Clinical and Epidemiological Analysis of 188 Hospitalized Pertussis Cases in Jingzhou City

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Abstract [**Objectives**] To analyze the clinical symptoms and epidemiological characteristics of 188 hospitalized pertussis cases in Jingzhou City. [**Methods**] Clinical data from 188 patients diagnosed with pertussis and admitted to two tertiary hospitals in Jingzhou City between March and August 2024 were collected. Patients were randomly divided into three groups: <3-year-old, 3—17-year-old, and ≥18-year-old. A retrospective analysis was performed on their clinical features (including laboratory findings, disease course, and imaging characteristics) and epidemiological characteristics. [**Results**] In the <3-year-old group, 28 cases (36.4%) were unvaccinated and 22 cases (28.6%) had received only one dose of the pertussis vaccine. In the 3—17-year-old group, 91 cases (94.8%) had received four doses. Vaccination history was unknown for the ≥18-year-old adult group. The <3-year-old group exhibited significantly higher incidences of cough with wheezing/dyspnea, paroxysmal spasmodic cough, cough with cyanosis or facial flushing, wheezes, and moist rales in the lungs compared to both the 3—17-year-old and ≥18-year-old groups. Post-tussive vomiting was less frequent in the <3-year-old group than in the 3—17-year-old group but more frequent than in the ≥18-year-old group; these differences were statistically significant ($P<0.05$). The ≥18-year-old group had significantly lower incidences of cough with wheezing/dyspnea, paroxysmal spasmodic cough, cough with cyanosis or facial flushing, wheezes, and moist rales in the lungs compared to both the <3-year-old and 3—17-year-old groups ($P<0.05$). The proportion of cases with pneumonia and increased lung markings was higher in the <3-year-old group than in the 3—17-year-old group but lower than in the ≥18-year-old group, showing statistically significant differences ($P<0.05$). The proportion of cases with pulmonary nodules and fibrotic foci was lower in the <3-year-old group than in both the 3—17-year-old and ≥18-year-old groups, and these differences were also statistically significant ($P<0.05$). The proportion of pneumonia cases in the 3—17-year-old group was lower than in both the <3-year-old and ≥18-year-old groups. The proportion of cases with increased lung markings was lower than in the <3-year-old group but higher than in the ≥18-year-old group; these differences were statistically significant ($P<0.05$). The proportion of cases with pulmonary nodules and fibrotic foci in the 3—17-year-old group was higher than in the <3-year-old group but lower than in the ≥18-year-old group, with statistically significant differences ($P<0.05$). The proportion of cases with pulmonary nodules and fibrotic foci was higher in the ≥18-year-old group than in both the <3-year-old and 3—17-year-old groups, and these differences were also statistically significant ($P<0.05$). [**Conclusions**] Analysis of the clinical symptoms and epidemiological characteristics of 188 hospitalized pertussis cases in Jingzhou City contributes to enhancing the prevention and control of pertussis within the city.

Key words Pertussis, Epidemiological characteristics, Clinical features, Imaging examination

0 Introduction

Infection with *Bordetella pertussis* is the primary causative agent of pertussis, an acute respiratory infectious disease. Its high infectivity and universal susceptibility across all age groups constitute its main epidemiological features, and it also remains a leading cause of illness and mortality in infants and young children[1]. Since 1978, with the widespread promotion and implementation of the Diphtheria - Tetanus - Pertussis (DTP) vaccine in China, the incidence and mortality rates of pertussis have substantially declined[2]. However, over the past two decades, a phenomenon termed "pertussis resurgence" has emerged. The incidence of pertussis has shown an increasing trend, with outbreaks occurring in some areas, and the age distribution of cases has gradually shifted towards older children and adults[1,3]. Pertussis is characterized by a protracted course, primarily manifesting as recurrent, severe coughing that is rapid and uncontrollable. Its clinical presentation is influenced by factors such as age, immune status, and co-infection with other viruses[4]. Early symptoms resemble those of the common cold, and the atypical presentation in some patients can lead to delays in diagnosis, isolation, and treatment, thereby facilitating the transmission of pertussis[5]. This study aims to provide robust epidemiological evidence to support the prevention and rational clinical management of pertussis in Jingzhou City.

1 Materials and methods

1.1 Study subjects A total of 188 patients diagnosed with pertussis and hospitalized between January 1, 2024, and May 31, 2024, at two tertiary hospitals in Jingzhou City were included. This study was approved by the Medical Ethics Committee of Jingzhou First People's Hospital (Ethics Approval No.: KY2024-071-01).

1.1.1 Inclusion criteria. (i) Meeting the clinical diagnostic criteria outlined in the *Pertussis Diagnosis and Treatment Plan (2023)*[6]; (ii) Positive nucleic acid test for *B. pertussis* from a throat swab specimen[7].

1.1.2 Exclusion criteria. (i) Patients with co-infection with

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Mycobacterium tuberculosis were excluded[8]; (ii) Patients whose cough was attributed to airway compression or congenital airway malformations were excluded[9]; (iii) Cases transferred between departments were considered the same case; cases readmitted multiple times with the same diagnosis; cases with incomplete clinical data.

1.2 Methods

1.2.1 Collection of clinical data. Data including clinical manifestations, pulmonary imaging findings, respiratory pathogen testing results, treatment outcomes, and epidemiological information for the enrolled patients were collected and subjected to retrospective analysis.

1.2.2 Methods for *B. pertussis* culture and identification. (i) Real-time fluorescent polymerase chain reaction (RT-PCR) was employed to detect *B. pertussis* nucleic acid in bronchoalveolar lavage fluid or throat swab samples obtained from patients[10]. (ii) Chemiluminescence immunoassay (CLIA) was utilized to test venous blood samples for antibodies against eight respiratory pathogens: parainfluenza virus, Influenza A (H1N1) subtype virus, respiratory syncytial virus, rhinovirus, Chlamydia pneumoniae, Influenza B virus, Mycoplasma pneumoniae, and adenovirus[11].

1.3 Statistical methods Statistical analysis was performed using SPSS software (version 27.0). Comparisons of rates between groups were conducted using the Chi-square (χ^2) test. For comparisons among multiple groups, the Kruskal – Wallis H test was applied. The Mann – Whitney U test was used for comparisons between groups for continuous data that were not normally distributed. Analysis of the incidence trend was performed using Joinpoint Regression software (version 5.0.2). The significance level was set at $\alpha = 0.05$.

2 Results and analysis

2.1 General characteristics This study included a total of 188 confirmed pertussis cases, with ages ranging from 21 days to 88 years (Fig. 1). Among them, 77 sporadic cases were children under 3 years old (<3-year-old group), 95 clustered cases were children aged 3—17 old years (3—17-year-old group), and 16 cases were adults aged ≥18 years (≥18-year-old group). The peak incidence ages were under 1 year and 5—7 years old (Fig. 2).

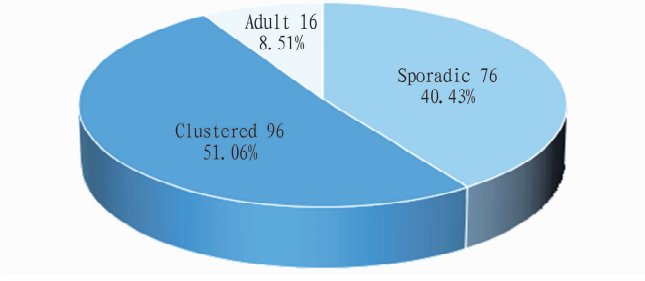

Fig. 1 Age distribution of pertussis patients

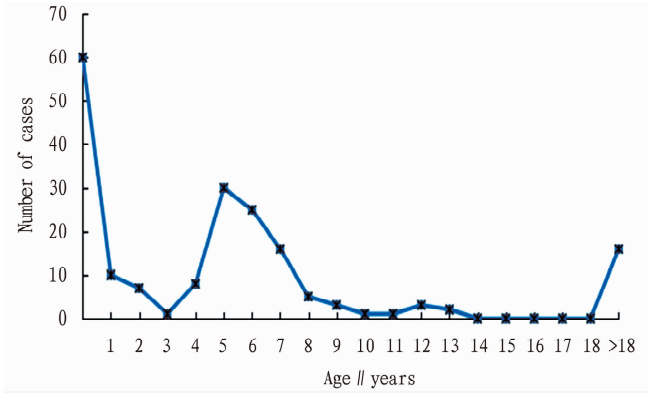

Fig. 2 Age distribution of pertussis patients

2.2 Exposure history Epidemiological investigation of the pertussis cases in this study revealed that a definitive exposure history could not be ascertained for patients over 3-year-old due to their wider range of activities. Among the 77 children in the <3-year-old group, 64 had a clear history of contact with individuals suffering from chronic cough. Specifically, 33 cases involved exposure to parents or grandparents with chronic cough, 28 cases involved exposure to older siblings with chronic cough, and 3 cases involved exposure to visiting relatives with chronic cough. Additionally, there were 3 cases where the sick child's illness led to secondary transmission and subsequent cases within the family (Fig. 3).

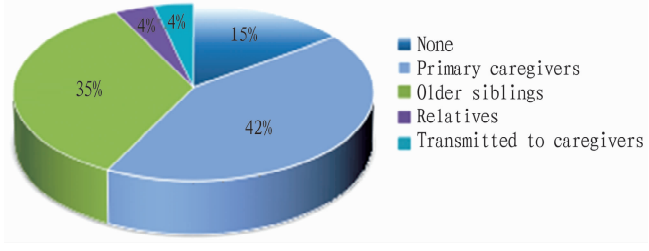

Fig. 3 Distribution of contact sources among children in the <3-year-old group

2.3 Vaccination history composition ratios across the three groups In the <3-year-old group, 28 cases (36.4%) were unvaccinated and 22 cases (28.6%) had received only one dose of the pertussis vaccine. In the 3—17-year-old group, 91 cases (94.8%) had received four doses. Vaccination history was unknown for all cases in the ≥18-year-old adult group (Table 1).

2.4 Comparison of clinical manifestations among the three pertussis patient groups The <3-year-old group exhibited significantly higher incidences of cough with wheezing/dyspnea, paroxysmal spasmodic cough, cough with cyanosis or facial flushing, wheezes, and moist rales compared to both the 3—17-year-old group and the ≥18-year-old group ($P < 0.05$). Post-tussive vomiting was significantly less frequent in the <3-year-old group than in the 3—17-year-old group but significantly more frequent than in the ≥18-year-old group ($P < 0.05$). The ≥18-year-old group had significantly lower incidences of

cough with wheezing/dyspnea, paroxysmal spasmodic cough, cough with cyanosis or facial flushing, wheezes, and moist rales compared to both the <3-year-old group and the 3—17-year-old group ($P<0.05$) (Table 2).

Table 1 Composition ratios of vaccination history among the three patient groups (n, %)

Number of doses	<3 years ($n=77$)	Composition ratio//%	3 – 17 years ($n=95$)	Composition ratio//%	≥18 years ($n=16$)	Composition ratio//%
0 Dose	28	36.36	0	0.00[a]	0	0
1 Dose	22	28.57	0	0.00[a]	0	0
2 Doses	5	6.49	0	0.00[a]	0	0
3 Doses	13	16.88	5	5.26[a]	0	0
4 Doses	9	11.69	90	94.74[a]	0	0
Unknown	0	0.00	0	0.00	16	100[ab]

NOTE [a]$P<0.05$ vs. 3—17-year-old group; [b]$P<0.05$ vs. ≥18-year-old group (same applies below).

Table 2 Comparison of clinical manifestations among the three pertussis patient groups (n, %)

Clinical manifestation	<3 years//%	3 – 17 years//%	≥18 years//%	χ^2 value	P
Number of cases	77	95	16		
Paroxysmal spasmodic cough	64 (83.12)[bc]	69 (72.63)[a]	3 (18.75)[ab]	16.54	<0.001
Cough with wheezing/dyspnea	39 (50.65)[bc]	16 (16.84)	2 (12.50)[ab]	29.95	<0.001
Cough with facial flushing or cyanosis	16 (20.78)[bc]	5 (5.26)	0 (0.00)[ab]	13.47	<0.001
Post-tussive vomiting	23 (29.87)[ac]	32 (33.68)	0 (0.00)[ab]	0.46	0.497
Moist rales in lungs	23 (29.87)[bc]	14 (14.74)	1 (6.25)[ab]	9.35	<0.001
Wheezes in lungs	41 (53.25)[bc]	27 (28.42)	0 (0.00)[ab]	22.93	<0.001

2.5 Comparison of imaging findings among the three groups

The proportion of cases with pneumonia and increased lung markings was significantly higher in the <3-year-old group than in the 3—17-year-old group, but significantly lower than in the ≥18-year-old group ($P<0.05$). The proportion of cases exhibiting pulmonary nodules and fibrotic foci was significantly lower in the <3-year-old group than in both the 3—17-year-old group and the ≥18-year-old groups ($P<0.05$). The proportion of pneumonia cases was significantly lower in the 3—17-year-old group than in both the <3-year-old group and the ≥18-year-old groups ($P<0.05$). The proportion of cases with increased lung markings was significantly lower than in the <3-year-old group but significantly higher than in the ≥18-year-old group ($P<0.05$). The proportion of cases showing pulmonary nodules and fibrotic foci was significantly higher in the 3—17-year-old group than in the <3-year-old group, but significantly lower than in the ≥18-year-old group ($P<0.05$). The proportion of cases with pulmonary nodules and fibrotic foci was significantly higher in the ≥18-year-old group than in both the <3-year-old group and the 3—17-year-old groups ($P<0.05$) (Table 3).

Table 3 Comparison of imaging findings among the three groups (n, %)

Imaging finding	<3 years ($n=68$)	Composition ratio//%	3 – 17 years ($n=88$)	Composition ratio//%	≥18 years ($n=16$)	Composition ratio//%	χ^2 value/ likelihood ratio	P
Pneumonia	29	42.65[bc]	25	28.41[ac]	9	56.25[ab]	6.235	0.044
Increased lung markings	22	32.35[bc]	26	29.55[ac]	0	0.00[ab]	11.235	0.004
Pulmonary nodules/fibrotic foci	0	0.00[bc]	4	4.55[ac]	6	37.50[ab]	22.591	0.000

3 Discussion

B. pertussis is the causative bacterium of human pertussis. It is highly contagious and exhibits a distinct tropism and adhesiveness for human respiratory ciliated epithelial cells. Humans are universally susceptible to *B. pertussis* and serve as its sole reservoir[12]. In this study, 64 children had a definite history of contact with individuals suffering from chronic cough, indicating that family members constitute the primary source of infection for childhood pertussis. Globally, within pertussis control initiatives, a strategy termed "cocooning" has been proposed. This strategy aims to vaccinate caregivers of infants and young children, including parents and other close contacts, to provide indirect protection[13]. In the present study, fever was reported in 20.20% of cases. Among the 188 cases, pulmonary imaging suggested pneumonia in 63 cases, implicating pulmonary infection as a contributor to the manifestation of fever. The proportions of pneumonia and increased lung markings were higher in the <3-year-old and 3—17-year-old groups compared to the ≥18-year-old group. Furthermore, the proportion of cases exhibiting pulmonary nodules and fibrotic foci was higher in the ≥18-year-old group than in both the <3-year-old and 3—17-year-old groups. All cases were hospitalized due to cough. Spasmodic cough was observed in 81.38% of the cases, while only 4.20% presented with the characteristic whooping cough (inspiratory whoop). This study demonstrates that the peak incidence ages for pertussis are under 3 years and 5 – 7 years old. Close contact with coughing family members is

identified as one of the primary modes of pertussis transmission. In the adult group, spasmodic cough occurred in only 18.75% of cases, indicating a less prominent presentation of typical symptoms. Pulmonary nodules and fibrotic foci were more commonly observed in the adult group. Therefore, when managing adults with prolonged cough for other pulmonary conditions, clinicians should consider the possibility of pertussis. For children under 3 years of age, clinical manifestations such as facial flushing, cyanosis, vomiting following cough, and cough accompanied by dyspnea/wheezing, often associated with moist rales in the lungs, are significant indicators. Wheezes may also be prominent. These typical clinical presentations facilitate timely diagnosis. However, a subset of cases may present atypically. Clinicians should rely on etiological test results to make an accurate diagnosis promptly and avoid delays in initiating appropriate treatment.

In summary, the following recommendations are proposed:

(i) Enhanced vaccination of family members (cocooning strategy) can provide indirect protection to young infants; therefore, the administration of adult pertussis vaccines should be promoted. (ii) Given that a proportion of pertussis cases lack typical symptoms and are prone to co-occurring pneumonia, leading to potential misdiagnosis during initial presentation, healthcare professional training on pertussis needs strengthening. For suspected cases, prompt nucleic acid testing for *B. pertussis* and testing for Mycoplasma pneumoniae should be performed. Particular attention should be paid to preventing the progression to pneumonia. (iii) Following the adjustments to the Diphtheria – Tetanus – Pertussis (DTP) vaccination schedule implemented in 2025, continuous active surveillance for pertussis should be conducted to understand the evolving epidemiological patterns and clinical characteristics of the disease post-schedule modification.

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