48.94
Moderate (2)	519	36.6
High (≥3)	205	14.46
B. Correlation between CURB-65 and inflammatory markers		
Marker	**r (95% CI)**	**p-value**
WBC (G/L)	0.10 (0.04–0.15)	0.0003
CRP (mg/L)	0.33 (0.28–0.38)	<0.0001
Procalcitonin (ng/mL)	0.05 (–0.09–0.19)	0.496

CRP demonstrated the strongest correlation with CURB-65, reinforcing its potential role as a supportive marker for clinical severity in CAP.

Fluoroquinolone monotherapy was the most frequently used empirical regimen (48.8%), followed by carbapenem monotherapy (11.6%) and carbapenem–fluoroquinolone combinations (8.0%). Overall, 74.9% received monotherapy and 25.1% received combination therapy. Most regimens remained unchanged during hospitalization (86.9%); 9.4% were de-escalated and 3.7% escalated.

Notably, all patients (100%) received antibiotics, even though pneumonic lesions were detected in <86%, leukocytosis in 35.7%, and elevated CRP in 72.6%. This reflects real-world practice patterns in which clinical diagnosis of CAP often prompts empiric antibiotic use regardless of microbiological confirmation (Table 3).

Table 3. *Antibiotic utilization: initial regimens, switching (n = 1,418)*

A. Initial empirical regimen (by group)		
Regimen group	**n**	**%**
Fluoroquinolone monotherapy	692	48.8
Carbapenem monotherapy	165	11.64
Carbapenem + Fluoroquinolone	114	8.04

Penicillin (+/– β-lactamase) + Other	81	5.71
Fluoroquinolone + Other + Penicillin (+/– β-lactamase)	47	3.31
Carbapenem + Other	27	1.9
Fluoroquinolone + Other	25	1.76
Nitroimidazole monotherapy	24	1.69
Fluoroquinolone + Nitroimidazole	21	1.48
Tetracycline monotherapy	19	1.34
Carbapenem + Nitroimidazole	19	1.34
Carbapenem + Fluoroquinolone + Other	17	1.2

B. Strategy and de-escalation/escalation

Category	n	%
Monotherapy	1,062	74.89
Combination therapy (≥2 agents)	356	25.11
No change in regimen	1,233	86.95
De-escalation	133	9.38
Escalation	52	3.67

Symptom improvement was commonly observed: fever improved in 63.6%, dyspnea in 74.7%, and chest pain in 77.9%. Cough showed modest improvement (10.7%). Inflammatory markers decreased significantly after treatment, with WBC decreasing from 9.93 ± 4.77 G/L on admission to 7.30 ± 3.49 G/L, and CRP from 78.1 ± 87.9 mg/L to 44.6 ± 57.2 mg/L (both $p < 0.0001$) (Table 4).

Table 4. *Clinical responses and biomarkers before vs. after treatment in CAP patients (n = 1,418)*

Variable	Pre, n/mean ± SD	Post, n/mean ± SD	Improved, n (%)	p-value (Wilcoxon)
Symptoms				
Cough	819	731	88 (10.7)	<0.001
Fever	665	242	423 (63.6)	<0.001
Dyspnea	426	108	318 (74.7)	<0.001
Chest pain	217	48	169 (77.9)	<0.001
Biomarkers				
WBC (G/L)	9.93 ± 4.77	7.30 ± 3.49	–	<0.0001
CRP (mg/L)	78.09 ± 87.90	44.57 ± 57.21	–	<0.0001

Both WBC and CRP improved significantly, consistently with favorable treatment response.

At discharge, 75.3% of patients were improved and 20.5% were cured, while only 4.2% showed no improvement or deterioration. Median length of stay was 6–10 days (39.5%), with 28.7% hospitalized for ≥10 days. Stratification by CURB-65 risk group demonstrated higher rates of clinical improvement and cure in low- and moderate-risk groups, while the high-risk group (≥3) showed greater proportions of treatment failure and prolonged hospitalization (Table 5).

Table 5. *Overall outcomes and hospital course in CAP patients (n = 1,418)*

Category	n	%
Clinical outcome		
Improved	1,068	75.3
Cured	291	20.5
No change	52	3.7
Worsened	7	0.5
Length of hospital stay		
2–3 days	130	9.2
3–5 days	320	22.6
6–10 days	560	39.5
10–20 days	342	24.1
>20 days	66	4.7
CURB-65 risk group		
Low (0–1)	694	48.9
Moderate (2)	519	36.6
High (≥3)	205	14.5

The relatively large proportion of short hospital stays (<6 days) underscores the importance of contextual interpretation, as early discharge may reflect rapid stabilization rather than minimal disease severity.

DISCUSSION

This study provides a comprehensive multi-year overview of clinical characteristics, antibiotic utilization, treatment responses, and outcomes among patients hospitalized with community-acquired pneumonia (CAP) at Hai Phong International Hospital between 2020 and 2024. Several important findings emerge, which both reflect local practice patterns and highlight challenges in the management of CAP in Vietnam.

First, the demographic profile of our cohort was dominated by elderly patients (≥60 years, 76.0%), consistent with global epidemiology showing that advanced age remains the strongest risk factor for severe CAP and adverse outcomes. The 2019 Global Burden of Disease report highlighted that pneumonia mortality is highest in older adults due to comorbidities and immune senescence [7]. Similarly, comorbidities such as hypertension (53.3%) and diabetes (37.8%) were frequent, mirroring findings from Asian CAP cohorts where chronic conditions amplify disease severity and prolong hospitalization [8].

Second, CURB-65 scores were predominantly in the low-to-moderate range (85.5% with score ≤2). Importantly, CRP showed a stronger correlation with CURB-65 than WBC or procalcitonin, reinforcing its role as a reliable marker of disease severity. Previous studies have reported that CRP, particularly when >100 mg/L, is predictive of severe disease, treatment failure, and mortality in CAP [9]. In contrast, procalcitonin was not significantly correlated with severity in our data, consistent with reports that its role is more useful in guiding antibiotic duration rather than severity stratification [10].

Third, our antibiotic utilization patterns reveal striking deviations from international guideline-concordant care. Fluoroquinolone monotherapy accounted for nearly half of all regimens, while carbapenem use was also frequent, despite IDSA/ATS 2019 guidelines recommending β-lactam plus macrolide or β-lactam plus fluoroquinolone as the preferred empirical regimens [11]. This heavy reliance on broad-spectrum monotherapy may reflect clinicians' concerns about high resistance rates among local pathogens, but it carries risks of antimicrobial overuse and selection pressure. Similar patterns of carbapenem overuse have been reported in tertiary hospitals in Southeast Asia, where stewardship programs remain under-implemented [12].

Fourth, treatment response was generally favorable, with marked improvement in fever, dyspnea, and chest pain, as well as significant reductions in WBC and CRP post-treatment. These findings are consistent with multicenter trials showing that resolution of fever and normalization of inflammatory markers within 5–7 days are strong indicators of favorable outcomes [13]. However, cough persisted in a substantial subset, highlighting the clinical challenge of differentiating bacterial resolution from post-infectious airway inflammation, a phenomenon commonly observed in CAP convalescence.

Finally, overall outcomes were positive, with 95.8% of patients either cured or improved and very low rates of treatment failure (4.2%). Hospital stays were typically 6–10 days, longer than in high-income settings, where median stays are often 3–5 days. This discrepancy may reflect delays in de-escalation, reliance on intravenous antibiotics, and the burden of comorbidities in our cohort. Importantly, stratification by CURB-65 confirmed that higher scores were associated with worse outcomes, supporting its utility in guiding admission and monitoring decisions in Vietnamese hospitals, in line with global evidence [4].

This study has several strengths, including a large sample size, multi-year scope, and integration of clinical, laboratory, and microbiological findings. However, several limitations should be acknowledged. The retrospective single-center design limits generalizability. Viral and atypical pathogen diagnostics were not routinely performed, restricting our ability to fully characterize etiological patterns. Additionally, the absence of mortality data and the descriptive nature of antibiotic utilization analysis (without linkage to pathogen-specific susceptibility profiles) limit the depth of conclusions regarding treatment appropriateness.

CONCLUSION

This study highlights the need to reinforce antimicrobial stewardship at the hospital level, with a focus on aligning empirical therapy with international guidelines and strengthening local resistance surveillance. Key priorities include restricting unnecessary

carbapenem monotherapy, promoting timely de-escalation, and enhancing clinician education on guideline-concordant regimens. Such tailored interventions are essential to improve the management of community-acquired pneumonia in Vietnam.

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