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A Clinical Study on Treatment for Delayed Neuropsychoneural Sequela After Acute CO Poisoning with ClearMate Gas Poisoning Emergency Ventilator

Wenqing Wu Yunyu Ma Ke Xu

Xinjiang Bazhou People's Hospital Emergency Centre, Bazhou, Xinjiang, Post code:841000

[Abstract] Objective: Our study aims to investigate therapeutic efficiency for acute carbon monoxide poisoning and eventual delayed neuropsychoneural sequela by using ClearMate gas poisoning emergency ventilator. **Method:** 120 patients who were treated from April 2010 to April 2014 in our hospital because of acute carbon monoxide poisoning in critical condition were included in this study. The patients were divided into control group and study group with 60 patients in each group. In the control group, patients received conventional treatment, while in the study group patients received treatment using ClearMate gas poisoning emergency ventilator. The therapeutic effect and incidence of delayed neuropsychoneural sequela were compared between two groups. **Result:** The total treatment efficiency was 96.67% in study group and 60.00% in the control group, with significantly higher result in study group ($P<0.05$). The incidence of delayed neuropsychoneural sequela in study group was 3.33%, significantly lower than the result of 30.00% in control group, ($P<0.05$). **Conclusion:** Application of treatment using ClearMate gas poisoning emergency ventilator in early stage of clinical intervention for acute carbon monoxide poisoning can significantly decrease incidence of delayed neuropsychoneural sequela among other sequelae. Because of the significant therapeutic efficiency and high safety of this treatment, it is worthy of recommendation for wide clinical use.

[Key words] ClearMate gas poisoning emergency ventilator, acute carbon monoxide poisoning, delayed neuropsychoneural sequelae

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In China, acute carbon monoxide poisoning mostly occurs in winter, especially in impoverished and backward areas^[1]. Once carbon monoxide enters blood, it binds with hemoglobin, and deprives their ability of oxygen transportation, and therefore leads to hypoxia in the central nervous system and the state of intoxication develops^[2]. If effective treatment is not given timely, complications may be induced and delayed neuropsychoneural sequela may occur. The purpose of this study was to investigate the therapeutic efficiency of ClearMate gas poisoning emergency ventilator in the treatment of carbon monoxide poisoning and delayed neuropsychoneural sequelae.

1 Material and Method:

1.1 Clinical Data One hundred and twenty patients were randomly selected as study subjects, who were treated between April 2010 to April 2014 in our hospital for acute carbon monoxide poisoning in critical condition, among them 62 were male and 58 were female, with age ranging from 15 ~ 65 years

old and average age was (35.21±9.35) years. Unhealthy patients, such as patients with severe heart, brain, renal or lung diseases were excluded from this study, and deceased cases were also excluded. The 120 selected patients were divided into 2 groups, with 60 in study group, among them 34 were male and 26 were female, age range was from 15 to 63 years old with average age being 33.61±7.56 years old; and the control group consisted of 32 male patients and 28 female patients, age ranged from 17 to 65 years old with average age of 37.43±8.28 years old. Gender and age in the two groups were comparable, and have no statistically significant difference ($p > 0.05$).

1.2. Method

Patients in control group were treated with conventional therapy, i.e. supplying oxygen through a nasal catheter while in the meantime establishing effective venous access, clearing discharges, conducting dehydration therapy by giving 20% mannitol to lower intracranial pressure, correcting water and electrolyte and acid-base balance, providing anti-infection treatment, and hyperbaric oxygen treatment was given after the patients were stabilized. Patients in the study group were quickly given treatment using ClearMate gas poisoning emergency ventilator beside same medication therapy as in the control group, and after 1 hour of treatment using the gas poisoning ventilator and if patient's vital characters were stable, had no seizures, the ventilator should be stopped as early as possible. After different procedures were taken in the early stage, both study group and control group received comprehensive treatments for prevention from cerebral edema, promotion of functional recovery of brain cells and maintenance of normal intracellular homeostasis. Follow-ups were conducted for both groups, and the incidence rates of delayed neuropsychoneural sequelae were investigated.

1.3 Diagnostic criteria Carbon monoxide poisoning is normally divided into 3 grades, namely mild, moderate and severe. Mild: symptoms such as headache, dizziness, nausea, malaise, but often no positive signs in physical examination; Moderate: patient presents disorder of consciousness, such as shallow coma, incontinence, decreased response to external stimuli, eventually positive pathological signs; Severe: patient is in moderate to severe coma, physiological and pathological reflexes disappear, maybe combined with cerebral edema, pulmonary edema, myocardial damage and a series of complications.

1.4 Assessment criteria for therapeutic efficiency: ① Cure: clinical signs of carbon monoxide poisoning disappear, patient can act normally; ② Significantly effective: patient returns to normal consciousness, respiratory function improved, and patient's condition is stable; ③ Effective: most of patient's symptoms improved, however, sequela developed; ④ Ineffective: no improvement in symptoms and signs, exacerbation or death.

1.5 The method and items of follow-ups: health records were set up for 60 patients, and they were followed-up within six months after discharge, at least three times a month for the first three months and at least once a month for the next three months; follow-up items were conducted according to examination of delayed encephalopathy.

1.6. Statistic methods: Statistics software was employed for data statistic analysis, X^2 test was applied to compare count data, and $p < 0.05$ was defined as statistical significance.

2. Results

2.1 Comparison of clinical efficiency between patients in tow groups The total treatment efficiency in study group was 96.67% and 60.00% in the control group, with significantly higher result in study group (P<0.05). The detailed data are shown in Table 1 below.

Table 1 Comparison of Therapeutic Efficiency between Two Groups [n (%)]

Groups	Patient Number (Case)	Cure	Significantly effective	Improved	Ineffective	Total Effective Rate (%)
Treatment Group	60	34 (56.67)	14 (23.33)	10 (16.67)	2 (3.33)	58 (96.67)
Control Group	60	14 (23.33)	12 (20.00)	10 (16.67)	24 (40.00)	36 (60.00)
χ^2						13.5513
p						0.0036

2.2 Comparison of incidences of delayed neuropsychoneural sequela between two groups The incidence of delayed neuropsychoneural sequela in study group was 3.33%, significantly lower than the result as of 30.00% in control group, (P<0.05). The detailed data are shown in Table 2 below.

Table 2 Comparison of incidences of delayed neuropsychoneural sequela between two groups [n (%)]

Groups	Patient Number (Case)	Clinical Manifestations for Delayed Neuropsychoneural Sequela			Incidence %
		Unconsciousness	Mental disorders	Motoric coordination disorders	
Treatment Group	60	0 (0.00)	0 (0.00)	2 (3.33)	3.33
Control Group	60	4 (6.67)	4 (6.67)	10 (16.67)	30.00
χ^2					33.4091
p					0.0000

3. Discussion

Acute carbon monoxide poisoning is caused by inhalation of carbon monoxide that is released by incomplete combustion of carbon containing materials, after inhaled into the lungs carbon monoxide enters blood circulation and combines with hemoglobin in the blood to form carboxyhemoglobin ^[4], which deprives hemoglobin of its oxygen carrying capacity, and the nervous system presents poisoning reactions due to acute hypoxia ^[5]. The degree of carbon monoxide poisoning depends on the concentration of carbon monoxide in the blood. The higher the concentration of carbon monoxide is, the more severe the hypoxia would be. The large amount of inhaled carbon monoxide can cause hypoxic damage to the brain and the heart, leading to brain edema, loss of consciousness, respiratory failure and circulatory failure, brain herniation or even death ^[6], the mortality is extremely high. After carbon

monoxide poisoning, if a patient does not receive effective treatment in time, he may develop delayed encephalopathy.

This study included 120 patients who were treated from April 2010 to April 2014 in our hospital for acute carbon monoxide poisoning in critical condition, among them 60 patients received conventional treatment, while 60 patients received treatment using gas poisoning emergency ventilator on the basis of conventional treatment. After the treatment, it was found that the total treatment efficiency of the therapy using ClearMate gas poisoning emergency ventilator was 96.67%, significantly higher than the result of conventional therapy group which was 60%, besides, the incidence of delayed neuropsychoneural sequela for the therapy using ClearMate gas poisoning emergency ventilator was as low as 3.33%.

The key factor for rescue is to take away patients from carbon monoxide poisoned environment as soon as possible, and to provide them an environment with sufficient oxygen so that a patient's state of hypoxia could be rapidly resolved and oxygen concentration in the body would increase ^[7], this would accelerate separating carbon monoxide from hemoglobin and facilitate transportation and utilization of oxygen. In the past, before arrival in hospital, patients with carbon monoxide poisoning only receive high flow oxygen through nasal catheter, the hypoxia symptoms won't be improved ^[8] in time. After patients being transported and admitted to hospital and they would be then given hyperbaric oxygen therapy, however, the therapeutic effect and patient's prognosis are not satisfying, and sequelae of various degrees could develop. For the poisoned patients, rescue time means life, within several minutes after the poisoning incident, ventilation through mask using ClearMate gas poisoning emergency ventilator ^[9] can relief patient's hypoxia symptoms quickly, also reduce complications, and the rescue success rate is significantly increased. ClearMate gas poisoning emergency ventilator provides positive end expiratory mechanical ventilation and continuous positive airway pressure ventilation ^[10], it can limit patients' pulmonary exudative amount, and on basis of enhancement of oxygen diffusion in lungs, it also accelerates oxygen dissolution in the blood. At the same time, under high oxygen partial pressure, carbon monoxide separates quickly from hemoglobin, and this leads to limiting symptoms of apoptosis in patient's body, and therefore therapeutic effect could be achieved.

Our study demonstrated that treatment for acute CO poisoning with ClearMate gas poisoning emergency ventilator has significant clinical effect, and at the same time, incidence of delayed neuropsychoneural sequela has been also significantly reduced, this treatment has high safety, and therefore it is worthy of recommendation for wide clinical use.

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