

# Analysis of clinical and complementary findings in the diagnosis of bacterial pneumonia in pediatric patients admitted to a tertiary hospital

## *Análise dos achados clínicos e complementares no diagnóstico de pneumonia bacteriana em pacientes pediátricos internados em um hospital terciário*

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### ABSTRACT

**Introduction:** Community-acquired pneumonia (CAP) is a disease contracted outside the hospital environment and one of the leading causes of morbidity and mortality in children under five, with about 156 million cases annually worldwide. In Brazil, it is the third leading cause of child death. **Objective:** this study aims to analyze the main symptoms found in the medical records of patients diagnosed with pneumonia in the pediatrics sector of a University Hospital. **Methods:** This is a retrospective and descriptive cross-sectional study, which used data obtained from the medical records of patients hospitalized for bacterial pneumonia in the pediatrics sector of the Hospital Universitário Júlio Bandeira (HUJB) from September 2017 to December 2021. **Results:** The results found indicate that fever (65.4%); cough (74.11%); tachypnea (22.61%) and dyspnea (58.85%) were the main symptoms described, and wheezing as a finding that speaks against the diagnosis of pneumonia (OR=0.21). The presence of an x-ray with a suggestive image can help in cases of diagnostic doubt (OR=2.9). Finally, the main clinical complication found was pleural effusion (4.5%). **Conclusion:** Fever associated with respiratory symptoms were the most reported symptoms, with the presence of wheezing being a finding against the diagnosis of pneumonia. Finally, x-rays are useful in cases of doubt.

**Keywords:** Pneumonia; Respiratory tract infection; Pediatrics; Early diagnosis; Diagnostic techniques and procedures; Diagnostic testing.

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#### Supporting sources:

None.

#### Conflict of interests:

None.

## RESUMO

**Introdução:** A pneumonia adquirida na comunidade (PAC) é uma doença contraída fora do ambiente hospitalar e uma das principais causas de morbimortalidade em crianças menores de cinco anos, com cerca de 156 milhões de casos anuais em todo o mundo. No Brasil, é a terceira principal causa de óbito infantil. **Objetivo:** Este estudo tem como objetivo analisar os principais sintomas encontrados nos prontuários de pacientes diagnosticados com pneumonia no setor de pediatria de um Hospital Universitário. **Métodos:** Trata-se de um estudo transversal, retrospectivo e descritivo, que utilizou dados obtidos dos prontuários de pacientes internados por pneumonia bacteriana no setor de pediatria do Hospital Universitário Júlio Bandeira (HUJB), no período de setembro de 2017 a dezembro de 2021. **Resultados:** Os resultados encontrados indicam que febre (65,4%); tosse (74,11%); taquipneia (22,61%) e dispnéia (58,85%) foram os principais sintomas descritos, sendo o sibilo um achado que fala contra o diagnóstico de pneumonia (OR=0.21). A presença de radiografia com imagem sugestiva pode auxiliar em casos de dúvida diagnóstica (OR=2.9). Por fim, a principal complicação clínica encontrada foi o derrame pleural (4,5%). **Conclusão:** A febre associada a sintomas respiratórios foi a manifestação mais frequentemente relatada, sendo o sibilo um achado que se contrapõe ao diagnóstico de pneumonia. Por fim, a radiografia mostrou-se útil em casos de dúvida diagnóstica.

**Palavras-chave:** Pneumonia; Infecção do trato respiratório; Pediatria; Diagnóstico precoce; Técnicas e procedimentos de diagnóstico; Testes diagnósticos.

## Ethic committee:

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee with opinion number 3,686,831 and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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## INTRODUCTION

Community-acquired pneumonia (CAP) is a respiratory infection acquired outside the hospital setting, affecting individuals who have not been hospitalized in the previous 30 days or who develop symptoms within 48 hours of hospital admission. Globally, CAP is a major cause of morbidity and mortality in children under five years of age, with an estimated 156 million new cases reported annually<sup>1</sup>.

In Brazil, the disease also poses a significant public health challenge, contributing to high rates of hospitalization and mortality in the pediatric population, with approximately 700,000 deaths in this age group<sup>2</sup>. The substantial burden of CAP at both global and national levels demonstrates the pressing need for targeted public health strategies to reduce its impact.

Therefore, early diagnosis is essential to reduce associated morbidity and mortality. Timely identification and appropriate treatment of CAP are key strategies for improving outcomes, particularly in pediatric populations where the disease remains a leading cause of hospitalization and death<sup>1,2</sup>. However, achieving early diagnosis remains a major challenge. Pneumonia is clinically characterized by fever, lower airway

symptoms, and lung parenchyma involvement, which may be identified on physical examination or through the presence of infiltrates on chest radiography<sup>3</sup>. Despite these typical findings, CAP diagnosis is primarily clinical and can be difficult due to its nonspecific and variable presentation, especially in young children. Recognizing typical and atypical signs and symptoms, as well as understanding the most common presentations by age group, is essential to avoid both diagnostic delays and inappropriate antibiotic use<sup>1,4,5</sup>.

In children under five years of age, the clinical presentation is often subtle or atypical. Infants may present without fever, showing only nonspecific signs such as irritability, poor feeding, or agitation<sup>4</sup>. In children under three, the disease may have an insidious onset with low-grade fever, wheezing, and tachypnea—features that often suggest a viral etiology. Conversely, children over five may present with a more prolonged course characterized by persistent cough, suggesting atypical pathogens, while a more acute presentation with high fever, prostration, and respiratory distress may indicate a bacterial cause<sup>4,5</sup>. These variations, along with the absence of specific radiologic markers, highlight the complexity of

diagnosing CAP in pediatric patients. Therefore, clinicians must be attentive to age-specific manifestations and local epidemiological patterns and rely on complementary diagnostic tools when necessary<sup>5</sup>.

Accordingly, this study aims to examine the different clinical presentations of CAP to support early recognition and management, ultimately helping healthcare professionals make informed clinical decisions.

## METHODS

### CHARACTERIZATION OF THE STUDY

This research involves human subjects and was conducted through a retrospective, descriptive, cross-sectional study of patients hospitalized in the pediatrics department of the Hospital Universitário Júlio Bandeira (HUJB), Cajazeiras, Paraíba, Brazil. HUJB serves as a reference hospital for the municipalities of the Ninth Health Region of Paraíba, covering the period from September 1, 2017, to December 31, 2021. It is an important municipal health resource, functioning as a secondary care facility for both the city and the surrounding region, admitting approximately 194 pediatric patients per year for pneumonia treatment.

### TARGET POPULATION/SAMPLE

The study included patients treated in the pediatrics department of the Júlio Bandeira University Hospital (children and adolescents up to 17 years and 11 months of age) who were diagnosed with bacterial pneumonia and admitted between September 2017 and December 2021. Children hospitalized with ICD-10 codes J00–J45 for airway diseases were also included to compare clinical and radiological similarities across conditions. Patients who were not pediatric or who were admitted for non-airway diseases were excluded.

### PROCEDURES AND DATA COLLECTION

Data collection was carried out at HUJB by accessing medical prescriptions and electronic medical records through the Management Application for University Hospitals (AGHU). The information was analyzed and entered into a spreadsheet containing the following data: age and sex; reported symptoms (fever, cough, pleuritic pain, tachypnea, level of consciousness, dyspnea, pleural effusion, wheezing, compatible auscultation, subcostal retraction, hypoxia); chest X-ray and its results (whether it was performed and whether the findings were compatible with pneumonia); and leukocytosis.

### ETHICAL ASPECTS

It is important to highlight that the present study was approved by the Research Ethics Committee for Human Subjects of the Teacher Training Center at the Federal University of Campina Grande, under opinion number 3,686,831.

### STATISTICAL ANALYSIS

The data were analyzed in a descriptive and exploratory manner to evaluate the distribution and characterize the study population. Categorical variables were presented as absolute (n)

and relative frequencies (%), while continuous variables were assessed using measures of central tendency and dispersion.

To assess whether the data approximated a normal distribution, the Kolmogorov-Smirnov test was used. As the data did not follow normality, differences between the proportions of categorical variables were evaluated using the Chi-square test (at a 5% significance level), while differences between medians were assessed using the Mann-Whitney U test. To analyze associated factors, simple non-conditional logistic regression was applied, and crude odds ratios with their respective 95% confidence intervals were reported. All analyses were performed using IBM® SPSS® v.26 software.

## RESULTS

After analyzing the 734 study records, the sociodemographic profile can be defined, with males being predominant (53.13%). Regarding age, the classification followed the age groups established in hospital protocols (up to 3 months; 4 months to 4 years; 5 years or older), with the 4-month-to-4-year-old age group being the most prevalent (64%).

Table 1 presents the signs and symptoms recorded in the medical records, showing the prevalence of cough (74.11%), fever (65.4%), dyspnea (58.85%), and tachypnea (22.61%).

**Table 1.** Signs and symptoms reported in the records of patients hospitalized for bacterial pneumonia in the pediatric sector from 2017 to 2021.

Variables	n	%
<b>Fever</b>		
Afebril	93	13.8
Fever without reported temperature	393	58.1
Low fever	11	1.6
High fever	76	11.2
Does not report	103	15.2
<b>Cough</b>		
No	139	20.4
Yes	544	79.6
<b>Pleuritic pain</b>		
No	645	94.2
Yes	40	5.8
<b>Tachypnea</b>		
No	81	12.0
Yes	166	24.5
Does not report	430	63.5
<b>Lowering of the level of consciousness</b>		
No	74	11.1
Yes	59	8.9
Does not report	533	80.0

continue...

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Variables	n	%
<b>Dyspnea</b>		
No	74	10.9
Yes	432	63.8
Does not report	171	25.3
<b>Pleural effusion</b>		
No	644	95.1
Yes	33	4.9
<b>Sibilance</b>		
No	134	19.8
Yes	72	10.6
Does not report	471	69.6
<b>Compatible auscultation*</b>		
No	114	16.8
Yes	156	23.0
Does not report	407	60.1
<b>Leukocytosis</b>		
No	118	17.4
Yes	145	21.4
Does not report	414	61.2
<b>Hypoxia</b>		
No	99	14.6
Yes	71	10.5
Does not report	507	74.9
<b>Respiratory discomfort</b>		
No	114	16.9
Yes	80	11.8
Does not report	482	71.3

\*Compatible auscultation includes findings regarding crackles and snoring.

**Legend:** 95% CI = 95% Confidence Interval; *p*-value = adopted 5% or 0.05.

**Source:** Own Authorship.

Regarding severity, the clinical conditions of the patients were classified as mild or severe, with severe cases defined as those presenting respiratory distress, hypoxia, and/or decreased level of consciousness. In this context, 166 (22.61%) of the hospitalized patients during the study period presented with a severe condition.

Furthermore, among the complications, pleural effusion was the only one reported in the medical records, occurring in 33 (4.5%) patients. In these cases, cough and dyspnea were commonly observed, at rates of 63.63% and 66.6%, respectively. It is important to note that not all patients who developed pleural effusion were classified as having severe pneumonia; only 21.2% were.

Finally, white blood cell count and chest X-ray were used as complementary diagnostic tests, with Table 2 showing their relationship with the diagnosis of bacterial pneumonia. Regarding the former, data analysis did not indicate significant relevance for diagnosing pneumonia; however, among those who underwent a chest X-ray (43.32%), the presence of suggestive findings (40.87%) helped confirm the diagnosis (OR=2.9).

An intriguing finding, although not a complementary test, is the presence of wheezing, which argues against the diagnosis of pneumonia (OR=0.21).

## DISCUSSION

The analysis of the sociodemographic profile is consistent with what is reported in the literature, with males being predominant<sup>6-8</sup>. Regarding the 4-months-to-4-year age group, which was also predominant, it is important to highlight that pneumonia is common in this population, accounting for 15% of deaths in this age group worldwide in 2015, in addition to being one of the main causes of hospitalization<sup>7,9</sup>.

The diagnosis of community-acquired pneumonia (CAP) in the pediatric population is clinical, meaning it is based on symptoms<sup>10</sup>. The main symptoms associated with this diagnosis are tachypnea combined with fever and/or cough, which is consistent with both the present study and the literature<sup>11,12</sup>. In this study, fever (65.4%) and

**Table 2.** Impact of wheezing and complementary tests reported in medical records for the diagnosis of bacterial pneumonia in the population hospitalized for bacterial pneumonia in the pediatric sector from 2017 to 2021.

Variables	Diagnosis				RC	IC 95%	<i>p</i> -value
	Other diagnosis		Pneumonia				
	n	%	n	%			
<b>Sibilance</b>							
no	10	7.5	124	92.5	1		
yes	20	27.8	52	72.2	0.21	0.92 - 0.48	<0.001
<b>Performed X-ray</b>							
no	35	10.1	312	89.9	1		
yes	39	11.5	301	88.5	0.87	0.53 - 1.40	0.559

continue...

... continued Table 2

	Diagnosis				OR	95% CI	p-value
	Other diagnosis		Pneumonia				
<b>Suggestive X-ray</b>							
no	10	24.4	31	75.6	1		
yes	30	10.0	270	90.0	2.90	1.30 - 6.50	0.010
<b>Leukocytosis</b>							
no	16	13.6	102	86.4	1		
yes	15	10.3	130	89.7	1.36	0.64 - 2.88	0.423

**Legend:** 95% CI = 95% Confidence Interval; *p*-value = adopted 5% or 0.05.

**Source:** Own authorship.

cough (74.11%) were the predominant findings, along with tachypnea (22.61%). The lower frequency of tachypnea reported differs from the literature; however, this figure may be underestimated, as 63.5% of the medical records did not report the respiratory rate.

According to the study by Galviz et al. (2020)<sup>15</sup>, based on a systematic review published in JAMA (2017), the absence of fever (<37.5 °C) and cough, as well as RR <40 bpm (in children under 5 years old), is associated with a lower probability of pneumonia. Cough was the most prevalent symptom observed, which differs from other literature where fever is more common than cough. Another important finding highlighted by Galviz's et al.<sup>15</sup> research is that coughing and vomiting were not associated with an increased likelihood of pneumonia, and no specific respiratory sounds on auscultation were linked to the disease<sup>15</sup>.

Still regarding respiratory symptoms, dyspnea was present in 64.5% of patients according to Huijskens et al. (2014)<sup>11</sup>, a value consistent with that observed in this study (63.8%). Chest pain was reported in 19.9% of individuals, a frequency that differs from this study, in which only 5.85% of patients reported this symptom. This disparity may be explained by the underreporting of chest pain in the HUIJB records, which likely led to an underestimated frequency of this symptom.

In CAP, infectious agents in the lung tissue trigger an inflammatory response that increases vascular permeability and produces inflammatory exudate. This exudate replaces normal lung tissue, causing pulmonary consolidation, which reduces alveolar ventilation and expansion, thereby impairing gas exchange. This process explains the main signs and symptoms of pneumonia, such as tachypnea, fever, and, less commonly, chest pain and wheezing<sup>12-14</sup>.

Finally, it should be noted that auscultation may initially reveal no abnormalities but later may show decreased breath sounds and/or rales. While auscultation can provide diagnostic clues, the findings are nonspecific and cannot be used to exclude pneumonia, as no specific respiratory sounds are uniquely associated with the disease and they may also be present in other respiratory conditions<sup>15,16</sup>.

Furthermore, the present study identified that the presence of wheezing in a patient increases the likelihood

of excluding a diagnosis of CAP, with the probability of its occurrence in a patient with pneumonia being low (OR=0.21, *p*<0.001). Wheezing may therefore serve as an auxiliary clinical finding in the differential diagnosis with other respiratory diseases. This finding is consistent with the literature, which highlights that wheezing is an uncommon symptom in children with pneumonia and is more frequently observed in other conditions, such as asthma or bronchiolitis, although it does not entirely rule out pneumonia from the diagnostic considerations<sup>17,18</sup>.

In children under five with acute lower respiratory tract infections, viruses such as human rhinovirus, influenza, adenovirus, and especially respiratory syncytial virus (RSV) are common, with most cases presenting with wheezing. This supports the link between viral etiology and wheezing, associating it more with bronchiolitis and asthma than with pneumonia<sup>19,20</sup>. In RSV infections, lung mucosal damage from intense inflammation may increase sensitivity to allergens or expose irritant receptors, contributing to recurrent wheezing, although its exact pathophysiology remains unclear<sup>20,21</sup>.

In contrast, a study conducted by Mata et al. (2021)<sup>18</sup> in a hospital on the outskirts of São Paulo showed that, among 124 children admitted with wheezing symptoms, 59.3% were diagnosed with pneumonia. This finding may be explained by Aurilio et al. (2020)<sup>6</sup>, who reported an association between wheezing and underlying diseases. Since patients with comorbidities have a higher likelihood of developing severe pneumonia (31.4% of the more severe cases), they may present with pneumonia accompanied by wheezing.

The diagnosis of CAP is clinical, and additional tests are not necessary for confirmation<sup>10</sup>. This is because radiological findings indicative of pneumonia can be masked by anatomical structures or may not be present in the early stages of the disease. This was confirmed in the present study, where only 40.87% of patients had suggestive radiographic changes<sup>22</sup>. For this reason, the frequency of chest X-rays is generally low, being 18% in the study by Van de Maat et al. (2021)<sup>23</sup> and 25.22% in Poutanen (2020)<sup>24</sup>, which differs from the present research, in which it was 46.32%. This discrepancy may be attributed to HUIJB

functioning as a closed-door hospital that admits patients referred from emergency units (UPAs), where pediatric care is often provided by physicians without specialized training.

However, despite not being a routine test, data analysis shows that when suggestive findings are present, the likelihood of pneumonia is higher (OR=2.9). This finding is consistent with the literature, where chest X-ray can be used in cases of diagnostic uncertainty or when there is a need to exclude other causes—always in conjunction with the patient's clinical condition<sup>17</sup>.

Finally, the last complementary test analyzed through the medical records was the white blood cell count. It was observed that leukocytosis was slightly more frequent in patients with a confirmed diagnosis of pneumonia (56%); however, the presence of this laboratory finding is not sufficient to support the diagnosis<sup>25,26</sup>. Similar results were reported in the review by Rocha (2022)<sup>27</sup>, who noted leukocytosis as one of the main hematological changes in patients with bacterial pneumonia. Therefore, performing a leukogram is not recommended in the diagnostic evaluation of pneumonia, as it is nonspecific and does not help identify the pathogen. Both viral and bacterial agents can cause leukocytosis, and leukopenia may also be observed in patients with pneumonia, including the most severe cases<sup>25,26,28,29</sup>.

The present study identified that 166 (22.61%) of hospitalized patients were classified as having severe pneumonia; this analysis was based on documented symptoms. Literature reports show considerable variation, with lower percentages, as in the study by Rabha et al. (2021)<sup>30</sup>, which evaluated 115 children treated for pneumonia, 14% of whom had a severe condition, and higher percentages, as in a study conducted across 17 health centers in Goiânia-GO that reviewed 95 medical records and identified 59 cases of severe pneumonia (62.1%)<sup>31</sup>.

In the first case, the discrepancy can be explained by the fact that the hospital where the study was conducted, despite having around 135 beds, is not the reference hospital in its region. Furthermore, in the Goiânia-GO study, multiple reference centers were evaluated, allowing for the identification of more severe cases. In contrast, in the institution where this research was carried out, the most severe patients, who require intensive care, are transferred to other centers, such as the Alcides Carneiro University Hospital in Campina Grande/PB.

Regarding complications, it is worth highlighting that, according to Krapiec (2022)<sup>32</sup>, pleural effusion results from the pulmonary infectious process, and, in these cases, symptoms are more pronounced. Among the signs of severity, it is the most common, which corroborates the findings of this study, as it was the only radiological sign of severity identified, present in 4.5% of the records<sup>33</sup>. In a study conducted by Bini (2020)<sup>34</sup>, pleural effusion was also found to be the most common complication in children hospitalized for pneumonia, with an estimated 40% of pediatric CAP cases developing pleural effusion. This occurs because the pathophysiology of the infection leads to the accumulation of exudate, which may include pus, in the pleural space.

The present study has limitations inherent to its retrospective design, which relied on the review of medical records without a pre-established data collection protocol. This resulted in incomplete information, such as missing respiratory rates and other clinical indicators of respiratory distress, as well as inconsistencies related to documentation quality among different professionals. Furthermore, the absence of microbiology services prevented the identification of the etiological agent, limiting diagnostic precision. Selection bias is also possible, as the study was conducted in a tertiary hospital, where patients are generally more severe or present with more complex conditions, which may not reflect the general population. Altogether, these factors underscore issues of incomplete data, lack of standardization, and potential biases that must be considered when interpreting the findings.

Because differentiating pneumonia from other airway conditions is challenging, implementing and evaluating a standardized protocol for recording respiratory symptoms among the hospital's medical team could greatly improve data accuracy and the quality of patient care.

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## CONCLUSION

In line with this study's objective of supporting the early recognition and management of community-acquired pneumonia (CAP), data analysis revealed that fever accompanied by respiratory symptoms was the most frequently reported clinical presentation. Although auscultation alone proved nonspecific for confirming the diagnosis, the absence of wheezing emerged as a useful finding, as its presence tends to argue against CAP. While not essential for diagnosis, chest radiography was valuable in uncertain cases, with suggestive findings increasing diagnostic confidence. Additionally, pleural effusion was the only complication identified in the reviewed medical records, emphasizing the importance of its early identification to prevent the progression to more severe outcomes.

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## AUTHOR'S CONTRIBUTIONS

We describe contributions to the papers using the taxonomy (CRediT) provided above:

*Conceptualization, Investigation, Methodology, Visualization & Writing – review & editing:* Author XXX; Author BB. *Project administration, Supervision & Writing – original draft:* Author XXX; Author CCC; Author DD. *Validation & Software:* Author CCC. *Resources & Funding acquisition:* Author DD. *Data curation & Formal Analysis:* Author BB.

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