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Diagnostic Efficacy of Hypersensitive C-reactive Protein and Blood Routine Test in Different Respiratory Pathogen Infections in Children

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Abstract: To investigate the value of hypersensitive C-reactive protein (hs-CRP) and blood routine test in the diagnosis of different respiratory pathogen infections in children, we selected children with respiratory pathogen infections received from November 2023 to January 2024 as the observation group. And 137 children who were admitted to the hospital for treatment but not with respiratory pathogen infections during the same period were selected as the control group, with the children in the observation group classified into 128 cases of mycoplasma pneumoniae, 57 cases of influenza A and B viruses, and 240 cases of adenovirus according to the types of different pathogen infections. Blood indicators were collected from the study subjects to detect the hs-CRP level with the Mindray CRP-M100, detect the levels of white blood cell count (WBC), neutrophil percentage (NEUT%), lymphocyte percentage (LY%), monocyte percentage (MO%), percentage of eosinophilic cells (EO%), and percentage of basophilic cells (BASO%) with a hematology analyzer. The detected results of indicators in each group and detection methods were compared to detect the positive results. The blood hs-CRP levels of the mycoplasma pneumoniae group, the influenza A and B viruses group, and the adenovirus group were all higher than those of the control group ($P < 0.05$), with the hs-CRP detection value of the influenza A and B viruses group being the highest, followed by the mycoplasma pneumoniae group and the adenovirus group. The differences in the detection indicators of different pathogens were statistically significant in the comparison ($P < 0.05$). The levels of WBC, NEUT% and MO% in the detection of each pathogen infection group were higher than those in the control group, and the levels of LY% and EO% were both lower than those in the control group ($P < 0.05$), and the WBC level in the adenovirus group was higher than that in the other 3 groups ($P < 0.05$). The positive detection rate of different pathogens by hs-CRP+blood routine test was higher than that of single hs-CRP test or single blood routine test ($P<0.05$). For respiratory pathogen infections in children, hs-CRP and routine blood tests are valuable in determining the type of disease, with the combination of tests increasing the positive detection rate, which is worthy of popularization.

1. Introduction

In pediatric clinical practice, acute respiratory infections are one of the most common illnesses and a leading cause of pediatric visits and hospitalizations [1]. Respiratory tract infections can be caused by a variety of pathogens, including viruses, bacteria, and even fungi and mycoplasmas. It is challenging to identify different pathogenic infections only by clinical signs and symptoms because of the similarity of clinical manifestations caused by these pathogens [2]. Blood routine test is commonly used as a standardized laboratory test for the initial clinical assessment of inflammation. For example, white blood cell count (WBC) and its classification, platelet count (PLT) and hemoglobin (Hb) levels can provide physicians with initial clues about the organism prevalence [3]. However, such tests cannot effectively differentiate between different respiratory pathogen infections, limiting their use in accurately guiding anti-infective therapy. In recent years, some novel biomarkers such as hypersensitive C-reactive protein (hs-CRP) have gradually gained attention as an inflammatory indicator in blood routine test due to their high sensitivity and specificity with the development of laboratory technology [4]. Compared with conventional CRP assays, hs-CRP has a lower limit of detection that makes it more sensitive in assessing low-grade inflammation, which has been shown to be closely related to the pathogenesis and prognosis of certain diseases [5]. Based on this, the study was conducted to investigate the diagnostic efficacy of hs-CRP and blood routine test in children with different respiratory pathogen infections, providing references for clinical treatment. Therefore, it is reported as follows.

2. Information and Methods

2.1 General information

426 children with respiratory pathogen infections admitted from November 2023 to January 2024 were selected as the observation group, and 137 children who were admitted to the hospital for treatment but not with respiratory pathogen infections during the same period were selected as the control group. Inclusion criteria: Children with complete clinical data in the observation group had different degrees of fever, runny nose, eye discomfort and other symptoms, and were diagnosed by physical examination and throat swab culture. Parents were informed about the study and signed an informed consent form. Exclusion criteria: those with autoimmune disease or organ function damage; those with coagulation dysfunction or other hematologic diseases; those with cognitive dysfunction; patients with systemic inflammatory diseases and congenital heart disease. The children in the observation group were grouped according to the type of disease, including 128 cases of mycoplasma pneumoniae, 58 cases of influenza A and B viruses, and 240 cases of adenovirus, among which there were 79 males and 49 females with mycoplasma pneumoniae, aged 6 months to 18 years, with a mean of (9.86±1.38) years, there were 29 males and 28 females with influenza A or B viruses, aged 3 months to 17 years, with a mean of (9.92±1.43) years, and there were 138 males and 102 females with adenovirus, aged 6 months to 18 years, with a mean of (10.01±1.34) years. In the control group, there were 70 males and 67 females, aged 3 months to 20 years, with a mean of (10.08±1.28) years. There were no statistically significant differences in the general information of patients in each group ($P > 0.05$). The study was approved by the Medical Ethics Committee of the hospital.

2.2 Methods

All study objects were fasted for at least 6h, and 2-3ml of venous blood was collected by experienced nurses in the morning, with all collection equipment and nurses' hands strictly sterilized to ensure the sterility of the sampling equipment. The collected venous blood was put into an

anticoagulative tube filled with ethylenediamine tetraacetic acid dipotassium in advance to be mixed with the anticoagulant for examination.

The Mindray CRP-M100 was used for hs-CRP detection, and the Mindray BC-6900 blood cell analyzer was used for blood routine test, including items like WBC, neutrophil percentage (NEUT%), lymphocyte percentage (LY%), monocyte percentage (MO%), percentage of eosinophilic cells (EO%), and percentage of basophilic cells (BASO%), which were all tested by the Shenzhen Mindray Biomedical Electronics Co. Ltd. test reagents strictly according to the step-by-step procedures. The reference values of each index range from 4.1-11.0 $\times 10^9$/L for WBC, 37.0-77.0% for NEUT%, 17.0-54.0% for LY%, 2.0-11.0% for MO%, 0-9% for EO%, 0-1.0% for BASO%, and 0-3mg/L for hs-CRP.

2.3 Observation indicators

(1) hs-CRP detection level. The levels of serum hs-CRP indicators were compared in each group. (2) Blood routine test. The levels of blood routine-related indexes of people with different diseases were compared. (3) Positive detection rate. The positive detection rate of hs-CRP and blood routine in different infected groups (detection indicators higher or lower than the normal value are considered positive, and two or more positive items are recognized as positive) were compared.

2.4 Statistical methods

SPSS21.0 software was used to analyze the statistical results, with measurement data expressed as mean ± standard deviation ($\bar{x} \pm s$). The t-test was used, with the count data expressed as (%). The $\chi 2$ test was used for intergroup comparisons, with $P<0.05$ indicating a statistically significant difference.

3. Results

3.1 Comparison of hs-CRP levels between groups

In the blood hs-CRP indicator test, the serum hs-CRP level of the control group was within the normal reference value. The blood hs-CRP levels in the mycoplasma pneumoniae group, influenza A and B viruses group, and adenovirus group are higher than the control group, with a statistically significant difference ($P < 0.05$). As for the specific test results, the influenza A and B viruses group had the highest detection values, followed by the mycoplasma pneumoniae group and the adenovirus group. The differences of different pathogens infected with the disease detection indexes were statistically significant ($P < 0.05$), as shown in Table 1.

Table 1: Comparison of blood hs-CRP levels between groups (mg/L, $\bar{x} \pm s$)

Group	n	hs-CRP
Mycoplasma pneumoniae group	128	6.02 ± 1.26^{abc}
Influenza A and B viruses group	57	8.21 ± 1.75^{ab}
Adenovirus group	240	4.25 ± 0.75^{a}
Control group	137	1.86 ± 0.34
F value		12.485
P value		<0.001

Note: Compared with the control group, $^{a}P<0.05$; compared with the adenovirus group, $^{b}P<0.05$; compared with the influenza A and B viruses group, $^{c}P<0.05$.

3.2 Comparison of the blood routine indicators in each group

The levels of WBC, NEUT% and MO% of each pathogen infection group were higher than those of the control group, and the levels of LY% and EO% were lower than those of the control group, with statistically significant differences (P<0.05). However, there was no statistically significant difference in the BASO% level of the various groups (P>0.05). The WBC level in the adenovirus group was higher than that of the other three groups, with statistically significant differences (P<0.05), as shown in Table 2.

Table 2: Comparison of the blood routine indicators in each group ($\bar{x} \pm s$)

Group	n	WBC ($\times 10^9$/L)	NEUT% (%)	LY% (%)	MO% (%)	EO% (%)	BASO% (%)
Mycoplasma pneumoniae group	128	8.25 ± 0.86[ab]	72.25 ±7.36[a]	12.51 ±1.86[a]	8.86 ±1.36[a]	0.75 ±0.08[a]	0.15 ±0.03
Influenza A and B viruses group	58	8.62 ± 0.91[ab]	74.11 ±7.21[a]	11.36 ±1.92[a]	9.02 ±1.42[a]	0.77 ±0.11[a]	0.13 ±0.02
Adenovirus group	240	12.41 ±1.86[a]	71.96 ±7.15[a]	12.86 ±1.88[a]	8.75 ±1.36[a]	0.72 ±0.06[a]	0.14 ±0.03
Control group	137	7.86 ± 0.86	54.25 ±6.35	30.36 ±2.86	6.02 ±0.89	2.42 ±0.26	0.12 ±0.03
F value		12.415	20.415	18.652	8.154	13.154	0.156
P value		<0.001	<0.001	<0.001	<0.001	<0.001	0.826

Note: Compared with the control group, [a]P<0.05; Compared with the adenovirus group, [b]P<0.05.

3.3 Comparison of positive detection of hs-CRP and blood routine test

As for the detection of different respiratory pathogen infections in children by different testing methods, the positive detection rate of hs-CRP was higher than that of routine blood test, without difference in the positive detection rate of different diseases (P > 0.05). However, the positive detection rate of different pathogen infections by applying the testing method of hs-CRP+blood routine test was higher than that of single hs-CRP or single blood routine test, with statistically significant differences (P<0.05), as shown in Table 3.

Table 3: Comparison of positive detections of blood hs-CRP and blood routine in each group of patients

Group	n	hs-CRP		Blood routine test		hs-CRP+blood routine test	
		Positive	Positive rate (%)	Positive	Positive rate (%)	Positive	Positive rate (%)
Mycoplasma pneumoniae group	128	105	82.03	87	67.97	121	94.53[*#]
Influenza A and B viruses group	58	47	81.03	38	65.52	55	94.83[*#]
Adenovirus group	240	201	83.75	156	65.00	226	94.17[*#]

Note: Compared with hs-CRP test, [*]P<0.05; compared with blood routine test, [#]P<0.05.

4. Discussion

Children's immune systems are not fully mature compared to adults, which means that their bodies are less resistant to pathogens [6]. Children, especially preschool children, are often in close contact with other children at school, kindergarten, or other collective activities, increasing the chances of respiratory disease transmission. In addition, children have relatively narrow airways compared to adults, which tends to make the inflammatory response more pronounced and then leads to more severe symptoms [7]. Children's respiratory tract infections have various types of pathogens, including mycoplasma pneumoniae, influenza A and B viruses and adenovirus. Different treatment methods should be selected for different types of pathogen infections, which requires early diagnosis of the disease, identification of disease type, and targeted and personalized treatment according to the identification of the lesion situation, thus achieving a satisfactory therapeutic effect to ensure children's lives and health [8].

Blood routine test is a routine test program with relevant detected indicators helpful to the identification of infection or disease [9]. The detection of WBC, NEUT%, LY%, MO%, EO%, and BASO% in the blood routine indexes have a certain role for respiratory pathogen infections in children, in which the total WBC is usually elevated at the onset of infection [10]. However, different types of infections can lead to different changes. For example, bacterial infections may lead to significant elevation, and viral infections may cause a mild increase or even normalization. Neutrophils are the first line of defense against bacterial infections [11]. Neutrophils may be significantly elevated in bacterial infections, as evidenced by a leftward shift in leukocytes. Lymphocytes play an important role in the immune response in the body [12]. Viral infections can lead to a relatively higher percentage of lymphocytes. Monocytes play a role in the body's fight against pathogens, especially intracellular infections (e.g., certain viruses, bacteria, and parasites), with numbers being slightly elevated in these infections [13]. Eosinophils are commonly associated with allergic reactions and certain parasitic infections. Generally, eosinophils will not change significantly under normal conditions with the smallest number. Based on the results of single or multiple indicators, the blood routine test results can be compared with normal reference values for the early diagnosis of disease and the early detection of disease [14]. However, part of the bold routine test indicators like BASO% test indicators usually do not change without indicative. In addition, different respiratory pathogen infections will not show obvious differences in a number of indicators, which makes it difficult to distinguish between different pathogen infections. Therefore, the difficult in the identification of disease is not conducive to personalized treatment, with the treatment effect being hard to meet expectations [15], which is the reason why more indicative indicators are needed.

CRP is an acute inflammatory marker that is produced soon after infection or tissue injury. CRP can be used as one of the infection indicators as its levels increase rapidly under inflammatory response [16]. For respiratory infections, CRP can be used in conjunction with other clinical symptoms and test results to help physicians assess the inflection severity and guide therapeutic decisions. hs-CRP is a more sensitive assay for CRP that can detect lower concentrations of CRP, which is widely used in the assessment of inflammatory diseases and coronary heart disease risk with more subtle hs-CRP changes in the inflammatory response [17]. For the diagnosis and differentiation of respiratory pathogen infections, hs-CRP levels increase with the infection severity and can be used to assess infection severity and to determine the treatment effect. Although hs-CRP cannot distinguish between bacterial and viral infections alone, high levels of hs-CRP can indicate a greater likelihood of bacterial infection [18]. In addition, the combination of other clinical symptoms and test results can better identify the pathogen type. Regular measurement of CRP and hs-CRP levels during treatment can be used to monitor disease progression and determine the treatment effect, with a decline in inflammatory markers usually meaning that the disease is under control.

The study results showed that the detection level of patients with various diseases is higher than that of the control group in the detection of blood hs-CRP levels, with significant differences between groups that the influenza A and B viruses group is significantly higher in the detection level, which indicates that the detection of hs-CRP is of assistance in identifying respiratory tract infections. In the detection of blood routine indicators, there were significant differences in various indicators of respiratory pathogen infections between groups except for BASO%. However, there were not any significant differences in various respiratory infections between groups, indicating that the detection of blood routine indicators can be used for early diagnosis of respiratory pathogen infections, but is defective in identifying the disease, which means it is unable to determine the specific type of pathogen infection. As for the positive detection results of different pathogen infections by single hs-CRP test and blood routine test, it shows that the positive detection rate of various diseases is significantly higher by adopting the hs-CRP combined with blood routine test, indicating that the hs-CRP combined with blood routine test has a higher accuracy in diagnosing different respiratory pathogen infections in children, which is mainly due to that an increase in hs-CRP implies an inflammatory response in the body. An abnormal white blood cell count found on blood routine test can be more specific in suggesting a disease state. For example, the combination of a significant increase in neutrophils in the blood routine test and an increase in hs-CRP is more supportive of a diagnosis of bacterial infection. During respiratory infections, individual markers may change at specific disease stages. Rapid increases in hs-CRP are consistent with an acute phase of infection, and changes in cellular ratios in blood routine test may indicate different stages of the infection process. Combined testing allows for more comprehensive monitoring of disease progression. In addition, certain patterns of blood routine changes combined with an increase in hs-CRP can increase suspicion for a particular infection although it cannot directly identify pathogens. For example, an elevated percentage of lymphocytes and a slight increase in hs-CRP in blood routine test can be used to support the diagnosis of viral infections.

5. Conclusion

In summary, the detection of hs-CRP and blood routine for the diagnosis of children's different respiratory pathogen infections have a certain value, but the combined detection method is worth promoting with a higher positive rate, providing a favorable reference for the early treatment of the disease.

References

[1] Shi H J. The value of fully automated blood cell analyzer in the diagnosis of pediatric bacterial infectious diseases by hypersensitive C-reactive protein combined with blood routine test [J].Chinese Medical Journal of Metallurgical Industry, 2023, 40(3):333-334.

[2] Wang Z Z, Zhang H Y, Wu L M, et al. Clinical characteristics, etiology and severity of infection in infants with infectious fever between 1 and 2 months of age [J].Medical Innovation of China, 2020, 17(26):127-131.

[3] Shang N, Tie F, Liu P F. Efficacy of blood routine test combined with serum C-reactive protein and prealbumin in the diagnosis of bacterial infectious disease in children [J].Medical Journal of Chinese People's Health, 2023, 35(17):130-132.

[4] Yi S M, Yi H R. Diagnostic value of whole blood C-reactive protein and blood routine test in pediatric bacterial infectious diseases [J].Heilongjiang Medicine Journal, 2023, 36(2):423-425.

[5] Yang L.Application value of blood routine test combined with procalcitonin and C-reactive protein tests in bacterial infectious diseases in children [J].Journal of Women and Children's Health Guide, 2023, 2(2):49-51.

[6] Liu Y, Lin R F, Chen H F. Application of whole blood C-reactive protein and blood routine test in the diagnosis of bacterial infectious diseases [J].Quality Safety Inspection and Testing, 2022,32(1):103-104.

[7] Tang Y M, Liu Z C, Ye D, et al. Effect analysis of procalcitonin and hypersensitive C-reactive protein test on the early diagnosis of upper respiratory tract infection [J].The Medical Journal of the Present Clinical, 2022, 35(5):9-10.

[8] Yao P. Value analysis of procalcitonin and C-reactive protein combined with blood routine test in the diagnosis of

acute upper respiratory infections in children [J].Modern Diagnosis & Treatment, 2023, 34(4):592-593.
[9] Li Y, Wang J, Luo R R, et al. Survey result analysis on the present rate of hospital-acquired infections in a tertiary A-class hospital from 2016 to 2018 [J].Medical Innovation of China, 2019, 16(06):71-74.
[10] Wang Z F, Sun H W, Yang X H, et al. Diagnostic value of peripheral blood lymphocyte subsets and inflammatory indices in respiratory tract infections in children [J].The Journal of Medical Theory and Practice, 2023, 36(9):1464-1467.
[11] Shu Y M. Effectiveness analysis of blood routine test combined with C-reactive protein and SAA tests for identifying the etiology of pediatric infections [J].Modern Diagnosis & Treatment, 2022,33(6):899-901,931.
[12] Zhou G T, Ye H M, Xie Z H. Clinical value analysis of CRP combined with blood routine test in pediatric acute upper respiratory tract infections [J].Chinese Journal of Practical Medicine, 2022, 17(1):64-66.
[13] Zhao Y A, Zhou Y. The value of combined C-reactive protein and white blood cell count testing in pediatric lower respiratory tract infectious diseases [J].Guizhou Medical Journal, 2023, 47(11):1753-1754.
[14] Wu Y J, Liu J. Diagnostic value of serum CRP combined with SAA test in digestive tract infectious diseases in children [J].Guizhou Medical Journal, 2023, 47(4):611-612.
[15] Mao Y, Xie J, Liu Y, et al. Study on the value of serum amyloid A, blood routine, and C-reactive protein in pediatric infectious diseases [J].Chinese Medical Sciences Journal, 2023, 13(6):89-92.
[16] Wei Y M, Chen M W, Xu X L, et al. Epidemiologic and clinical characterization of a swimming-associated human adenovirus respiratory infection [J].Medical Innovation of China, 2020, 17(24):153-157.
[17] Dong J P. The value of combined whole blood C-reactive protein and blood routine test in the diagnosis of infectious diseases [J].Journal of Aerospace Medicine, 2023, 34(9):1050-1052.
[18] Zhao S, Qian X Y, Peng R R. Diagnostic value of white blood cell count, hypersensitive C-reactive protein and T-cell subset levels in children with acute upper respiratory tract infection combined with febrile convulsions [J].Journal Of Medical Systems, 2022,7(15):13-16,26.