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Analysis of the characteristics of community-acquired pneumonia in children and the high-risk factors leading to severe disease in China

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Abstract

This was a research study, analysed the characteristics of community-acquired pneumonia (CAP) in children and the high-risk factors causing severe disease. Three hundred and ninety CAP children accepted therapy to First Hospital of Qinhuangdao from February 2019 to January 2020 were divided into spring onset group, summer onset group, autumn onset group and winter onset group. The detection rates of streptococcus pneumonia, haemophilus influenzae and mycoplasma pneumoniae in the winter onset group were higher than the other groups, while the detection rate of moraxella mucositis in the spring onset group was higher as than the other groups. Univariate analysis and Logistics regression analysis revealed that C-reactive protein (CRP), procalcitonin (PCT) and white blood cell (WBC) levels, anemia, malnutrition, previous infection history, and preterm birth were the major factors influencing the severity of symptoms in children. The major pathogenic bacteria of CAP in children were streptococcus pneumoniae, haemophilus influenzae, and moraxella mucositis. Mycoplasma pneumoniae showed an increasing trend in summer and autumn, and some of them were associated with bacterial infection. We conclude that CRP, PCT, WBC, anemia, malnutrition, previous infection history, and preterm birth were the major factors influencing the severity of symptoms in children. *(Afr J Reprod Health 2025; 29 [3]:125-131).*

Keywords: community-acquired pneumonia, children, high-risk factors

Résumé

Il s'agissait d'une étude de recherche analysant les caractéristiques de la pneumonie communautaire (PAC) chez les enfants et les facteurs de risque élevés provoquant une maladie grave. Trois cent quatre-vingt-dix enfants CAP ont accepté une thérapie au premier hôpital de Qinhuangdao de février 2019 à janvier 2020. Ils ont été divisés en groupe d'apparition au printemps, groupe d'apparition en été, groupe d'apparition en automne et groupe d'apparition en hiver. Les taux de détection de pneumonie à streptocoque, d'Haemophilus influenzae et de mycoplasma pneumoniae dans le groupe à apparition hivernale étaient plus élevés que dans les autres groupes, tandis que le taux de détection de mucite à Moraxella dans le groupe à apparition au printemps était plus élevé que dans les autres groupes. L'analyse univariée et l'analyse de régression logistique ont révélé que les taux de protéine C-réactive (CRP), de procalcitonine (PCT) et de globules blancs (WBC), l'anémie, la malnutrition, les antécédents d'infection et la naissance prématurée étaient les principaux facteurs influençant la gravité des symptômes chez les enfants. Les principales bactéries pathogènes de la PAC chez les enfants étaient Streptococcus pneumoniae, Haemophilus influenzae et la mucosite à Moraxella. Mycoplasma pneumoniae a montré une tendance à la hausse en été et en automne, et certains d'entre eux étaient associés à une infection bactérienne. Nous concluons que la CRP, la PCT, les globules blancs, l'anémie, la malnutrition, les antécédents d'infection et la naissance prématurée étaient les principaux facteurs influençant la gravité des symptômes chez les enfants. *(Afr J Reprod Health 2025; 29 [3]: 125-131).*

Mots-clés: pneumonie communautaire, enfants, facteurs de risque élevé

Introduction

Community-acquired pneumonia (CAP) belongs to an infectious parenchymal inflammation of the lung developed outside the hospital, and is a major cause of deaths in infants[1]. CAP can cause symptoms such as hypoxia and infection to different degrees, and easily leads to complications such as hypoxemia, thus aggravating the condition of patients[2]. In addition, some severe cases lead children to develop chronic airway diseases, which seriously influence the life quality along with safety of children.

In recent years, due to the influence of diverse factors, the incidence of CAP has increased significantly, and is a serious public health concern[3]. At present, it is believed that the main pathogenic spectrum of CAP includes fungi, viruses

and bacteria[4]. Among them, Streptococcus pneumoniae, Staphylococcus aureus and Haemophilus influenzae are the most common pathogens causing pneumonia. With the continuous progress of etiological examination technology, the pathogen spectrum of CAP has been expanded to cover a variety of virus species, including human adenovirus, influenza virus, human metapneumonia virus, human rhinovirus, and respiratory syncytial virus. Studies have confirmed that the vast majority of respiratory infections are caused by viral infections, and a small part is caused by mixed infections of bacteria and viruses[5].

The pathogenic spectrum of CAP in children will change with the change of population, time, and region[6]. China has a large population, a wide land area, and significant regional differences in climate, geography, economy and other factors. Therefore, the spectrum of CAP pathogens in different regions is also different, and it will also have the characteristics of seasonal epidemic[7]. It was previously believed that under the influence of climate change, autumn and winter were the seasons with high incidence of CAP infection in children[8]. However, other studies have also shown that the seasonal characteristics of CAP infection in children are also different due to differences in economic, health, educational and cultural levels[9]. Therefore, it is necessary to understand the causes of the disease in children with CAP and identify the high-risk factors for severe diseases, so as to achieve reasonable treatment and prevention.

In this study, we analyzed the characteristics of CAP in children and the high-risk factors leading to severe disease.

Methods

Materials

Three hundred and ninety children with CAP accepted therapy in First Hospital of Qinhuangdao, Qinhuangdao, Hebei, China from February 2019 to January 2020 were included. They were divided into spring onset group (n=120), summer onset group (n=60), autumn onset group (n=80) and winter onset group (n=130) according to different seasons when the infections occurred.

No significant difference was exhibited in general information among the 4 groups (P>0.05, Table 1). The inclusion criteria were: (1) informed consent provided by family members; (2) children less than 15 years old; (3) good treatment compliance; (4) children who met the relevant diagnostic criteria in the "Guidelines for the Diagnosis and Treatment of Community-Acquired Pneumonia in Children (2019 edition)"[10]; (5) the child had no history of allergy to multiple drugs and macrolides; and (6) the child had no infection or inflammation in other parts of the body.

The exclusion criteria were: (1) children with immunodeficiency disorders; (2) those with cardiovascular, cerebrovascular, lung, liver, kidney, nervous system, blood system diseases; (3) patients with bronchial asthma and bronchiectasis; (4) those without a confirmed diagnosis of CAP and (5) children treated with macrolides or (and) gamma globulin within one month prior to enrollment.

Observed indicators

(1) Age distribution of children in each group.

(2) Etiological characteristics of children in each group and distribution characteristics of children at different ages: containing bacteria (streptococcus pneumoniae, staphylococcus aureus, haemophilus influenzae, moraxella catamella along with other bacteria), influenza virus (respiratory syncytial virus, adenovirus along with other viruses), and atypical microbialvirus (mycoplasma pneumonia).

(3) Factors affecting the severity of symptoms in children including single factor and multiple factors.

Statistical analysis

SPSS 24.0 statistical software was implemented for data analysis, and included univariate and multiple logistic regression analysis. Count data were exhibited as (n, %), and $\chi 2$ test was implemented for comparisons. Measurement data were expressed as ($x \pm s$), and one-way ANOVA was used for comparison among groups. The influencing factors were analyzed by multi-factor Logistics regression. $P<0.05$ meant statistical significance.

Table 1: General data of patients in 2 groups

Groups	Cases	Gender (male/female)	Age (years)	Course of disease (d)
Spring onset group	120	70/50	4.68±2.20	3.49±1.04
Summer onset group	60	30/30	4.65±2.23	3.52±1.06
Autumn onset group	80	35/45	4.53±2.18	3.48±1.02
Winter onset group	130	70/60	4.56±2.15	3.43±1.06
χ^2/F		4.3	0.1	0.1
P		0.2	1.0	0.9

Ethical consideration

Our study was approved by the Ethics Committee of First Hospital of Qinhuangdao on August 15, 2020, and the Ethical number was 2020F001.

Results

Age distribution of children in each group

Table 2 showed no difference in age distribution between the groups (P>0.05).

Pathogenic distribution characteristics among children of different ages

There was no difference in pathogenic distribution characteristics among children of different ages (P>0.05, Table 3).

Etiological characteristics of children in each group

The detection rates of streptococcus pneumonia, haemophilus influenzae and mycoplasma pneumoniae in the winter onset group were higher when compared with the other three groups (P<0.05). The detection rate of moraxella mucositis in the spring onset group was higher when compared with the other three groups (P<0.05). There were no significant differences in the detection rates of other viruses and bacteria (P>0.05, Table 4).

Univariate analysis affecting the severity of symptoms in children

Among the 390 cases, 150 were mild while 240 were severe. The results of univariate analysis revealed significant differences in anaemia, malnutrition, previous infection history, preterm birth, hospitalization history, C-reactive protein (CRP), procalcitonin (PCT) and white blood cell (WBC) levels between mild and severe children (P<0.05, Table 5).

Multivariate analysis of influencing degree of symptoms in children

The degree of symptoms of patients was used as the dependent variable to assign values: 0 for mild cases and 1 for severe cases;, anemia, malnutrition, previous infection history, preterm birth, hospitalization history, CRP, PCT and WBC levels were used as covariates: No anemia was 0, anemia was 1; Normal nutrition was 0, malnutrition was 1; No history of infection was 0, and history of infection was 1. Non-preterm birth was 0, preterm birth was 1; No previous hospitalization history was 0, and previous hospitalization history was 1. Logistics regression analysis showed that CRP, PCT, WBC, anemia, malnutrition, previous infection history, and preterm birth were the main factors affecting the severity of symptoms in children (P<0.05, Table 6).

Discussion

CAP can be caused by a variety of pathogenic microorganisms, among which bacteria, viruses and mycoplasma are the most common, but it varies greatly due to regional, economic, disease season, culture, health environment and other factors[11]. Early detection and timely treatment of high-risk children are of great significance to improve prognosis.

Studies have shown that CRP, PCT, and WBC levels are significantly elevated in children with severe CAP[12]. CRP is a common index to judge the severity of disease and treatment response of children[13].

Table 2: Age distribution of children in each group

Groups	≤1 year old	>1 year old and ≤3 years old	>3 year old and ≤5 years old	>5 year old and <15 years old
Spring onset group (n=120)	17 (14.1)	14 (11.7)	47 (39.2)	42 (35.0)
Summer onset group (n=60)	10 (16.7)	8 (13.3)	26 (43.3)	16 (26.7)
Autumn onset group (n=80)	21 (26.3)	12 (15.0)	29 (36.2)	18 (22.5)
Winter onset group (n=130)	20 (15.4)	15 (11.5)	51 (39.3)	44 (33.8)
χ^2	8.9			
P	0.5			

Table 3: Pathogenic distribution characteristics among children of different ages

Pathogenic distribution	≤1 (n=68)	>1 and ≤3 (n=49)	>3 and ≤5 (n=153)	>5 and <15 (n=120)	χ^2	P
Virus						
Respiratory syncytial virus	21 (30.9)	10 (20.4)	30 (19.6)	26 (21.7)	3.7	0.3
Parainfluenza virus	6 (8.8)	8 (16.4)	10 (6.5)	12 (10.0)	4.4	0.2
Influenza virus	3 (4.4)	4 (8.2)	13 (8.5)	7 (5.8)	1.6	0.7
Adenovirus	3 (4.4)	2 (4.1)	16 (10.5)	7 (5.8)	4.3	0.2
Bacteria						
Streptococcus pneumoniae	6 (8.8)	2 (4.1)	13 (8.5)	14 (11.7)	2.5	0.5
Haemophilus influenzae	3 (4.4)	1 (2.0)	3 (2.0)	3 (2.5)	1.2	0.8
Moraxella mucositis	6 (8.8)	2 (4.1)	12 (7.7)	10 (8.3)	1.1	0.8
Staphylococcus aureus	3 (4.4)	1 (2.0)	3 (2.0)	5 (4.2)	1.7	0.6
Pseudomonas aeruginosa	1 (1.5)	1 (2.0)	1 (0.7)	2 (1.7)	0.9	0.8
Others	1 (1.5)	1 (2.0)	1 (0.7)	2 (1.7)	0.9	0.8
Atypical microorganism						
Mycoplasma pneumoniae	15 (22.1)	17 (34.7)	51 (33.3)	32 (26.6)	4.0	0.3

Table 4: Etiological characteristics of children in each group

Pathogenic distribution	Spring onset group (n=120)	Summer onset group (n=60)	Autumn onset group (n=80)	Winter onset group (n=130)	χ^2	P
Virus						
Respiratory syncytial virus	17 (14.2)	12 (20.0)	9 (11.3)	22 (16.9)	2.4	0.5
Parainfluenza virus	15 (12.5)	5 (8.3)	12 (15.0)	9 (6.9)	4.3	0.2
Influenza virus	12 (10.0)	1 (1.7)	9 (11.3)	6 (4.6)	7.4	0.1
Adenovirus	9 (7.5)	6 (10.0)	9 (11.3)	6 (4.6)	3.6	0.3
Bacteria						
Streptococcus pneumoniae	5 (4.2)	3 (5.0)	7 (8.7)	22 (16.9)	13.8	0.0
Haemophilus influenzae	1 (0.8)	1 (1.7)	7 (8.7)	16 (12.3)	16.7	<0.001
Moraxella mucositis	20 (16.7)	3 (5.0)	7 (8.7)	1 (0.8)	22.1	<0.001
Staphylococcus aureus	9 (7.5)	5 (8.3)	5 (6.3)	10 (7.7)	0.2	1.0
Pseudomonas aeruginosa	1 (0.8)	2 (3.3)	2 (2.5)	1 (0.8)	2.7	0.4
Others	1 (0.8)	2 (3.3)	2 (2.5)	1 (0.8)	2.7	0.4
Atypical microorganism						
Mycoplasma pneumoniae	30 (25.0)	20 (33.4)	11 (13.7)	36 (27.7)	8.1	0.0

Table 5: Univariate analysis affecting the severity of symptoms in children

Factors	Mild (n=150)	Severe (n=240)	χ^2/t	P
Gender (cases)			0.6	0.4
Male	75 (50.0)	130 (54.2)		
Female	75 (50.0)	110 (45.8)		
Age distribution (cases)			0.9	0.8
≤1 year old	26 (17.3)	42 (17.5)		
>1 year old and ≤3 years old	16 (10.7)	33 (13.8)		
>3 year old and ≤5 years old	60 (40.0)	93 (38.7)		
>5 year old and <15 years old	48 (32.0)	72 (30.0)		
Infection causes (cases)			5.2	0.1
Virus	62 (41.3)	126 (52.5)		
Bacteria	47 (31.3)	60 (25.0)		
Atypical microorganism	41 (27.4)	54 (22.5)		
Anemia (cases)			18.4	<0.001
Yes	42 (28.0)	120 (50.0)		
No	108 (72.0)	120 (50.0)		
Malnutrition (cases)			14.1	<0.001
Yes	52 (34.7)	130 (54.2)		
No	98 (65.3)	110 (45.8)		
Previous infection history (cases)			22.1	<0.001
Yes	35 (23.3)	113 (47.1)		
No	115 (76.7)	127 (52.9)		
Premature birth (cases)			25.4	<0.001
Yes	37 (24.7)	121 (50.4)		
No	113 (75.3)	119 (49.6)		
Hospitalization history (cases)			8.8	0.0
Yes	60 (40.0)	133 (55.4)		
No	90 (60.0)	107 (44.6)		
CRP (mg/L)	14.1±1.8	15.8±2.4	8.3	<0.001
PCT (ng/mL)	1.9±0.2	2.4±0.3	23.4	<0.001
WBC ($\times10^9$/L)	7.3±0.8	8.5±0.9	17.4	<0.001

Table 6: Multivariate analysis of influencing degree of symptoms in children

Factors	B value	SE value	Wald value	P value	OR value	95% CI
Anemia	0.7	0.2	10.1	0.0	2.1	1.3-3.3
Malnutrition	0.6	0.2	7.8	0.0	1.9	1.2-2.9
Previous infection history	0.9	0.2	15.6	<0.001	2.6	1.6-4.1
Preterm birth	1.1	0.2	22.8	<0.001	3.1	2.0-5.0
Hospitalization history	0.5	0.2	4.6	0.0	1.6	1.0-2.5
CRP	0.1	0.0	14.1	<0.001	1.1	1.1-1.2
PCT	0.5	0.2	12.2	<0.001	1.7	1.3-2.3
WBC	0.2	0.0	21.5	<0.001	1.3	1.2-1.4

If CRP is increased within 1 to 3 days after the onset of the disease, it can indicate that the cause of the disease is related to bacterial infection. Moreover, the degree of the increase of CRP is related to the course of the disease in children[14]. PCT is a classic indicator of inflammation in the laboratory, and its elevated level means that the body is in a state of inflammation[15]. The level of WBC in the body increases with the severity of the disease. In addition, children with bacterial infections have higher levels of WBC[16].

The outcomes of our study indicated that the detection rates of streptococcus pneumonia, haemophilus influenza and mycoplasma

pneumoniae in the winter onset group were higher when compared with the other three groups. The detection rate of moraxella mucositis in the spring onset group was higher compared with the other 3 groups.

These results indicate that streptococcus pneumoniae, haemophilus influenza, moraxella mucositis along with mycoplasma pneumoniae were the main causes of CAP infection, which was in line with previous studies[17,18].

Logistics regression analysis showed that CRP, PCT, WBC, anemia, malnutrition, previous infection history, and preterm birth were the main factors affecting the severity of symptoms in children, which was similar to previous studies[19-21]. The reason may be that anemia, malnourished children and premature children have poor body resistance, so infection is more likely to lead to the deepening of the disease[22]. At the same time, the development of children's immune system is not mature, so children with a history of previous infection are more likely to deepen the degree of disease due to the greater damage to the body attributable to repeated attacks[23]. The high levels of CRP, PCT and WBC indicate that the inflammation in the body is intense, which will cause further damage to the body[24].

Study strengths and limitations

The main advantage of this study is to explore the characteristics of CAP in children and the risk factors leading to serious diseases through univariate and multivariate logistic regression analysis, which provide clinical reference for CAP treatment in children. The disadvantage is that this study is a single-center study

Conclusion

We conclude that the main pathogenic bacteria of CAP in children in winter and spring were streptococcus pneumoniae, haemophilus influenzae and moraxella mucositis. Mycoplasma pneumoniae showed an increasing trend in summer and autumn, and some of them were associated with bacterial infection. CRP, PCT, WBC, anemia, malnutrition, previous infection history, and preterm birth were the major factors influencing the severity of symptoms in children.

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Contribution of authors

Liu L, Huang W: conceived and designed the study, and collected and analysed the data. Zhang SS, Li ML: prepared the manuscript. All authors mentioned in the article approved the manuscript t.

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