EFFECT OF HYBRID BLOOD PURIFICATION ON SERUM PROTEIN BINDING TOXIN, TBIL, ALT, Cr, BUN IN PATIENTS WITH MSOF AFTER MUSHROOM POISONING

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Abstract. *Objective:* To analyze the clinical efficacy of hybrid blood purification in treating mushroom poisoning with MSOF. *Methods:* A total of 100 patients with multiple systemic organ failure (MOSF) after mushroom poisoning in the Department of Nephrology, the second people's Hospital of Liangshan Yi Autonomous Prefecture, Sichuan Province from May 2020 to May 2024 were selected by convenience sampling method as research group and control group (N = 50). The research group was treated with hybrid blood purification treatment (HBPT) of hemoperfusion combined with continuous veno venous hemofiltration (CVVH). At admission (T0), the third day (T1), the seventh day (T2), and the fourteenth day (T3), control group received HBPT. The clearance effect of serum protein binding toxoid [indoxyl sulfate (IS), p-cresyl sulfate (PCS) and hippuric acid (HA)] and the changes of total bilirubin (TBIL), alanine aminotransferase (ALT), creatinine (CR) and blood urea nitrogen (BUN) were compared between the two; Survival rate within 14 days was counted. *Results:* Compared with T0 time, the levels of TBIL, ALT, Cr, BUN, IS, PCS and HA had no statistical significance ($P > 0.05$); TBIL, ALT and CR levels at T1 were not significant ($P > 0.05$), but BUN, IS, PCS and HA were lower; Compared with T2 time, TBIL, ALT, Cr, BUN, IS, PCS, HA were significantly lower than T0 and T1 time, and research group was lower; Compared with T3 time, TBIL, ALT, Cr, BUN, IS, PCS, HA were lower than T0, T1, T2, and research group was lower. From T0 to T4, survival rate of research group was higher ($P < 0.05$).
Keywords: *hybrid blood purification, poisonous mushroom poisoning, consolidate MSOF, toxin clearance, serum protein*

Introduction

Toadstools belong to higher fungi and have high application value in the field of food and medicinal materials, but they contain toxins such as ghost pen peptide and amanitin. Improper consumption can lead to acute poisoning, OSF in a short time, and death in serious cases (Li et al., 2021). According to the epidemiological statistics of public health emergencies in China, from 2004 to 2011, there were many poisonous mushroom poisoning events in the southwest, while Sichuan Province is located in the fungus abundance zone in the southwest of China with complex and diverse terrain, and its wild fungi account for 95% of the country (Sık et al., 2020).

According to the relevant data, the most common acute poisoning of toadstools is liver injury (45.68%), and the mortality rate is as high as 50-90%. The principle of treatment for mushroom poisoning is to remove toxins as soon as possible and reduce organ damage. There are still non-toxic mushroom poisoning specific detoxification drugs in clinic, which are mainly treated by gastric lavage, catharsis, brain protection, kidney protection and anti shock, but the therapeutic effect is limited. Blood purification can effectively remove endotoxin from organs and blood through diffusion, convection,

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adsorption and separation, so as to achieve the damage of residual toxin and organ function (Sanchez and Balogun, 2021).

Mushroom poisoning can severely affect multiple organ systems, particularly the brain and kidneys, necessitating targeted protective and anti-shock interventions. Neurotoxins in toxic mushrooms, such as amatoxins, can lead to encephalopathy, seizures, and cognitive dysfunction, requiring brain protection strategies such as oxygen therapy, neuroprotective antioxidants, and supportive care (Kuwabara et al., 2005). Acute kidney injury (AKI) is a common complication due to direct nephrotoxicity and systemic hypoperfusion, often requiring renal replacement therapy such as hemodialysis and hemoperfusion (Yang et al., 2006). In cases of orellanine-induced renal toxicity, early intervention with hemoperfusion has been shown to prevent permanent kidney damage (Esposito et al., 2015). Severe mushroom poisoning can also cause shock due to dehydration, hypotension, and systemic inflammatory responses, requiring aggressive fluid resuscitation, vasopressor therapy, and corticosteroids to stabilize hemodynamics (Beaumier et al., 2019).

Currently, blood purification technologies such as hemodialysis, hemoperfusion, plasma exchange and continuous renal replacement therapy (CRRT) are mainly used in clinic. However, due to the different principles of various purification technologies, the actual effects are different (Wu et al., 2003). For patients with mushroom poisoning, protein bound toxoid cannot be removed by ordinary hemodialysis, while is, PCs, HA protein bound toxoid deposited in the body can easily lead to damage to liver, kidney, heart, brain, blood vessels and other tissues. HBPT refers to the combination of two or more simultaneous or sequential modes of blood purification that can effectively remove harmful substances and improve the solute clearance rate. In addition to acute and chronic renal failure, HBPT can also be used for liver, respiratory and moderate multiple organ failure. HP and CVVH are widely used. HP refers to the removal of internal and external toxicants by drawing blood out of the body through the adsorption of perfusion device. CVVH can continuously purify the blood in the body, isosmotically remove solute and water, and maintain hemodynamic stability. It is widely used in the emergency treatment of MOSF patients, but the hybrid mechanism and effect of the combination of the two need to be verified. Therefore, this study focuses on the efficacy of hybrid blood purification and hemoperfusion on toxin clearance and body function recovery in patients with mushroom poisoning.

Methods

General information

This study included 100 patients diagnosed with multiple organ system failure (MOSF) following mushroom poisoning who met the inclusion and exclusion criteria. Patients were admitted to the Department of Nephrology at the Second People's Hospital of Liangshan Yi Autonomous Prefecture, Sichuan Province, between May 2020 and May 2024. They were randomly assigned to either the research group or the control group, with 30 patients in each. Informed consent was obtained from all patients and their families. Ethical approval for the study was granted by the hospital's ethics committee.

Inclusion and exclusion criteria

Inclusion criteria

Patients were eligible for the study if they:

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(a) Had a confirmed history of consuming non-cultivated mushrooms before symptom onset.
(b) Met the diagnostic criteria outlined in the Chinese Expert Consensus on Diagnosis and Treatment of Acute Severe Disease (Lu, 2019).
(c) Developed symptoms within three days of mushroom ingestion.
(d) Had clinical indicators suggesting damage to multiple organs or systems.
(e) Had complete clinical data and had not received any treatment before hospital admission.

Exclusion criteria

Patients were excluded if they:

(a) Had pre-existing liver, kidney, pancreatic dysfunction, or neurological impairments.
(b) Had undergone blood purification treatment prior to admission.
(c) Had missing clinical data exceeding 10%.

Treatment protocol

All patients underwent gastric lavage using an automatic gastric lavage machine, received 250-500 mL of 20% mannitol for catharsis, and underwent activated charcoal adsorption to remove residual toxins. Vitamin C and E were administered to support organ protection, alongside interventions aimed at protecting the brain and kidneys and counteracting shock. Patients presenting with respiratory failure received ventilator-assisted ventilation, while those experiencing circulatory failure were treated with volume expansion and vasoactive drugs.

Control group (HP treatment)

Patients in the control group received hemoperfusion (HP) using an Edwards Aquarius blood perfusion machine and an HA330 primary perfusion device (Zhuhai Jianfan Medical Instruments Co., Ltd.). The blood circulation pathway was established via femoral vein puncture. Prior to treatment, the perfusion device underwent heparinization using a 50 mg/mL heparin solution. Precharge procedures were performed for both the hemoperfusion device and the dialyzer, ensuring adequate saline flushing before initiating blood flow. During treatment, a blood pump speed of 250 mL/min was maintained. Hemoperfusion was performed for 2-2.5 h per session, with repeated sessions at intervals of 12-24 h.

Research group (HP + CVVH treatment)

The research group received hybrid blood purification therapy, combining HP with continuous veno-venous hemofiltration (CVVH). The HP procedure followed the same protocol as the control group. After completing HP, CVVH was initiated using the Feisen MultiFiltrate CRRT system and PlasmaFLUX P2dry plasma separator. The replacement fluid was prepared based on patient body weight and hematocrit levels. To optimize clearance rates and avoid reduced perfusion, the replacement solution was administered using a post-dilution strategy. CVVH was performed with a blood flow rate of 150-200 mL/min and a replacement fluid volume of 3500 mL/h. Anticoagulation therapy was initiated with an initial heparin dose of 1 mg/kg, followed by continuous

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infusion at 5 mg/h. Patients with coagulation dysfunction, commonly observed in mushroom poisoning-induced liver impairment, received adjusted heparin doses as needed. Heparin administration was discontinued 30 min before treatment completion, and the circuit was flushed with 0.9% saline. If required, heparin-free plasma exchange and hemoperfusion were performed. Electrolyte levels were continuously monitored, and imbalances were corrected as needed.

Outcome measures

Organ damage criteria

Organ damage was defined using the following parameters:

(a) *Liver dysfunction:* Alanine aminotransferase (ALT) levels exceeding six times the normal upper limit (≥240 U/L) and/or total bilirubin (TBIL) levels ≥35 μmol/L (Huddam et al., 2021).

(b) *Renal dysfunction:* Creatinine (Cr) levels twice the normal upper limit (>220 μmol/L) (Kundakci et al., 2010).

(c) *Neurological dysfunction:* Symptoms such as headache, coma, seizures, and delirium following mushroom ingestion (Macedo and Foreman, 2017).

(d) *Pancreatic dysfunction:* Pancreatic amylase levels exceeding three times the normal upper limit (>345 U/L) (Tribl and Sibbald, 2001).

The severity of illness was assessed using the Acute Physiology and Chronic Health Evaluation II (APACHE II) score, a validated tool for mortality prediction in critically ill patients (Knaus et al., 1985).

Systemic inflammatory response syndrome (SIRS) was evaluated based on standard criteria (Raith et al., 2017).

Biochemical analysis

Peripheral venous blood (5 mL) was collected at four time points: admission (T0), day 3 (T1), day 7 (T2), and day 14 (T3).

(a) *Liver and kidney function:* TBIL, ALT, Cr, and blood urea nitrogen (BUN) were measured using a Roche automatic analyzer via monoclonal immunofluorescence.

(b) *Toxin clearance assessment:* Serum levels of protein-bound toxins (indoxyl sulfate [IS], p-cresyl sulfate [PCS], and hippuric acid [HA]) were analyzed using a Biochrom 30 + automatic amino acid analyzer.

Survival analysis

Patient survival rates were assessed at T3 (day 14).

Statistical analysis

Data were analyzed using SPSS 26.0. The Kolmogorov–Smirnov test confirmed the normal distribution of continuous variables, which were expressed as mean ± standard deviation. Independent *t*-tests were used for comparisons between groups. Categorical variables were presented as frequencies and percentages, with chi-square (χ^2) tests performed for group comparisons. GraphPad Prism 9 was used to visualize biochemical index changes and to generate survival curves at T0.

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Results

General information comparison

No difference showed in gender, age, time from onset to treatment, SIRS score, Apache II score, combined MOSF and general clinical manifestations ($P > 0.05$) (see *Table 1*).

Table 1. *General information comparison (x ± s) or [n (%)]*

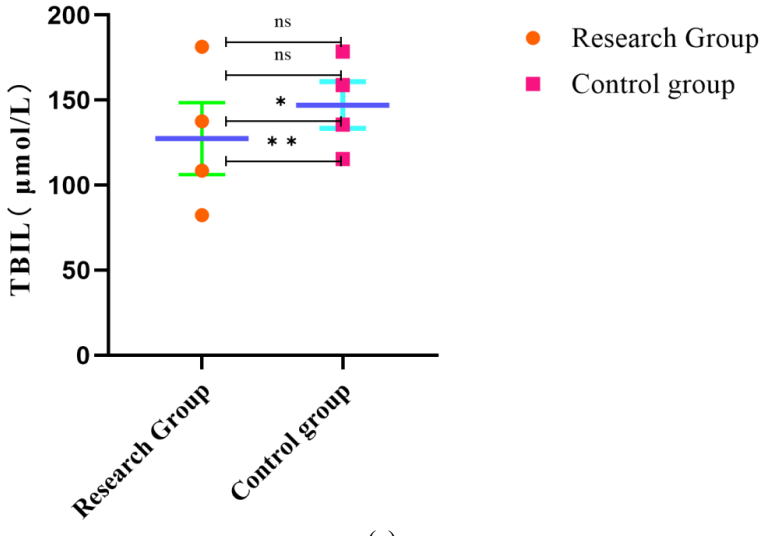
Group	n	Gender		Average age (years)	Time from onset to visit (H)	Sirs score (points)	Apache II score (points)
		Male	Female				
Research group	30	16	14	43.16 ± 10.42	18.67 ± 5.24	2.68 ± 0.31	19.54 ± 4.62
Control group	30	17	13	42.98 ± 12.11	17.98 ± 6.19	2.59 ± 0.55	20.16 ± 3.97
X^2/t		0.067		0.107	0.804	1.347	0.963
P		0.795		0.915	0.422	0.180	0.337

Group	n	Merge MOSF					Clinical manifestation				
		Liver function	Renal function	Pancreatic function	Nervous system	Other	Dizziness and headache	Convulsion	Dyspnea	Hemoptysis	Arrhythmia other
Research group	30	3	5	8	10	4	7	6	7	7	3
Control group	30	2	7	7	12	2	6	8	6	8	2
X^2/t		1.450					0.710				
P		0.836					0.951				

SIRS: systemic inflammatory response syndrome
Apache II score: acute physiology and chronic health evaluation II

Comparison of TBIL, ALT, Cr and BUN levels at different time periods

TBIL, ALT, Cr and BUN levels had no statistical significance at T0; Compared with T0 time, TBIL, ALT and Cr levels had no statistical significance ($P > 0.05$). But BUN was significantly lower than T0 time; Compared with T2 and T3, TBIL, ALT, Cr and BUN were lower in the research group ($P < 0.05$) in *Table 2* and *Figure 1*.



(a)

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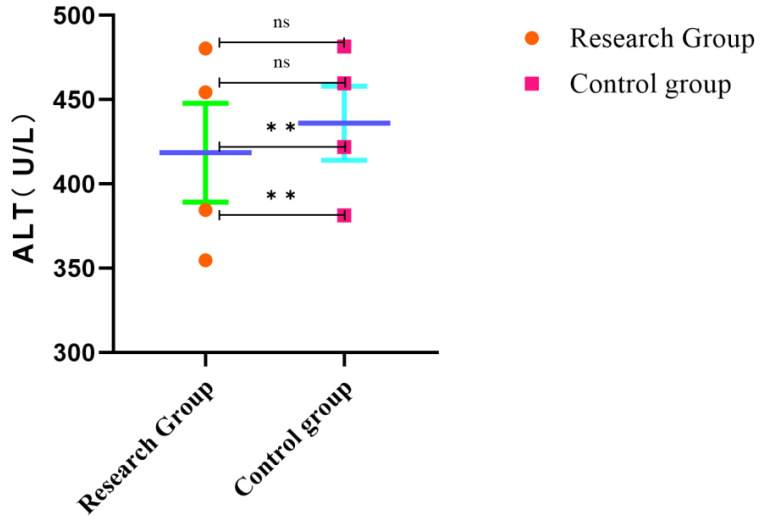
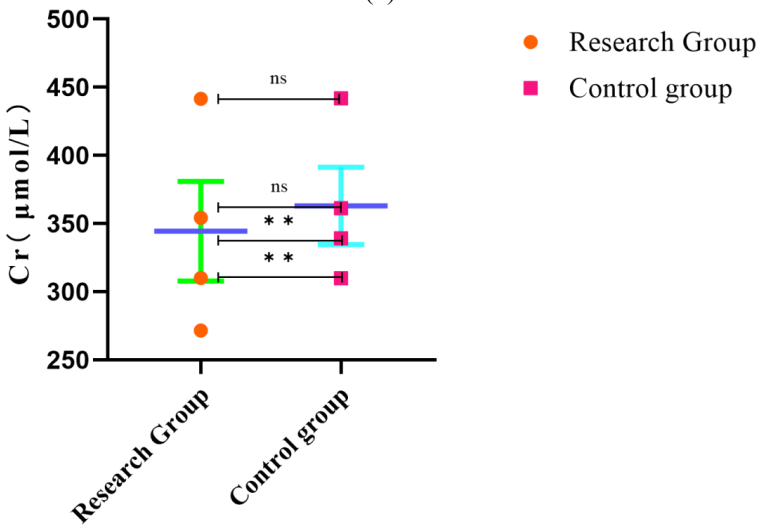


(b)



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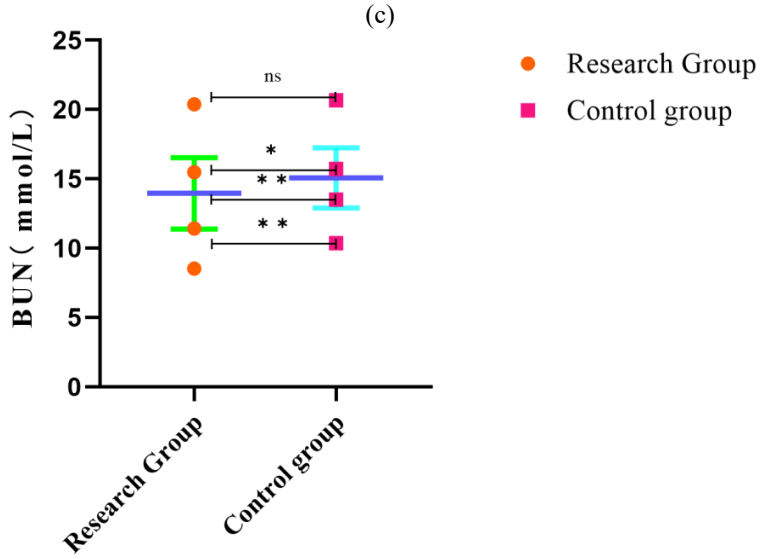

(d)

Figure 1. *TBIL, ALT, Cr and BUN levels after treatment in different time periods. (a) TBIL index level; (b) ALT index level; (c) CR index level; (d) BUN index level. Pink is the control group, yellow is the research group, and the horizontal line is the difference*

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Table 2. *TBIL, ALT, Cr and BUN levels comparison at different time periods (x ± s)*

Group	*n*	TBIL (μ Mol/l)			
		T0	**T1**	**T2**	**T3**
Research group	30	181.34 ± 15.16	154.52 ± 21.05	128.52 ± 17.43^{b}	82.37 ± 19.82^{bc}
Control group	30	178.62 ± 13.01	158.91 ± 14.67	135.66 ± 20.71^{b}	115.36 ± 15.43^{bc}
X^2/t		1.289	1.620	2.494	12.434
P		0.199	0.107	0.014	0.000
Group	***n***	**ALT (U/L)**			
		T0	**T1**	**T2**	**T3**
Research group	30	480.34 ± 26.51	454.37 ± 19.57	384.52 ± 13.54^{b}	354.82 ± 12.57^{bc}
Control group	30	481.52 ± 19.82	459.67 ± 21.58	421.84 ± 11.54^{b}	381.44 ± 15.82^{bc}
X^2/t		0.338	1.721	19.854	12.455
P		0.736	0.087	0.000	0.000
Group	***n***	**Cr (μ Mol/l)**			
		T0	**T1**	**T2**	**T3**
Research group	30	441.52 ± 28.94	354.26 ± 31.52	310.09 ± 27.58^{b}	271.63 ± 25.91^{bc}
Control group	30	442.01 ± 29.81	361.27 ± 24.37	339.27 ± 31.74^{b}	309.84 ± 30.37^{bc}
X^2/t		0.112	1.666	6.562	9.051
P		0.911	0.098	0.000	0.000
Group	***n***	**BUN (mmol/l)**			
		T0	**T1**	**T2**	**T3**
Research group	30	20.39 ± 1.37	15.49 ± 0.31^{a}	11.42 ± 0.69^{ab}	8.54 ± 0.71^{abc}
Control group	30	20.67 ± 1.01	15.71 ± 0.94^{a}	13.52 ± 0.71^{ab}	10.37 ± 0.91^{abc}
X^2/t		1.558	2.098	20.065	14.989
P		0.121	0.037	0.000	0.000

In T0 time, $^{a}P < 0.05$, $^{ab}P < 0.01$, $^{abc}P < 0.01$; T1, $^{b}P < 0.01$, $^{c}P < 0.01$; T2 time, $^{c}P < 0.01$

Compared with hemoperfusion therapy, TBIL, ALT, Cr and BUN levels in research group of hybrid blood purification were decreased; These levels changes in two groups are shown in *Figure 1*. Indicators levels showed no difference in each group at T0 time ($P > 0.05$). Until T3 time, the indicators in the research group were lower ($P < 0.05$).

Comparison of clearance effect of serum protein binding toxins in two groups at different time periods

At T0, the levels of IS, PCS and HA were not significant; Compared with T1 time, IS, PCS, HA were lower than T0 time, and the research group was lower; Compared with T2 time, IS, PCS, HA were lower than T0 and T1 time, and the research group was lower; Compared with T3 time, IS, PCS, HA were lower than T0, T1, T2, and the research group was lower, as shown below ($P < 0.05$) (*Table 3*).

Compared with hemoperfusion therapy, IS, PCS and HA levels in hybrid blood purification were decreased; *Figure 2* shows t IS, PCS and HA levels changes; Indicators levels showed no difference in each group at T0 time ($P > 0.05$). Until T3 time, the indicators in the research group were lower ($P < 0.05$).

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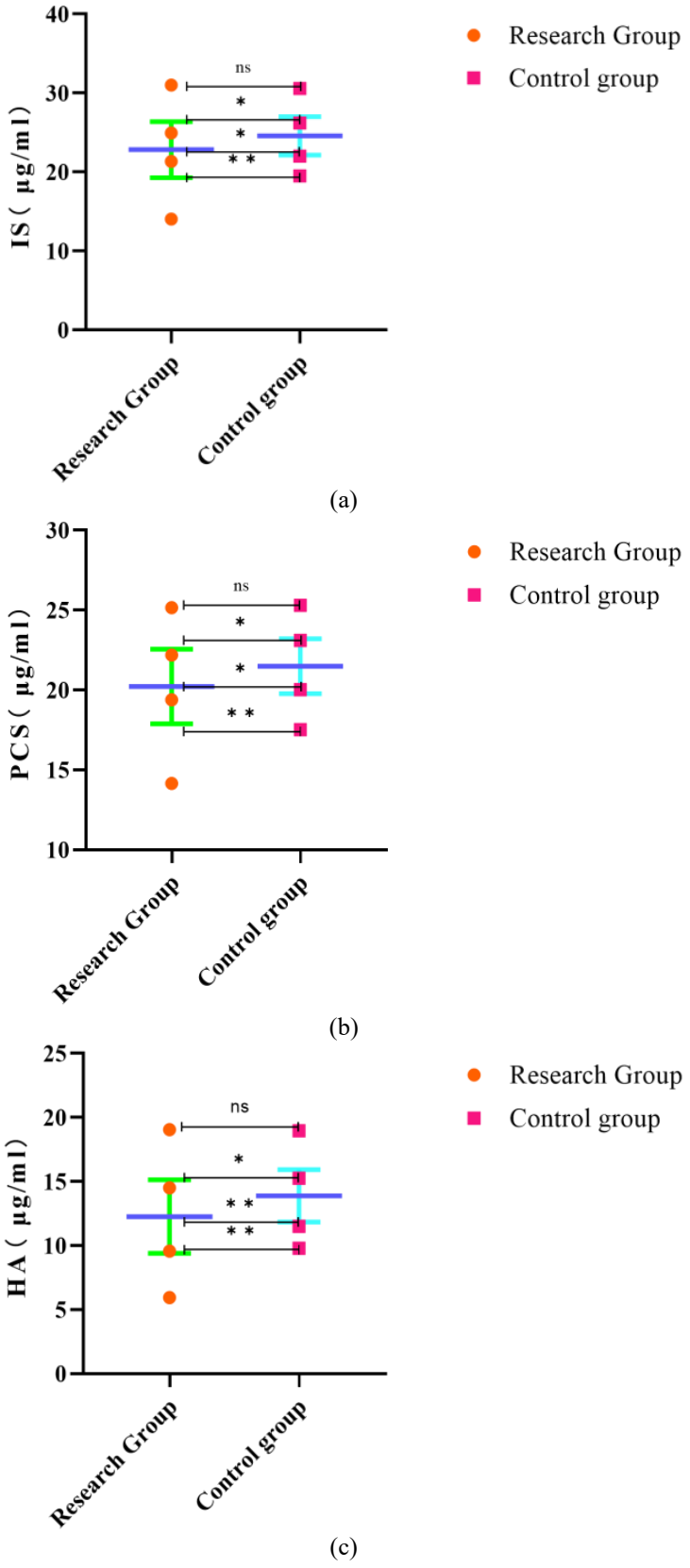

Figure 2. *IS, PCS and HA levels after treatment in different time periods. (a) IS index level; (b) PCs index level; (c) HA index level. Pink is the control group, yellow is the research group, and the horizontal line is the difference*

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Table 3. *Clearance effect comparison of serum protein binding toxins at different periods (x ± s)*

Group	n	IS (μ g/ml)			
		T0	T1	T2	T3
Research group	30	31.02 ± 9.85	24.94 ± 3.46[a]	21.35 ± 2.29[ab]	14.05 ± 3.01[abc]
Control group	30	30.58 ± 10.26	26.23 ± 5.01[a]	22.01 ± 1.18[ab]	19.52 ± 2.19[abc]
X^2/t		0.293	2.002	2.428	13.914
P		0.770	0.047	0.016	0.000
Group	**n**	**PCS (μ g/ml)**			
		T0	**T1**	**T2**	**T3**
Research group	30	25.16 ± 10.23	22.19 ± 3.11[a]	19.39 ± 1.28[ab]	14.16 ± 1.84[abc]
control group	30	25.31 ± 9.89	23.11 ± 2.84[a]	20.02 ± 2.11[ab]	17.52 ± 2.01[abc]
X^2/t		0.100	2.067	2.412	11.662
P		0.921	0.040	0.017	0.000
Group	**n**	**HA (μ g/ml)**			
		T0	**T1**	**T2**	**T3**
Research group	30	19.05 ± 5.84	14.51 ± 2.51[a]	9.58 ± 1.74[ab]	5.94 ± 1.37[abc]
Control group	30	18.97 ± 5.97	15.26 ± 1.26[a]	11.52 ± 2.01[ab]	9.81 ± 2.01[abc]
X^2/t		0.091	2.531	6.901	15.035
P		0.928	0.012	0.000	0.000

In T0 time, [a]$P < 0.05$, [ab]$P < 0.01$, [abc]$P < 0.01$; T1, [b]$P < 0.05$; T2 time, [c]$P < 0.01$

Comparison of 14 d survival rate between the two groups

From T0 to T4, there were 4 deaths in the research group, 1 case in 3-5 days and 1 case in 14 days; Control group had 11 cases. Among these cases, 2 deaths occurred on the third day, 1 death occurred on the fourth day, 4 deaths occurred on the fifth day, 1 death occurred on the sixth day, 1 death occurred on the eighth day, 1 death occurred on the ninth day, and 1 death occurred on the tenth day. Kaplan Meier method product limit method analyzed the survival of tumor free survival events, and the Logrank test compared survival rates. Through comparison, it is known that: $\chi^2 = 4.176$, $P = 0.041$. Difference showed in the survival rate in *Table 4* and *Figure 3*.

Table 4. *Mean and median survival*

Factor	Average value	SE	95% CI mean
Control group	10.967	0.768	9.461-12.472
Research group	13.000	0.635	11.756-14.244
Whole	11.983	0.507	10.989-12.978

Compared with the research group with hybrid blood purification, survival rate of control group with hemoperfusion was lower by the end of 14 days ($P < 0.05$), and survival rates of two groups were shown in *Figure 3*; It can be seen that the death time of hemoperfusion and blood purification was concentrated in 3-10 days after admission.

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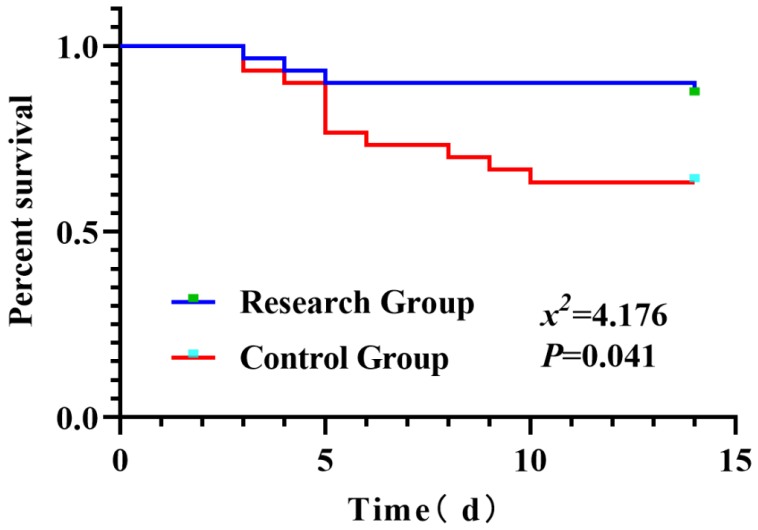

Figure 3. *Comparison of survival rate within 14 days between the two groups. The figure shows the survival status of the two groups of patients as of the 14th day of the study, in which blue is research group and red is control group. With observation time as horizontal axis and the survival rate as the vertical axis, the corresponding survival rate at each time point is connected together to draw a ladder curve*

Discussion

The symptoms of mushroom poisoning can occur within 1-2 h after eating, and the gastrointestinal tract, liver, kidney, blood coagulation and nerve functions of patients can be damaged to varying degrees. Because mushroom toxins are reversible for the damage of body tissues and organs, it is important to remove toxins in the body as soon as possible to reduce the damage to the functions of organs. Based on this, the development of toadstools is easy to develop MOSF (liver dysfunction is the most common). Relevant studies have shown that the mortality rate of mushroom poisoning with two organ failure is 50-60%, the mushroom mortality rate with three organ failure is as high as 80%, and with four or more organ failure is nearly 100% (Peng et al., 2018).

Toxins are mainly protein binding molecules (IS, PCS, HA). Protein binding toxoids are divided into three types according to the affinity of other albumin binding (Zhang et al., 2014). Among them, the protein binding rate of is and PCs is 95%, and it is mainly metabolites in the intestine and liver, while the protein binding rate of HA is 55%, which is mainly converted from benzoic acid in food. Protein bound toxins are widely found in vascular endothelial cells, etc. through organic anion transporters (OATs) in the body. Such protein bound toxins are mainly excreted in the urine through the kidney, When the toxic mushroom poisoning is complicated with MOSF, the residual levels of IS, PCS and HA in the kidney can be excluded, which can activate the renin angiotensin aldosterone (RAS) system, increase the level of inflammatory reaction and oxidative stress, lead to the differentiation and proliferation of renal interstitial fibroblasts, and aggravate the degree of renal failure, The decreased expression of oats in renal epithelial cells leads to the binding of ingestable proteins to toxoid in other organs, which further induces the aggravation of multiple organ failure (Acharya et al., 2022). The results showed that IS, PCS and HA levels gradually decreased from T1 to

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T3, and research group was lower ($P < 0.05$); It is consistent with the results of Onodera M (Onodera, 2013). It can be seen that HBPT can effectively remove protein binding toxins in patients with mushroom poisoning. The mechanism is mainly because CVVH can remove medium and large molecules, immune complexes and protein binding toxins, reduce the waterfall effect mediated by the body's inflammatory response, avoid the further impact of residual toxins on the body, and facilitate the recovery of hidden functions on the basis of the clearance of small molecules compatible with HP (Mingnan, 2018). HP perfusion equipment is mainly a kind of non-polar resin, which has strong adsorption and strong biocompatibility, but its removal effect of medium molecular toxins is not good and it is easy to reach saturation of the device; Compared with HP, CVVH has two complementary advantages: sustainability and macromolecular clearance. In addition, CVVH can accurately control the volume, maintain a slow speed to continuously remove solutes and liquids, so as to ensure the balance of water and electrolyte, and avoid brain edema caused by failure to control the volume. The hybrid application of the two can effectively remove large, medium and small inflammatory mediators and substances in the body, maintain the stability of cell membranes such as monocyte macrophages and endothelial cells, reduce the release and production of inflammatory mediators, stabilize the internal environment, and reduce the degree of MOSF (Zhong et al., 2023).

Amanita toxin in mushroom toxin has dual toxicity of kidney and liver. It can inhibit protein synthesis by blocking RNA polymerase II in liver, and up regulate the body's inflammatory and oxidative stress response. If not treated in time, patients are very easy to transition from SIRS (systemic inflammatory response syndrome) to MSOF, and even die. As for acute poisoning, liver and kidney function damage, and MOSF, the Chinese expert consensus on the diagnosis and treatment of acute poisoning (2016) recommended blood purification technology, but the application fields of different technologies are different (Zavaliy et al., 2021). The results showed that TBIL, ALT, Cr and BUN levels gradually decreased from Ti to T3, and research group was lower ($P < 0.05$). It is consistent with the research results of Stankiewicz et al. (2016). It can be seen that hybrid blood purification technology is effective for liver and kidney biochemical indexes of patients with mushroom poisoning. TBIL and AST are sensitive indicators of liver function damage. Mushroom consumption and delayed treatment time are in direct proportion to the degree of liver cell damage. Therefore, the change of their levels can become an important basis for liver damage. Liver injury after mushroom poisoning is the most serious and common. After clinical treatment, there is often a "false recovery period". Although the symptoms of patients have improved, the levels of TBIL and AST have increased gradually, which means that liver function has gradually deteriorated. Four observation time points are designed based on this study, which is convenient for full observation of liver injury. However, Cr and BUN are sensitive indicators of renal function damage, and their levels can be up-regulated, which can inhibit the filtration capacity of renal tubules and glomeruli, resulting in toxins that cannot be eliminated from the body, and then induce or aggravate other organ damage (Mokhtar et al., 2021). Although single hemoperfusion can remove some harmful substances under adsorption, on the one hand, some macromolecular substances cannot be removed. On the other hand, after a single HP treatment or regular HP treatment, the mycotoxins in the circulating blood temporarily decreased, but after several hours, the toxins distributed in various organs were released into the blood again and the blood concentration increased; In addition, during the interval of perfusion,

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protein binding toxins in the liver were repeatedly absorbed through the liver intestinal circulation, resulting in rebound and intermediate syndrome. This combined CVVH can increase dispersion and convection mode on the basis of adsorption, continuously reduce BUN and Cr levels, enhance body permeability and improve renal failure. The above protein binding toxins and the improvement of liver and kidney functions can ultimately achieve the goal that survival rate of research group is higher, so as to save patients lives and reduce organ failure degree.

In conclusion, hybrid blood purification can effectively treat protein binding toxins in patients with mushroom poisoning and MOSF, and alleviate further liver and kidney failure. Whether the combined use of HP and CVVH can repair neurological function needs to be further studied by expanding the sample size.

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