Comparison of Clinical Characteristics, Treatment Response and Prognostic Differences Among Patients with Community-Acquired Pneumonia Infected by Different Pathogens

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Abstract: Objective: To explore the differences in clinical characteristics, treatment response, and prognosis among patients with community-acquired pneumonia (CAP) infected by different pathogens. Methods: A total of 80 CAP patients admitted from January 2024 to December 2024 were selected and divided into three groups based on etiological test results: bacterial infection group, atypical pathogen infection group, and mixed infection group. The differences in clinical manifestations, inflammatory markers, symptom relief time, and hospitalization outcomes among the three groups were compared. Results: Streptococcus pneumoniae was the most common pathogen in the bacterial infection group. The mixed infection group had the highest fever rate, detection rate of moist rales, and levels of inflammatory markers. Patients in the atypical pathogen infection group had milder symptoms, faster fever resolution and cough relief, but a longer hospital stay. The incidence of complications in the mixed infection group was significantly higher. Conclusion: Pneumonia caused by different pathogens shows significant heterogeneity in clinical manifestations and outcomes. Accurate identification of pathogen types is conducive to optimizing treatment decisions and improving clinical prognosis.

***Keywords*:** community-acquired pneumonia (CAP); pathogens; clinical characteristics; treatment response; prognosis

1. Introduction

As a clinically prevalent respiratory infectious disease, community-acquired pneumonia (CAP) has long maintained a high incidence. It not only causes symptoms such as cough and fever that affect patients' quality of life but may also lead to severe complications like respiratory failure and septic shock, increasing the social medical burden [1]. In clinical practice, CAP can be caused by a variety of pathogens, and the clinical manifestations, treatment response, and final prognosis of patients infected by different pathogens vary significantly. However, in some current diagnosis and treatment processes, insufficient accuracy of etiological diagnosis often leads to a lack of targeting in initial treatment regimens, thereby affecting treatment efficacy [2-3]. Based on this, this study selected 80 CAP patients admitted from January 2024 to December 2024, and analyzed the differences in clinical characteristics, treatment response, and prognosis among patients infected by different pathogens to provide references for formulating precise clinical diagnosis and treatment plans.

2. Materials and Methods

2.1 General Information

A total of 80 CAP patients admitted from January 2024 to December 2024 were enrolled as the research subjects, including 42 males and 38 females, aged 22–78 years with an average of (56.3±12.5) years. Among them, 12 cases had diabetes mellitus and 9 cases had chronic obstructive pulmonary disease (COPD).

Inclusion criteria: Patients who met the clinical diagnostic criteria for CAP, i.e., presence of cough, expectoration or aggravated symptoms with purulent sputum, with or without fever, pulmonary consolidation signs, etc., combined with infiltrative shadows on chest imaging, excluding non-infectious lung diseases.

Exclusion criteria: Patients with complicated pulmonary tuberculosis or lung cancer; patients with severe liver and kidney failure or immunodeficiency; patients who had received standardized anti-infective treatment for more than 48 hours before admission.

All patients voluntarily participated in the study and signed the informed consent form.

2.2 Methods

A combined multi-method protocol was adopted for etiological detection, and specimens were collected from all patients before antibiotic use:

Sputum specimen collection: Patients were instructed to gargle first, then cough deeply to collect purulent sputum,

which was sent for testing within 1 hour. Qualified specimens (squamous epithelial cells <10 per low-power field, polymorphonuclear cells >25 per low-power field) were screened by Gram staining microscopy, inoculated on blood agar plates for culture, and drug sensitivity tests were performed.

Blood tests: Venous blood was collected for blood culture. Enzyme-linked immunosorbent assay (ELISA) was used to detect antibody titers of Mycoplasma pneumoniae, Chlamydia pneumoniae, and Legionella pneumophila. Immunochromatography was used to detect Streptococcus pneumoniae urinary antigen.

Imaging and data collection: Chest CT examination was performed to evaluate the scope and morphology of pulmonary lesions. Meanwhile, patients' clinical data were collected, including symptoms (fever, cough, etc.), signs (respiratory rate, moist rales, etc.), and laboratory indicators (white blood cell (WBC) count, C-reactive protein (CRP), procalcitonin (PCT), etc.).

Treatment was conducted by selecting corresponding antibacterial drugs based on etiological results and drug sensitivity tests: β-lactams or quinolones were used for bacterial infection; macrolides or tetracyclines were used for atypical pathogen infection. All patients received symptomatic and supportive treatment.

2.3 Evaluation Indicators and Judgment Criteria

Treatment response indicators: Fever resolution time, cough and sputum relief time, and time for CRP and PCT to return to normal.

Prognosis indicators: Length of hospital stay, incidence of complications.

Treatment efficacy judgment: Effective treatment was defined as alleviation of symptoms and decrease in inflammatory markers 72 hours after treatment initiation; otherwise, it was considered ineffective.

2.4 Statistical Methods

SPSS 26.0 statistical software was used for data analysis. Measurement data were expressed as mean ± standard deviation after normality test; count data were expressed as cases (percentage). Comparison of measurement data between groups was performed by t-test or analysis of variance (ANOVA), and comparison of count data was performed by chi-square test. The significance level was set at $\alpha=0.05$.

3. Results

3.1 Etiological Distribution

According to the combined multi-method etiological detection protocol in 1.2, there was a difference between the number of patients with confirmed pathogen infection and those with unconfirmed pathogen infection among the 80 patients. Among patients with confirmed pathogen infection, the proportion of bacterial infection was the highest, followed by atypical pathogen infection, and mixed infection (bacteria + atypical pathogens) had the lowest proportion. The specific distribution and proportion of different pathogen types are shown in Table 1.

Table 1. Etiological Distribution of 80 Patients with Community-Acquired Pneumonia

Pathogen Type	Number of Cases (n=68)	Proportion (%)
Streptococcus pneumoniae	18	26.5
Haemophilus influenzae	12	17.6
Mycoplasma pneumoniae	15	22.1
Chlamydia pneumoniae	9	13.2
Legionella pneumophila	6	8.8
Bacteria + Atypical pathogens	8	11.8

3.2 Differences in Clinical Characteristics Among Patients Infected by Different Pathogens

The clinical characteristics (refer to symptoms, signs, and inflammatory markers in 1.3) of the bacterial infection group, atypical pathogen infection group, and mixed infection group were compared. Differences were observed in fever rate, detection rate of moist rales, and levels of inflammatory markers among the three groups. The mixed infection group had higher fever rate, detection rate of moist rales, and levels of all inflammatory markers than the other two groups, while the atypical pathogen infection group had the lowest levels of these indicators. Statistical analysis (as described in 1.4) showed that the differences in the above indicators among the three groups were statistically significant ($P<0.05$). Detailed data are shown in Table 2.

Table 2. Comparison of Clinical Characteristics Among Patients Infected with Different Pathogens (±s/case, %)

Indicator	Bacterial Infection Group (n=30)	Atypical Pathogen Infection Group (n=30)	Mixed Infection Group (n=8)	P Value
Fever rate (%)	86.7	63.3	100	<0.05
Detection rate of moist rales (%)	73.3	46.7	87.5	<0.05
WBC count (×10⁹/L)	12.5±3.2	8.8±2.1	14.3±2.8	<0.05
CRP (mg/L)	68.5±15.3	35.2±10.8	82.6±12.5	<0.05
PCT (ng/mL)	1.8±0.6	0.5±0.2	2.5±0.4	<0.05

3.3 Differences in Treatment Response and Prognosis Among Patients Infected by Different Pathogens

Evaluation based on the treatment response and prognosis indicators in 1.3 showed differences in fever resolution time, cough and sputum relief time, length of hospital stay, and incidence of complications among the three groups. The atypical pathogen infection group had the shortest fever resolution time and cough and sputum relief time, but the longest hospital stay. The mixed infection group had the highest incidence of complications, which was significantly higher than the other two groups. Statistical analysis (as described in 1.4) showed that the differences in the above indicators among the three groups were statistically significant ($P<0.05$). Detailed data are shown in Table 3.

Table 3. Comparison of Treatment Response and Prognosis Among Patients Infected with Different Pathogens (±s/case, %)

Indicator	Bacterial Infection Group (n=30)	Atypical Pathogen Infection Group (n=30)	Mixed Infection Group (n=8)	P Value
Fever resolution time (days)	3.5±0.7	2.1±0.5	4.8±0.6	<0.05
Cough and sputum relief time (days)	5.6±1.1	4.2±0.8	6.9±0.9	<0.05
Length of hospital stay (days)	9.5±1.5	7.3±1.2	12.8±1.8	<0.05
Incidence of complications (%)	16.7	6.7	37.5	<0.05

4. Conclusion

In terms of etiological distribution, this study showed that confirmed pathogen infections in CAP patients were mainly caused by bacteria (Streptococcus pneumoniae, Haemophilus influenzae) and atypical pathogens (Mycoplasma pneumoniae, Chlamydia pneumoniae), with a relatively low proportion of mixed infections. This distribution characteristic is basically consistent with the epidemiological characteristics of common pathogens causing CAP, suggesting that clinical diagnosis and treatment should focus on the detection and targeted intervention of the above two types of pathogens.

Analysis of differences in clinical characteristics revealed that the mixed infection group had higher fever rate, detection rate of moist rales, and levels of inflammatory markers (WBC count, CRP, PCT) than the pure bacterial infection group and atypical pathogen infection group, while the atypical pathogen infection group had the lowest levels of these indicators. This may be related to differences in the pathogenic mechanisms of different pathogens: bacterial infections tend to exacerbate local inflammatory responses; atypical pathogens mostly cause relatively mild inflammatory manifestations through intracellular parasitism; and mixed infections further enhance the intensity of inflammatory responses due to the synergistic effect of pathogens.

In terms of treatment response and prognosis, the atypical pathogen infection group had the shortest fever resolution time and cough and sputum relief time but the longest hospital stay, which is presumably related to the faster relief of symptoms caused by atypical pathogen infections but the longer absorption cycle of pulmonary lesions. The mixed infection group had the highest incidence of complications, significantly higher than the other two groups, reflecting that mixed infections are more likely to cause complications such as respiratory failure and septic shock due to complex pathogen types and severe inflammatory responses, leading to poor prognosis.

In conclusion, CAP patients infected by different pathogens show significant differences in clinical characteristics, treatment response, and prognosis. In clinical practice, precise etiological detection is required to identify the type of infection, and individualized treatment plans should be formulated based on this to improve treatment efficacy and patient prognosis.

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