A retrospective survey of *Chlamydia pneumoniae* infection rates in paediatric patients from a single centre in Wuxi, China

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Abstract

Objective: To provide some epidemiological data on *Chlamydia pneumoniae* infection rates in paediatric patients at a single centre in Wuxi, China.

Methods: This was a retrospective analysis of serum samples from paediatric patients ($<$12 years) with a respiratory tract infection (RTI) and who had been admitted to the Department of Paediatrics, Wuxi No.2 People's Hospital, China, from 01 January 2015 to 31 December 2016. *C. pneumoniae* IgM antibodies had been analysed using enzyme-linked immunosorbent assay (ELISA).

Results: Of the 3866 children (2073 boys, 1793 girls) with a RTI that provided serum samples, 19% were positive for *C. pneumoniae* IgM antibodies. Among these children, 56% were positive for other infections.

Conclusions: Children over 6 years of age with a RTI had a higher *C.pneumoniae* infection rate than younger children and the infection rate was more common in winter months compared with other times of the year.

Introduction

Chlamydia pneumoniae is one of the main pathogens responsible for human respiratory tract infections (RTIs)[1] and an important cause of pneumonia in children.[2]

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C. pneumoniae can induce persistent and repeated infections,[3,4.] and there is increasing evidence that the pathogen may play a role in paediatric asthma as well as in asthma exacerbations[5,6] C. pneumoniae has also been associated with atherosclerotic cardiovascular disease and neurological diseases.[7,8]

The detection rates of C. pneumoniae in children with RTI have been reported to vary with age, geographic location, seasons and testing methods.[1,4,9,10] In an attempt to provide some epidemiological data on C. pneumoniae infection from Wuxi, in the Jiangsu province, China, we retrospectively analysed data from children admitted to hospital with a RTI.

Patients and methods

This was a retrospective analysis of serum samples taken from paediatric patients with RTIs who had been admitted to the Department of Paediatrics, Wuxi No.2 People's Hospital, China, from 01 January 2015 to 31 December 2016. Patients who met the following criteria were included in the study: age <12 years; presence of RTI which included upper RTI (URTI), bronchitis, pneumonia and/or asthma. Patients with a congenital disease or who were immunocompromised were excluded from the study as were patients with a concomitant skin, digestive tract or urinary tract infection.

Within 24 h of admission, serum antibodies to C. pneumoniae had been assayed by enzyme-linked immunosorbent assay (ELISA). Evidence of infection was defined as presence of IgM antibody (≥1). The sensitivity and specificity of the antibody test were 90%. In addition, serum samples were also tested for antibodies to Mycoplasma pneumoniae, Streptococcus pneumoniae, rubella virus, respiratory syncytial virus (RSV) and Epstein-Barr virus (EBV).

The following data were recorded: patients' age; date of onset of the RTI; type of RTI (i.e., URTI, bronchitis, pneumonia and/or asthma); presence of other viruses (i.e., M. pneumoniae, S. pneumoniae, rubella virus, RSV, EBV).

The study was approved by the Ethics committee of Wuxi No.2 People's Hospital, and because of its retrospective design, there was no requirement for patients' informed consent.

Statistical analyses

Data were analysed using the Statistical Package for Social Sciences (SPSS®) for Windows® release 19.0 (IBM Corp., Armonk, NY, USA) and a P-value <0.05 was considered to indicate statistical significance. Quantitative data were expressed as frequencies and percentages and were analysed using the χ^2 test.

Results

In total, 3866 children (2073 boys, 1793 girls) with a RTI provided serum samples and were included in the analysis. Their mean age ± SD was 5.2 ± 2.6 years (range 6 months to 12 years). Of the 3,866 serum samples, 724 (18.7%) were C. pneumoniae-IgM positive. The difference between age groups in the rate of C. pneumoniae positive infection was statistically significant ($P = 0.001$); the lowest incidence (9.2%) was in the 0 – 1year group and the highest incidence (26.7%) was in the 6 – 12 year group (Table 1).

The difference between time of onset (seasons) and the rate of C. pneumoniae positive infection was statistically significant ($P = 0.001$); the lowest incidence (6.1%) was in the summer months and the highest incidence (34.3%) was in the winter months (Table 2).

The difference between types of RTI and C. pneumoniae positive infection was

Table 1. Detection of *Chlamydia pneumoniae* (CP)-IgM antibodies in the different age groups.

Group	Number of cases	CP-IgM positive	CP-IgM rate (%)*
0 – <1 year	654	60	9.2
1 – <3 years	413	78	18.9
3 – <6 years	1591	263	16.5
6 – <12 years	1208	323	26.7

*$P<0.001$ (χ^2 test).

Table 2. Detection of *Chlamydia pneumoniae* (CP)-IgM antibodies according to time of onset (seasons).

Season	Number of cases	CP-IgM positive	CP-IgM rate (%)*
Spring (March – May)	982	197	20.1
Summer (June – August)	654	40	6.1
Autumn (September – November)	1047	81	7.7
Winter (December – February)	1183	406	34.3

*$P<0.001$ (χ^2 test).

Table 3 Detection of *Chlamydia pneumoniae* (CP)-IgM antibodies according to type of respiratory tract infection.

Diseases	Number of cases	CP-IgM positive	CP-IgM rate (%)*
URTI	759	81	10.7
Bronchitis	1308	272	20.8
Pneumonia	1562	340	21.8
Asthma	237	31	13.1

URTI, upper respiratory tract infection
*$P<0.001$ (χ^2 test).

Table 4. The presence of other infections in *Chlamydia pneumoniae* (CP) positive patients.

Other infections	CP-IgM positive	CP-IgM rate (%)
Mycoplasma pneumoniae	262	36.2
Respiratory syncytial virus	83	11.5
Streptococcus pneumoniae	41	5.7
Rubella virus	7	1.0
Epstein Barr virus	9	1.2

statistically significant ($P=0.001$); the lowest incidence (10.7%) was in patients with URTI and the highest incidences were in patients with pneumonia (21.8%) and bronchitis (20.8%) (Table 3). Interestingly, the infection rate in asthmatics was

Of the 724 patients with *C. pneumoniae* positive infection, 402 (55.5%) had other infections and the most common concomitant infection was *M. pneumoniae* (36.2%) (Table 4). The multiple infection rate(i.e., more than three pathogens) was 8.7% (63/724).

Discussion

C. pneumoniae is a common pathogen in the respiratory tract.[4] However, its infection lacks special clinical manifestations and so laboratory tests are required to distinguish this micro-organism from other common pathogens. Currently, the main methods used to identify *C. pneumoniae* are tissue culture, from nasopharyngeal or pharyngeal swabs, Polymerase Chain Reaction (PCR) methods and serology using an enzyme-linked immunosorbent assay (ELISA).[4,9,10] Because *C. pneumoniae* culture is difficult and time consuming and PCR methods require expensive instruments, serology remains the main diagnostic tool used in clinical practice.[9] However, variation in methods and diagnostic criteria used across studies has led to a wide variation in findings. Results from one study that reviewed data from 14 studies from different countries worldwide found that the proportion of lower respiratory tract infections in children and adults, including community- acquired

pneumonia, associated with *C. pneumoniae* infection ranged from 0 to 44%.[10] In this present study of paediatric patients our *C. pneumoniae* infection rate of 18.7% was higher than previously reported in hospitalized children with acute RTI in Suzhou, China (6.0%), Vienna, Austria (6.7%) and Greifswald, Germany (9.3%).[4,11,12] Nevertheless, our rate was lower than reported in 110 hospitalised children in Poland (28.5%).[13] The high population density in China, which increases exposure and chance of infection, may have an important influence on acquiring *C. pneumoniae* infection.[4]

We found that the highest *C. pneumoniae* infection rate (26.7%) was in school-aged children (6–12 years) and the lowest rate (9.2%) was in infants (0-1-year). We suggest that this finding is related to pathogen exposure. For example, most of the infants would have had the infection for the first time and so would probably have had a relatively low positive detection rate. By contrast, school-aged children may have been infected several times and so would have had a relatively high positive detection rate. In addition, some studies have suggested that serological testing is problematic and unreliable in young children.[10]

Although some studies have found no seasonality or correlation with climatic conditions,[4] we found the highest rate of *C. pneumoniae* infections was in the winter months (December to February) and the lowest in the summer months (June to August). Our findings are consistent with those from a study involving 110 children in Sudan that found the peak period of *C. pneumoniae* infections was from November to February of the following year.[14]

Similar to previous studies, we observed, high *C. pneumoniae* infection rates in children with lower RTIs, particularly pneumonia and bronchitis (approximately 21%).[10] In children with asthma, we found a *C. pneumoniae* infection rate of 13%.

C. pneumoniae infection tends to be chronic and persistent,[3,4.] which may result in immune hypersensitivity of the host, allowing susceptibility to other pathogens. We found that 56% children with *C. pneumoniae* infection had other infections and 9% children had multiple infections.

Limitations of this report include the inclusion of only one *C. pneumoniae* detection method and the data were obtained retrospectively from a single centre. Therefore, further prospective studies comparing several detection methods are required to confirm our results.

In conclusion, this study provides some epidemiological data of *C. pneumoniae* infection in children from a single hospital in the Jiangsu province in China. These preliminary results suggest that children over six years of age with a RTI have a higher incidence of *C. pneumoniae* infection compared with younger children. In addition, the infection rate was more common in the winter months compared with other times of the year.

Declaration of conflicting interests

The authors declare that there are no conflicts of interest.

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