Clinical assessment of low dose of dopamine combined with dobutamine and conventional treatment on children with severe pneumonia

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ABSTRACT

Objective: To analyze the clinical effect of low dose of dopamine combined with dobutamine combined with conventional treatment of severe pneumonia in children. Methods: A total of 218 cases of children with severe pneumonia treated in our hospital from August 2011 to May 2014 were enrolled for study and divide into observation group and control group according to different treatment methods. Control group received conventional treatment, observation group received low dose of dopamine combined with dobutamine combined with conventional treatment, and then differences in symptomatic relief time, blood gas indexes, inflammatory factor levels and pulmonary surfactant protein levels between two groups were compared. Results: Time that temperature subsided, time that difficulty in breathing was relieved, time that heart rate returned to normal and time that pulmonary rale disappeared of observation group after treatment were all shorter than those of control group; 3 d and 7 d after treatment, PaO2 and HCO3 levels in arterial blood of observation group were higher than those of control group, and PaCO2 level was lower than that of control group; serum IL-1β, IL-6, TNF-α, sICAM-1 and CRP levels of observation group 7 d after treatment were lower than those of control group at the same period, and IL-10 level was higher than that of control group; 7 d, 10 d and 14 d after treatment, serum SP-A, SP-B, SP-C and SP-D levels of observation group were significantly lower than those of control group. Conclusion: Adding low dose of dopamine and dobutamine to treatment of children with severe pneumonia can promote the improvement of clinical symptoms, reduce systemic inflammation, optimize pulmonary ventilation and aeration function while reduce lung parenchyma damage, and it has active clinical significance.

1. Introduction

Severe pneumonia in children belongs to pediatric severe disease with high incidence of complications in heart, liver, kidney and other vital visceral organs and also high case fatality rate, and it has huge blow to both children and their families. The curative effect of conventional antibiotic therapy for children with severe pneumonia is limited, and clinical scholars recommend the combined use of dopamine and dobutamine for its treatment at present[1]. Dopamine belongs to endogenous catecholamine drug, and application of low dose can excite respiratory centre and improve body’s hypoxia state. Dobutamine belongs to dopamine homologue, it selectively acts on β1 receptor, and it has weak effect or even no effect at all on β2, α and dopamine receptors[2]. Application of low dose of dobutamine helps improve peripheral circulation resistance and optimize pulmonary aeration function, and it has active significance in reducing cardiac stress. In the research, children with severe pneumonia were selected as research subjects, the curative effect of low dose of dopamine combined with dobutamine was the research emphasis, and detailed analysis was as follows.
2. Information and methods

2.1. General information

218 cases of children with severe pneumonia treated in our hospital from August 2011 to May 2014 were enrolled for study, the treatment they received was retrospectively analyzed, and they were divided into control group 117 cases who received conventional treatment and treatment group 101 who received low dose of dopamine combined with dobutamine combined with conventional treatment. Control group included 50 male cases and 51 female cases, they were 8 months - 9 years old, the average age was (4±1) years, the course of disease was 1-7 d and the average course of disease was (3±1) d; observation group included 61 male cases and 56 female cases, they were 6 months-8 years old, the average age was (5±1) years, the course of disease is 1-9 d and the average course of disease was (4±2) d. Differences in gender, age, course of disease and other general information between two groups were not significant, P>0.05 and they were comparable.

2.2. Treatment methods

Control group received conventional treatment: intravenous drip of cephalosporin antibiotics, acyclovir and other antiviral drugs, and switching to other drugs with similar intensity of drug effect if there was allergy. At the same time, related clinical symptoms were actively treated, those with severe panting received low flow oxygen uptake, those with severe toxicity symptoms received oral administration of glucocorticoid 0.2 mg/(kg·d), and water-electrolyte imbalance was also corrected.

Based on conventional treatment, observation group received low dose of dopamine and dobutamine: dopamine and dobutamine 2 μ g/kg was diluted and slowly intravenously injected via minipump, injecting for 4-6 h every day and a total of 3-5 d. Conventional treatment program was the same as that of control group.

2.3 Observation indexes

Improvement of related clinical symptoms of both groups was recorded, including the time that temperature subsided, time that heart rate returned to normal and time that pulmonary rale disappeared.

Before treatment as well as 3 d and 7 d after treatment, arterial blood was drawn from patients to detect blood gas indexes, including partial pressure of oxygen (PaO2), partial pressure of carbon dioxide (PaCO2) and sodium bicarbonate (HCO3-) levels.

7 days after treatment, 5mL of peripheral venous blood was drawn from children in the morning and then centrifuged for 10 min with 3 000 r/min to get upper serum. Immunoturbidimetric assay was used to detect serum C-reactive protein (CRP) level. Enzyme-linked immunosorbent assay (ELISA) was used to detect levels of serum inflammatory factors, including interleukin-1β (IL-1β), interleukin-6 (IL-6), interleukin-10 (IL-10), tumor necrosis factor-α (TNF-α) and soluble intercellular adhesion molecule-1 (sICAM-1).

2.4 Statistical methods

Statistical software SPSS 23.0 was used to analyze data in the research, measurement data among groups was by variance analysis and P<0.05 was set as the standard of statistical significance in differences.

3. Results

3.1. Symptomatic relief time

After different treatment, relief of related symptoms of both groups was recorded in real time. Comparison of body temperature, breathing, heart rate, lung auscultation and other clinical symptoms and signs between two groups showed that time that temperature subsided, time that difficulty in breathing was relieved, time that heart rate returned to normal and time that pulmonary rale disappeared of observation group after treatment were all shortened significantly, and compared with those of control group, there were statistical differences (P<0.05), shown in Figure 1.

3.2. Blood gas indexes

Arterial blood was collected to detect improvement of blood gas indexes of both groups after treatment, and specific manifestations were that before treatment, PaO2, PaCO2, and HCO3- levels in arterial blood of all children were without significant differences (P>0.05), 3 d and 7 d after treatment, PaO2 and HCO3- levels in arterial blood of observation group were higher than those of control group, and PaCO2 level was lower than that of control group (P<0.05), shown in Table 1.

Table 1

<table>
<thead>
<tr>
<th>Groups</th>
<th>Before treatment</th>
<th>3 d after treatment</th>
<th>7 d after treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PaO2 (kPa)</td>
<td>PaCO2 (kPa)</td>
<td>HCO3-(mmol/L)</td>
</tr>
<tr>
<td>Observation</td>
<td>6.37±0.54</td>
<td>7.51±0.69</td>
<td>17.05±1.32</td>
</tr>
<tr>
<td>Control</td>
<td>6.41±0.52</td>
<td>7.48±0.71</td>
<td>17.28±1.45</td>
</tr>
<tr>
<td>t</td>
<td>0.132</td>
<td>0.119</td>
<td>0.156</td>
</tr>
<tr>
<td>p</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
</tr>
<tr>
<td>P</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
<td>&gt;0.05</td>
</tr>
</tbody>
</table>

Figure 1. Clinical symptomatic relief time of two groups after treatment

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3.3. Inflammatory factor levels

After low dose of dopamine combined with dobutamine treatment, enzyme-linked immunosorbent assay (ELISA) was used to detect levels of serum inflammatory factors below, and results were as follows: serum IL-1β, IL-6, TNF-α, sICAM-1 and CRP levels of observation group 7 d after treatment were lower than those of control group at the same period, and IL-10 level was higher than that of control group (P<0.05), shown in Table 2.

3.4. Pulmonary surfactant protein levels

At different time (3 d, 7 d, 10 d and 14 d) after two groups received treatment, peripheral venous blood was drawn to detect pulmonary surfactant levels, and results showed that 3 d after treatment, serum SP-A, SP-B, SP-C and SP-D levels of observation group were lower than those of control group, but differences between groups were without statistical significance (P>0.05), and 7 d, 10 d and 14 d after treatment, serum SP-A, SP-B, SP-C and SP-D levels of observation group were significantly lower than those of control group (P<0.05), shown in Figure 2.

Table 2
Comparison of serum inflammatory factor levels between two groups after treatment

<table>
<thead>
<tr>
<th>Groups</th>
<th>IL-1β (pg/mL)</th>
<th>IL-6 (ng/L)</th>
<th>IL-10 (pg/mL)</th>
<th>TNF-α (ng/L)</th>
<th>sICAM-1 (pg/mL)</th>
<th>CRP (ng/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>1.21±0.13</td>
<td>9.23±0.76</td>
<td>34.82±2.77</td>
<td>42.18±3.92</td>
<td>6.92±0.59</td>
<td>12.77±1.89</td>
</tr>
<tr>
<td>Control</td>
<td>2.47±0.23</td>
<td>18.67±1.53</td>
<td>18.91±1.63</td>
<td>73.07±6.11</td>
<td>25.16±2.14</td>
<td>48.36±3.92</td>
</tr>
<tr>
<td>t</td>
<td>6.034</td>
<td>8.923</td>
<td>9.023</td>
<td>7.384</td>
<td>11.832</td>
<td>10.028</td>
</tr>
<tr>
<td>P</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

4. Discussion

Pneumonia in children is quite common in clinical practice, and children with serious infections and poor physical fitness may progress to severe pneumonia. Severe pneumonia is with long course of disease and serious illness, poses great threat to children’s health and needs active and effective clinical intervention. Studies have shown that the leading cause of death in severe pneumonia children under the age of 5 is complicated heart failure, and in view of limited efficacy of antibiotic treatment alone, adding vasodilator treatment becomes a whole new way to treat severe pneumonia[3,4].

A scholar has proposed the application of dopamine and dobutamine in treatment of children with severe pneumonia, dopamine is endogenous catecholamine and it exerts myocardial positive stress, enhances alveolar tension and increases renal and mesenteric blood flow through exciting dopamine receptor, α and β receptors[5]. Low dose of dopamine can also excite respiratory centre, inhibit cortical network structure and improve body’s hypoxia state. Dobutamine has similar effect to dopamine, and it has active effect on increasing myocardial contractility and stroke volume and expanding pulmonary and coronary blood flow. Low dose of dobutamine is not obvious in cardiovascular dilation, but can reduce peripheral resistance, increase pulmonary vascular resistance and reduce cardiac stress[6,7]. In the research, low dose of dopamine combined with dobutamine was used for treatment of children with severe pneumonia, and changes in symptomatic relief, blood gas index change as well as inflammatory factor and pulmonary surfactant protein levels were mainly studied.

Children with severe pneumonia are mostly manifested as high fever, difficulty in breathing, increased heart rate, pulmonary auscultation rale and so on, and the most intuitive manifestation of clinical therapeutic effectiveness is the relief of clinical symptoms. Above research results showed that time that temperature subsided, time that difficulty in breathing was relieved, time that heart rate returned to normal and time that pulmonary rale disappeared of observation group after treatment were all shortened, indicating that adding low dose of dopamine and dobutamine on the basis of conventional treatment could rapidly improve the clinical symptoms, promote disease recovery and significantly shorten course of disease,
and it embodied the effectiveness and superiority of combined treatment as a whole[8,9]. There is severe pulmonary ventilation and aeration dysfunction in children with severe pneumonia, which is manifested as significantly abnormal blood gas index values, such as reduced partial pressure of oxygen and increased partial pressure of carbon dioxide. In the research, PaO₂ and HCO₃ levels in arterial blood of observation group were higher and PaCO₂ level was lower after treatment, indicating that combined treatment improved difficult ventilation in children, relieved carbon dioxide accumulation and acidosis in the body, eventually effectively improved partial pressure of oxygen and reversed hypoxic performance in children.

C-reactive protein (CRP) is a typical acute phase protein, its content is less in normal human body, and in cases of trauma or inflammation, CRP level increases rapidly and is directly proportional to the severity of disease. Interleukin-6 (IL-6) can induce the liver to produce acute phase protein, enhance the body itself and damage inflammation[10]. TNF-α is one of the inflammatory factors earliest generated in the body after infection, its content is less in human body under physiological conditions, and in cases of inflammation, its level increases and can cause local immune response, organ injury and even system damage. Interleukin-10 (IL-10) is a cytokine with extensive immune effect, is a negative regulator, has strong immunosuppressive activity and can inhibit the generation and release of IL-2, TNF-α and pro-inflammatory factors[11,12].

Pulmonary surfactant is synthesized and secreted by type 2 alveolar epithelial cells (AEC-2), and contain 90% phospholipid as well as 10% SP-A, B, C and D. Pulmonary surfactant is closely related to bad lung status, lung injury and so on, and may strongly regulate pulmonary inflammation and immune function [13]. Gene polymorphism of SP-B is closely related to case fatality rate of ARDS, and SP-A and SP-D play important roles in host pulmonary local immunity, and can be combined with saccharide structure on pathogenic microorganism surface and promote macrophage uptake of pathogenic microorganism. Plasma SP-D level in patients with pneumonia is related to the severity, prognosis and so on of the disease in patients. Studies have shown that serum SP-A and SP-D levels in children with pandemic influenza H1N1 significantly increase, which might be caused when pathogen invades lung parenchyma, damages alveolar epithelial cells and surrounding capillaries and causes increased permeability of alveolar capillary, so SP content in bloodstream is one of the objective indicators to judge the severity of pulmonary diseases[14,15]. At present, the changes of pulmonary surfactant proteins in children with severe pneumonia are seldom studied, and in the research, pulmonary surfactant protein contents in blood of children at different time after treatment were detected. Above research results showed that serum SP-A, SP-B, SP-C and SP-D levels of observation group were lower after treatment, indicating that combined treatment could exert lung parenchyma protection effect and ultimately improve children’s lung function and promote disease recovery through enhancing body’s antiviral strength and reducing pathogen damage to lung tissue.

To sum up, it is concluded as follows: low dose of dopamine combined with dobutamine treatment for children with severe pneumonia can effectively improve clinical symptoms, reduce systemic inflammation, optimize pulmonary ventilation and aeration function while reduce lung parenchyma damage, and it’s worth popularization in clinical practice in the future.

References


