Clinical, paraclinical and bacteriological characteristics of community-acquired pneumonia in children at Hai Phong International Obstetrics and Pediatrics Hospital from 09/2024 to 04/2025

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ABSTRACT

Background: This study aimed to describe the clinical and paraclinical characteristics of community-acquired pneumonia (CAP) in patients at Hai Phong International Obstetrics and Pediatrics Hospital from September 1, 2024 to April 30, 2025 and to identify the bacterial pathogens causing CAP in these children. ***Methods:*** We analyzed data from the medical records of 340 patients aged under 15 years with CAP who underwent a Real-time PCR (RT-PCR) test from nasopharyngeal samples on admission. ***Results:*** Community-acquired pneumonia (CAP) was most common in children aged 12 months to under 5 years, in males and typically presented with cough, fever, tachypnea and crackles on lung examination. *S. pneumoniae* and H. influenzae were the predominant bacterial pathogens, while atypical bacteria were uncommon. The high rate of bacterial co-infection suggested a complex microbial etiology. ***Conclusion:*** CAP was the most common in children aged 12 months to under 5 years. RT-PCR revealed that *S. pneumoniae* and H. influenzae were the most predominant bacterial pathogens, while atypical bacteria are uncommon.

Keywords: *children, community-acquired pneumonia, S. pneumoniae, H. influenzae*.

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Received: June 11, 2025
Reviewed: June 14, 2025
Accepted: June 25, 2025

INTRODUCTION

Community-acquired pneumonia (CAP) is infection acquired outside hospital setting, and its symptoms typically appear within the first 48 hours of a hospital admission. However, it may also include cases in which symptoms develop within 48 hours of admission if the infection was likely contracted prior to hospital arrival [1, 2]. CAP is among the most common causes of hospitalization and mortality in children, particularly in those under 5 years of age. The global burden of hospital admissions for community-acquired pneumonia exceeds 20 million annually [3]. Multiple microorganisms contribute to the pathophysiology of CAP, among which bacterial pathogens are important factors that can result in a high mortality rate. Early diagnosis and appropriate treatment are therefore crucial for improving clinical outcomes, reducing complications, and preventing death, especially in young children. Previous studies have shown that the bacteriological profile of community-acquired pneumonia differs among countries and may change over time even within the same country [4-8] . This research aimed to achieve the following two objectives:

1. To describe some clinical and paraclinical characteristics of community-acquired

pneumonia in children at Hai Phong International Obstetrics and Pediatrics Hospital from September 1, 2024 to April 30, 2025.

2. To characterize the bacterial pathogens responsible for CAP in these patients.

METHODS

Subjects

All medical records of patients under 15 years of age who were diagnosed with community-acquired pneumonia (CAP) and treated at the Respiratory and Cardiology Department of Hai Phong International Obstetrics and Pediatrics Hospital from September 1, 2024, to April 30, 2025, were reviewed .

Inclusion Criteria

Patients were diagnosed with pneumonia based on the World Health Organization (WHO) guidelines [9], which include clinical findings such as cough, tachypnea or dyspnea, and the presence of crackles or bronchial breath sounds on auscultation. For microbiological assessment, nasopharyngeal swab samples were collected upon hospital admission and analyzed at the hospital's Microbiology Laboratory. The samples underwent Multiplex Real-time PCR to detect the following bacteria: *S. pneumoniae*, *H. influenzae*, M. pneumoniae, C. pneumoniae, B. pertussis, L. pneumoniae and B. parapertussis.

Exclusion Criteria

- Medical records with incomplete research information.
- Children presenting with acute asthma, pre-existing chronic diseases, or conditions associated with immunosuppression on hospital admission were excluded.

Research Methods

Research design: retrospective case series study.

Sample size and sample selection: the sample size was calculated for estimating a single proportion using the following formula:

$$n = \frac{Z^2_{1-\alpha/2} \times p(1-p)}{d^2}$$

n is the required sample size; $Z_{1-\alpha/2}$ is the standard normal deviate corresponding to the desired confidence level (1.96 for 95% confidence); p is the estimated proportion of the outcome of interest from previous studies (According to the study by Ngo Anh Vinh et al. (2023), the positive PCR rate in nasopharyngeal samples of patients with community-acquired pneumonia was 73.2%) [7], d is the allowable margin of error (d=0.05). After applying the formula, the minimum sample size required was 302 patients. The study employed a systematic random sampling method, with k=5. In total, 340 cases of CAP were included in this study.

Information Collection Method: data were extracted from eligible medical records using a pre-designed data collection form.

Data Processing: data were analyzed using IBM SPSS Statistics version 27.0 (IBM®, USA). Descriptive statistics were used to summarize the data; percentages were calculated for categorical variables, and continuous variables were presented as median and IQR. A p-value < 0.05 was considered statistically significant.

Research ethics: this research was conducted with the approval of the Ethics Committee of Hai Phong University of Medicine and Pharmacy and Hai Phong International Obstetrics and Pediatrics Hospital. Patient information was de-identified to ensure confidentiality and was used solely for research purposes.

RESULTS

A total of 340 patients with CAP who met the inclusion criteria were enrolled in the study.

Table 1. *Demographic characteristics of children with community-acquired pneumonia (n = 340)*

Characteristics		Number of cases (n)	Percentage (%)
Age	< 2 months	6	1.8
	2 – < 12 months	22	6.5
	12 months - < 5 years	263	77.4
	≥ 5 years	49	14.4
Sex	Male	192	56.5
	Female	148	43.5
Chief complaint	Cough	93	27.4
	Cough and fever	230	67.6
	Cough and dyspnea	17	5.0
Duration from onset to admission	< 7 days	237	69.7
	7 – <14 days	75	22.1
	≥ 14 days	28	8.2
Antibiotic use prior to hospitalization	Yes	265	77.9
	No	75	22.1

Remarks: Regarding patient characteristics, the majority of patients were in the 12-month to <5-year age group. The most common chief complaint was a combination of cough and fever. Most patients had used antibiotics prior to hospitalization.

Table 2. *Clinical characteristics of children with community-acquired pneumonia (n = 340)*

Signs and symptoms		Number of cases (n)	Percentage (%)
Signs	Cough	340	100.0
	Runny nose	295	86.8
	Dyspnea	17	5.0
	Vomiting	38	11.2
	Diarrhea	21	6.2
	Abdominal pain	2	0.6
	Chest pain	3	0.9
	Fever	230	67.6
	Skin rash	6	1.8
	Hoarseness	15	4.4
Symptoms	Stridor	2	0.6
	Wheezing	248	72.9
	Cyanosis	1	0.3
	Tachypnea	311	91.5

	Chest indrawing	17	5.0
	Coarse crackles	319	93.8
	Rhonchi	116	34.1
	Fine crackles	1	0.3

Remarks: The most common signs and symptoms among the children with CAP were cough, runny nose, fever, tachypnea, coarse crackles, wheezing and rhonchus.

Table 3. *Paraclinical characteristics of children with community-acquired pneumonia (n = 340)*

Paraclinical characteristics		**Number of cases (n)**	**Percentage (%)**
WBC	Elevated	125	36.8
	Normal	208	61.2
	Decreased	7	2.1
CRP	0 - 6 mg/l	221	65.0
	> 6 mg/l	119	35.0
Chest X-ray findings	Infiltration	195	57.4
	Consolidation	24	7.1
	Hyperinflation	17	5.0
	Pleural effusion	3	0.9

Remarks: Approximately one-third of the patients showed elevated WBC and serum CRP level. Pulmonary infiltration was detected in more than 50% of patients.

Table 4. *Distribution of bacterial pathogens by age groups identified by Real-time PCR (n = 340)*

Pathogens	**<2 months**	**2–<12 months**	**12 months – <5 years**	**≥5 years**	**Total**
S. pneumoniae	3	14	241	44	302
H. influenzae	1	10	152	26	189
B. pertussis	0	0	0	4	4
M. pneumoniae	1	0	2	0	3
C. pneumoniae	0	0	1	0	1

Remarks: *S. pneumoniae* and *H. influenzae* were the most frequently detected bacterial pathogens in children with CAP.

Table 5. *Bacterial coinfection rates detected by Real-time PCR (n = 340)*

Type of bacterial infection	**Number of cases (n)**	**Percentage (%)**
Single bacterial infection	144	42.4
Co-infection with two bacterial species	170	50.0
Co-infection with three bacterial species	5	1.5
Negative	21	6.2

Remarks: Bacterial co-infection was detected in more than 50% of patients.

DISCUSSION

Clinical, subclinical characteristics of CAP in children

General characteristics of patients

The findings demonstrated that CAP occurred across all pediatric age groups, with the majority of cases (77.4%) observed in children aged 12 months to less than 5 years, followed by those aged 5 years and older (14.4%), infants aged 2 to less than 12 months (6.5%) and infants under 2 months (1.8%). These results are consistent with previous studies conducted both in Vietnam and globally, which indicate that pre-school-aged children are the most vulnerable due to immature immune responses and increased exposure in community settings [10]. In children aged 5 years and older, the prevalence of CAP decreases significantly, which corresponds to the maturation of the immune system and age-related improvements in airway defense mechanisms [11]. The low incidence among infants under 2 months can be explained by patient classification, as these cases are often managed in neonatal or intensive care units. Moreover, neonates benefit from passive immunity (through transplacental transfer of maternal IgG antibodies). If the mother has been vaccinated against relevant pathogens, these antibodies may confer protection against severe disease during the first few months of life [12].

Notably, a male predominance was observed, with patients being 56.5% male and 43.5% female. This findings is consistent with previous research, which, despite variations in exact ratios, generally reports that CAP is more common in boys than in girls [8, 13, 14]. This finding may be explained by several biological mechanisms, including the role of sex hormones and differences in gene expression between XX (female) and XY (male) individuals. Hormones such as estrogen are known to enhance immune function, whereas testosterone tends to have immunosuppressive properties. Furthermore, the influence of these hormones on the balance between T-helper type 1 and type 2 (Th1/Th2) responses has been proposed as a key mechanism contributing to the higher susceptibility and severity of diseases, including community-acquired pneumonia, observed in males [15, 16].

Moreover, the most common reason for hospital admission was cough accompanied by fever (67.6%), followed by cough alone (27.4%). This pattern aligns with the typical clinical presentation of CAP in children, as cough and fever are the most recognizable symptoms prompting early medical attention. These findings are consistent with previous studies, both national and international, which also identified cough and fever as the main symptoms leading caregivers to seek medical care. Conversely, the lower proportion of admissions for cough with dyspnea (5%) may be explained by several factors. It may reflect that most patients were hospitalized at earlier stages, before respiratory distress (which often develops in more severe cases) could set in. Additionally, this lower rate may be attributed to variations in parental awareness, healthcare accessibility, and initial screening practices at primary health facilities. [17, 18].

In our study, most pediatric patients (69.7%) were admitted to the hospital within 7 days of symptom onset. Only 22.1% were hospitalized between 7 and 14 days, and 8.2% were admitted after 14 days. This finding reflects that most parents recognized abnormal symptoms in their children early and sought medical attention during the initial phase of the illness. However, the considerable proportion of children admitted

more than 7 days after onset (30.3% combined) suggests barriers to healthcare access. These may include limited awareness of disease severity, ineffective outpatient treatment (such as inappropriate antibiotics), or socioeconomic and geographical constraints. Comparable results have been reported in other studies regarding the average interval between symptom onset and hospital admission, indicating similar healthcare-seeking behaviors among caregivers [19]. Nonetheless, variations in the rate of delayed hospitalization across studies may be associated with differences in the primary healthcare system and the effectiveness of health communication within the community.

A high proportion (77.9%) of pediatric patients had used antibiotics before hospital admission, whereas only 22.1% had not. This finding reflects a common situation in Vietnam and many other developing countries, where the misuse of antibiotics, including prevalent over-the-counter use, remains a significant concern [20, 21]. Early antibiotic administration, particularly when not prescribed by healthcare professionals, poses a risk of promoting antimicrobial resistance and compromising the accuracy of microbiological diagnosis.

Clinical characteristics of CAP in children

In our study, cough was the most common symptom, present in al patients (100%). This finding is consistent with both national and international studies [8, 14, 18, 22]. Crackles were also highly prevalent (99.7%), followed by wheeze (53.8%). Among the detected crackles, 94.1% were coarse. This pattern aligns with findings from previous Vietnamese studies [14, 18]. Tachypnea was recorded in 91.5% of children, supporting its diagnostic value for pneumonia [23]. Runny nose was present in 86.8% of patients, suggesting concurrent upper respiratory tract involvement in most cases. Chest indrawing was less frequent (5.0%), indicating that most children were admitted before developing severe respiratory distress. Hoarseness and stridor were uncommon (4.4% and 0.6%, respectively), likely reflecting coexisting upper airway infections. Finally, dyspnea and cyanosis were rare. This finding is consistent with global and local data showing these severe signs in only a small subset of hospitalized children [24].

Moreover, fever was recorded in 67.6% of patients. This finding is consistent with previous studies, which suggests that fever is common but nonspecific manifestation of community-acquired pneumonia (CAP) in children [14, 18, 23, 25]. Among extrapulmonary symptoms, vomiting was observed in 11.2% and diarrhea in 6.2% of cases. These findings may reflect systemic infection, antibiotic-associated dysbiosis, or concurrent gastrointestinal involvement, especially given the high rate of pre-hospital antibiotic use in Vietnam. Less frequent symptoms included rash (1.8%), chest pain (0.9%), and abdominal pain (0.6%), which were mostly nonspecific and likely related to immune or inflammatory responses [26].

Paraclinical characteristics of CAP in children

In our study, leukocytosis (elevated white blood cell count) was observed in 36.8% of children with community-acquired pneumonia (CAP), while leukopenia (a low white blood cell count) was recorded in 2.1% of cases. Elevated serum CRP levels were detected in 35% of patients, whereas 65% remained within the normal range. These rates are lower than those reported in some other Vietnamese studies. For example, Bui Anh Son et al. reported leukocytosis in 74.5% and CRP elevation in 58.6% of patients,

while Dinh Duong Tung Anh et al. reported figures of 70.2% and 56.7%, respectively [14, 24].

In the present study, the most common chest X-ray finding was alveolar infiltration (57.4%), followed by pulmonary consolidation (7.1%), hyperinflation (5.0%), and pleural effusion (0.9%). Atelectasis was not observed in any case. These results are consistent with many national and international studies on pediatric community-acquired pneumonia, which has indentified pulmonary infiltration as the most typical and frequent radiologic finding [14, 27]. Notably, although hyperinflation was observed in only 5.0% of cases, it remains clinically relevant, as it is often seen in secondary bronchiolitis or infections caused by atypical bacteria. Pleural effusion was detected in only 0.9% of cases, a finding that is consistent with this complication being uncommon in pediatric community-acquired pneumonia [27].

Bacterial pathogens of community-acquired pneumonia in children

In the present study, *S. pneumoniae* and *H. influenzae* were the predominant bacterial pathogens, detected in 88.8% and 55.6% of cases, respectively. Other bacteria, including *Mycoplasma pneumoniae* (0.9%), *Chlamydophila pneumoniae* (0.3%), and *Bordetella pertussis* (1.2%) were detected only sporadically, while *Legionella pneumoniae* and *Bordetella parapertussis* were not identified. These findings indicate that *S. pneumoniae* and *H. influenzae* remain the major causative agents of community-acquired pneumonia in children. This observation was consistent with previous studies, Ngo Anh Vinh et al., reported *H. influenzae* in 52.1% and *S. pneumoniae* in 33.9% of cases [7], and by Tran Quang Khai et al. in Can Tho city, observed isolation rates of 66.1% and 22.9% for *S. pneumoniae* and *H. influenzae*, respectively [28]. Similarly, Le Thi Hien Anh et al. more recently, another study at the hospital reported an isolation rate of *S. pneumoniae* of 66.8% [29]. *S. pneumoniae* and *H. influenzae* were also the most frequent pathogens in children with CAP in another study at Hai Phong Children's Hospital recently [30]. The consistency across these findings reinforces the predominant role of these two classical pathogens in the etiology of pediatric community-acquired pneumonia.

Atypical pathogens such as *M. pneumoniae* and *C. pneumoniae* were detected only sporadically. These findings are consistent with the notion that these bacteria are more commonly associated with older children and adolescents. For example, a study conducted in Taiwan also demonstrated that *M. pneumoniae* infection was significantly more prevalent among children aged 5 years and older compared to younger age groups [24]. Similarly, a study in the United States involving 2,254 children with community-acquired pneumonia found that M. pneumoniae was detected more frequently in those aged 5 years and older, whereas the prevalence was substantially lower among children under 5 years of age [31]. In contrast, *B. pertussis* was identified only in children aged 5 years and older, reflecting the epidemiologic characteristics of pertussis and suggesting waning vaccine-induced immunity over time. Multiple studies have shown that the protective efficacy of pertussis vaccines declines markedly within 4–12 years after completion of the primary immunization series, thereby increasing susceptibility among older children and adolescents [32]. These findings imply a potential role of waning post-vaccination immunity and highlight the need to consider

booster immunization strategies at school age to sustain community-level protection.

Bacterial coinfection was highly prevalent among children with community-acquired pneumonia (CAP), with 53.3% of cases exhibiting coinfection with two bacterial species and 1.6% showing triple bacterial coinfection. Only 45.1% of patients had a single bacterial pathogen detected. These findings suggest that mixed bacterial infections play an important role in the pathogenesis of pediatric CAP. The results of our study are consistent with those reported by Tran Quang Khai et al. [33].

CONCLUSION

Community-acquired pneumonia (CAP) was most common among children aged 12 months to under 5 years, occurred predominantly in males, and typically presented with cough, fever, tachypnea, and crackles on lung examination. *S. pneumoniae* and *H. influenzae* were the most common bacterial pathogens, whereas atypical bacteria were uncommon. The high rate of bacterial co-infection suggests a complex microbial etiology, underscoring the importance of accurate diagnosis and appropriate antibiotic selection to optimize treatment outcomes.

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