ORIGINAL RESEARCH ARTICLE

Effectiveness of continuous renal replacement therapy and hemoperfusion in treatment of acute severe organophosphorus pesticide poisoning

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Xiaorong Cheng[1], Haiyang Yang[1], Jun Wu[1], Li Wang[1], Tingting Wu[1] and Yuhong Chen[2]*

Department of Emergency Intensive Care Unit, Nangjing First Hospital, Nangjing Medical University, Nangjing, Jiangsu 210014, China[1]; Department of Nursing, Nangjing First Hospital, Nangjing Medical University, Nangjing, Jiangsu 210014, China[2]

***For Correspondence:** Email: *wxyff456@163.com*

Abstract

This study aimed to investigate the effectiveness of continuous renal replacement therapy and hemoperfusion in acute severe organophosphorus pesticide poisoning patients. Fifty-eight acute severe organophosphorus pesticide poisoning patients who accepted therapy in Nangjing First Hospital, Nangjing Medical University from January 2018 to December 2022 were chosen as the study participants. They were randomly divided into a control group and a research group. Both groups received conventional treatment, while the research group received continuous renal replacement therapy combined with hemoperfusion therapy. Relative to the control group, the research group had higher total effectiveness rate, shorter coma time, cholinase recovery time, reduced stay in intensive care unit, less atropine dosage, lower levels of inflammatory factors and lower sequential organ failure assessment scores. Our study suggests that continuous renal replacement therapy combined with hemoperfusion can improve the clinical therapeutic effect in patients with acute severe organophosphorus pesticide poisoning, effectively control the inflammatory response, and shorten the clinical rescue and treatment time of patients. *(Afr J Reprod Health 2025; 29 [5s]: 74-80).*

Keywords: Acute severe organophosphorus pesticide poisoning, continuous renal replacement therapy, hemoperfusion, inflammatory response

Résumé

Cette étude visait à évaluer l'efficacité de la suppléance rénale continue et de l'hémoperfusion chez les patients atteints d'intoxication aiguë sévère aux pesticides organophosphorés. Cinquante-huit patients atteints d'intoxication aiguë sévère aux pesticides organophosphorés, admis au traitement au Nangjing First Hospital de l'Université de médecine de Nangjing entre janvier 2018 et décembre 2022, ont été sélectionnés comme participants à l'étude. Ils ont été répartis aléatoirement en un groupe témoin et un groupe de recherche. Les deux groupes ont reçu un traitement conventionnel, tandis que le groupe de recherche a reçu une suppléance rénale continue associée à une hémoperfusion. Par rapport au groupe témoin, le groupe de recherche présentait un taux d'efficacité globale plus élevé, une durée de coma plus courte, un temps de récupération de la cholinase plus court, une durée d'hospitalisation réduite en unité de soins intensifs, une dose d'atropine plus faible, des taux de facteurs inflammatoires plus faibles et des scores d'évaluation de la défaillance organique séquentielle plus faibles. Notre étude suggère que la suppléance rénale continue associée à l'hémoperfusion peut améliorer l'effet thérapeutique clinique chez les patients atteints d'intoxication aiguë sévère aux pesticides organophosphorés, contrôler efficacement la réponse inflammatoire et raccourcir la durée de la prise en charge et du traitement. *(Afr J Reprod Health 2025; 29 [5s]: 74-80).*

Mots-clés: Intoxication aiguë sévère aux pesticides organophosphorés, thérapie de remplacement rénal continu, hémoperfusion, réponse inflammatoire

Introduction

Organic phosphorus pesticides (OPS) are widely used in China with the largest dosage of pesticides.[1] Acute severe organophosphorus pesticide poisoning (ASOPP) belongs to a group of injuries resulting in nervous system damage after the short-term exposure to large amounts of organophosphorus pesticides.[2] Clinically, it mainly contains cholinergic excitement or crisis in acutely poisoned patients, resulting in intermediate syndrome (IMS) as well as delayed peripheral neuropathy (OPIDPN).[3] If the treatment is not timely, the toxin spreads into the fat reservoir, where it will be

continuously released into the blood circulation system, resulting in multiple organ failure and extremely high mortality.[4] At present, gastric lavage, catharsis, atropine and phosphodesidine are mainly used in clinical treatment of acute severe organophosphorus pesticide poisoning, but there are still more than 10% of patients who die due to unsatisfactory therapeutic effect.[5]

Continuous renal replacement therapy (CRRT) belongs to a blood purification therapy technique that continuously as well as slowly removes water and solutes via extracorporeal circulation blood purification in order to replace kidney function.[6] Relative to ordinary hemodialysis, CRRT prolongs the treatment time of blood purification as well as reduces the efficiency of treatment per unit time, so that the influence of changes in the concentration as well as volume of solute in blood on the body is minimized.[7] At the same time, CRRT uses high permeability as well as good biocompatibility filters, which offers a crucial homeostasis balance for treating severe patients.[8] Hemoperfusion is the blood through extracorporeal circulation to the perfusion device, through the adsorbent adsorption of toxic substances, and then play the role of blood purification.[9] Both CRRT and hemoperfusion can quickly and effectively remove toxic substances from the blood, reduce the harmful effect on patients and improve the prognosis of patients.[10]

In this study, we investigated the impact of CRRT and hemoperfusion in ASOPP patients.

Methods

Materials

Fifty-eight ASOPP patients accepted therapy in Nangjing First Hospital, Nangjing Medical University from January 2018 to December 2022 were chosen as the study participants. They were randomly divided into a control group (CG, n=29) and a research group (RG, n=29) using a random number table method. The CG contained 15 males and 14 females, aged 20-65 years old, with a mean of (39.32±4.28) years old. The RG contained 16 males and 13 females, aged 20-64 years old, with a mean age of (39.27±3.89) years old. There was no difference in socio-demographic characteristics between the two groups (P>0.05), reflecting comparability. All patients' families signed informed consent.

The inclusion criteria were: (1) patients diagnosed with ASOPP, (2) those with confusion or coma; and (3) those with stable vital signs. The exclusion criteria were: (1) patients with severe dysfunctions of heart, liver, and kidney; (2) those with other complications; and (3) patients with mental anomaly.

Therapeutic methods

Patients in both groups accepted routine treatment, including gastric lavage, emesis, catharsis, diuresis, and correction of water and electrolyte disorders. All patients were given intravenous infusion of atropine, so that patients could achieve atropine as soon as possible and then maintain a certain amount of intravenous injection based on the actual situation of the patients. All patients were treated with phosphodesidine at an early stage, 10 g a day, with a micropump for 24 h, lasting at least 3 days.

On the basis of routine treatment, patients in the RG were treated with CRRT combined with hemoperfusion. For CRRT, the specific operation was as follows: The femoral vein of patients was intubated, blood route was established, and the Prisma Flex CRRT machine was used for continuous treatment. Heparin anticoagulant therapy was routinely given, and 3-7 days of treatment were given according to the patient's condition, with each treatment ≥8 h. For hemoperfusion, the Belang Dilpact CRRT machine was used for hemoperfusion treatment, three times on the 1st day, two times on the 2nd day and one time on the 3rd day.

Nursing methods

During the treatment period, both groups of patients were given routine nursing care, including (1) Immediately after entering the intensive care unit, closely observe changes in vital signs, consciousness, pupils, and urine output. (2) Keeping the airway open, inhaling oxygen, and performing mechanical ventilation as necessary. (3) Observing reactions after drug application, and informing the doctor to adjust the treatment plan in time; and (4) keeping the patients' various channels open and in place.

Observation indices

(1) Curative effect in both groups was compared. Evaluation criteria: (1) Obvious effect: central nervous symptoms such as headache, dizziness, fatigue, restlessness, coma, and convulsion were significantly relieved, and patients regained consciousness within 24 hours of treatment. (2) Effective: central nervous symptoms were relieved, and the patient basically regained consciousness within 24 hours of treatment. (3) Ineffective: no relief or even aggravation of central nervous symptoms, or ineffective rescue due to poisoning death. Total effectiveness rate = (number of effective cases + number of effective cases)/total cases ×100%.
(2) Coma time, cholinase recovery time, atropine dosage, and ICU stay time were compared between the groups.
(3) About 4 ml of fasting venous blood was obtained from the patients in the morning. Using enzyme-linked immunosorbent assay, serum interleukin-4 (IL-4) and tumor necrosis factor-α (TNF-α) levels were measured.
(4) The occurrence of intermediate syndrome along with mortality in both groups was compared.
(5) The severity of organ failure in the two groups was assessed by SOFA scoring standard.

Statistical analysis

All data were statistically processed by means of SPSS 22.0 software. Measurement data expressed by mean ± standard deviation were compared using independent sample t test. Count data exhibited as number and rate were compared using chi-square test. $P<0.05$ meant the difference was significant.

Ethical clearance

This study was consistent with the ethical standards of the 1964 Declaration of Helsinki and its later amendments, and was approved by the Ethics Committee of Nangjing First Hospital, Nangjing Medical University on November 2, 2020, and the ethical approval number was KY20201102-03.

Results

Clinical efficacy in both groups

Relative to the CG, the RG had higher total effectiveness rate ($(\chi^2=6.44$, $P<0.05$, Figure 1).

Coma time, cholinase recovery time, atropine dosage, and ICU stay time in both groups

Relative to the CG, the RG had shorter coma time, cholinase recovery time, and ICU stay time, as well as less atropine dosage ($P<0.05$, Figure 2).

Serum L-4 and TNF-α levels in both groups

No difference was shown in serum IL-4 and TNF-α levels in both groups prior to treatment ($P>0.05$). After therapy, both levels were elevated in the two groups, and relative to the CG, the RG had lower IL-4 and TNF-α levels ($P<0.05$, Figure 3).

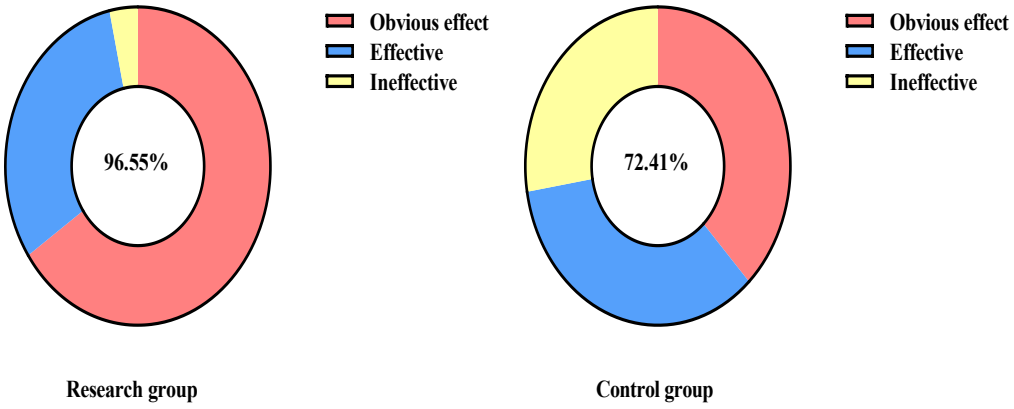

Figure 1: Clinical efficacy in both groups

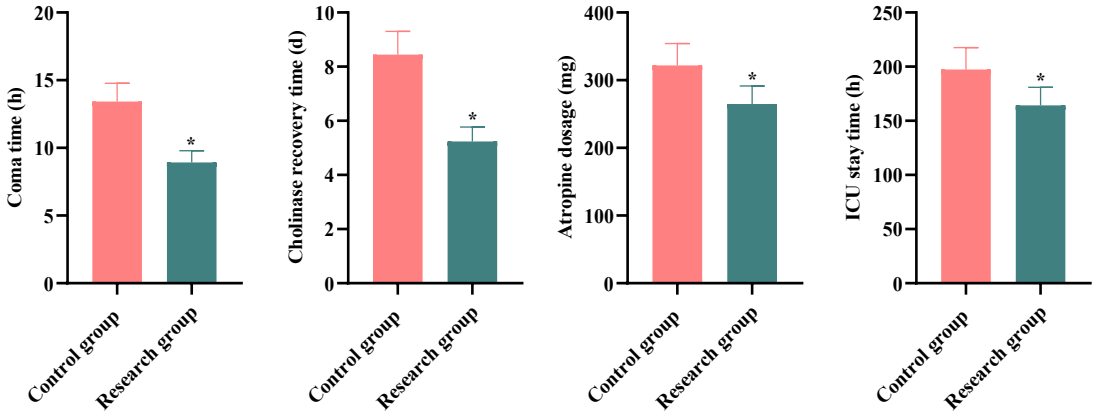

Figure 2: Coma time, cholinase recovery time, atropine dosage, and ICU stay time in both groups. *P<0.05

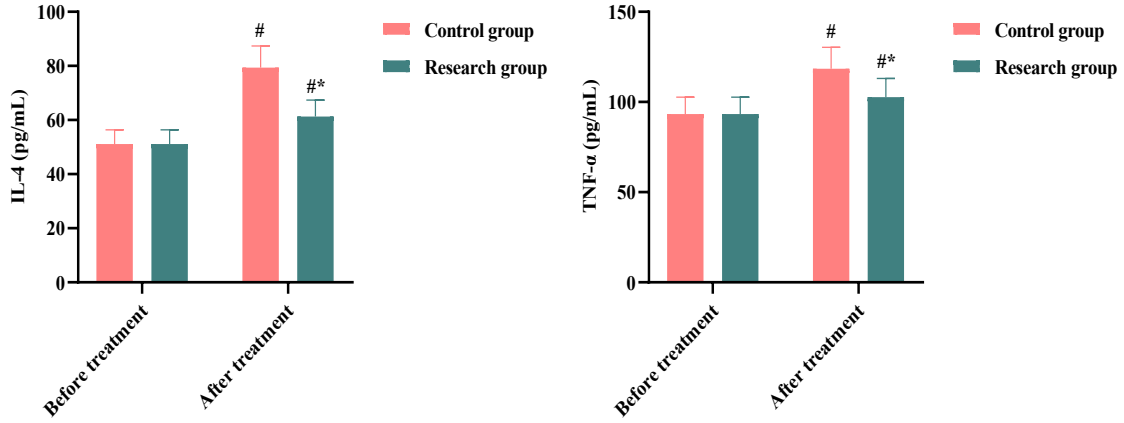

Figure 3: Serum levels of IL-4 and TNF-α in both groups. #P<0.05, relative to before treatment. *P<0.05, relative to the control group

Table 1: Incidence and intermediate syndrome as well as the mortality in both groups (n, %)

Groups	Incidence of intermediate syndrome	Mortality
Control group (n=29)	6 (20.69%)	3 (10.34%)
Research group (n=29)	2 (6.90%)	1 (3.45%)
χ^2	2.32	1.07
P	>0.05	>0.05

Occurrence of intermediate syndrome along with the mortality in both groups

Relative to the CG, the RG had lower occurrence of intermediate syndrome along with the mortality, but the difference was no significance (P>0.05, Table 1).

SOFA scores in both groups

No difference was shown in SOFA scores in both groups prior to treatment (P>0.05). After treatment, SOFA scores were lessened in 2 groups, and relative to the CG, the RG had lower SOFA scores (P<0.05, Figure 3).

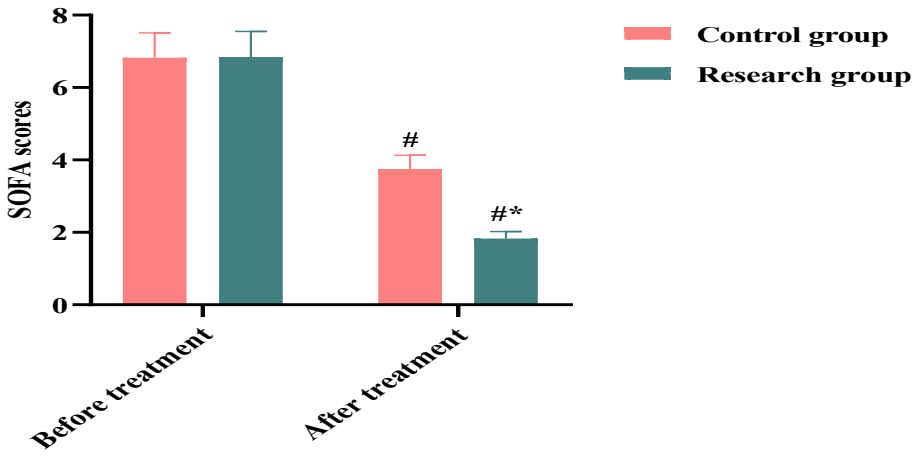

Figure 4: SOFA scores in both groups. #P<0.05, relative to before treatment. *P<0.05, relative to the control group

Discussion

ASOPP is a critical disease, which develops rapidly. If not handled properly, the mortality rate is very high.[11] Pharmacological studies have shown that organophosphorus pesticides enter the digestive tract through the oral cavity, are absorbed by the digestive tract, and rapidly spread to various organs throughout the body. In local tissues, organophosphorus pesticides can cause acetylcholine hydrolase to lose hydrolytic activity, which in turn causes continuous activation and accumulation of acetylcholine, produce a series of nicotinic-like and muscarinic-like symptoms, and cause damage to the central nervous system.[12] At the same time, since most of these patients take organophosphorus pesticides orally, a large amount of pesticides will accumulate in the folds of digestive tract mucosa, so gastric lavage cannot effectively remove pesticides in the body, but will cause continuous release of pesticides into the blood, causing a variety of irreversible lesions including respiration, circulation, and nervous system.[13] Therefore, in clinical practice, in the process of rescue and nursing of patients with ASOPP, it must be timely, accurate, and against the clock to save their lives.

CRRT can remove oxygen free radicals and inflammatory mediators from the blood and regulate water and electrolyte disorders.[14] Hemoperfusion is the use of carbon adsorption capacity, rapid removal of toxins in the blood,[15] both have a positive effect on patients with organophosphorus poisoning.[16,17] In this study, after different treatments and the same routine nursing, relative to the CG, the RG had higher total effective rate, shorter coma time, cholinase recovery time and ICU stay time, and less dosage of atropine, indicating that CRRT combined with hemoperfusion had better efficacy in the treatment of moderate severe organophosphorus pesticides, which could effectively promote the recovery of patients and reduce the amount of atropine, which was similar to former studies.[18] The reasons may be because that both CRRT and hemoperage can rapidly and effectively discharge toxic substances from the body, reduce the accumulation of toxic substances in the body, decrease the damage to the organs, lessen the inhibition of acetylcholinase, and thus shorten the coma time of patients, the recovery time of cholinase is shorter, the condition of patients is stable, and the length of ICU stay is shortened.

Severe organophosphorus pesticide poisoning can result in a series of complex pathological reactions in the body, including the activation of the inflammatory system, leading to the release of numerous inflammatory factors.[19] It has been documented that organophosphorus pesticides can activate immune active cells, lead to increased activity of neutrophils and macrophages, induce inflammatory response, and lead to increased production of IL-4, TNF-α as well as other inflammatory factors.[20] The outcomes of this study demonstrated that, after treatment, relative to the

CG, the RG had lower IL-4 and TNF-α levels. The reasons may be because that both CRRT and blood perfusion can quickly and effectively remove organophosphorus from the body, reduce the concentration of organophosphorus toxins in the body, and effectively inhibit the secondary injury of toxin rebound on patients. Simultaneously, hemodynamics is stable during the treatment of CRRT, and there is no damage to the intima of blood vessels.

Moreover, SOFA score is mostly used clinically to assess the severity of organ function injury, so observing the changes of SOFA score is conducive to reflecting the patients' organ injury.[21] In our study, after treatment, SOFA scores were lessened in 2 groups, and relative to the CG, the RG had lower SOFA scores, which implied that suggested that CRRT combined with hemoperfusion is helpful to alleviate organ function injury of patients. Additionally, the occurrence of intermediate syndrome along with the mortality was declined in the RG relative to the CG, but the difference was no significance. This may be due to the smaller sample size, and a larger sampler size was required for further exploration.

Strengths and limitations

Our study evaluated the effects of CRRT combined with hemoperfusion on ASOPP patients with significant evidence for validity. A limitation of our findings is that the sample size was relatively small.

Conclusion

CRRT combined with hemoperfusion can play a positive role in ASOPP, which can improve the clinical therapeutic effect, effectively control the inflammatory response, and shorten the clinical rescue and treatment time of patients, which is worth popularizing and using in clinic.

Competing interests

The authors report no actual or potential conflicts of interest.

Contribution of authors

Cheng XR and Yang HY: conception and design. Wu J and Wang L: analysis and interpretation of data. Wu TT and Chen YC: drafting the article or revising it critically for important intellectual content. All authors: final approval of the version to be published.

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