

The Value of RDW, PDW, and Immunoglobulin E in the Clinical Diagnosis of Pediatric Asthma

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Abstract: *Objective:* To observe and explore the value of the combined application of red blood cell distribution width (RDW), platelet distribution width (PDW), and immunoglobulin E (IgE) in the process of clinical diagnosis of children with asthma. *Methods:* Fifty-five children with suspected asthma were admitted to the hospital from July 2021 to July 2023. They underwent a bronchodilator test upon admission and their RDW, PDW, and IgE were detected. The efficacy of diagnosis with a single indicator (RDW/PDW/IgE) and combined parameters (PDW + PDW + IgE) were compared with the results of the bronchodilator test. *Results:* 49 cases of pediatric asthma were diagnosed by the bronchodilator test. RDW and PDW of asthmatic children were lower than those of non-asthmatic children, while the IgE of asthmatic children was higher than that of non-asthmatic children, and there was a significant difference in the RDW, PDW, and IgE among children with different degrees of asthma severity ($P < 0.05$). The positive rate of the three combined diagnostic tests of RDW, PDW, and IgE was significantly higher than the positive rate of a single-parameter diagnosis ($P < 0.05$). *Conclusion:* The combination of RDW, PDW, and IgE plays a crucial role in the clinical diagnosis of asthmatic children. These tests further improve the efficiency of clinical diagnosis and help identify the severity of the disease.

Keywords: Asthma; Pediatric; RDW; PDW; IgE

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1. Introduction

Asthma is a common and frequent chronic airway disease in the younger age group of young children, which can lead to coughing, chest tightness, shortness of breath, and dyspnea, which is extremely detrimental to the healthy growth of children^[1]. If treatment is delayed, it is likely to lead to persistent exacerbation of asthma, impairment of lung function, and even loss of mobility. Therefore, early examination and intervention are important to improve the prognosis of children in time to promote disease regression. The bronchodilator test is the most accurate method for diagnosing clinical asthma, but the execution process is complicated, so it is necessary to find a more efficient and convenient diagnostic method^[2]. Red blood cell distribution width (RDW) can well reflect the heterogeneity of red blood cell volume size, and currently has a certain auxiliary role in the diagnosis of asthma^[3]; platelet distribution width (PDW) can well reflect the platelet size variability parameter

and has a certain suggestive role for the diagnosis of asthma, and its elevated value is commonly found in giant platelet syndrome, anemia, and other diseases^[4]; Immunoglobulin E (IgE) is derived from plasma cells and is an important antibody leading to the development of type I allergic reactions, which is closely related to the development of asthma^[5]. In this study, 55 children with suspected asthma were included as clinical diagnosis subjects, and their RDW, PDW, and IgE levels were observed.

2. Information and methods

2.1. General information

Fifty-five children with suspected asthma were admitted to the hospital from July 2021 to July 2023, of whom 29 were boys and 26 were girls, aged 3–11 years, with a mean age of 7.75 ± 2.45 years. The duration of the disease of the patients was 5–28 d, with a mean of 13.96 ± 5.59 d, and their weights were 7–25 kg, with a mean of 16.86 ± 1.27 kg. They were admitted to the hospital because of symptoms such as coughing, tightness in the chest, shortness of breath, etc. The guardians gave informed consent to the study. The patients' coagulation functions were normal, they had not used anticoagulants in the last 3 months or received a blood transfusion. All of them were admitted to the hospital for symptoms such as cough, chest tightness, shortness of breath, dyspnea, etc. Patients with hypertension, cardiac, hepatic, or renal insufficiency, severe acute or chronic infections, benign or malignant tumors, arrhythmia, cardiac failure, infectious diseases, mental illness, history of thrombosis, history of allergy, and those who withdrew or missed the visit for any reason were excluded.

2.2. Methods

Bronchodilator test was performed on all admissions, and the patients' RDW, PDW, and IgE levels were detected. (1) Bronchodilator test: Firstly, the patients needed to keep quiet and rest for 15 min. Next, the doctor listened to the patients' lungs to check for the presence of croups and other signs. The patients were then instructed to inhale 0.5% salbutamol with their noses and mouths through a nebulizer. Auscultation of their lungs was then performed again after 15–20 minutes. Subsequently, pulmonary function instruments were used to assess the patients' lung capacity, peak expiratory flow rate, and the rate of increase of the 1st expiratory volume during exertion. These instruments provided measurements for lung volume, peak expiratory flow rate, and the rate of increase of expiratory volume during the 1st exertion. (2) 2–3 mL of venous blood were routinely drawn from the elbow. The RDW and PDW of the patients were detected using an automated hematology analyzer, and their IgE was determined using an automated biochemistry analyzer.

2.3. Observation indicators

(1) The number of asthma cases detected by bronchodilator test was recorded. (2) The RDW, PDW, and IgE levels of asthmatic and non-asthmatic children were compared. The RDW, PDW, and IgE levels were also compared among different levels of severity of asthma (mild, moderate, severe) according to Guidelines for the Diagnosis and Prevention of Bronchial Asthma in Children^[6]. (3) The results of the bronchodilator test were used as a reference to determine the efficacies of single-parameter diagnosis and combined-parameter diagnosis.

2.4. Statistical processing of data

SPSS 22.0 was used to perform data analysis. The count data were described in the form of percentages and compared using a χ^2 . The measurement data were described in the form of mean \pm standard deviation and compared using a *t*-test. The difference between the data of multiple groups was tested by analysis of variance (ANOVA). The difference was statistically significant when the *P*-value was less than 0.05.

3. Results

3.1. Results of the bronchodilator test

In this study, 55 children with suspected asthma underwent the bronchodilator test, resulting in the diagnosis of 49 cases of pediatric asthma, accounting for 89.09% (49/55). Among them, there were 5 cases of cough variant asthma, 23 cases of allergic asthma, 2 cases of pharmacological asthma, 11 cases of infectious asthma, and 8 cases of locomotor asthma.

3.2. Clinical test results of asthmatic and non-asthmatic children

The RDW and PDW of the asthmatic children were lower than the non-asthmatic children. However, asthmatic children exhibited higher IgE compared to non-asthmatic children ($P < 0.05$). The details are shown in **Table 1**.

Table 1. RDW, PDW, and IgE levels in asthmatic and non-asthmatic children

Group	Number of cases	RDW (%)	PDW (%)	IgE (IU/mL)
Asthmatic	49	9.95 ± 0.34	10.45 ± 1.12	81.28 ± 5.49
Non-asthmatic	6	15.62 ± 2.24	15.79 ± 1.03	37.95 ± 5.35
<i>t</i>	-	6.085	7.112	7.403
<i>P</i>	-	< 0.05	< 0.05	< 0.05

3.3. Comparison of clinical test results between children with mild, moderate, and severe asthma

Among the 49 cases of pediatric asthma, 23 cases were mild, 16 cases were moderate, and 10 cases were severe. The RDW and PDW decreased with increasing severity of asthma, while IgE increased with increasing severity of asthma ($P < 0.05$). The details are shown in **Table 2**.

Table 2. RDW, PDW, and IgE levels in asthmatic and non-asthmatic children

Group	Number of cases	RDW (%)	PDW (%)	IgE (IU/mL)
Mild	23	18.75 ± 2.43	18.98 ± 2.13	81.15 ± 4.39
Moderate	16	14.95 ± 2.11	15.05 ± 2.19	90.25 ± 4.34
Severe	10	12.23 ± 2.05	11.03 ± 2.12	99.96 ± 4.45
<i>F</i>	-	5.186	6.016	9.453
<i>P</i>	-	< 0.05	< 0.05	< 0.05

3.4. Observation of single and combined test results

RDW detected 39 cases of positivity, accounting for 70.91% (39/55), of which 36 cases were true positivity; PDW detected 38 cases of positivity, accounting for 69.09% (36/55), of which 36 cases were true positivity; IgE detected 35 cases of positivity, accounting for 63.64% (35/55), of which 33 cases were true positivity; the combination of RDW + PDW + IgE detected 48 positive cases, accounting for 87.27% (48/55), of which all 48 cases were truly positive. Therefore, the positive rate of combined-parameter detection was higher than the positive detection rate of single-parameter detection ($P < 0.05$). The details are shown in **Table 3**.

Table 3. Observation of single and combined test results

	Bronchodilator test		Total
	Positive	Negative	
RDW			
Positive	36	3	39
Negative	13	3	16
Total	49	6	55
PDW			
Positive	36	2	38
Negative	13	4	17
Total	49	6	55
IgE			
Positive	33	2	35
Negative	16	4	20
Total	49	6	55
RDW + PDW + IgE			
Positive	48	0	48
Negative	1	6	7
Total	49	6	55

3.5. Comparison between the efficacy of single-parameter and combined-parameter diagnosis

The single-parameter test of RDW, PDW, and IgE was notably less effective than the combined test of the three parameters ($P < 0.05$). The details are shown in **Table 4**.

Table 4. Comparison of single and combined test efficacy

Group	Accuracy	Sensitivity	Specificity
RDW	70.91% (39/55)	73.47% (36/49)	50.00% (3/6)
PDW	72.73% (40/55)	73.47% (36/49)	66.67% (4/6)
IgE	67.27% (37/55)	67.35% (33/49)	66.67% (4/6)
RDW + PDW + IgE	98.18% (54/55)	97.96% (48/49)	100.00% (6/6)

4. Discussion

Asthma is a relatively common chronic airway disease. Pediatric asthma may be related to bad habits, environmental changes, climate, genetics, and many other factors [7]. If the disease is not controlled in time, prolonged recurrent coughing, shortness of breath, and dyspnea will not only lead to further exacerbation of asthma but also affect the overall health of the child. Therefore, early detection and diagnosis are crucial to facilitate effective treatment of pediatric asthma preventing the regression of the disease.

In this study, 55 children with suspected asthma underwent a bronchodilator test, and 49 cases of asthma

were confirmed. The RDW and PDW of non-asthmatic children were lower than those of non-asthmatic children but asthmatic children exhibited higher levels of IgE. Besides, RDW and PDW decreased with asthma aggravation and were negatively correlated with the severity of the disease, while IgE increased with asthma aggravation and was positively correlated with the severity of the disease. RDW is relatively rarely used in the diagnosis of asthma, and in most cases, it is used to assist in the diagnosis of anemic diseases [8]. In general, heterogeneity analysis, based on the standard of average red blood cell volume, investigates the variability in the size of red blood cell volume. This analysis holds significant pathological diagnostic value, and an elevated value indicates greater variability in red blood cell volume. Consequently, a higher value suggests more pronounced pathological manifestations within the organism [9]. PDW mainly reflects the variability of the platelet volume, and elevated PDW is commonly found in thrombotic diseases, hemolytic anemia, platelet disorders, leukemia, and other blood disorders [10]. Elevated PDW indicates large differences in the platelet volume, suggesting that the person may be in an abnormal pathological state [11]. IgE is an essential humoral immune cytokine commonly utilized in modern clinical settings that exhibits notable biological activity. When it interacts with inflammatory factors, it stimulates the release of various mediators. This process can result in bronchial smooth muscle spasms, increased vascular permeability, and the initiation of an immune reaction [12]. The immune response will destroy the cells in the body, damage the immune system, and weaken the body's immune resistance, leading to RDW and PDW abnormalities, forming a vicious circle [13]. Immune response has a positive role in promoting the development of pediatric asthma [14]. At the same time, the joint diagnosis of RDW + PDW + IgE is far more accurate, sensitive, and specific compared to using either of the parameters alone ($P < 0.05$). This indicates that the combination of the three indexes has a higher diagnostic value. This may be due to the fact that the combined test makes up for the insufficiency of the single-parameter test. This form of diagnosis greatly improves the efficiency of asthma diagnosis [15].

5. Conclusion

In conclusion, the combined application of RDW, PDW, and IgE has a definite value in the clinical diagnosis of pediatric asthma. Besides, it can effectively identify the severity of asthma, further improving the efficiency of clinical diagnosis. Therefore, this method should be popularized.

Disclosure statement

The author declares no conflict of interest.

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