ISSN 2307-8960 (online)

World Journal of *Clinical Cases*

World J Clin Cases 2023 September 16; 11(26): 6031-6317

Published by Baishideng Publishing Group Inc

World Journal of Clinical Cases

Contents Thrice Monthly Volume 11 Number 26 September 16, 2023

World Journal of Clinical Cases

Thrice Monthly Volume 11 Number 26 September 16, 2023

Contents

SCIENTOMETRICS

CASE REPORT

World Journal of Clinical Cases

Thrice Monthly Volume 11 Number 26 September 16, 2023

Contents

Contents

Thrice Monthly Volume 11 Number 26 September 16, 2023

ABOUT COVER

Editorial Board Member of *World Journal of Clinical Cases*, Vikram K Mahajan, MD, Professor, Dermatology, Venereology and Leprosy, Dr. Radhakrishnan Government Medical College, Kangra 177001, Himachal Pradesh, India. vkm1@rediffmail.com

AIMS AND SCOPE

The primary aim of *World Journal of Clinical Cases* (*WJCC*, *World J Clin Cases*) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

INDEXING/ABSTRACTING

The *WJCC* is now abstracted and indexed in Science Citation Index Expanded (SCIE, also known as SciSearch®), Journal Citation Reports/Science Edition, Current Contents®/Clinical Medicine, PubMed, PubMed Central, Reference Citation Analysis, China National Knowledge Infrastructure, China Science and Technology Journal Database, and Superstar Journals Database. The 2023 Edition of Journal Citation Reports® cites the 2022 impact factor (IF) for *WJCC* as 1.1; IF without journal self cites: 1.1; 5-year IF: 1.3; Journal Citation Indicator: 0.26; Ranking: 133 among 167 journals in medicine, general and internal; and Quartile category: Q4.

RESPONSIBLE EDITORS FOR THIS ISSUE

Production Editor: *Hua-Ge Yu*; **Production Department Director:** *Xu Guo*; **Editorial Office Director:** *Jin-Lei Wang*.

NAME OF JOURNAL
World Journal of Clinical Cases

ISSN
ISSN 2307-8960 (online)

LAUNCH DATE
April 16, 2013

FREQUENCY
Thrice Monthly

PUBLICATION DATE
September 16, 2023

World Journal of Clinical Cases

Submit a Manuscript: https://www.f6publishing.com

World J Clin Cases 2023 September 16; 11(26): 6073-6082

DOI: 10.12998/wjcc.v11.i26.6073

ISSN 2307-8960 (online)

ORIGINAL ARTICLE

Retrospective Study

Continuous renal replacement therapy with oXiris® in patients with hematologically malignant septic shock: A retrospective study

Juan Wang, Shu-Run Wei, Tong Ding, Li-Ping Zhang, Zhi-Hua Weng, Ming Cheng, Yang Zhou, Meng Zhang, Fang-Jun Liu, Bei-Bei Yan, Dan-Feng Wang, Ming-Wen Sun, Wei-Xin Cheng

Specialty type: Hematology

Provenance and peer review: Unsolicited article; Externally peer reviewed.

Peer-review model: Single blind

Peer-review report's scientific quality classification

Grade A (Excellent): 0
Grade B (Very good): B
Grade C (Good): C
Grade D (Fair): 0
Grade E (Poor): 0

P-Reviewer: de Vries PS, United States; Nathaniel T, United States

Received: April 21, 2023
Peer-review started: April 21, 2023
First decision: June 14, 2023
Revised: July 4, 2023
Accepted: July 14, 2023
Article in press: July 14, 2023
Published online: September 16, 2023

Juan Wang, Shu-Run Wei, Tong Ding, Li-Ping Zhang, Zhi-Hua Weng, Ming Cheng, Yang Zhou, Meng Zhang, Fang-Jun Liu, Bei-Bei Yan, Dan-Feng Wang, Ming-Wen Sun, Intensive Care Unit, Hebei Yanda Hospital, Langfang 065201, Hebei Province, China

Wei-Xin Cheng, Department of Emergency, Peking University International Hospital, Beijing 102206, China

Corresponding author: Wei-Xin Cheng, MD, Doctor, Emergency Department, Peking University International Hospital, No. 1 Life Park Road, Life Science Park of Zhong Guancun, Changping District, Beijing 102206, China. 18911652172@163.com

Abstract

BACKGROUND

The mortality rate from septic shock in patients with hematological malignancies (HMs) remains significantly higher than that in patients without HMs. A longer resuscitation time would definitely be harmful because of the irreversibly immunocompromised status of the patients. Shortening the resuscitation time through continuous renal replacement therapy (CRRT) with oXiris® would be an attractive strategy in managing such patients.

AIM

To explore the effects of CRRT and oXiris® in shortening the resuscitation time and modifying the host response by reducing inflammation mediator levels.

METHODS

Forty-five patients with HM were diagnosed with septic shock and underwent CRRT between 2018 and 2022. Patients were divided into two groups based on the hemofilter used for CRRT (oXiris® group, n = 26; M150 group, n = 19). We compared the number of days of negative and total fluid balance after 7 d of CRRT between the groups. The heart rate, norepinephrine dose, Sequential Organ Failure Assessment (SOFA) score, and blood lactic acid levels at different time points in the two groups were also compared. Blood levels of inflammatory mediators in the 26 patients in the oXiris® group were measured to further infer the possible mechanism.

RESULTS

The average total fluid balance after 7 d of CRRT in the oXiris® group was

significantly lower than that of patients in the M150 hemofilter group. The SOFA scores of patients after CRRT with oXiris® therapy were significantly lower than those before treatment on day 1 (d1), d3 and d7 after CRRT; these parameters were also significantly lower than those of the control group on d7. The lac level after oXiris® therapy was significantly lower than that before treatment on d3 and d7 after CRRT. There were no significant differences in the above parameters between the two groups at the other time points. In the oXiris® group, procalcitonin levels decreased on d7, whereas interleukin-6 and tumor necrosis factor levels decreased significantly on d3 and d7 after treatment.

CONCLUSION
CRRT with oXiris® hemofilter may improve hemodynamics by reducing inflammatory mediators and playing a role in shortening the resuscitation period and decreasing total fluid balance in the resuscitation phases.

Key Words: Hematological malignancy; Septic shock; oXiris® hemofilter; Blood purification; Fluid balance

Core tip: oXiris® is a high permeability polyacrylonitrile-based membrane with enhanced endotoxic blood adsorption and cytokine removal; it can be used either in continuous venovenous hemofiltration or continuous venovenous hemodiafiltration. In this study, we explored its effects of shortening the resuscitation time and modifying the host response by reducing levels of inflammatory mediators.

Citation: Wang J, Wei SR, Ding T, Zhang LP, Weng ZH, Cheng M, Zhou Y, Zhang M, Liu FJ, Yan BB, Wang DF, Sun MW, Cheng WX. Continuous renal replacement therapy with oXiris® in patients with hematologically malignant septic shock: A retrospective study. *World J Clin Cases* 2023; 11(26): 6073-6082
URL: https://www.wjgnet.com/2307-8960/full/v11/i26/6073.htm
DOI: https://dx.doi.org/10.12998/wjcc.v11.i26.6073

INTRODUCTION

The mortality rate from septic shock in patients with hematological malignancies (HMs) is significantly higher in the disease-related immunocompromised state or its management[1]. Septic shock is a subset of sepsis, clinically identified as a requirement for vasopressors to maintain the mean arterial blood pressure (MAP) ≥ 65 mmHg despite adequate fluid resuscitation and a lactate level > 2 mmol/L[2,3]. It is useful to consider different phases of fluid management in patients with septic shock over the course of acute illness, which are the resuscitation, optimization, stabilization, and evacuation phases[4]. However, patients with HM admitted to the intensive care unit (ICU) have an increased risk of hospital-acquired infection, which can deteriorate the patient's condition and lead to high mortality[5]. Shortening the resuscitation period, and therefore, shortening the time spent in the ICU by safely adjusting the fluid balance with continuous renal replacement therapy (CRRT) would be an attractive strategy, especially for such patients. Moreover, rapid improvement has been reported in the hemodynamic status of patients with hematologically malignant septic shock treated by CRRT using oXiris®[6]. oXiris® is a high-permeability polyacrylonitrile (AN69)-based membrane (oXiris®, Gambro) with enhanced endotoxic blood adsorption and cytokine removal[7] and can be used either in continuous venovenous hemofiltration (CVVH) or continuous venovenous hemodiafiltration (CVVHDF). This study explored its effects of shortening the resuscitation time and modifying the host response by reducing levels of inflammatory mediators.

MATERIALS AND METHODS

This retrospective cohort study was conducted in the ICU of Hebei Yanda Hospital in China between January 1, 2018 and January 1, 2022. All patients were treated at the Ludaopei Hebei Yanda Hospital (a special hematological hospital) for HM before being diagnosed with septic shock and admitted to the ICU. Blood purification, as a standard approach to manage septic shock, was implemented as a host response modifier, using either the oXiris® membrane (observation group, n = 26) or the standard M150 hemofilter (AN69 membrane, control group, n = 19). All data were obtained from the electronic medical records of Hebei Yanda Hospital. This study was approved by the Ethics Committee of the hospital according to Chinese legislation.

Demographic data (sex and age), underlying disease, duration after the primary treatment, Acute Physiology and Chronic Health Evaluation II score on the day of admission to the ICU, infection site, possible pathogen, whether mechanical ventilation was used, length of ICU stay, survival, or death in the ICU were recorded. Blood, sputum, urine, and cerebrospinal fluid samples were obtained for bacterial cultures. We compared the days with negative balance

(output > input) and total fluid balance (total liquid input minus total liquid output) 7 d after CRRT between the groups. The heart rate (HR), norepinephrine (NE) dose, Sequential Organ Failure Assessment (SOFA) score, and lactate blood levels at different time points in the two groups were also compared. Blood levels of inflammatory mediators [procalcitonin (PCT), interleukin (IL)-6, tumor necrosis factor (TNF)-α] in the 26 patients in the oXiris® group were evaluated to further infer the possible mechanism. Three days were needed to obtain a negative balance for the oXiris® group and 7 d for the control group. Renal therapy modality (CVVH or CVVHDF), the prescribed dialysis dosage, anticoagulant (citrate, heparin, or none), total duration of RRT during the ICU stay, and the number and duration of CRRT sessions performed with oXiris® membrane. The time in hours between ICU admission and the initiation of blood purification with the oXiris® membrane was also recorded.

Inclusion and exclusion criteria

The inclusion criteria were patients who: (1) Were diagnosed with HM; (2) were in septic shock on admission (met the diagnostic criteria of sepsis 3.0[2]); (3) received CRRT treatment (oXiris® filter or M150 filter) after admission; and (4) signed the informed consent, or their representative family members did. The exclusion criteria were as follows: (1) Failure to meet the inclusion criteria; and (2) ICU stay time < 48 h. The oXiris® group comprised 26 patients who met the inclusion criteria and underwent CRRT using the oXiris® membrane as a hemofilter. The control group included 19 patients who met the inclusion criteria but underwent CRRT using a standard M150 hemofilter (AN69 membrane).

Septic shock management protocol

All patients received standard treatment based on the Sepsis Bundle[3], including initial fluid resuscitation while pursuing source control, obtaining further laboratory results, and attaining more precise measurements of their hemodynamic status. All patients received organ function support (including invasive and noninvasive mechanical ventilation). The underlying condition (HM) of all patients was determined by the chief director of the original hematological department.

Blood purification protocol

A temporary hemodialysis catheter in the femoral vein (12 Fr-20 cm for adults and 8.5 Fr-11 cm for children; Baihe Medical, Guangzhou, China) or internal jugular vein (11.5 Fr-15 cm for adults; Baihe Medical) was inserted under echographic guidance. CRRT was performed using either CVVHDF or CVVH. The adsorbing membrane oXiris® (Baxter, USA) or the M150 hemofilter (AN69 membrane; Baxter) was used through a Prismaflex CRRT system (Baxter) for the observation and control groups, respectively. Blood flow rates were designed to be 150–180 mL/min for adults and 50–100 mL/min for children, and the prescribed dialysis doses were in the range of 25–30 mL/kg/h based on tolerance. Citrate was used as an anticoagulant in the dialysis circuit *via* continuous infusion. The filters were changed either after clotting or after 72 h.

Statistical analysis

SPSS analyses were performed using IBM SPSS Statistics for Windows version 25. Normal distribution data are represented as mean ± SD and non-normal distribution data are represented by the quartile [p50 (p25, p75)]. Differences between the two groups were compared by independent sample *t* test; differences at different time points within a group were compared by repeated measurement analysis of variance; and multiple comparisons were made using the Bonferroni method. Differences between the two groups were compared using the nonparametric Mann–Whitney *U* test; differences at different time points within a group were compared using the nonparametric Friedman analysis; and multiple comparisons were made using the Bonferroni correction. The χ^2 test was used to compare the differences in numerical data, and the Mann–Whitney *U* test was used to compare the differences in non-normal distribution data; for all analyses, $P < 0.05$ was considered statistically significant.

RESULTS

Patients condition

Overall, 45 patients were included in this study, with 26 in the observation group and 19 in the control group (Table 1). In the observation group, 69.23% (18 patients) were admitted after hematopoietic stem cell transplantation (HSCT), 23.08% (6 patients) after chemotherapy, and 7.69% (2 patients) after chimeric antigen receptor T-cell immunotherapy (CAR-T). Blood cultures tested positive for bacteria in 13 cases (50%), severe pneumonia in eight (30.77%), liver abscess in two (7.69%), severe acute pancreatitis in two (7.69%), and splenic abscess in one (3.85%). Nineteen patients (73.08%) were supported by invasive mechanical ventilation and seven (26.92%) by either a high-flow nasal cannula (HFNC) or face mask. The length of ICU stay ranged from 3 to 87 d and 17 patients (65.38%) survived in the ICU (mortality rate 34.6%).

In the control group, 13 patients (68.42%) were admitted to the ICU after HSCT, five patients (19.23%) were treated with chemotherapy, and one (5.26%) was treated with CAR-T before ICU admission. Blood cultures tested positive for bacteria in 12 cases, severe pneumonia in five, skin soft-tissue infection in one, and splenic abscess in one. Of the 19 patients, 14 (73.6%) received invasive mechanical ventilation, whereas the others received either an HFNC or facemask oxygen. The length of ICU stay for these patients ranged from 3 to 49 d. Of the 19 patients, 11 died and eight survived, resulting in a mortality rate of 57.8% (Table 1).

Table 1 Description of the patients included in the two groups, *n* (%)

	oXiris® group (*n* = 26)	CRRT group (*n* = 19)	χ^2	*P* value
Management before			0.309[f]	1
HSCT	69.23 (18)	68.42 (13)		
Chemotherapy	23.08 (6)	19.23 (5)		
CAR-T	7.69 (2)	5.26 (1)		
Source of infection			4.218[f]	0.592
Positive blood culture	50 (13)	63.15 (12)		
Severe pneumonia	30.77 (8)	26.32 (5)		
Liver abscess	7.69 (2)			
Severe acute pancreatitis	7.69 (2)			
Splenic abscess	3.85 (1)	5.26 (1)		
Skin soft tissue infection		5.26 (1)		
Respiratory support			0.002	0.964
Invasive ventilation	73.08 (19)	73.6 (14)		
HFNC or face mask	26.92 (7)	26.4 (5)		
APACHE II	26.5 (20.75, 32.25)	29.5 (22.0, 31.25)	-0.431[z]	0.667
Outcome				
ICU stay (d)	9.5 (5.75, 22.5)	10.5 (6.5, 24.0)	0[z]	1
Mortality (%)	34.60	57.80	2.409	0.121

[f]Fisher's exact test.
[z]Mann–Whitney *U* test.
APACHE II: Acute physiology and chronic health evaluation II score; CAR-T: Chimeric antigen receptor T-cell immunotherapy; HSCT: Hematopoietic stem cell transplantation; ICU: Intensive care unit.

CRRT condition

Among the 26 patients in the oXiris® group, 18 received CVVH and eight received CVVHDF; 25 patients received citrate anticoagulant and only one did not receive any anticoagulation treatment. The start-up time of oXiris® was 0.5–48 h, and the number of oXiris® membranes used was 1–4. The total duration of the oXiris®–CRRT ranged from 24 to 215 h. Among the 19 patients in the CRRT group, 15 received CVVH and four received CVVHDF. Anticoagulation therapy was administered to 19 patients. The start-up time for CRRT was 1–28 h and the number of CRRT membranes used was 1–5. The total duration of oXiris®–CRRT therapy was 21–256 h (Table 2).

Patients' fluid balance

We measured the fluid balance of patients treated with oXiris® and those in the control group during the first 7 d after CRRT commencement. We found that the oXiris® group had negative fluid balance from day 3 (d3) (273.55 ± 981.09 mL), whereas the control group reached a negative fluid balance on d7 (Figure 1). The total fluid balance in the oXiris® group was 213.54 ± 2243.22 mL compared with that of the control group, which was 3347.58 ± 4743.07 mL. The total fluid balance in the oXiris® group was significantly lower than that in the CRRT group (t = 3.034, P = 0.006) (Figure 2). The proportion of negative balance on d3 in the oXiris® group was 46.2%, and the proportion of negative balance on d3 in the CRRT group was 26.3%. The proportion of patients with a negative balance on d4 in the oXiris® group was 57.7%, and the proportion of negative balance on d4 in the CRRT group was 26.3%. On d4 of blood purification, the proportion of patients with a negative balance in the oXiris® group was significantly higher than that in the CRRT group (P = 0.036, Table 3).

Patient hemodynamic parameters and organ function

The MAP of all patients was maintained above 65 mmHg during both types of treatment. The HR, NE dose, lactate levels, and SOFA scores of patients after CRRT with oXiris® therapy were significantly lower than those before treatment (HR: F = 6.743, P = 0.004; NE: H = 3 0.865, P < 0.001; SOFA: F = 7.864, P = 0.002) on d1, d3 and d7 after CRRT. The lactate levels of patients were significantly lower after CRRT with oXiris® therapy than before treatment (H = 21.963, P < 0.001) on d3 and d7 after CRRT. The HR, NE dose, and SOFA score of the oXiris® group were significantly higher than those of the control group on d7 (HR: t = 3.621, P = 0.001; NE: z = 2.931, P = 0.003; SOFA: t = 3.096, P = 0.004). There were no significant differences in the above indices between the two groups at other time points, and there were no significant differences in

Table 2 Continuous renal replacement therapy treatment condition, *n* (%)

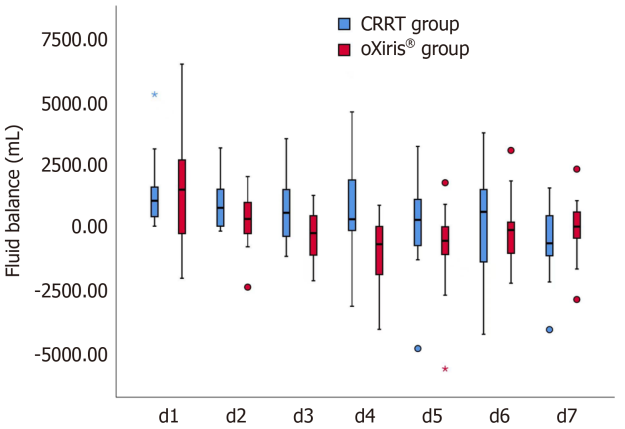
0.530 (χ^2)	oXiris® group (*n* = 26)	CRRT group (*n* = 19)	χ^2	*P* value
CRRT			0.530	0.467
CVVH	18 (69.2)	15 (78.9)		
CVVHDF	8 (30.8)	4 (21.1)		
citrate	96.15 (25)	100	0.747[f]	1
No anticoagulation	3.65 (1)	0	0.747[f]	1
Time between ICU admission and initiation of blood	5 (3, 21.25)	15 (3, 22)	-0.761[z]	0.447
Total CRRT hours	58 (48, 88.5)	86 (39, 122)	-0.726[z]	0.468
Sessions	2 (1, 2)	2 (1, 3)	-1.141[z]	0.254

[f]Fisher's exact test.
[z]Mann–Whitney *U* test.
CRRT: continuous renal replacement therapy; CVVH: Continuous venovenous hemodiafiltration; CVVHDF: Continuous venovenous hemodiafiltration; ICU: Intensive care unit.

Table 3 Proportion of negative balance of the two groups on d3 and d4, *n* (%)

	oXiris® group (*n* = 26)	CRRT group (*n* = 19)	χ^2	*P* value
d3	12/26 (46.2)	5/19 (26.3)	1.838	0.175
d4	15/26 (57.7)	5/19 (26.3)	4.377	0.036[a]

[a]Indicates statistically significant difference compared with the control group ($P < 0.05$).
CRRT: Continuous renal replacement therapy; d3 and d4, days 3 and 4.



DOI: 10.12998/wjcc.v11.i26.6073

Figure 1 Fluid balance at different times. d1, d2, d3, d4, d5, d6, and d7 represent time after initiation of continuous renal replacement therapy. Asterisks and circles indicate outliers. CRRT: Continuous renal replacement therapy.

the lactate levels between the two groups at any of the specified time points. There were no significant differences in the above indices between different time points in the CRRT group (HR: $F = 0.686$, $P = 0.566$; NE: $H = 3.488$, $P = 0.322$; SOFA: $F = 1.461$, $P = 0.24$; lactate: $H = 2.836$, $P = 0.418$) (Figure 3).

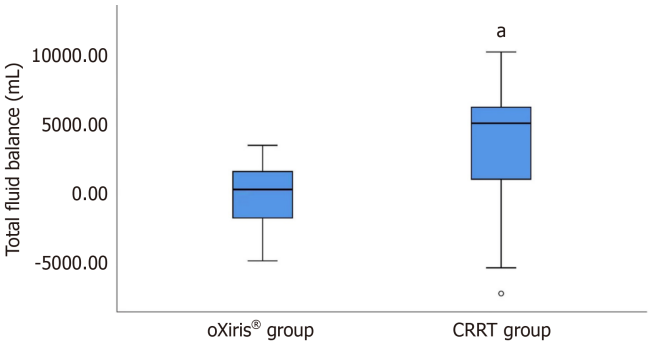
Patient infection indicators

The procalcitonin (PCT) before treatment was 15 ± 21 ng/mL; however, 7 d after treatment, it decreased to 3 ± 5 ng/mL ($t = 2.235$, $P = 0.004$). After oXiris® treatment, IL-6 and TNF-α levels were significantly reduced at 3 d (IL-6: $t = 4.766$, $P < 0.001$; TNF-α: $t = 3.369$, $P < 0.001$) and 7 d (IL-6: $t = 4.805$, $P < 0.001$; TNF-α: $t = 3.998$, $P < 0.001$) after treatment (Table 4).

Table 4 Perfusion computed tomography and blood cytokine levels in the oXiris® group

	d0	d3	d7
PCT (ng/mL)	15 ± 21	14 ± 23	3 ± 5[a]
IL-6 (pg/mL)	2871 ± 2063	32 ± 16[a]	9 ± 7[a]
TNF-α (pg/mL)	12 ± 10	2 ± 1.8[a]	0.3 ± 0.4[a]

[a]Indicates a statistically significant difference compared with the 0 day ($P < 0.05$).
PCT: Perfusion computed tomography; IL-6: Interleukin 6; TNF-α: Tumor necrosis factor .



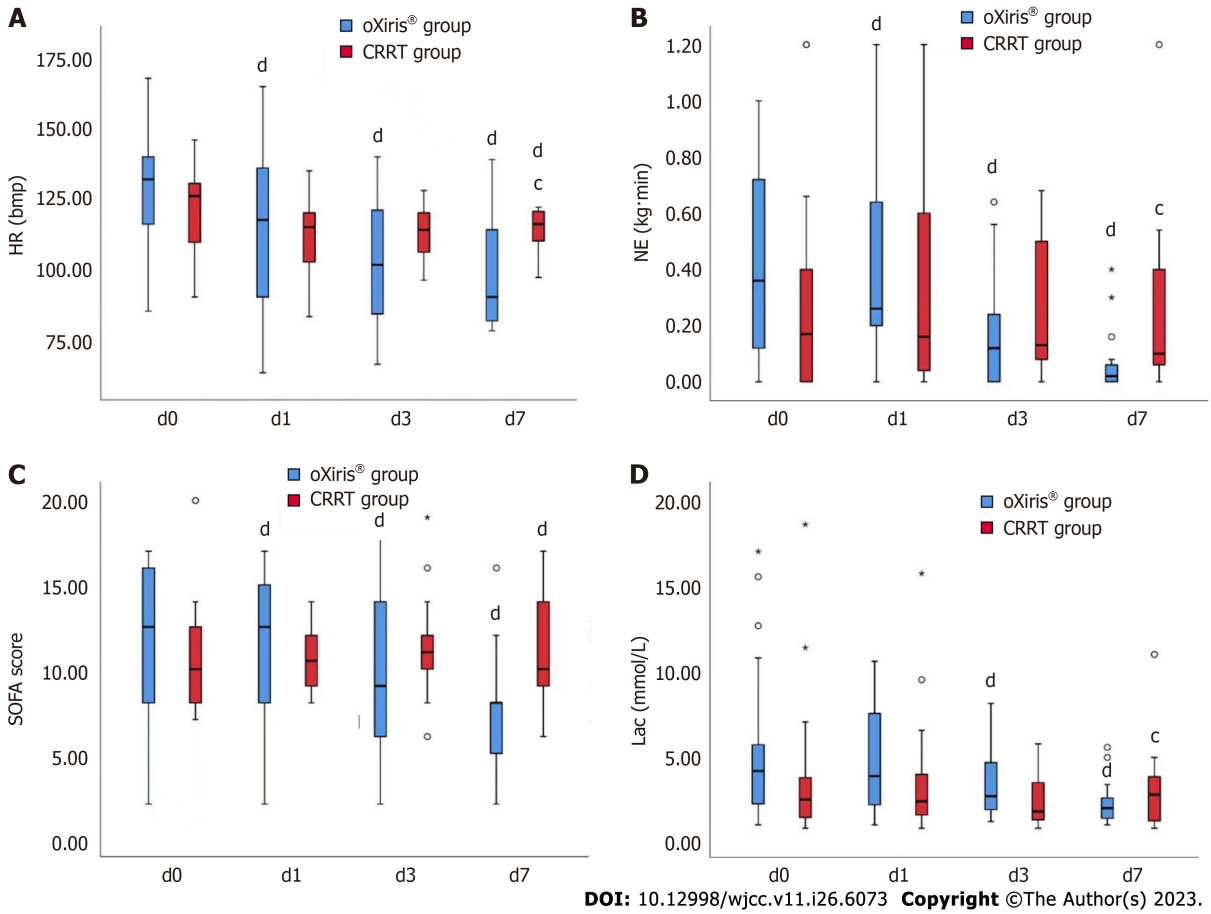
DOI: 10.12998/wjcc.v11.i26.6073

Figure 2 Total fluid balance after 7 d of continuous renal replacement therapy in the two groups. [a]Indicates a statistical difference compared with the control group ($P < 0.05$). Circle indicates an outlier. CRRT: Continuous renal replacement therapy.

DISCUSSION

Despite advances in the identification and treatment of sepsis, the outcome remains poor in patients with HM. Research published by Manjappachar *et al*[8] examined the effect of septic shock on patients with HM. They found that the mortality rate was 67.8% at 28 d and only 19.4% of the patients remained alive after 90 d[8]. Sepsis management includes three major aspects: infection control, hemodynamic stabilization, and host response modulation. Extracorporeal blood purification, using different systems to remove excess mediators and/or endotoxins, has been proposed as a host response modification method for the management of septic shock[9]. To date, a few studies have shown that some adsorption materials (polymyxin adsorption material[10,11], cytosorb filter[12], AN69 ST[13], and oXiris® filter[14]) affect septic shock treatment. The oXiris® membrane is a product based on the AN69 hydrogel structure. Several retrospective observational studies and two prospective observational studies have demonstrated the benefits of oXiris®[13,15]. Case data from these observational studies were mostly collected while the patients were under anesthesia or in the surgical intensive care[16]. Most of the results have confirmed that oXiris® endotoxin adsorption can effectively remove endotoxins and cytokines, reduce the inflammatory response, improve hemodynamics and the SOFA score when used during treatment of septic shock[12,17]. In a French two-center observational study, 31 patients with septic shock who were treated with oXiris® showed significant improvements in the hemodynamics and lactate levels, especially patients with abdominal or Gram-negative bacterial infections [18]. In a single-center study, CRRT with an oXiris® blood filter improved hemodynamic parameters in 35 patients with sepsis and severe renal insufficiency. The NE dose requirement, HR, and lactate levels decreased significantly [12,17,19,20]. In the current study, the oXiris®-endotoxin adsorption device was used in patients with septic shock and HM. In the observation arm, we found improved hemodynamics, as previously reported. The NE dose requirement, HR, and lactate levels decreased significantly (Figure 3). Moreover, we found that with the same septic shock protocol (international guidelines for the management of sepsis and septic shock 2021)[3], CRRT with oXiris® hemofilter resulted in negative fluid balance 4 d earlier than that by conventional treatment (Figure 1). The total fluid balance after 7 d of management was significantly lower in the observation group than in the control group (Figure 2). We infer that this may be a clinical sign after modifying the host response effectively. A positive fluid balance at 3 d is associated with significantly increased mortality[20]. Patients admitted to the ICU are at increased risk of developing hospital-acquired infection. A diagnosis of cancer alone increases the risk of sepsis by 3–5-fold, which further increases the risk of nosocomial infection, subsequently deteriorating results and leading to high mortality[5]. Therefore, it is particularly valuable for immunocompromised patients.

Studies have shown that the SOFA score can be an effective indicator for assessing the prognosis of HM as there may be a strong association between the mortality rate of patients admitted to the ICU and HM[21]. A retrospective cohort study conducted in China also found that the initial SOFA score on the day of admission to the ICU, coupled with the changes in the SOFA score during admission, was associated with survival outcomes, with a downward trend in the SOFA score predicting better patient outcomes[22]. Shum *et al*[23] found that patients with septic shock who were treated with oXiris® had a significant decrease in the SOFA scores at 48 h. Similarly, Adamik *et al*[24] found that the SOFA scores



DOI: 10.12998/wjcc.v11.i26.6073

Figure 3 Trends in the changes in the heart rate, norepinephrine dose, Sequential Organ Failure Assessment score, and lactic acid in the two groups. A: Trends in the changes in the heart rate in the two groups; B: Trends in the changes in the norepinephrine dose in the two groups; C: Trends in the changes in the Sequential Organ Failure Assessment score in the two groups; D: Trends in the changes in the lactic acid in the two groups. oXiris® group (n = 26), control group (n = 19). Asterisks and circles indicate outliers; [c]Indicates a statistically significant difference compared with control group (P < 0.05); [d]Indicates a statistically significant difference compared with d0 in the oXiris® group (P < 0.05).

decreased from 14 to 7 at 3 d after oXiris® treatment. Our study demonstrated that the SOFA scores declined significantly on d3 and d7 post-treatment (Figure 3). PCT, IL-6 and TNF-α levels were significantly elevated before treatment. After oXiris® treatment, IL-6 and TNF-α levels were significantly lower than before treatment and PCT level in the blood was significantly decreased (Table 4). Turani *et al*[14] found that the use of the oXiris® filter significantly reduced the levels of circulating endotoxins IL-6 and IL-10. Broman *et al*[25] found significant reductions in endotoxin, IL-6, IL-8, TNF-α, and interferon-γ levels after treatment using oXiris® filter compared with a conventional filter.

The main limitations of the present study were its retrospective design and small number of study subjects. The others include: (1) No comparison of the changes in endotoxin levels before and after oXiris® treatment; since endotoxin activity was not measured in this study, the changes in endotoxin levels before and after oXiris® treatment could not be compared; (2) different treatments; the study subjects included in this study received different types of treatment, such as HSCT, chemotherapy, or CAR-T, perhaps representing different endotypes of septic shock; and (3) no evaluation of the life expectancy of the oXiris® filter. Currently, some experts suggest that the filter should be replaced within 24 h to achieve optimal results. Shum *et al*[23] used an oXiris® filter for 61 h, which effectively improved hemodynamics and organ function. Turani *et al*[14] applied each set of filters for approximately 24 h in their study. In our study, the mean time for each filter was 42 h. Further research is required to determine the optimal time for each filter and the overall optimal number/duration of treatments.

CONCLUSION

CRRT with an oXiris® hemofilter may be used as a host response modulation method in patients with septic shock and HM. This may improve the hemodynamic parameters by reducing the levels of inflammatory mediators. Clinically, it might play a role in shortening the resuscitation period and decreasing the total fluid balance in the resuscitation phase, thus reducing edema and decreasing the rate of hospital-acquired infection.

ARTICLE HIGHLIGHTS

Research background

The mortality rate from septic shock in patients with hematological malignancies (HMs) remains significantly higher than that in patients without HMs.

Research motivation

Continuous renal replacement therapy (CRRT) with oXiris® might shorten the time from resuscitation to fluid negative balance. It may also improve hemodynamic parameters and decrease the blood levels of inflammatory mediators.

Research objectives

This study aimed to explore the effects of CRRT and oXiris® in shortening the resuscitation time as well as a modifier for the host response by reducing levels of inflammation mediators.

Research methods

Patients with HMs who were diagnosed with septic shock and underwent CRRT were divided into two groups based on the hemofilter used. The days with negative balance and total fluid balance after 7 d of CRRT were compared between the groups. The heart rate, norepinephrine dose, Sequential Organ Failure Assessment (SOFA) score, and blood lactic acid levels at different time points in the two groups were also compared.

Research results

The average total fluid balance after 7 d of CRRT in the oXiris® group was significantly lower than that of patients in the M150 hemofilter group, and the SOFA scores of patients after CRRT with oXiris® therapy were significantly lower than those before treatment on day 1 (d1), d3 and d7 after CRRT; these parameters were also significantly lower than those of the control group on d7. Lactate levels after CRRT with oXiris® therapy were significantly lower than those before treatment on d3 and d7 after CRRT. In the oXiris® group, procalcitonin levels decreased on d7, and interleukin-6 and tumor necrosis factor- levels reduced significantly on both d3 and d7 after oXiris® treatment.

Research conclusions

CRRT with oXiris® hemofilter might improve the hemodynamic parameters and play a role in shortening the resuscitation period, thus decreasing the total fluid balance in the resuscitation phase.

Research perspectives

CRRT with an oXiris® hemofilter may be used as a host response modulation method in patients with septic shock and HM. This may improve hemodynamic parameters by reducing the levels of inflammatory mediators.

FOOTNOTES

Author contributions: Wang J and Cheng WX were responsible for research design, statistics and paper writing; Wei SR, Ding T, Zhang LP, Weng ZH, Cheng M, Zhou Y, Zhang M, Liu FJ, Yan BB, Wang DF, and Sun MW were responsible for the collation of data; all authors proofed the manuscript.

Supported by Hebei Health Science and Education Project, No. 20200852.

Institutional review board statement: This study was approved by the hospital's ethics committee.

Informed consent statement: Patients were not required to provide informed consent for the study because the analysis used anonymous clinical data that were obtained after each patient or their representative family members agreed to the treatment by written consent.

Conflict-of-interest statement: The authors declare no conflicts of interest.

Data sharing statement: Some or all data, models, or codes generated or used during the study are available from the corresponding author upon request.

Country/Territory of origin: China

ORCID number: Juan Wang 0009-0007-0201-7470; Wei-Xin Cheng 0000-0003-1764-0779.

S-Editor: Liu JH

L-Editor: Kerr C
P-Editor: Xu ZH

REFERENCES

1 **Al-Zubaidi N**, Shehada E, Alshabani K, ZazaDitYafawi J, Kingah P, Soubani AO. Predictors of outcome in patients with hematologic malignancies admitted to the intensive care unit. *Hematol Oncol Stem Cell Ther* 2018; **11**: 206-218 [PMID: 29684341 DOI: 10.1016/j.hemonc.2018.03.003]
2 **Singer M**, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, Bellomo R, Bernard GR, Chiche JD, Coopersmith CM, Hotchkiss RS, Levy MM, Marshall JC, Martin GS, Opal SM, Rubenfeld GD, van der Poll T, Vincent JL, Angus DC. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA* 2016; **315**: 801-810 [PMID: 26903338 DOI: 10.1001/jama.2016.0287]
3 **Evans L**, Rhodes A, Alhazzani W, Antonelli M, Coopersmith CM, French C, Machado FR, Mcintyre L, Ostermann M, Prescott HC, Schorr C, Simpson S, Wiersinga WJ, Alshamsi F, Angus DC, Arabi Y, Azevedo L, Beale R, Beilman G, Belley-Cote E, Burry L, Cecconi M, Centofanti J, Coz Yataco A, De Waele J, Dellinger RP, Doi K, Du B, Estenssoro E, Ferrer R, Gomersall C, Hodgson C, Møller MH, Iwashyna T, Jacob S, Kleinpell R, Klompas M, Koh Y, Kumar A, Kwizera A, Lobo S, Masur H, McGloughlin S, Mehta S, Mehta Y, Mer M, Nunnally M, Oczkowski S, Osborn T, Papathanassoglou E, Perner A, Puskarich M, Roberts J, Schweickert W, Seckel M, Sevransky J, Sprung CL, Welte T, Zimmerman J, Levy M. Surviving sepsis campaign: international guidelines for management of sepsis and septic shock 2021. *Intensive Care Med* 2021; **47**: 1181-1247 [PMID: 34599691 DOI: 10.1007/s00134-021-06506-y]
4 **Malbrain MLNG**, Van Regenmortel N, Saugel B, De Tavernier B, Van Gaal PJ, Joannes-Boyau O, Teboul JL, Rice TW, Mythen M, Monnet X. Principles of fluid management and stewardship in septic shock: it is time to consider the four D's and the four phases of fluid therapy. *Ann Intensive Care* 2018; **8**: 66 [PMID: 29789983 DOI: 10.1186/s13613-018-0402-x]
5 **Yerzhan A**, Razbekova M, Merenkov Y, Khudaibergenova M, Abdildin Y, Sarria-Santamera A, Viderman D. Risk Factors and Outcomes in Critically Ill Patients with Hematological Malignancies Complicated by Hospital-Acquired Infections. *Medicina (Kaunas)* 2023; **59** [PMID: 36837416 DOI: 10.3390/medicina59020214]
6 **Hawchar F**, Rao C, Akil A, Mehta Y, Rugg C, Scheier J, Adamson H, Deliargyris E, Molnar Z. The Potential Role of Extracorporeal Cytokine Removal in Hemodynamic Stabilization in Hyperinflammatory Shock. *Biomedicines* 2021; **9** [PMID: 34356830 DOI: 10.3390/biomedicines9070768]
7 **Zhang C**, Sun B, Lin T, Wang W, Jin Y, Liu S, Zhang J, Wang Z, Liu C. [Usage of oXiris hemofilter for septic shock patients: a single-center experience]. *Zhonghua Wei Zhong Bing Ji Jiu Yi Xue* 2019; **31**: 1531-1534 [PMID: 32029043 DOI: 10.3760/cma.j.issn.2095-4352.2019.12.019]
8 **Manjappachar NK**, Cuenca JA, Ramírez CM, Hernandez M, Martin P, Reyes MP, Heatter AJ, Gutierrez C, Rathi N, Sprung CL, Price KJ, Nates JL. Outcomes and Predictors of 28-Day Mortality in Patients With Hematologic Malignancies and Septic Shock Defined by Sepsis-3 Criteria. *J Natl Compr Canc Netw* 2022; **20**: 45-53 [PMID: 34991066 DOI: 10.6004/jnccn.2021.7046]
9 **Vincent JL**, van der Poll T, Marshall JC. The End of "One Size Fits All" Sepsis Therapies: Toward an Individualized Approach. *Biomedicines* 2022; **10** [PMID: 36140361 DOI: 10.3390/biomedicines10092260]
10 **Cruz DN**, Antonelli M, Fumagalli R, Foltran F, Brienza N, Donati A, Malcangi V, Petrini F, Volta G, Bobbio Pallavicini FM, Rottoli F, Giunta F, Ronco C. Early use of polymyxin B hemoperfusion in abdominal septic shock: the EUPHAS randomized controlled trial. *JAMA* 2009; **301**: 2445-2452 [PMID: 19531784 DOI: 10.1001/jama.2009.856]
11 **Vincent JL**, Marini JJ, Pesenti A. Do trials that report a neutral or negative treatment effect improve the care of critically ill patients? No. *Intensive Care Med* 2018; **44**: 1989-1991 [PMID: 29947879 DOI: 10.1007/s00134-018-5220-y]
12 **Kogelmann K**, Jarczak D, Scheller M, Drüner M. Hemoadsorption by CytoSorb in septic patients: a case series. *Crit Care* 2017; **21**: 74 [PMID: 28343448 DOI: 10.1186/s13054-017-1662-9]
13 **Ugurov P**, Popevski D, Gramosli T, Neziri D, Vuckova D, Gjorgon M, Stoicovski E, Marinkovic S, Veljanovska-Kiridjievska L, Ignevska K, Mehandziska S, Ambarkova E, Mitrev Z, Rosalia RA. Early Initiation of Extracorporeal Blood Purification Using the AN69ST (oXiris(®)) Hemofilter as a Treatment Modality for COVID-19 Patients: a Single-Centre Case Series. *Braz J Cardiovasc Surg* 2022; **37**: 35-47 [PMID: 33113325 DOI: 10.21470/1678-9741-2020-0403]
14 **Turani F**, Martini S. Extracorporeal Blood Purification with the Oxiris Membrane in Septic Shock. In: Agrawal A, Waindeskar V, editors. Management of Shock - Recent Advances. London: IntechOpen Limited, 2022 [DOI: 10.5772/intechopen.106227]
15 **Wei T**, Chen Z, Li P, Tang X, Marshall MR, Zhang L, Fu P. Early use of endotoxin absorption by oXiris in abdominal septic shock: A case report. *Medicine (Baltimore)* 2020; **99**: e19632 [PMID: 32664051 DOI: 10.1097/MD.0000000000019632]
16 **Andrei S**, Nguyen M, Berthoud V, Morgant MC, Bouhemad B, Guinot PG; ECMORIX Study Group. Evaluation of the Oxiris Membrane in Cardiogenic Shock Requiring Extracorporeal Membrane Oxygenation Support: Study Protocol for a Single Center, Single-Blind, Randomized Controlled Trial. *Front Cardiovasc Med* 2021; **8**: 738496 [PMID: 34708091 DOI: 10.3389/fcvm.2021.738496]
17 **Zhai Y**, Pan J, Zhang C. The application value of oXiris-endotoxin adsorption in sepsis. *Am J Transl Res* 2021; **13**: 3839-3844 [PMID: 34017574]
18 **Schwindenhammer V**, Girardot T, Chaulier K, Grégoire A, Monard C, Huriaux L, Illinger J, Leray V, Uberti T, Crozon-Clauzel J, Rimmelé T. oXiris® Use in Septic Shock: Experience of Two French Centres. *Blood Purif* 2019; **47** Suppl 3: 1-7 [PMID: 30982028 DOI: 10.1159/000499510]
19 **Lumlertgul N**, Srisawat N. The haemodynamic effects of oXiris haemofilter in septic shock patients requiring renal support: A single-centre experience. *Int J Artif Organs* 2021; **44**: 17-24 [PMID: 32393096 DOI: 10.1177/0391398820917150]
20 **Jaffee W**, Hodgins S, McGee WT. Tissue Edema, Fluid Balance, and Patient Outcomes in Severe Sepsis: An Organ Systems Review. *J Intensive Care Med* 2018; **33**: 502-509 [PMID: 29172943 DOI: 10.1177/0885066617742832]
21 **Demandt AMP**, Geerse DA, Janssen BJP, Winkens B, Schouten HC, van Mook WNKA. The prognostic value of a trend in modified SOFA score for patients with hematological malignancies in the intensive care unit. *Eur J Haematol* 2017; **99**: 315-322 [PMID: 28656589 DOI: 10.1111/ejh.12919]
22 **Liu J**, Cheng Q, Yang Q, Li X, Shen X, Zhang L, Liu Z, Khoshnood K. Prognosis-related factors in intensive care unit (ICU) patients with

hematological malignancies: A retrospective cohort analysis in a Chinese population. *Hematology* 2015; **20**: 494-503 [PMID: 25585045 DOI: 10.1179/1607845414Y.0000000216]

23 **Shum HP**, Chan KC, Kwan MC, Yan WW. Application of endotoxin and cytokine adsorption haemofilter in septic acute kidney injury due to Gram-negative bacterial infection. *Hong Kong Med J* 2013; **19**: 491-497 [PMID: 23650198 DOI: 10.12809/hkmj133910]

24 **Adamik BA**, Smiechowicz JS, Zielinski SZ, Kübler AK. Use of extracorporeal endotoxin elimination therapy for septic shock. *Crit Care* 2013; **17** Suppl 2: P66 [DOI: 10.1186/cc12004]

25 **Broman ME**, Hansson F, Vincent JL, Bodelsson M. Endotoxin and cytokine reducing properties of the oXiris membrane in patients with septic shock: A randomized crossover double-blind study. *PLoS One* 2019; **14**: e0220444 [PMID: 31369593 DOI: 10.1371/journal.pone.0220444]

Published by **Baishideng Publishing Group Inc**
7041 Koll Center Parkway, Suite 160, Pleasanton, CA 94566, USA
Telephone: +1-925-3991568
E-mail: bpgoffice@wjgnet.com
Help Desk: https://www.f6publishing.com/helpdesk
https://www.wjgnet.com