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Clinical study on humidified high-flow nasal cannula in the treatment of recurrent apnea in premature infants

Binbin Yi
Hebi People's Hospital, Hebi, China

Abstract. Purpose: To explore the clinical effect of humidified high-flow nasal cannula (HHFNC) in the treatment of recurrent apnea in premature infants. Methods: 94 premature infants with recurrent apnea were selected and randomly divided into two groups. The observation group was treated with NHFNC, and the control group was treated with nasal continuous positive airway pressure (NCPAP). The clinical effects of the two groups were compared. Results: there was no statistically significant difference in total effective rate, non-invasive assisted ventilation time and oxygen therapy time between the two groups (P>0.05); the start time of breastfeeding and the time to reach full enteral feeding of the observation group were shorter than those of the control group; $PaCO_2$ and PaO_2 were compared 24h after treatment; the incidences of feeding intolerance, nasal injury and abdominal distension of the observation group were lower than those of the control group, and the differences were statistically significant (P<0.05). Conclusion: HHFNC treatment of recurrent apnea can improve the patients' blood gas indicators, shorten the time of non-invasive ventilation, and reduce the incidence of complications.

Keywords. Humidified high-flow nasal cannula, premature infants, recurrent apnea.

Apnea of premature infants means that the apnea time of infants with a gestational age < 37 weeks is > 20 s or < 20 s but with bradycardia and decreased oxygen saturation. The occurrence of this disease is mainly due to the development defects of the central nervous system, respiratory system and other functions of premature infants, and the smaller the gestational age of the newborn, the higher the incidence of this disease [1]. Nasal continuous positive airway pressure (NCPAP) is currently a commonly used method to treat apnea, but this method may cause nasal injury and air leak in children, which restrict its clinical treatment effect [2]. Humidified high-flow nasal cannula (HHFNC) is a new treatment method gradually promoted and applied abroad in recent years. It can effectively improve the ventilation status of children, ensure that the airway of children is moist, and reduce the occurrence of complications [3, 4]. This paper studied 94 premature infants with recurrent apnea, and analyzed the application effects of HHFNC. The results are reported as follows.

1. Data and methods

1.1. General data

94 premature infants with recurrent apnea admitted to Hebi People's Hospital from August 2016 to August 2018 were selected and randomly divided into two groups. The control group included 47 cases, including 27 males and 20 females, with an average gestational age of (31.86 ± 1.68) weeks; the average birth weight was (1378.61 ± 162.01) g; and the average Apgar score was (8.01 ± 0.36). The observation group included of 47 cases, including 26 males and 21 females, with an average gestational age of (31.57 ± 1.72) weeks; the average birth weight was (1371.62 ± 164.41) g; and the average Apgar score was (8.18 ± 0.32). There was no statistically significant difference in general data between the two groups (P > 0.05). The family members of the patients were informed about this study, and signed the informed consent.

Inclusion criteria: meeting the diagnostic criteria of apnea; the child developed progressive dyspnea within 6h after birth, accompanied by three concave signs of inspiration; gestational age < 36 weeks, birth weight ≤ 2000 g; percutaneous oxyhemoglobin saturation under nasal cannula oxygen supply < 88%. Exclusion criteria: those with incomplete spontaneous respiration and severe congenital malformation; those with severe respiratory distress syndrome; those with hyperbilirubinemia, polycythemia, hemolytic disease of newborn, and reaching the blood exchange transfusion indications.

1.2. Methods

All children received ECG monitoring after admission, and the nurse in charge closely observed the respiratory rhythm, frequency and heart rate of the children. At the same time, the children were given treatment to maintain the balance of water and electrolyte, and given oxygen therapy, skin stimulation and other treatment measures after apnea. The children in the control group were treated with NCPAP, the air flow rate was 6~8 L/min, the positive end-respiratory pressure was 4~6 cm H_2O, and the partial pressure of fractional concentration of inspired oxygen was 21% - 40%. The patients in the observation group were treated with HHFNC by Bird Blenders air-oxygen mixer and Optiflow TM system, nasal plugs were selected according to the individual conditions of the children, and the parameter settings were an air flow rate of 2~6 L/mm, a heated humidified inhaling air of 37°C, and a fractional concentration of inspired oxygen of 21% - 40%.

1.3. Efficacy evaluation criteria [3, 4]

Significantly effective: the symptom does not recur within 24h after treatment, and disappears within 48h; effective:

the symptom does not recur within 48h after treatment, and disappears within 72h; ineffective: The above standards are not reached. Effective rate = Significantly effective rate + Effective rate.

1.4. Observation indicators

Clinical indicators: The non-invasive assisted ventilation time, the oxygen therapy time, the start time of breastfeeding and the time to reach full enteral feeding were recorded. Blood gas indicators: the $PaCO_2$, PaO_2 and oxygen saturation (SaO_2) before treatment (0h), 12h and 24 h after treatment. Occurrence of complications: The occurrence of nose injury, abdominal distension, patent ductus arteriosus and other complications during treatment were recorded.

1.5. Statistical methods

SPSS22.0 was used for data analysis. The measurement indicators were expressed in $\bar{x} \pm s$, the t test was used for comparison between groups; the rate was expressed in %, x^2 test was used for comparison between groups; the difference was statistically significant when $P<0.05$.

2. Results

2.1. Comparison of therapeutic effects between the two groups (see Table 1)

Table 1. Comparison of therapeutic effects between the two groups ($\bar{x} \pm s$)

Group	Total effective rate (%)	Non-invasive assisted ventilation time (d)	Oxygen therapy time (d)	Start time of breastfeeding (h)	Time to reach full enteral feeding (d)
Control group	78.7	9.2 ±2.7	15.8 ±3.6	79.2 ±6.1	22.1 ±5.9
Observation group	87.2	8.4 ±2.4	14.3 ±3.2	60.1 ±5.8	18.3 ±6.7
t/x^2 value	0.83	1.18	1.64	11.16	4.56
P value	0.37	0.20	0.22	0.00	0.00

2.2. Comparison of blood gas indicators between the two groups (see Table 2)

Table 2. Comparison of blood gas indicators between the two groups ($\bar{x} \pm s$)

Group	$PaCO_2$ (mmHg)			PaO_2 (mmHg)			SaO_2 (%)		
	0h	12h	24h	0h	12h	24h	0h	12h	24h
Control group	46.9±2.6	59.8±2.7	65.1±4.5	55.1±3.7	47.5±4.1	43.4±4.5	69.4±2.6	85.6±1.9	93.6±1.1
Observation group	47.1±2.7	61.2±3.9	74.9±4.4	55.3±3.6	46.2±3.5	38.2±4.2	69.9±2.4	85.4±1.6	94.9±0.9
t value	1.02	1.92	4.54	0.97	1.20	4. 68	0.89	0.86	0.92
P value	0.26	0.16	0.00	0.30	0. 22	0.00	0.36	0.37	0.34

2.3. Comparison of complications between the two groups (see Table 3)

Table 3. Comparison of complications between the two groups, cases

Group	Feeding intolerance	Nose injury	Abdominal distension	Patent ductus arteriosus
Control group	23	17	16	10
Observation group	14	5	6	11
x^2 value	3.97	5.64	5.14	2.02
P value	0.05	0.04	0.04	0.08

3. Discussion

The repeated occurrence of apnea will cause hypoxemia, which seriously affects the oxygen supply of body tissues. If effective treatment cannot be provided in time, it will also lead to hypoxic injury of brain tissue in children, and even cause death [3]. Therefore, how to regulate and maintain the respiratory rhythm of children is a study hotspot in this field. HHFNC is a new treatment method that is being gradually promoted abroad. It can deliver medical mixed gas heated to near body temperature and 100% humidified to patients through nasal cannula, and has the characteristics of high safety, high comfort and good efficacy. However, it is rarely used in China at present [4].

This study compared the therapeutic effects of the two groups and found that the differences in $PaCO_2$ and PaO_2 after 24h between the two groups were statistically significant ($P<0.05$); however, there was no statistical significance in comparison of SaO_2 between the two groups at any time ($P>0.05$). The results suggested that HHFNC could more effectively improve the alveolar ventilation function of patients than NCPAP, because HHFNC could promote the pulmonary inflation of children, improve the oxyhemoglobin saturation in a short time, reduce the retention of CO_2, and increase the arterial partial pressure of oxygen, thus keeping the arterial oxygen saturation within the normal range and improving the vital signs of children. Some studies show that through adjusting the inhaled gas temperature to about 37°C, HHFNC treatment can make the airway maintain optimal humidification, keep the airway unblocked, and avoid the difficulty of spontaneous breathing caused by the cooling of the airway and the accumulation of secretions [2-4]. This study also showed that the incidence of nasal injury in the observation group was significantly lower than that in the

control group, with a statistically significant difference (P<0.05). The size of the nasal cannula inserted by HHFNC was appropriate, so it could improve the goodness of fit of the interface during the treatment process, and avoid the occurrence of external force compression and nasal injury [3, 4]. Abdominal distension and feeding intolerance are also the main complications of NCPAP in the treatment of apnea. This study showed that the incidences of abdominal distension and feeding intolerance in the observation group were lower, and the start time of breastfeeding and the time to reach full enteral feeding were significantly shorter than those of the control group; for children with this disease, we should promote the start of breastfeeding as soon as possible to achieve full enteral feeding, so as to stimulate bile flow, increase the synthesis and secretion of cholecystokinin, and finally achieve the goal of preventing parenteral nutrition. Therefore, the application of HHFNC is more beneficial to the growth and development of children, and avoids the occurrence of lactose intolerance and growth retardation. It should be noted that although HHFNC has a good effect in the treatment of apnea, some problems need to be solved urgently at present. HHFNC will produce a certain positive airway pressure, so when it is used, the doctors should consider adjusting the positive airway pressure and closely observe its impact on the pulmonary function of children. In addition, in the application of HHFNC, attention should also be paid to adjust the temperature to avoid infection caused by excessive condensation water due to overtemperature.

To sum up, HHFNC has a good effect in the treatment of recurrent apnea, which can improve the blood gas indicators of patients, shorten the non-invasive ventilation time, and reduce the incidence of complications.

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