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Correlation between serum vitamin D expression and changes of immune indexes in children with pneumonia of different degrees

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Abstract: To explore the correlation between serum vitamin D expression and changes in immune indicators in children with different degrees of pneumonia. From January 2019 to January 2020, 60 children with pneumonia admitted to our hospital and 30 healthy children who came to our hospital for physical examination were selected as the research subjects, and divided into the severe group (severe pneumonia) and the mild group (mild pneumonia), each 30 cases, and 30 healthy children were set as control group. The serum vitamin D level was observed and detected, and its correlation with humoral and cellular immune indicators were analyzed. Remarkably better results was observed in the control group than the other groups in terms of rate of serum vitamin D deficiency, humoral immunity indexes, cellular immune indexes, the CRP index and the IL-6 index (all $p<0.05$). Vitamin D expression is positively correlated with immune indexes. There is a certain correlation between serum vitamin D expression and immune indicators. Insufficient serum vitamin D expression gives rise to decreased immune function indicators. Taken together, early detection of children's vitamin D indicators is conducive to understand the severity of the child's condition, and beneficial for the later treatment as well.

Keywords: Pneumonia, vitamin D expression, immune index changes, correlation.

INTRODUCTION

Pediatric pneumonia, a common disease of the respiratory system, refers to the inflammation of the lungs caused by bacterial invasion or infection (Lapi *et al*., 2019; Li *et al*., 2019). The principal presentations are cough, fever, and fine wet rales, or even difficulty breathing, pale complexion, and rapid heart rate in severe cases. In absence of prompt treatment, complications such as heart failure, high fever, empyema, etc. may arise, severely threatening life safety of children (Dondo *et al*., 2019; Sharma-Kuinkel *et al*., 2019; Cohen *et al*., 2019). As a leading cause of disease-related death, pediatric pneumonia attacks all year round and frequently seen in the cold season in northern China or when the climate changes suddenly. Generally, children grow faster and have higher calcium requirements than adults, and the intake of vitamin D is from diet and ultraviolet light. Insufficient drinking water and lack of outdoor activities in children will result in insufficient vitamin D intake, which will weaken the immunity of children and increase the probability of respiratory diseases (Ashraf *et al*., 2019; Bhuiyan *et al*., 2019; Bitar *et al*., 2019). The improvement of medical technology in recent years, considerable achievements have been obtained in treating pneumonia in children. Additionally, some scholars believe that the severity of the disease children with pneumonia is related to expression of serum vitamin D. Therefore, for further explore correlation between serum vitamin D expression and changes in immune indicators in children with pneumonia, this study was conducted by selecting 60 children with pneumonia admitted of hospital between January 2019 and January 2020 and 30 healthy children who came to our hospital same period physical examination was taken as the research object. The results are shown below.

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MATERIALS AND METHODS

General information

A retrospective analysis was conducted on 60 children with pneumonia admitted to local hospital between January 2019 and January 2020, and 30 healthy children who came to our hospital for physical examination during the same period.

Inclusion criteria

(1) Met the diagnostic criteria for children with pneumonia; (1) Complete clinical data; (1) The study was conducted with the permission of the hospital ethics committee, and the children's family members informed consent to the purpose and process of the study.

Exclusion criteria

(1) Congenital heart disease; (2) Recent infection; (3) Immune system diseases.

Methods

A routine inspection was performed on all research subjects and the children's information were documented on file. After admission, 5mL of fasting venous blood was collected in the early morning, centrifuged, and isolated; then, the supernatant was obtained and all serum samples

were placed at -80℃ and the enzyme-linked immunoassay (ELISA) kit (manufacturer: Absen Biotech Co., Ltd.) instructions was used to determine the serum vitamin D in the sample; simultaneously, ethylenediaminetetraacetic acid was used to anticoagulate the 2mL sample, and the flow cytometer (manufacturer: Beckman Coulter Co., Ltd., USA ; Model CytoFLEX) was used to detect CD3, CD4, CD8, CD4/8 in T lymphocyte subsets; next, immunoscattering turbidimetric method was used to detect IgA, IgG, IgM in 1mL serum sample, all operations were performed in accordance with the reagent operating procedures; finally, the CRP and IL-6 of serum inflammatory factors of the three groups of children was determined, analyzed and compared.

Outcome measures

The serum vitamin D indicators of the three groups of subjects were determined. Normal is considered if the child's serum vitamin D index is greater than 20ng/mL; insufficient is deemed if the child's serum vitamin D index is 15ng/mL-20ng/mL; deficient is considered if the child's serum vitamin D index is <15ng/mL. The CRP and IL-6 of the three groups of subjects were analyzed and compared. The changes of vitamin D index and immune index were analyzed and compared.

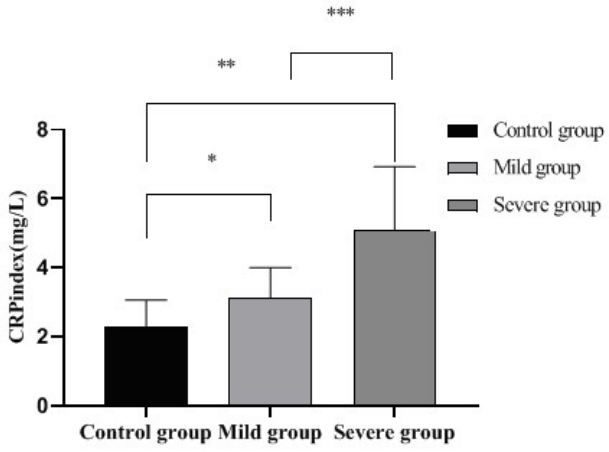
STATISTICAL ANALYSIS

All data analysis was performed by SPSS20.0, GraphPad prism 8.0 software was used for graphic plotting. X2 test, t test and normality test were used to test the count data and measurement data. The p value <0.05 was significant.

RESULTS

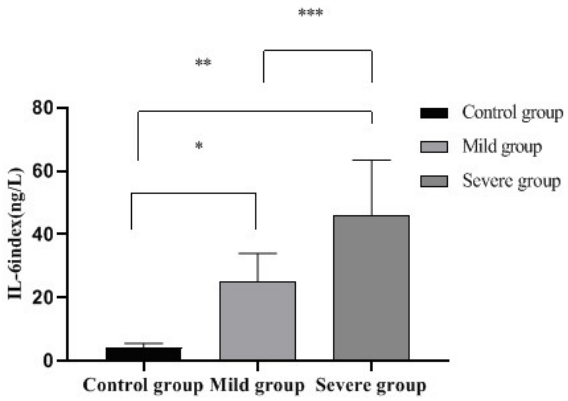
Baseline data

There was no difference in relevant data among the three groups (p>0.05), as shown in table 1.



Note: The abscissa represents the control group, the mild group, and the severe group, and the ordinate represents the CRP index, mg/L;
The CRP of the control group was (2.31±0.75) mg/L;
The CRP of the mild group was (3.12±0.89) mg/L;
The CRP of the severe group was (5.08±1.85) mg/L;
*indicates that there is a significant difference in CRP between the mild group and the control group (t=3.812, p=0.000);
**indicates that there is a significant difference in CRP between the severely ill group and the control group (t=7.600, p=0.000);
***indicates that there is a significant difference in CRP between the mild group and the severe group (t=5.229, p=0.000).

Fig. 1: Comparison of CRP indicators of the three groups (x±s)



Note: The abscissa represents the control group, the mild group, and the severe group, and the ordinate represents the IL-6 index, ng/L;
The IL-6 of the control group was (4.35±1.23) mg/L;
The IL-6 of the mild group was (25.24±8.72) mg/L;
The IL-6 of the severe group was (46.23±17.25) mg/L;
*indicates that there is a significant difference in IL-6 between the mild group and the control group (t=12.993, p=0.000);
**indicates that there is a significant difference in IL-6 between the severe group and the control group (t=13.264, p=0.000);
*** indicates that there is a significant difference in IL-6 between the mild group and the severe group (t=5.948, p=0.000).

Fig. 2: Comparison of IL-6 among the three groups (x±s)

Comparison of serum vitamin D

Remarkably lower rate of serum vitamin D deficiency in mild group than control group was witnessed (p<0.05); similarly, severe group was more lower than other patients (p<0.05). See table 2.

Comparison of serum vitamin D and humoral immune indexes

As compared of control group, mild group obtained a observably lower humoral immunity indexes (p<0.05), and similar result was observed of severe group (p<0.05). See table 3.

Comparison of serum vitamin D indexes and cellular immune indexes

Table 4 shows that he cellular immune indexes of mild group weremore lower than another group (p<0.05), and a similar trend was witnessed in the severe group (p<0.05).

Table 1: Comparison of general information

	Mild group (n=30)	Severe group (n=30)	Control group (n=30)	x^2 or t	*p*
Age (years)				0.230	0.819
	6.11±1.25	6.21±0.93	6.15±1.23		
Height (cm)				0.142	0.888
	116.67±0.38	116.65±0.35	116.66±0.36		
BMI(kg/m^2)				0.422	0.679
	11.23±0.32	11.25±0.31	11.28±0.29		
Gender				0.150	0.717
Male	21(70.00	20(66.67)	19(63.33)		
Female	9(30.00)	10(33.33)	11(36.67)		
Residence				0.317	0.853
Township	20(66.67)	21(70.00)	22(73.33)		
Rural area	10(33.33)	9(30.00)	8(26.67)		

Table 2: Comparison of serum vitamin D indicators [n(%)]

Groups	N	Normal	Insufficient	Deficient
Control group	30	93.33% (28/30)	3.33% (1/30)	3.33% (1/30)
Mild group	30	60.00% (18/30)	16.67% (5/30)	23.33% (7/30)[a]
Severe group	30	36.67% (11/30)	13.33% (4/30)	50.00% (15/30)[bc]

Note: a indicates that there is a significant difference in serum vitamin D between the mild group and the control group (x^2=5.192, *p*=0.023); b indicates that there is a significant difference in serum vitamin D between the severe group and the control group (x^2= 16.705, *p*=0.000); C indicates that there is a significant difference in serum vitamin D between the severe group and the mild group (x^2=4.593, *p*=0.032).

Table 3: Comparison of serum vitamin D and humoral immune indexes of three groups (x±s)

Groups	N	Vitamin D (ng/mL)	IgA (g/L)	IgG (g/L)	IgM (g/L)
Control group	30	59.66±5.99	1.45±0.11	12.11±0.43	1.99±0.12
Mild group	30	28.27±4.22[a]	0.79±0.06[c]	8.01±0.45[e]	1.37±0.06[g]
Severe group	30	21.11±3.15[b]	0.43±0.02[d]	5.23±0.32[f]	0.81±0.02[h]

Note: a indicates that there is a significant difference in serum vitamin D between the mild group and the control group (t=23.465, *p*=0.000); b indicates that there is a significant difference in serum vitamin D between the severe group and the control group (t=31.199, *p*=0.000); c indicates that there is a significant difference in IgA between the mild group and the control group (t=28.851, *p*=0.000); d indicates that there is a significant difference in IgA between the severe group and the control group (t=49.969, *p*=0.000); e indicates that there is a significant difference in IgG between the mild group and the control group (t=36.079, *p*=0.000); f indicates that there is a significant difference in IgG between the severe group and the control group (t=69.385, *p*= 0.000); g indicates that there is a significant difference in IgM between the mild group and the control group (t=25.311, *p*=0.000); h indicates that there is a significant difference in IgM between the severe group and the control group (t=52.127, *p*=0.000).

Table 4: Comparison of serum vitamin D and cellular immune indexes (x±s)

Groups	N	Vitamin D(ng/mL)	CD3(%)	CD4(%)	CD8(%)	CD4/8(%)
Control group	30	59.66±5.99	69.12±2.15	41.11±1.21	22.89±0.91	1.93±0.13
Mild group	30	28.27±4.22	56.93±1.88[a]	33.24±1.13[c]	26.21±1.41[e]	1.37±0.08[g]
Severe group	30	21.11±3.15	49.27±1.79[b]	24.26±1.01[d]	33.43±1.85[f]	0.72±0.03[h]

Note: a indicates that there is a significant difference in CD3 between the mild group and the control group (t=23.377, *p*=0.000); b indicates that there is a significant difference in CD3 between the severe group and the control group (t=38.863, *p*=0.000) ; C indicates that there is a significant difference in CD4 between the mild group and the control group (t=26.036, *p*=0.000); d indicates that there is a significant difference in CD4 between the severe group and the control group (t=58.555, *p*=0.000); e indicates that there is a significant difference in CD8 between the mild group and the control group (t=10.836, *p*=0.000); f indicates that there is a significant difference in CD8 between the severe group and the control group (t=28.001, *p*=0.000); g Indicates that there is a significant difference in the CD4/8 between the mild group and the control group (t=20.094, *p*=0.000); h indicates that there is a significant difference in the CD4/8 between the severe group and the control group (t=49.675, *p*=0.000).

Comparison of CRP indicators

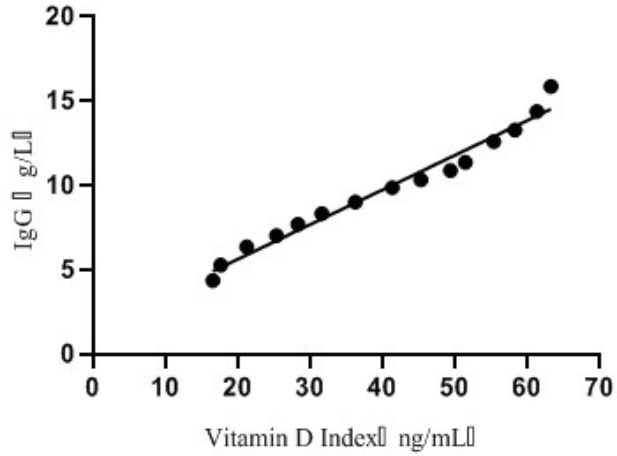
As shown in fig. 1, the CRP index was higher in the mild group (p<0.05) and a resemble result occurred in the severe group (p<0.05).

Comparison of IL-6 indicators

The IL-6 index of the mild group was significantly higher (p<0.05) and the IL-6 index of severe group was more higher than that of other group (p<0.05), as shown in fig. 2.

Correlation analysis of vitamin D expression and immune indicators

Vitamin D expression is positively correlated with immune indexes. If vitamin D indexes are insufficient, the immune indexes decreases, as shown in fig. 3.



Note: The abscissa indicates the IgG index and the ordinate indicates the Vitamin D index.

Fig. 3: Correlation analysis of vitamin D expression and immune indicators (x±s)

DISCUSSION

Pneumonia, a common childhood respiratory system disease, of major contributory factor of high disease incidence and mortality (Yamashita *et al*., 2019; Cappell *et al*., 2018). Clinical studies have found that the pathogenic factors of pneumonia are related to mycoplasma, bacteria and viruses and delayed treatment of colds and coughs would result in pneumonia (van *et al*., 2019; Bae *et al*., 2019; Petraitis *et al*., 2019). Additionally, specific research shows that the level of vitamin D is low in children would weaken immune function, thereby increasing the risk of pneumonia in children. It would even give rise to symptoms such as purulent lesions in severe cases, severely undermining the growth and psychological development of children (Pulavendran *et al*., 2019; Glick *et al*., 2019; Niedzwiecka *et al*., 2019). Therefore, early detection of children's vitamin D levels play a critical role in effectively assessing the children's condition, preventing the occurrence of the disease and inhibiting development of disease. Moreover, the occurrence of pneumonia is related to immune function of the children, and the immune function of the children is related to the level of vitamin D. As is known, vitamin D, mainly from ultraviolet light and dietary intake, can not only remove pathogenic bacteria from the human body and enhance the body's resistance, but serves as an essential nutrient for the growth and development of children (Lau *et al*., 2019; Pervaiz *et al*., 2019; Greiller *et al*., 2019). The main role of vitamin D is to regulate the metabolism of phosphorus and calcium in the body of children, maintain blood phosphorus and calcium levels, and ensure the normal growth and development of bones and teeth. Vitamin D in children's body mainly regulates various physiological functions by promoting the absorption of calcium. Vitamin D exists in the activated form of 1,25-dihydroxyvitamin D3 after being activated by the liver and kidney, and binds to the receptor to play a role in regulating calcium and phosphorus. However, due to the unstable concentration of 1,25-dihydroxyvitamin D3 in the circulation and short half-life, it is difficult to determine. Encouragingly, its precursor 25-dihydroxyvitamin D3 can be considered a stable indicator that accurately reflects the nutritional status of vitamin D owing to its long half-life in the blood and stable performance (Yu *et al*., 2019; Kwan *et al*., 2019)

Kotlarz *et al*., 2019). In this study, the serum vitamin D indicators of the three groups were compared and it was found that the number of children with vitamin D deficiency in mild and severe group was significantly higher than that in the control group, fully suggesting that the vitamin D index level is associated with the severity of disease.

Vitamin D has a positive effect on the adjustment of immune system of the human body. Its deficiency can cause disorders of the immune system and calcium and phosphorus metabolism, leading to a decline in resistance and the occurrence of a variety of infectious diseases (Khan *et al*., 2019; Xu *et al*., 2019). Prior studies have demonstrated that vitamin D can inhibit the phagocytic function of macrophages and reduce the secretion of inflammatory factors, exerting an anti-inflammatory effect, and further killing pathogenic microorganisms. If children are lack of vitamin D, it will inhibit the differentiation and proliferation of B cells, thereby reducing the body's immune function. This study showed that IgA, IgG and IgM were lower in mild and severe groups, which was similar to results of the study by Kalyan *et al*. (2019) who revealed that the IgA, IgG, and IgM of study groups A and B were (0.80±0.05) g/L, (8.07±0.44)g/L, (1.45±0.07) g/L, (0.48±0.05)g/L, (5.69±0.34)g/L, (0.98±0.05) g/L, respectively, significantly lower than the control group (1.47±0.10)g/L, (11.07±0.41)g/L, (1.97±0.10)g/L, indicating that the

expression of serum vitamin D in children with pneumonia is correlated with immune indicators. Furthermore, with the decrease of serum vitamin D expression, the immune index of the child is gradually reduced, and the lack of vitamin D index will inhibit the immune function of the child, thereby further aggravating the disease of the child.

CONCLUSION

To sum up, there is a certain correlation between serum vitamin D expression and immune indicators. Insufficient serum vitamin D expression gives rise to decreased immune function indicators. Taken together, early detection of children's vitamin D indicators is conducive to understand the severity of the child's condition and beneficial for the later treatment as well.

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