

## **Clinical treatment of severe pneumonia complicated with heart failure in children.**

Huiqing Wang<sup>1,2\*</sup>, Fengyan Zhao<sup>1,2</sup>, Weijia Liu<sup>1,2</sup>

<sup>1</sup>Department of Pediatrics, West China Second University Hospital, Sichuan University, Chengdu, PR China

<sup>2</sup>Key Laboratory of Birth Defects and Related Diseases of Women and Children, Sichuan University, Ministry of Education, Chengdu, PR China

### **Abstract**

**Objective:** This study aimed to investigate the clinical curative effects of dopamine and phentolamine on severe pneumonia complicated with heart failure in children.

**Methods:** Fifty-eight children with severe pneumonia complicated with heart failure were selected as research objects. All of the patients were randomly divided into two groups, namely, control group (n=29) and observation group (n=29). The children in the control group were treated with dopamine, whereas the children in the observation group were administered with phentolamine based on the treatment in the control group. Clinical curative effects, time of improvement in clinical signs and changes in cardiac function before and after the treatment in both groups were observed and compared.

**Results:** The total effective rate of the clinical treatment in children in the observation group was 96.55% which was significantly higher than that in the control group (68.96%). After the treatment was administered, the Heart Rate (HR), left ventricular end-diastolic diameter and left ventricular ejection fraction of the children were  $119 \pm 6$  times/min,  $32 \pm 3$  mm and  $73\% \pm 10\%$  in the observation group and  $136 \pm 9$  times/min,  $38 \pm 4$  mm and  $58\% \pm 10\%$  in the control group, respectively. After the treatment was given, the HR of the children in the observation group decreased significantly, the left ventricular end-diastolic diameter reduced and the left ventricular pumping ability significantly increased. The stable breathing time, disappearance time of pulmonary rales, time of improvement in HR, liver retraction time and hospitalisation time of children were  $1.3 \pm 0.6$ ,  $8.1 \pm 1.6$ ,  $1.7 \pm 0.5$ ,  $2.1 \pm 1.2$  and  $10.1 \pm 2.3$  d in the observation group and  $2.5 \pm 0.4$ ,  $11.6 \pm 1.5$ ,  $2.7 \pm 0.5$ ,  $3.6 \pm 1.2$  and  $14.3 \pm 2.8$  d in the control group, respectively. The time of improvement in each clinical sign in the observation group was significantly shorter than that in the control group.

**Conclusion:** The clinical curative effect of dopamine combined with phentolamine in the treatment of severe pneumonia complicated with heart failure in children is clear and can significantly improve the cardiac function, enhance the left ventricular pumping ability and reduce the HR and left ventricular end-diastolic diameter of children. Thus, this effect can shorten the time of improvement in clinical signs of children. It can also reduce the hospitalisation time of children. Consequently, the suffering of children and the economic burden against children and their family members can be considerably alleviated. Thus, the effect has a high clinical application value.

**Keywords:** Children, Severe pneumonia, Heart failure, Changes in cardiac function.

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### **Introduction**

Paediatric pneumonia is a clinically common lung disease that often occurs in the alteration period of winter and spring with an apparent seasonal characteristic. It is also one of the most important causes of death of infants and children [1]. When children manifest symptoms of pneumonia, the disease becomes aggravated if no timely treatment is provided, leading to severe pneumonia that seriously affects children's physical health, physical and mental development and vital signs. Clinically, children with severe pneumonia suffer from

hypopnoea, nasal flaring, three concave signs, nodding-like breathing, grey complexion, vomiting, diarrhoea, disturbance of water and electrolyte balance, positive occult blood, abdominal distension, disappearance of bowel sounds, restlessness, lethargy, convulsions and other clinical symptoms; these children also likely suffer from myocarditis and heart failure, seriously threatening their lives [2]. When heart failure complications occur in children, the Heart Rate (HR) reaches more than 160 times per minute, accompanied with frequent crying, sweating and oliguria, severely affecting the physical health of children. Effective drugs help promote

the clinical curative effect on children with severe pneumonia complicated with heart failure [3]. In our study, two kinds of drug therapies were compared, and their clinical curative effects on children admitted to our hospital were observed. Changes in vital signs before and after treatment and their clinical curative effects on patients in both groups were also compared.

## Data and Methods

### Basic data

Fifty-eight children with severe pneumonia complicated with heart failure treated in the Paediatric Department of our hospital from September 2016 to May 2017 were selected as research objects and randomly divided into two groups. Each group comprises 29 cases. Of the 58 children, 33 were males and 25 were females, and their age was 0.3-3.4 y (average age of  $1.8 \pm 0.7$  y). Furthermore, 37 cases of congenital heart disease and 22 cases of anaemia were involved in this study. Patients were included if they satisfied the following inclusion criteria: 1) patients with significant heart and lung enlargement revealed by X-ray examination; 2) patients meeting the diagnostic criteria for severe pneumonia indicated by clinical examination and clinically manifesting symptoms in line with the typical characteristics of severe pneumonia complicated with heart failure in children; 3) patients with a HR of 170 times/min and polypnoea of up to 55 times/min; 4) patients whose guardians voluntarily signed the informed consent; and 5) patients with significant moist rales and cardiac murmur *via* lung auscultation [4]. Patients were excluded if they satisfied the following criteria: 1) patients with severe liver or kidney dysfunction and 2) patients whose guardians did not sign the informed consent. In the control group, 17 were males and 12 were females, and their age was 0.4-3.4 y with an average age of  $1.9 \pm 0.5$  y. Moreover, 18 cases of congenital heart disease and 11 cases of anaemia were included. In the observation group, 16 were males and 13 were females, and their age was 0.3-3.1 y with an average age of  $1.4 \pm 0.9$  y. In addition, 15 cases of congenital heart disease and 11 cases of anaemia were considered. The two groups of children did not significantly differ in terms of gender, age and causes of heart failure ( $P > 0.05$ ), and data were comparable.

### Methods

All of the patients received conventional treatments, such as diuretics, digitalis, sedation, anti-infection, oxygen uptake, anti-asthma, anti-phlegm, anti-cough and antibiotics, including lincomycin or erythromycin for patients with allergic pneumonia, penicillin for patients with bacterial pneumonia and acyclovir or ribavirin for patients with viral pneumonia.

The control group was treated with an intravenous drip of 3–5  $\mu\text{g}/(\text{kg}\cdot\text{min})$  dopamine hydrochloride (Asikeding, NMPN H20040213, 2011-03-28, Jilin Sihuan Pharmaceutical Co., Ltd., China) dissolved in 10% glucose solution for 2 h. According to the patients' conditions, the treatment was

provided 1-3 times a day, and 3 days was considered one treatment course [5].

Based on the treatment in the control group, the observation group was given an intravenous drip of 1.5-2.5  $\mu\text{g}/(\text{kg}\cdot\text{min})$  phentolamine mesilate (NMPN H32020439, 2010-09-30, Jiangsu Bikang Pharmaceutical Co., Ltd., China) dissolved in 10% glucose solution for 2 h. According to the patients' conditions, the treatment was administered 1-3 times a day, and 3 d was set as one treatment course [6].

### Observation indexes

1. Clinical treatment effects were described according to the following characteristics: remarkably effective when cough, fever and other symptoms completely disappeared; effective when cough, fever and other symptoms were significantly alleviated; and ineffective when no change occurred or when clinical symptoms became aggravated. The total effective rate was calculated as follows: total effective rate = remarkably effective + effective.
2. Changes in cardiac function included HR per minute, left ventricular end-diastolic diameter and left ventricular ejection fraction.
3. The time of improvement in clinical signs was indicated by stable breathing time, disappearance time of pulmonary rales, time of improvement in HR, liver retraction time and hospitalisation time.

### Statistical analysis

Data were statistically analysed using SPSS 15.0. Measurement data were presented as  $\bar{x} \pm s$ , and t-test was performed. Enumeration data were presented as percentage (%), and Chi-square test was used.  $P < 0.05$  was considered statistically significant.

## Results

### Comparison of clinical treatment effects between the two groups

The total effective rate of the clinical treatment in the observation group was significantly higher than that in the control group ( $P < 0.05$ , Table 1).

**Table 1.** Comparison of total effective rate of clinic treatment between two groups of child patients (n (%)).

Group	N	Remarkably effective	Effective	Ineffective	Total rate
Observation group	29	20 (68.97)	8 (27.58)	1 (3.45)	96.55
Control group	29	15 (51.72)	5 (17.24)	9 (31.04)	68.96
$\chi^2$	--	--	--	--	7.733

P	--	--	--	--	<0.05
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**Comparison of changes in cardiac functions between the two groups before and after treatment**

No significant differences were found in the changes in cardiac functions between the two groups of patients before treatment

(P>0.05). The HR per minute, left ventricular end-diastolic diameter and left ventricular ejection fraction in the observation group were significantly superior to those in the control group after treatment (P<0.05, Table 2).

**Table 2.** Comparisons of changes in cardiac functions between two groups of child patients before and after treatment ( $\bar{x} \pm s$ ).

Group	N	Before treatment			After treatment		
		HR (time/min)	Left ventricular end-diastolic diameter (mm)	Left ventricular ejection fraction (%)	HR (time/min)	Left ventricular end-diastolic diameter (mm)	Left ventricular ejection fraction (%)
Observation group	29	(176 ± 22)	(43 ± 2)	(47 ± 11)	(119 ± 6)	(32 ± 3)	(73 ± 10)
Control group	29	(181 ± 19)	(41 ± 5)	(46 ± 12)	(136 ± 9)	(38 ± 4)	(58 ± 10)
t	-	0.769	1.661	0.274	7.029	5.367	4.743
P	-	>0.05	>0.05	>0.05	<0.05	<0.05	<0.05

**Comparison of the improvement time of clinical signs between two groups**

The stable breathing time, disappearance time of pulmonary rales, time of improvement in HR, liver retraction time and

hospitalisation time of the patients in the observation group were significantly shorter than those in the control group (P<0.05, Table 3).

**Table 3.** Comparison of improvement time of clinical signs between two groups of child patients ( $\bar{x} \pm s$ ).

Group	N	Stable breathing (d)	Disappearance of pulmonary rales (d)	Improvement in HR (d)	Liver retraction (d)	Hospitalization (d)
Observation group	29	(1.3 ± 0.6)	(8.1 ± 1.6)	(1.7 ± 0.5)	(2.1 ± 1.2)	(10.1 ± 2.3)
Control group	29	(2.5 ± 0.4)	(11.6 ± 1.5)	(2.7 ± 0.5)	(3.6 ± 1.2)	(14.3 ± 2.8)
t	--	7.442	7.137	6.325	3.953	5.184
P	--	<0.05	<0.05	<0.05	<0.05	<0.05

**Discussion**

Paediatric pneumonia is a common lung disease. According to different causes, paediatric pneumonia can be divided into mycoplasma pneumonia, chlamydial pneumonia, viral pneumonia, fungal pneumonia and bacterial pneumonia, and the common sources of infection are influenza virus, measles virus, adenovirus, *Aspergillus*, *Pneumocystis carinii*, *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Haemophilus influenzae* [7]. Severe pneumonia in children develops from paediatric pneumonia because of various factors that cause serious damage to the circulatory, respiratory, nervous and digestive systems of children. Moreover, severe pneumonia leads to a series of diseases, thereby affecting the growth and threatening the life of patients. According to the statistics of the Ministry of Health of China, severe pneumonia, as one of the four major diseases that should be prevented and treated in children, leads to the most number of deaths of hospitalised patients in China. Furthermore, paediatric patients with pneumonia suffer from significant hypoxia at onset, resulting in poor internal energy metabolism and electrolyte

imbalance. During this time, the body organs of children are adversely affected, leading to heart failure and multiple illnesses that not only exacerbate treatment difficulties but also cause considerable damage to the body of patients. As a consequence, their lives are at risk. Severe pneumonia complicated with heart failure in children should be treated rapidly and timely. Abadesso [8] argued that pulmonary infection should be controlled first in the treatment of severe pneumonia complicated with heart failure in children to avoid the increase in scope of infection and reduce the cardiac burden, thereby enhancing myocardial tolerance in hypoxia, maintaining the normal metabolism of myocardial cells and improving the myocardial function in patients. This treatment should be based on cardiogenic and diuretic therapy and electrolyte balance maintenance. Thus, cardiac function in children can be effectively improved, and the survival rate of patients can be increased.

In this study, some patients with severe pneumonia complicated by heart failure were treated with dopamine combined with phentolamine, and the results indicated that the

total effective rate of clinical treatment in the observation group was significantly higher than that in the control group. The changes in cardiac indexes before and after treatment in the observation group were also significantly superior to those in the control group, and the time of improvement in clinical signs in the observation group was significantly shorter than that in the control group. These findings were observed possibly because dopamine hydrochloride is a dopamine receptor agonist, whereas dopamine is a neurotransmitter that conducts the pulse of chemical substances among human cells. When dopamine hydrochloride enters the human body, it quickly synthesises norepinephrine and epinephrine precursors that can excite adrenergic  $\alpha$  and  $\beta$  receptors, thereby affecting the ganglia and central and peripheral sympathetic nerves in the body, stimulating dopamine, exciting the heart, enhancing cardiac contractility and increasing myocardial output. As a result, the clinical symptoms of heart failure in children are alleviated. Dopamine hydrochloride can also cause renal vasodilation, improve renal function and increase the glomerular filtration rate and renal blood flow. Consequently, urine output increases and electricity–water balance in the body becomes regulated. However, pharmacokinetics has shown that dopamine, despite of its rapid onset, quickly degrades into an inactive compound *via* catechol methyltransferase and monoamine oxidase after this neurotransmitter, whose half-life period is about 1-2 min with a short onset time, is intravenously infused into the human body [9]. Therefore, dopamine should be continuously administered to treat paediatric patients with heart failure. However, the long-term application of dopamine hydrochloride easily produces drug resistance and affects the action of drugs, thereby reducing their clinical efficacy.

Based on the application of dopamine in the treatment of children with severe pneumonia complicated with heart failure, the combined application of phentolamine can significantly alleviate these conditions. Phentolamine, also known as regitine, is a competitive and nonselective  $\alpha_1$  and  $\alpha_2$  receptor blocker that can reduce the contraction of epinephrine on human blood vessels by blocking the  $\alpha_2$  receptor. This blocker can also enhance the contractile force and rate of human myocardium by increasing the release of norepinephrine from neurons. Therefore, phentolamine can significantly improve the side effects of dopamine, reduce the drug resistance of the human body, dilate blood vessels and increase the speed of blood circulation. Moreover, pharmacokinetics has revealed that phentolamine has a rapid onset of action, that is, it can rapidly affect the body within 30 min after it is intravenously injected, but it can quickly lose its efficacy within several minutes after the onset of action. Phentolamine, as a drug widely used for the treatment of cardiovascular diseases, does not harm the human body. Therefore, the combined application of dopamine and phentolamine for the treatment of severe pneumonia complicated with heart failure in children can significantly improve the effective rate of clinical treatment, reduce the HR and left ventricular end-diastolic diameter and enhance the left ventricular pumping ability in paediatric

patients. These drugs also considerably help shorten the time of improvement in clinical signs [10].

During clinical treatment, doctors should notice that their patients are infants and children. As special groups of patients, infants and children have incomplete physical development, low immunity and incomplete bone and organ development. Thus, infants and children are prone to problems in the presence of stimuli. Therefore, we should focus on the individual conditions of infants and children during treatment and avoid the application of cough medicine to prevent the development of phlegm or irritating cough. Moreover, health care practitioners should note the oxygen concentration in oxygen inhalation for children and strictly control the time of oxygen inhalation. They should also accompany their patients during the whole process. Once abnormal symptoms occur, patients should receive emergency treatment to avoid high-concentration oxygen in retinal blood vessels and prevent retinopathy. In cooling therapy, alcohol wipe should not be used to reduce their body temperature and thus prevent the absorption of alcohol through their skin, resulting in alcoholism.

In conclusion, the clinical curative effect of dopamine combined with phentolamine on severe pneumonia complicated with heart failure in children is significant. This treatment shortens the time of improvement in the clinical signs of these children. In addition, this treatment reduces not only the pain of patients but also the economic burden of their families. Thus, dopamine combined with phentolamine has a high clinical promotion value.

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**\*Correspondence to**

Huiqing Wang

Department of Pediatrics

West China Second University Hospital

Sichuan University

PR China