TO EVALUATE SAFETY OF THE ADSORPTION HEMOFILTRATION TECHNIQUE FOR TREATMENT OF SEPTIC SHOCK IN SEVERE BURN PATIENTS

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ABSTRACT

Objectives: *Evaluating the safety of continuous hemofiltration using an adsorbent membrane to treat septic shock in severe burns patients.*

Subjects and methods: *The study describes 55 episodes of septic shock in 38 severe burn patients (16 - 60 years old) treated at the Intensive Care Unit, Le Huu Trac National Burn Hospital from January 2023 to June 2024.*

Results: *The total number of filters used was 247, of which 8 filters had frozen membranes (3.2%), the average life of the filter was 15.87 hours. There were no cases of systolic blood pressure falling below 90 mmHg when entering the filter. During continuous veno-venous hemodiafiltration (CVVHDF): Body temperature was always within allowable limits; there were no differences in blood potassium levels, blood protein and albumin concentration, and hypocoagulation disorders at all time points (p > 0.05); blood sodium concentration decreased significantly to normal limits (p < 0.01).*

There was no difference in hypocoagulation status between time points (p > 0.05). There was 1 case of bleeding at the dialysis catheter fixation site (1.82%) and 2 cases of bleeding at the skin graft lesion requiring hemostatic treatment (3.62%).

Conclusion: *There were no differences in blood potassium levels, blood protein and albumin concentration, and hypocoagulation disorders at all time points.*

Keywords: *Severe burns, septic shock, CVVHDF*

1. INTRODUCTION

Continuous Renal Replacement Therapy (CRRT) eliminates cytokines and bacterial endotoxins from the body, reduces systemic inflammatory response syndrome and stabilizes hemodynamics. It is a proven effective method to support the treatment of septic shock: improving clinical status, reducing shock recovery time, preventing the progression of organ damage, and improving the mortality rate after 28 days [1], [2], [3], [4], [5]. However, in addition to the above benefits, the CRRT

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technique still has the risk of causing complications. The complications in CRRT can be divided into two large groups: Technical-related complications and clinical-related complications.

All complications have the potential to firstly endanger the patient's life and health, followed by reducing the effectiveness of dialysis, reducing the lifespan of the filter and increasing treatment costs. Clinicians must be able to prevent, recognize, and manage associated complications to ensure optimal dialysis outcomes for patients [6]. The objective of this study was to evaluate the complications of CRRT with adsorbent membranes to support the treatment of septic shock in patients with severe burns patients.

2. SUBJECTS AND RESEARCH METHODS

** Study subjects*

55 episodes of septic shock in 38 severe burn patients (16-60 years old) were treated at the Intensive Care Unit, Le Huu Trac National Burn Hospital from January 2023 to June 2024. There were no comorbidities or co-traumas. Septic shock was diagnosed according to Sepsis-3 [7].

Septic shock patients were treated according to the guidelines of the Surviving Sepsis Campaign (SSC) in 2021 and the guidelines of the International Society for Burn Injuries in 2023 [8], [9]. They received hemofiltration within 6 hours of septic shock diagnosis. Dialysis was terminated when the patient recovered from septic shock for 12 hours or died (requested discharge for death).

** Research methods*

- Prospective, descriptive, longitudinal follow-up

- Uniformly using one method, which is continuous veno-venous hemodiafiltration (CVVHDF) according to the established procedure, oxiris filter, blood flow rate of 180 ml/min, ultrafiltration dose of 25 ml/kg/hour, and dialysis dose of 25 ml/kg/hour.

- Research criteria:

+ Technical-related complications: Problems related to vascular access, hemolysis, air embolism, filter clotting, hypothermia.

+ Clinical-related complications: Hypotension at the start of filtration, electrolyte disturbances, bleeding, loss of protein and albumin.

- Diagnosis of coagulation disorders:

+ Hypocoagulable tendency based on routine coagulation tests based on the risk of bleeding is determined when one of the following four criteria is present: INR > 1.2 and/or aPTT > 1.2 and/or platelet count < 150,000/mm3 and/or Fibrinogen < 2 g/L.

+ Hypercoagulable tendency based on routine coagulation tests based on the risk of hypercoagulation is determined when one of the following four criteria is present: INR < 0.8 and/or aPTT < 0.8 and/or platelet count > 450,000/mm3 and/or Fibrinogen > 4 g/L.

+ Mixed hypercoagulable-hypocoagulable tendency based on routine coagulation tests is determined when there is at least one of the criteria for hypocoagulable tendency and at least one of the criteria for hypercoagulable tendency.

- Study time points: At the time of septic shock diagnosis (T1), at the time of CRRT (T2), 6 hours after CRRT (T3), 12 hours after CRRT (T4), 24 hours after CRRT (T5), and 48 hours after CRRT (T6).

- Data were analyzed using Stata 14.0 software, and a p-value < 0.05 was considered statistically significant.

3. RESULTS

There were 38 severe burn patients with 55 septic shock episodes. The average age of the study patients was 35.11 ± 1.67; males predominated (86.84%). The burn agent was mostly dry heat (84.21%), with 22 patients having respiratory burns (accounting for 57.89%). 23 patients had one episode of shock (60.53%), 13 patients had two episodes of shock (34.21%), and 2 patients had three episodes of shock (5.26%).

The total number of oxiris filters was 247, of which 8 filters were frozen (3.2%), there were no cases of systemic air, catheter kinking, or twisting. There were no cases of systolic blood pressure falling below 90 mmHg when entering the filter.

Table 3.1. Blood filtration parameters

Parameters	Value
Blood flow rate, ml/kg/min	180
Ultrafiltration dose, ml/kg/hour	25
Replacement fluid volume, ml/kg/ hour	25
Dialysis time, hour, median (Q1- Q3)	50 (39.5 - 83.5)
Number of oXiris filters, filter, median (Q1- Q3)	4 (3 - 4)
Life/ 01 oXiris, hour, $\overline{X}$ ± SD	15.87 ± 4.85
Time to start CRRT after septic shock diagnosis, min, $\overline{X}$ ± SD	87.62 ± 41.86

The Median CRRT time was 50 hours, and the number of filters used for each patient was 4. The average filter life was 15.87 hours.

Table 3.2. Coagulation changes before and during CRRT

Parameter	Time (n = 55)				p
	T1	T4	T5	T6	
Coagulation disorders, n (%)	55 (100%)	55 (100%)	55 (100%)	49 (89.09)	0.0004
Hypocoagulation, n (%)	44 (80%)	51 (92.73)	49 (89.09)	46 (83.64)	0.20
Hypercoagulation, n (%)	45 (81.82%)	44 (80)	41 (74.55)	23 (41.82)	0.0001

There was no difference in hypocoagulation status between time points ($p > 0.05$). The number of shock episodes that had coagulation disorders was significantly reduced after 48 hours after CRRT ($p < 0.001$). Along with that, the hypercoagulability also decreased significantly ($p < 0.001$).

Table 3.3. Clinical bleeding status

Parameter	Time (n = 55)			
	T3	T4	T5	T6
Bleeding through catheter fixation site, n (%)	0	0	0	1 (1.82)
Bleeding at superficial burn injury, n (%)	0	0	0	0
Bleeding at granulation tissue requiring hemostasis, n (%)	0	0	0	0
Bleeding at skin graft site requiring hemostasis, n (%)	0	0	1 (1.82)	1 (1.82)

There was no clinical bleeding at 6 hours and 12 hours after CRRT initiation. 24 hours after CRRT initiation, there was one case of bleeding at the skin graft site requiring treatment (1.82%). 48 hours after CRRT initiation, there was one case of bleeding through the catheter fixation site (1.82%) and one case of bleeding at the skin graft site requiring treatment (1.82%).

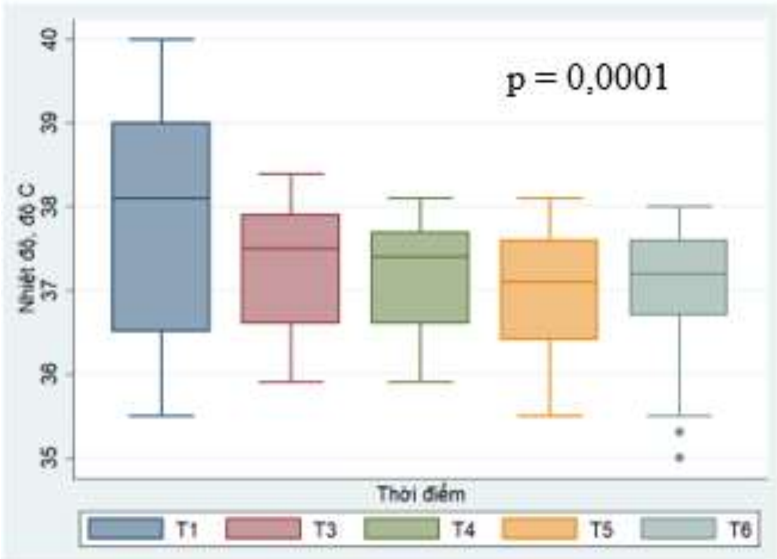

Chart 3.1. Box plots of body temperature changes during CRRT

At the time of septic shock, body temperature fluctuated between 36.5 and 39 degrees Celsius. After CRRT, the patient's body temperature decreased significantly ($p < 0.001$), but was still within the allowable range (36.5 to 38 degrees Celsius).

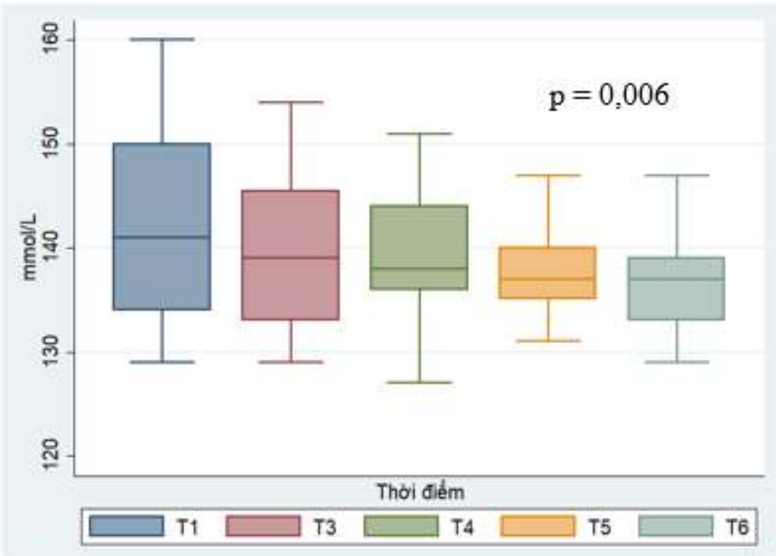

Chart 3.2. Box plot of changes in serum sodium concentration during CRRT

Before and during CRRT, the median blood sodium concentrations were within limits. Before CRRT, blood sodium concentration was concentrated in the range of 135 to 150 mmol/L. After CRRT, blood sodium concentration decreased significantly and was concentrated in the allowable range (135 - 145 mmol/L) (p < 0.01).

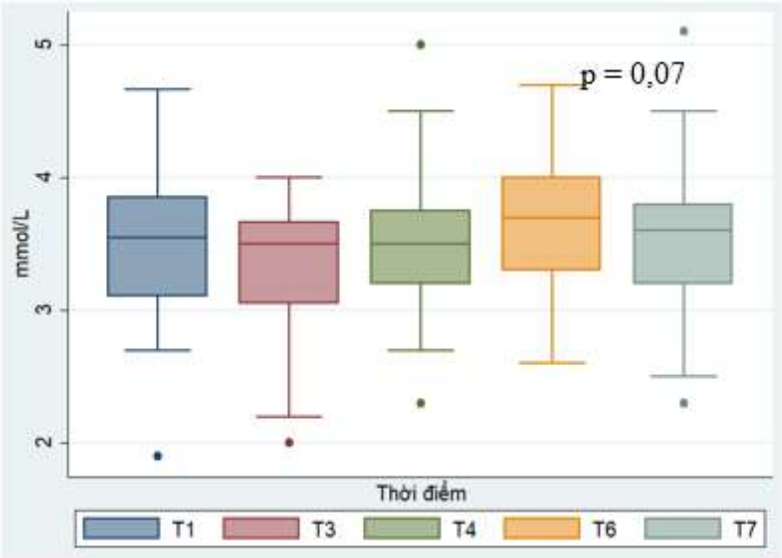

Chart 3.3. Box plot of changes in plasma potassium concentration during CRRT

Before and during CRRT, the median blood potassium level was within normal range and there was no difference between time points (p > 0.05).

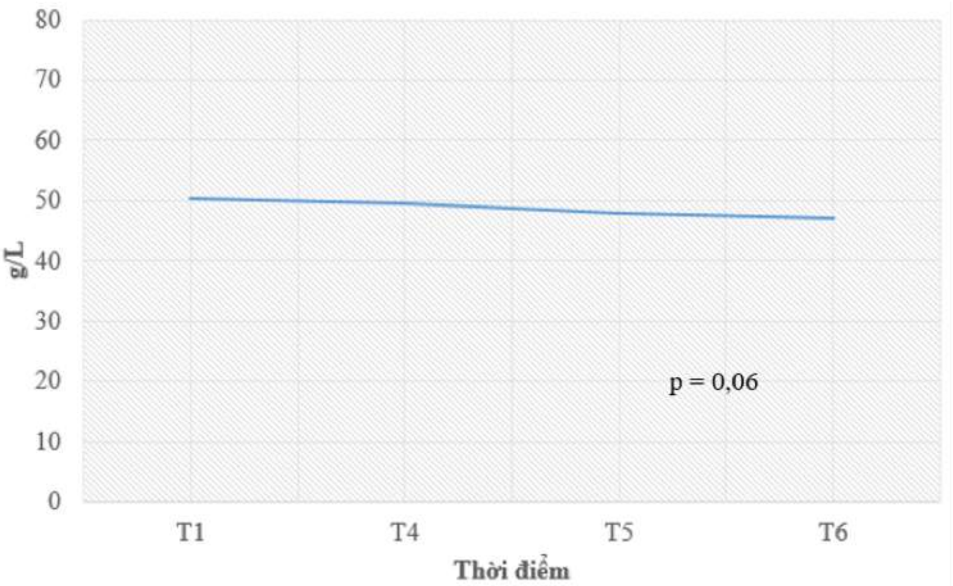

Chart 3.4. Plasma protein changes before and during CRRT

There was no difference in protein concentrations before and during CRRT (p > 0.05).

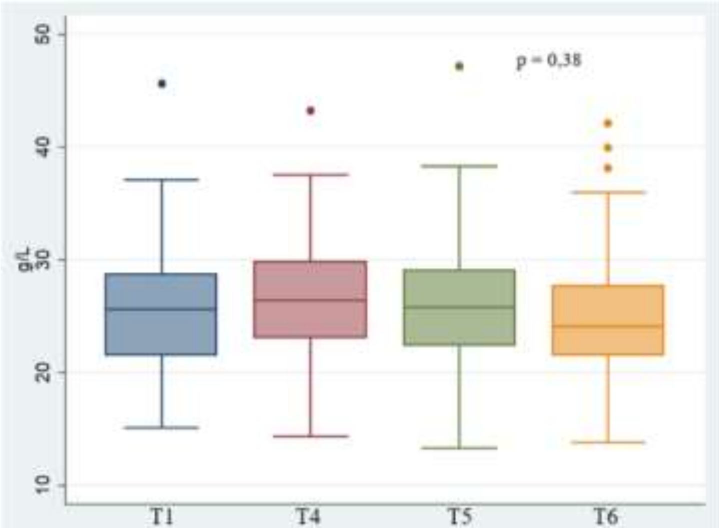

Chart 3.5. Plasma albumin changes before and during CRRT

Blood albumin concentration at all time points ranged from 22 g/L to 30 g/L with some abnormally high points. There was no difference in blood albumin concentration before and during CRRT ($p > 0.05$).

4. DISCUSSION

Technical-related complications include problems related to vascular access, hemolysis, air embolism, and filter clotting. These complications are mainly controlled by prevention, proper implementation of dialysis catheter placement techniques, filter priming, and proper anticoagulation procedures with heparin. Our results show that: in 55 episodes of septic shock in 38 severe burn patients undergoing CRRT with oxiris filter (247 oxiris filters), only 8 filters were frozen (3.2%), and there were no other technical-related complications. 8 filters froze (used for 6 - 8 hours) because the patient had just undergone necrosectomy, skin grafting, or amputation surgery within the previous 48 hours, and we could not use heparin for anticoagulation, accepting a reduction in filter lifespan.

Hypothermia is a common complication of CRRT. 90% of dialysis patients experience hypothermia. In Akhoundy's report, the core temperature before and after CRRT was 36.9^0C and 35.2^0C, respectively [6].

The results of our study show that at the time of septic shock, body temperature fluctuated between 36.5 and 39 degrees Celsius. After CRRT, the patient's body temperature decreased significantly ($p < 0.001$), but remained within the allowed range (36.5 to 38 degrees Celsius).

All of our CRRT patients received:

1) Use of the blood warmer available on the machine (set at 39 - 42 degrees Celsius depending on each patient).

2) Warming the dialysate with an incubator at 38 degrees Celsius before use for the patient.

3) All patient rooms had hot air conditioners turned on at 38 degrees Celsius.

4) Septic shock patients with hypothermia were warmed by a specialized heating lamp for burn patients.

In the study, we followed the correct procedure for blood withdrawal immediately after entering the filter, initially at 100 ml/min, monitoring systolic blood pressure, with systolic blood pressure stable above 90 mmHg, after 10 - 15 minutes increasing by 20 ml/min each time, reaching the target of 180 ml/min. As a result, there were no cases of hypotension immediately after entering the filter.

The results of charts 3.2 and 3.3 show that during CRRT, sodium and potassium concentrations were within the allowed limits. Using the correct protocol for adding potassium to the dialysate and adjusting it every 4 - 6 hours allows for better control of the patient's blood potassium levels.

During CRRT, there were no differences in the state of hypercoagulable disorders at various time points ($p > 0.05$). However, the number of shock episodes that had coagulation disorders was significantly reduced after 48 hours after CRRT ($p < 0.001$). Along with that, the hypercoagulability also decreased significantly ($p < 0.001$). This is because we used heparin for anticoagulation during CRRT. Good heparin adjustment during CRRT helps maintain the lifespan of the filter, in addition to correcting hypercoagulable disorders in septic shock patients. There were only 2 cases of clinical bleeding at the lesion that had just undergone necrosectomy and skin grafting within 3 days prior, requiring dressing changes and hemostasis. This highlights the difficulty in controlling coagulation and bleeding during CRRT in severe burn patients who require weekly necrosectomy of deep burns and autologous skin grafting.

5. CONCLUSION

During CRRT, there were no differences in plasma potassium concentration, plasma protein and albumin concentration, and hypocoagulation disorder at any time points ($p > 0.05$). Body temperature always remained within the permissible limits.

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