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Magnesium sulfate micro air pump suction for bronchiolitis treatment in infants under two years old

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Abstract. – OBJECTIVE: To investigate the efficiency, clinical effects and nursing methods related to the use of magnesium sulfate micro air pump suction for treating infants under two years old suffering from bronchiolitis.

PATIENTS AND METHODS: From January 2014 to September 2014, ninety-six infants with capillary bronchitis were enrolled. Patients were randomly divided into two groups: experimental group (n=49) and control group (n=47). All patients went through conventional anti-inflammatory therapy. Based on this, infants in the control group were additionally treated with intravenous drip of magnesium sulfate while patients in the experimental group were treated with magnesium sulfate micro air pump suction. We recorded all changes in blood gas and clinical scores, the residence time of symptoms and signs of bronchiolitis, and hospitalization time. Results obtained on clinical effects and adverse reactions were compared and analyzed.

RESULTS: The Variations of PaO_2, $PaCO_2$, SaO_2 before treatment in both groups did not show any statistically significant differences ($p>0.05$); while after treatment analyses demonstrated that in both groups we had an increase in PaO_2 and SaO_2 and a decrease in $PaCO_2$. The increase in PaO_2 and SaO_2 values were more pronounced while the decrease observed in $PaCO_2$ was more significant in our experimental group. The total effective rate was significantly higher while the total adverse reaction rate, the resolution time of clinical symptoms and hospitalization time were significantly lower in our experimental group.

CONCLUSIONS: Magnesium sulfate micro air pump suction was safe and effective in treating with bronchiolitis of infants below 2 years old, and its adverse reaction rate was low, nursing procedure was simple, and nursing difficulty level was low.

Key Words

Magnesium sulfate, Micro pump, Bronchiolitis, Nursing.

Introduction

Bronchiolitis is an infectious disease characterized by its symptoms, such as coughing, expectoration, and fever. There is seasonal difference in its incidence. Bronchiolitis frequently cause trouble in infants below 2 years old and attacts mostly the lower respiratory tract, including the lung and capillary bronchus. Infants under 2 years old, due to their weak immune system and imperfect respiratory structure, have a significantly higher morbidity rate compare to the children in other age groups[1]. The magnesium ions are showed to be capable of relieving the cough and preventing the asthma in infant. The curative effects of intravenous drip of magnesium sulfate have already been widely recognized, but due to the low selectivity of the medication and the infants' poor tolerance, the intravenous administration could result in adverse reactions in circulatory system[2]. Magnesium sulfate micro air pump suction, as an alternative method for magnesium ions delivery, has achieved very favorable curative efficacy. In this study we further investigated the implications of using magnesium sulfate micro air pump suction for the treatment of bronchiolitis in infants under 2 years old. We looked at clinical effects and nursing methods related to the use of magnesium sulfate micro air pump suction.

Patients and Methods

Patients

From January 2014 to September 2014, ninety-six infants with capillary bronchitis were enrolled. All patients were hospitalized in department of pediatric pneumology in our hospital. They all had clinical symptoms including

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persistent dry cough, fever, dyspnea and shortness of breath. Bubble sounds could be heard in both lungs. All patients conformed to the diagnostic criteria of capillary bronchial pneumonia and were excluded from bronchial foreign body, upper respiratory tract infection, lymph node tuberculosis and other diseases. For this study we obtained the approval from hospital's ethics committee and informed consent from patients and their families. Patients were randomly divided into two groups: experimental group (n=49) and control group (n=47), Control group had 27 males and 20 females, aged from 2 to 22 months, with an average of (6.9±1.3) months. Course of disease for patients in our control group ranged from 2 to 16 days with an average of (5.4±0.9) days. In our experimental group we had 28 males and 21 females, aging from 3 to 21 months. Average age for this group was (7.2±1.2) months and course of disease ranged from 3 to 15 days with an average of (5.6±0.6) days. Differences in the age, gender, and course of disease between the two groups were not statistically significant (p>0.05).

Research Method

First series of blood samples were collected from the patients immediately after admission and sent to laboratory for blood gas analysis. Another blood samples was conducted 24 hour after first treatment followed by blood gas analysis. Clinical scores were recorded according to the daily dynamic performances of the infant patients. Patients in the control group were treated with conventional therapy, such as anti-infection therapy, oral administration of cough and asthma reliving medicine, blood vessel extension, combined with slow and steady intravenous drip of mixed solution composed by 25% magnesium sulfate and 5% glucose, twice per day. Patients in the experimental group, on the other hand were treated with micro pump suction of 0.1 to 0.2 (kg·time) isotonic solution composed of 25% magnesium sulfate and saline solution via air atomizing pump, 4 to 6 times per day while they were under conventional therapy. Three days later, their electrocardiogram and serum electrolyte were examined. In the nursing process, strict dynamic observations on the patients' vital signs, state of consciousness, condition changes, functions and states of various organs were implemented to prevent any adverse reactions incurred from the infants' unconscious initiatives, and the characteristic symptoms, including cough, sputum, fever, and wheezing sound were recorded.

Curative Efficacy Evaluation

Criteria used for our curative efficacy evaluations were as follows: excellent, effective and ineffective.

Excellent: after treatment for 24 hours, the clinical symptoms, such as expectoration, oppression and asthma were significantly relieved or completely disappeared, and lung bubbling sound was significantly reduced. Effective: after treatment for 3 days, the clinical symptoms, such as cough, expectoration, oppression, and asthma were relieved to some extent, respiratory problems no longer occurred, and moist rale of lung was reduced. Ineffective: after 3 days of treatment, clinical symptoms were not improved, respiratory problems occurred occasionally, and noise in lung was not significantly reduced.

Observation Index

All changes in blood gas indexes, including dynamic oxygen partial pressure (PaO_2), degree of blood oxygen saturation (SaO_2), and carbon dioxide partial pressure ($PaCO_2$) were monitored and recorded in both groups before and after the treatment. Residence time of the symptoms, and the duration of hospitalization were also recorded. The clinical efficiency of the treatments and the quantity, the cause and the form of adverse reactions in both groups were all recorded.

Statistical Analysis

Statistical analyses on clinical score changes were performed. Statistical software package SPSS 19.0 (SPSS Inc., Chicago, IL, USA) was applied to process the data; measurement data were presented by means±standard deviation; t-test was used for comparisons between groups; enumeration data were presented by case or percentage (%); X^2-test was applied in comparisons between groups; $p<0.05$ was considered as statistically significant.

Results

Comparison on Blood Gas Changes Before and After Treatment Between the two Groups

The differences in PaO_2, $PaCO_2$, and SaO_2 variations upon admission in both groups were not statistically significant (p>0.05), however after treatment, PaO_2 and SaO_2 for both groups showed an increase while $PaCO_2$ decreased in both groups. The surge in PaO_2 and SaO_2 on the one hand and

Table I. Comparison of blood gas variations (PaO_2, $PaCO_2$, and SaO_2) in both groups before and after treatment.

	PaO_2 (mmHg)		$PaCO_2$ (mmHg)		SaO_2 (%)	
Group	**Pre-treatment**	**Post-treatment**	**Pre-treatment**	**Post-treatment**	**Pre-treatment**	**Post-treatment**
Experimental group (n=49)	68.2±3.7	86.9±1.4	51.8±3.3	32.9±2.8	83.4±2.2	98.1±2.7
Control group (n=47)	68.1±4.0	75.7±2.8	51.7±2.9	43.6±3.0	83.2±2.4	92.9±3.5
t	0.524	3.124	0.847	3.254	0.321	2.965
p	0.932	0.038	0.632	0.035	0.402	0.041

the drop in $PaCO_2$ on the other hand were more pronounced for the experimental group when compared to the control group. Differences were statistically significant ($p<0.05$) (Table I).

Comparison on Clinical Effective Rate and Adverse Reaction Incidence Between the two Groups

The total effective rate for our experimental group was significantly higher than that of the control group, and the total adverse reaction rate was significantly lower than that of the control group and differences were statistically significant ($p<0.05$) (Table II).

Comparison of Clinical Symptoms, Hospitalization Time and Score Changes Between the two Groups

The resolution time of clinical symptoms (including wheezing resolution, cough control, body temperature recovery and rale resolution) and hospitalization time in experimental group were significantly lower than those of the control group and differences were statistically significant ($p<0.05$). Difference in clinical scores upon admission between the two groups was not statistically significant [(72.6±12.6): (71.3±13.5), $t=0.824$, $p=0.139$]. Three days after treatment, clinical scores for both groups decreased, however the decline in experimental group was more significant. Differences were statistically significant ($p<0.05$) (Table III).

Discussion

Bronchiolitis is a common respiratory disease in children under two years old with seasonal, regional and recurrent characteristics. The infants' overall immunity in those ages is relatively weak and lumen of capillary bronchus is relatively small. As bronchial secretions increase and edema appear, the infants' bronchial lumens are more vulnerable to the obstruction, which may lead to severe complications, such as pneumonia, and respiratory failure. In more serious cases, it might influence the infants' normal development and even cause death[3].

Magnesium is one of the most important microelements in human body which plays an important role in the operation of the whole human body. It ranks the fourth in the content of extracellular fluid and the second in the intracellular fluid. Enzymes activation is one of the most important functions of magnesium[4]. A relatively big number of studies have been focusing on magnesium's curative effects for asthma. There are lots of reports about magnesium's curative effects for asthma in

Table II. Comparison of clinical effective rate and adverse reaction incidence [Case (%)] in two groups.

Group	**Excellence**	**Effective**	**Ineffective**	**Total effective rate**	**Facial redness**	**Somnolence**	**Others**	**Total adverse reaction rate**
Experimental group (n=49)	17	27	5	44 (89.8)	2	1	1	4 (8.2)
Control group (n=47)	13	24	10	37 (78.7)	3	3	3	9 (19.1)
X^2				4.128				4.628
p				0.026				<0.001

Table III. Comparison of clinical symptoms, hospitalization time and score changes in both groups..

Group	Clinical symptoms control time (day)	Hospitalization time (day)	Score changes
Experimental group (n=49)	2.8±0.5	5.7±0.4	46.2±5.7
Control group (n=47)	4.3±0.6	8.5±0.7	59.3±6.4
t (X^2)	2.826	3.954	4.028
p	0.036	0.029	0.016

the literature. Magnesium has the capacity to relax the bronchial smooth muscles, prevent hypersensitive reactions via controlling the respiratory tract, enlarge arterioles and capillary vessels and diminish the complications of lung and heart.

Most commonly used medications to combat spasmolysis and calm down asthma[5], such as salmeterol, ventolin, can control the symptoms only in short term and their long term efficacy cannot be guaranteed. Magnesium ions can promote gas exchange, reduce carbon dioxide retention, promote the ventilating blood flow, and correct hyperlipidemia as well as hypoxia. Magnesium sulfate could achieve high safety and definite clinical effects. Clinical observations revealed that the curative effects of magnesium sulfate application were directly related to the concentration of magnesium sulfate. When the concentration was too low, the treatment effect was not significant, but when the concentration was too high, the infants were liable to some adverse reactions, such as drowsiness and significantly lower blood pressure. However, adverse reactions can also be prevented. Nurses must closely observe the infants' heart rates, respiratory rates and occurrences of knee jerk reflex. If abnormal conditions occurred, antagonistic therapy must be applied immediately[6,7].

It was suggested that, while nursing the infants with bronchiolitis, the ward's environment must meet three requirements: i) room temperature must be kept within 18-20°C, windows must be opened for ventilation (2 to 3 times per day), and convection wind must be avoided; ii) indoor humidity must be kept within 50%-60% because humidity can dilute the concentration of sputum; iii) rooms must be noiseless and families should minimize their communication with their children and speak to the medical personnel outside the room in order to create an absolutely peaceful atmosphere for infants[5,6].

Children must lay down in their beds with chests up. Infants with severe wheeze should be maintained in semi-clinostatism to ensure smooth breathing. Oxygen therapy must be delivered if necessary to keep the infants' overall respiratory tracts smooth and free from any foreign body obstruction. Oral cavity must be kept clean and sputum should be disposed in a timely manner. In terms of diet, the number of daily meals should be increased while the amount of food is reduced and infants must have liquid or semi liquid food to avoid expiratory dyspnea incurred from being too full. Due to the fact that the self-controlling capacities of the infant become relatively poor, in the case of diarrhea, nurses shall pay close attention to keep the buttock clean to prevent secondary infection. Complexions, vital signs, respiratory rate, heart rate, body circulation and secondary defecation must be closely monitored. Once abnormal situation transpired, physicians must be notified instantaneously to avoid the occurrence of severe suffocation and other complications[6-8]. Infant bronchiolitis usually occurred abruptly and may develop into more serious situations, however in most cases infants can be cured as long as the treatment initiates without long delays.

We demonstrated that magnesium sulfate micro pump suction significantly improved the infants' ventilation functions, reduced tissue oxygen consumption, improved oxygenation capacity and respiratory muscle strength, and eased the respiratory muscle fatigue caused by infants' breathing. Results from our study revealed that the differences observed in PaO_2, $PaCO_2$, SaO_2 between the experimental group and the control group upon admission were not statistically significant. However, after treatment, PaO_2 and SaO_2 increased more significantly and $PaCO_2$ decreased more significantly in the experimental group. The total effective rate of the experimental group was significantly higher, and the total adverse reaction rate was significantly lower. Additionally, the resolution time of clinical symptoms as well as hospitalization time for experimental group were also significantly lower. All differences in abovementioned parameters were proven to be statistically significant. Difference in clinical scores upon admission between the two groups was not statistically significant while 3 days

after treatment, clinical scores for our experimental group dropped more significantly compare our control group, and again differences were statistically significant.

Conclusions

The magnesium sulfate micro air pump suction showed to be a safe and effective tool, with a negligible adverse reaction rate, in treating infants under 2 years old who suffers from bronchiolitis. The treatment protocol for applying the magnesium sulfate micro air pump suction requires a simple and low difficulty nursing procedure.

Conflicts of interest

The authors declare no conflicts of interest.

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