Community Acquired Infection

ORIGINAL ARTICLE

Seasonal changes in mycoplasma pneumonia and a review of influencing factors of pediatric respiratory diseases

Yihan Liu[1], Lingjie Gao[2], Beining Zhang[1], Min Liu[3*]

[1]The First Affiliated Hospital of China Medical University, Shenyang 110000, Liaoning Province, China
[2]Scientific research section, The First Affiliated Hospital of China Medical University, Shenyang 110000, Liaoning Province, China
[3]Department of Respiratory Medicine, The First Affiliated Hospital of China Medical University, Shenyang 110000, Liaoning Province, China

Abstract

Objective: To identify factors influencing mycoplasma pneumonia and respiratory diseases as a function of yearly seasons. **Methods:** Records of respiratory disease cases, as obtained from the respiratory laboratory of the First Affiliated Hospital of China Medical University over the period from November 2013 to October 2018, were retrospectively analyzed. Susceptible factors, as related to the general data from mycoplasma pneumonia cases, included season of the year along with the age and gender of the patients. **Results:** Statistically significant differences in mycoplasma pneumonia were obtained among the different seasons (χ^2 = 496.24, P < 0.05), ages (P < 0.05) and gender (χ^2 = 300.10, P < 0.05). The rate and number of mycoplasma pneumonia cases were highest in the winter and lowest in the summer, with the difference between these two seasons being statistically significant (P < 0.05). Among confirmed positive cases, infection rates of mycoplasma pneumonia in young and middle-aged patients were significantly greater than that in the elderly (P < 0.05) and the incidence in women was significantly greater than that in men (χ^2 = 300.10, P < 0.05). Among the total of all lung diseases sampled, the largest numbers were observed in pediatric cases and the peak period of disease occurrence was over the period from October to January. **Conclusion:** The incidence of pneumonia shows significant differences as a function of the season of the year, effects which are observed in all ages.

Key words: mycoplasma pneumonia; seasonal factors; gender factors; age factors; drug resistance

Seasonal changes can affect the onset of various diseases as these changes can alter immune responses and thus play a role in immune defense and homeostasis. For example, seasonal changes affecting the respiratory system can result in fluctuations of local immune balance, and if such changes exceed the physiological limits of the human body, it can lead to respiratory diseases.[1] Mycoplasma pneumonia (MP) represents one of the most common respiratory-related pathogens of community acquired pneumonia (CAP) in children, accounting for 10%–30% of the pathogens of CAP and greater than 50% in children over five years of age with CAP.[2] In this study, we investigated the incidence of MP as a function of the different seasons of the year. To accomplish this goal we reviewed the data from MP cases as seen at the First Affiliated Hospital of China Medical University over the period from November 2013 to October 2018. With this review it was possible to analyze the pathogenic factors associated with MP and provide new insights into the basis for clinical prevention and treatment of this condition.

***Corresponding Author:**
Min Liu, E-mail: liuminxiaoqi@163.com; https://orcid.org/0000-0001-9066-4318.

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INFORMATION AND METHODS

General information

Over the period from November 2013 to October 2018 there were a total of 73,189 cases of MP seen in the respiratory laboratory of the First Affiliated Hospital of China Medical University. The subjects included in this study consisted of cases seen from January 1, 2014, to December 31, 2018. The data were obtained from

cases within the Shenyang region with March to May designated as the spring season, June to August summer, September to November autumn and December to February winter. As a portion of the data in the winter of 2018 were not available, data from December 2018 were not included in the analysis with November and December of 2013 then used as supplements to analyze the differences in sample testing among the different seasons. The total number of cases in the winter group was 20,030 (8607 positive and 11,423 negative cases – 42.97% detection rate), 18,509 in the spring (6603 positive and 11,906 negative cases – 35.67% detection rate), 16,713 in the summer (5648 positive and 11,065 negative cases – 33.79% detection rate) and 17,937 in the autumn (6791 positive and 11,146 negative cases – 37.86% detection rate). The differences in general information among the four groups were statistically significant ($P < 0.05$), with comparability.

Over the five year period from 2014 to 2018, the greatest number of lung disease cases (14,019) were present within the Pediatrics Department. When expressed over the different seasons, the number of cases were 5796 in November–January, 2883 in February–April, 1964 in May–July and 3376 in August–October. Accordingly, these data indicate that pediatric pneumonia was most frequently observed in the winter (November–January) and autumn (August–October) seasons. The incidence of MP was found to be greater in women (40.22%) versus men (34.05%). The Hospital Ethics Committee approved this study (2022YL124).

Statistical methods

Data were analyzed using the SPSS 22.0 program (IBM Corp., Armonk, USA). Enumeration data were expressed as case numbers or percentages. The χ^2 test was used for assessing inter-group differences. A $P < 0.05$ was required for results to be considered as statistically significant.

RESULTS

The rate of MP in the winter (42.97%) was significantly greater than that obtained in the summer (33.79%) ($P < 0.05$; Table 1). It appears that air pollutants and meteorological factors (air temperature/pressure, wind speed, relative humidity) represent critical factors which affect this increase of respiratory diseases in the winter. Moreover, pollutants can exert synergistic or antagonistic effects upon the impact of respiratory diseases.

As based on the results of the χ^2 analysis ($\alpha = 0.05$, $\chi^2 = 496.24$; $P < 0.05$), the original hypothesis demonstrated a seasonal difference in mycoplasma virus detection rates was rejected. Positive cases of mycoplasma were more prevalent in younger patients that that of negative cases (Table 2).

As based on the results of the χ^2 analysis ($\alpha = 0.05$, $\chi^2 = 300.10$; $P < 0.05$), the original hypothesis of a gender difference in the detection rate of the mycoplasma virus was rejected.

To test for seasonal differences in the number of pediatric pulmonary diseases, the year was partitioned into three periods (October–January, February–May and June–September). The data from February 2014–January 2015, February 2015–January 2016, February 2016–January 2017 and February 2017–January 2018 are presented in Figure 1. The maximal number of pediatric pulmonary diseases were observed over the period from October to January (Table 3). These pediatric pneumonia cases tend to show increases in autumn and winter and then begin to decline in February. Therefore, the peak of the curve indicating the maximal occurrence of pediatric pneumonia is observed from October to January (Figure 2). Figure 2 contains the data when presented as divided into four periods over the year: February 2014–January 2015, February 2015–January 2016, February 2016–January 2017 and February 2017–January 2018.

DISCUSSION

Respiratory system diseases represent one of the most

Table 1: Mycoplasma pneumonia rates as a function of different seasons

Items	Winter	Spring	Summer	Autumn
Mycoplasma (+), *N*	8607	6603	5648	6791
Mycoplasma (–), *N*	11,423	11,906	11,065	11,146
Total, *N*	20,030	18,509	16,713	17,937
Detection rate, %	42.97	35.67	33.79	37.86

Table 2: Age and sex distribution of mycoplasma pneumonia cases

	Age, years	Sex, *N*	
		Man	Woman
Mycoplasma pneumonia (+)	17 (5–45)	12,465	14,860
Mycoplasma pneumonia (–)	40 (5–61)	24,143	22,084

Table 3: Total number of pediatric pulmonary disease cases

	October–January (Group 1), *N*	February–May (Group 2), *N*	June–September (Group 3), *N*
2014–2015	5734	4746	4803
2015–2016	6041	5284	4399
2016–2017	6507	6033	4951
2017–2018	7195	5470	5059
Total	25,477	21,333	19,212

Statistically significant differences were obtained between Groups 1 *vs.* 2 ($P = 0.043$) and 1 *vs.* 3 ($P = 0.021$), while differences between Groups 2 and 3 failed to achieve statistical significance.

common and frequently occurring diseases. Based on the 2012 mortality statistics as resulting from major diseases, the mortality rate of respiratory system diseases ranks third in cities and first in rural areas, and is a significant cause of death in Chinese residents.[3] MP is one of the primary pathogens responsible for respiratory tract infection. Therefore, identifying the pathogenesis and an early detection of MP are essential in guiding the development of an effective clinical treatment plan.

Air temperature has been shown to be a contributing factor for bronchitis, with patients exposed to lower air temperatures being at a greater risk. The excessive amount of heat required for people living in the Shenyang region also exerts a substantial effect upon their health due to the pollutants associated with this heat. Notably, SO_2, NO_2 and HONO, from industrial and heating coal combustion along with industrial emissions are significant sources of acid gases in the atmosphere. In addition, NH_3 is one of the leading trace gases and most alkaline gas in the atmosphere. The influence of NH_3 on respiratory diseases has exceeded that of conventional pollutants such as PM2.5, SO_2 and NO_2. In the process of SCR denitration in coal-fired power plants, excessive levels of NH_3 are produced and escape into the atmosphere, with the result that these will induce a significant degree of irritation within the esophagus.[4,5]

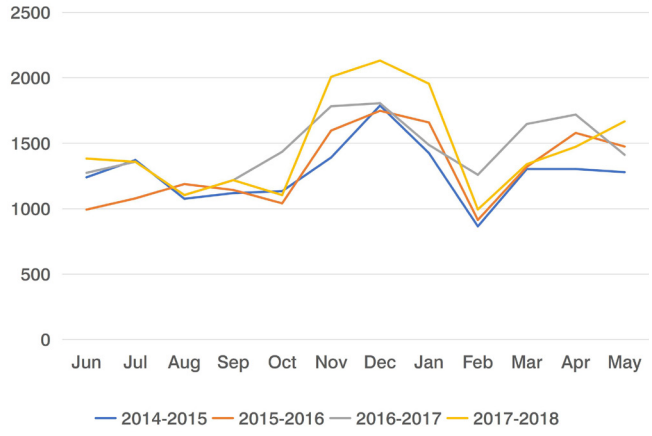

Figure 1. Total number of pediatric pulmonary disease cases.

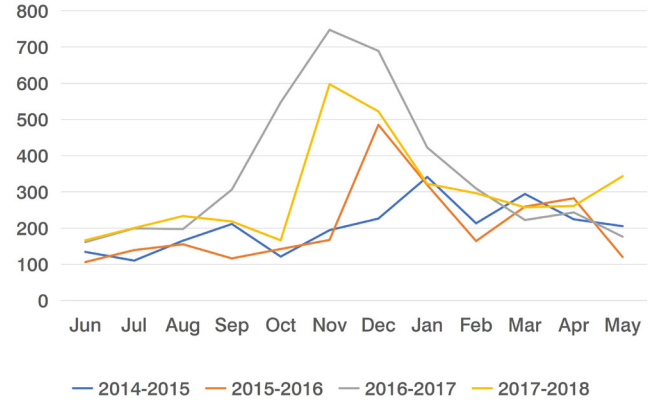

Figure 2. Total number of pediatric pneumonia cases.

It has also been reported that in middle-aged and elderly patients, the colder temperatures and lower air pressure of winter are associated with dilation of microvessels within the bronchial mucosa and inflammation, along with a reduction in cilia activity. As a result, bronchi become convulsive, impeding the discharge of minute particles (*e.g.* dust), thus aggravating chronic respiratory diseases such as COPD.[6] When administered in the spring and summer, Yinqiao formula combined with azithromycin have demonstrated significant efficacy in treating MP in children, which then reduces the duration of their clinical symptoms and has a high degree of safety.[7] Based on these findings, it is recommended that patients with chronic primary respiratory disease should limit their time outdoors or wear masks when atmospheric pollution is more severe as in the winter.

In this study, we found that the infection rate of MP in young and middle-aged patients was greater than that observed in the elderly, indicating that these former groups were at a higher risk for development of MP infection (Table 2). Interestingly, in addition to seasonal factors, adults who work late at night, experience excessive mental stress leading to decreased immunity and/or have contact with MP patients, are likely to contract MP.

The results of our study also demonstrate that the number of confirmed MP cases in women is significantly greater than that in men (Table 2). It appears that the effects of HONO, NH_3, and PM2.5 in women are far greater than that in men and that women are more susceptible to these pollutants. The positive rate of MP in female children is also significantly greater than in male children.[8] When comparing the amount of exercise of middle school students it was found that increased levels of exercise/movement were observed in boys.[9] Therefore, it seems that the higher prevalence rate of MP in women may be related to a combination of differences in immune function and general activities between men and women, resulting in women being at a greater potential risk to pollutants. Such findings are consistent with previous results indicating that women are more sensitive to contaminants than men.[10,11]

Our results also revealed that the most significant number of cases were observed within our Pediatrics Department. The incidence of pulmonary diseases in children has increased in recent years. Therefore, the bases and analysis of pediatric respiratory disorders remains a significant topic warranting further investigation (Table 3).

The peak incidence of pulmonary diseases in children was found to be concentrated over the period from October to January (Figure 2). In addition to these seasonal factors, which can exert a significant impact

within northern climates, a number of other related factors may contribute to this condition. Children may be more likely to experience respiratory tract infections due to their respiratory anatomy and incomplete development of immune function.[12] Moreover, while macrolide antibiotics have been used as the first choice for treatment of MP in children, the MP strains isolated from children in China have a high resistance to macrolides. As based on the analyses of common antibacterial drug resistance, it appears that azithromycin, erythromycin and roxithromycin exhibit a good degree of sensitivity and can be used as first-line drugs for the treatment of MP infection in children. In contrast, josamycin shows a high resistance rate to MP, indicating that it can no longer be used as a first-line treatment for MP infections in children.[13] It has also been reported that an irregular use of macrolide antibiotics can increase MP resistance rates, which appear to be related to a gene mutation in the 23s rRNA V region. Regular use of azithromycin as a means for an anti-infection regime of children's MP infection will not induce the emergence of drug-resistant strains without drug sensitivity results.[14] Moreover, as it is often difficult to distinguish the clinical manifestations of patients with MP from viral versus bacterial respiratory tract infections, it becomes difficult, if not impossible. to timely and effectively identify the pathogenic bacteria and clinically apply sensitive antibiotics. As a result, their condition can be easily misdiagnosed, leading to a delay in treatment and aggravation of their condition, thus seriously affecting the prognosis of these children. Therefore, it is essential to fully understand the distribution of pathogenic bacteria and drug sensitivity of CAP in children and to select antibiotics which can offer the best opportunity to improve the clinical treatment of these patients.[15]

There are some limitations in this study which should be noted. Notably, only cases diagnosed in the Shenyang region were retrospectively analyzed. As China represents a vast territory, there may exist significant regional differences in the characteristics of MP. The factors assessed were limited and therefore will need to be further corroborated and supplemented from subsequent more rigorous and comprehensive studies.

In summary, seasonal changes significantly impact the incidence of MP and we have identified other factors which may be associated with this condition. Therefore, these findings combined with the accumulation of additional data, along with health education and dynamic tracking of MP patients it will be possible to achieve further advances in reducing the incidence of such diseases.

Author contributions

All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

Ethics approval

The Hospital Ethics Committee approved this study (2022YL124).

Conflicts of interest

There is no conflict of interest among the authors.

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