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Time-Dependent Kinetics and Saturation Dynamics of Interleukin-6 Clearance During Combined HA380 Hemoadsorption and Continuous Renal Replacement Therapy in Sepsis-Associated Acute Kidney Injury

short title: IL-6 Clearance Kinetics in Sepsis-AKI: Combined HA380 Hemoadsorption and CRRT

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Keywords: HA380; sepsis-associated acute kidney injury; hemoperfusion; interleukin-6; continuous renal replacement therapy; cytokine clearance

Abstract

Introduction: The HA380 hemoadsorption cartridge is increasingly used in septic patients receiving continuous renal replacement therapy (CRRT) for cytokine removal. However, its adsorption kinetics and saturation threshold in clinical settings remain unclear.

Methods: We conducted a prospective observational study in the intensive care unit of the First Affiliated Hospital of Harbin Medical University from July 2023 to July 2024. Thirty patients with sepsis-associated acute kidney injury (SA-AKI) who required CRRT were enrolled. Blood samples were collected from the inflow and outflow ports of the HA380 cartridge at baseline and every two hours during a 24-hour treatment session. Interleukin-6 (IL-6) concentrations were determined by ELISA, and clearance efficiency was calculated. Key laboratory parameters, including procalcitonin (PCT), C-reactive protein (CRP), and acid–base balance, were compared before and after treatment. Changes in adsorption efficiency over time were analyzed using linear mixed-effects models.

Results: IL-6 clearance reached its maximum at 2 hours (90.0%) and progressively decreased by 13.32% compared with baseline at 14 h ($p=0.004$). PCT and white blood cell counts decreased significantly after therapy ($p<0.05$), while CRP levels showed no significant change. Blood pH and base excess improved significantly, whereas reductions in serum creatinine and urea nitrogen were not statistically significant.

Conclusions: In patients with SA-AKI undergoing CRRT combined with HA380 hemoadsorption, IL-6 removal was most effective within the first 2 hours, the clearance rate shows an increasing trend from 4 to 12 hours and then decreases and declined notably after approximately 12 hours, indicating cartridge saturation. These findings suggest that cartridge replacement within this timeframe may help maintain effective cytokine clearance and support optimal treatment performance.

Introduction:

Sepsis is a life-threatening syndrome characterized by dysregulated host immune responses to infection, frequently resulting in systemic inflammation, multiple organ

dysfunction syndrome (MODS), and high mortality rates [1],[2],[3],[4]. According to the latest version of the Sepsis-3 criteria, sepsis is defined as a life-threatening organ dysfunction resulting from a dysregulated host response to infection [1]. Organ dysfunction in the Sepsis-3 criteria is manifested as a clinical deterioration, indicated by an increase of ≥2 points in the Sequential Organ Failure Assessment (SOFA) score due to infection[3]. Among affected patients, acute kidney injury (AKI) is a prevalent and severe complication admitted to intensive care units (ICUs), affecting approximately 40–50% of these patients [5],[6]. According to the 2012 Kidney Disease: Improving Global Outcomes (KDIGO) guidelines, AKI is defined as an increase in serum creatinine of ≥ 0.3 mg/dl or ≥ 26.5 μmol/L within 48 hours, or an increase of ≥ 1.5 times the baseline within the past 7 days, or a urine output of < 0.5 mL/kg/h for at least 6 hours [7]. This form of renal injury, termed sepsis-associated acute kidney injury (SA-AKI), differs pathophysiologically from other types of AKI. SA-AKI is generally defined as the presence of both sepsis criteria and AKI criteria when AKI occurs within 7 days from diagnosis of sepsis[8]. It is driven largely by systemic inflammation, endothelial dysfunction, and immune dysregulation rather than by isolated hemodynamic changes [9].

Current SA-AKI management primarily involves supportive treatments, including fluid resuscitation, vasoactive medications, mechanical ventilation, and renal replacement therapy (RRT)[10] . Continuous renal replacement therapy (CRRT) is widely used in septic patients for gentle, continuous solute and fluid removal, maintaining better hemodynamic stability compared to intermittent hemodialysis [10], [11],[12],[13]. In recent years, extracorporeal blood purification techniques have been explored as adjunctive therapies in sepsis. By removing circulating inflammatory mediators, these approaches may help rebalance immune responses and mitigate organ injury [14].

Hemoperfusion (HP), an extracorporeal adsorption technique, can be integrated with CRRT circuits to remove inflammatory cytokines and other toxins from circulation [15]. Despite increasing clinical application, optimal operational duration, adsorption

capacity, and saturation thresholds for various commercial cartridges remain uncertain [16].The HA380 cartridge (Jafron Biomedical, Zhuhai, China), a nonselective hemoadsorption device, has demonstrated potential efficacy for cytokine removal in septic patients. However, comprehensive clinical data on its adsorption kinetics and saturation threshold remain sparse. Preliminary studies involving similar adsorption devices such as CytoSorb(CytoSorbents Corporation,New Jersey) have produced variable cytokine clearance results, underscoring the necessity for cartridge-specific evaluations [17]. To our knowledge, there have been no systematic assessments of the time-dependent adsorption characteristics of HA380 cartridges focusing on interleukin-6 (IL-6) clearance in SA-AKI patients undergoing CRRT combined with HP.

Therefore, We conducted a prospective observational study to characterize the time-dependent kinetics and saturation behavior of interleukin-6 (IL-6) clearance during combined HA380 hemoperfusion and CRRT in patients with SA-AKI, by identifying the temporal profile of adsorption efficiency, this study aims to provide practical reference data for optimizing hemoadsorption therapy in critically ill patients.

Material and Methods

Study Setting

This prospective, single-center observational study was conducted at the intensive care unit (ICU) of the First Affiliated Hospital of Harbin Medical University from July 2023 to July 2024. The study aimed to evaluate the cytokine adsorption efficacy and saturation characteristics of HA380 hemoperfusion cartridges (Jafron Biomedical Co., Zhuhai, China) during continuous renal replacement therapy (CRRT) in critically ill patients with sepsis-associated acute kidney injury (SA-AKI). The protocol was approved by the institutional ethics committee (The First Affiliated Hospital of Harbin Medical University / Research / Article Review 2022156), and the study was performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from each patient's legally authorized representative prior to enrollment.

Patient Selection

Patients over 18 years old admitted to the ICU who met Sepsis-3 diagnostic criteria and developed SA-AKI necessitating CRRT were enrolled. Inclusion required Acute Physiology and Chronic Health Evaluation II (APACHE II) scores >15. Exclusion criteria included severe arrhythmias (e.g., rapid atrial fibrillation or ventricular tachycardia), anticoagulant drug allergies, acute cerebral hemorrhage, gastrointestinal bleeding, hematological diseases, pregnancy or lactation, immunological disorders, recent immunomodulator usage, advanced malignancy, immunodeficiency, organ transplantation, HIV infection, CRRT duration <6 hours and planned or unplanned CRRT interruptions. Ultimately, 30 patients met these criteria.

Treatment Protocol

All patients received CRRT using a Prismaflex system (Vantive, USA). The HA380 hemoperfusion cartridge was integrated upstream of the CRRT circuit. The blood flow rate was maintained between 150 and 200 mL/min, and the prescribed CVVH dose was 30 mL/kg/h.

Regional citrate anticoagulation was applied in all cases, and bicarbonate-based replacement fluid was used.Hemoperfusion with HA380 was conducted for up to 24 hours, after which the cartridge was removed and CRRT was continued as clinically indicated.

Data Collection and Measurements

Baseline demographics, clinical characteristics, APACHE II and SOFA scores, vital signs, mechanical ventilation status, and ICU duration were documented upon admission. Laboratory tests included complete blood count, serum biochemical parameters (urea nitrogen, creatinine, bilirubin, alanine aminotransferase [ALT], aspartate aminotransferase [AST]), coagulation parameters (prothrombin time [PT], activated partial thromboplastin time [APTT], international normalized ratio [INR]), inflammatory biomarkers (C-reactive protein [CRP], procalcitonin [PCT]), and arterial blood gas analysis (pH, base excess [BE], lactate, PaO2/FiO2 ratio). These parameters were evaluated at baseline (first examination upon admission) and after

CRRT-HP treatment (first examination following CRRT-HP) as part of a protocol.

Blood samples for interleukin-6 (IL-6) assessment were simultaneously collected from inflow (pre-cartridge) and outflow (post-cartridge) ports at baseline (T0) and subsequently every 2 hours for 24 hours. Plasma was separated immediately by centrifugation (3500 rpm, 5 minutes) and stored at −80°C until batch analysis. IL-6 concentrations were measured using enzyme-linked immunosorbent assay (ELISA) kits (Shanghai Jingkang Bioengineering) per the manufacturer's guidelines.

Clearance Calculation

IL-6 clearance was calculated at each measurement interval to assess adsorption efficiency over the treatment duration.

$$\text{Clearance efficiency}\ (\%) = \left(\frac{C_{in\text{-}Cout}}{C_{in}}\right) \times 100$$

Linear mixed-effects modeling was employed to determine significant changes in adsorption efficiency over time, accounting for repeated measurements within subjects. The model is set as follows:

$$efficiency_{ij} = \beta_0 + \beta_1 \cdot time_{ij} + u_{0i} + \varepsilon_{ij}$$

$efficiency_{ij}$: the efficiency value of the i^{th} subject at the J^{th} time point, calculated by

$efficiency = \left(\frac{C_{in\text{-}Cout}}{C_{in}}\right) \times 100$; β_0: fixed intercept; β_1: a fixed effect of time; u_{0i}: the random intercept of the i^{th} subject; ε_{ij}: residual error term.

Electron microscopy scan of the microstructure of HA380 adsorption beads

To examine the structural characteristics of the HA380 adsorbent material, representative beads were rinsed with deionized water, fixed in 10% neutral formalin for 3 hours at 4°C, and air-dried. Samples were mounted on conductive stubs and sputter-coated with gold. Scanning electron microscopy (SEM) was performed at an accelerating voltage of 15kV and a working distance of 10mm. Images were captured at magnifications ranging from 50× to 40,000× to evaluate surface morphology and

pore structure.

Statistical Analysis

Descriptive statistics summarized patient baseline characteristics and treatment outcomes. Categorical variables were expressed as frequencies and percentages, and continuous variables as mean ± standard deviation (SD) or median (interquartile range [IQR]), based on normality. Pre- and post-treatment differences were compared using paired t-tests (normal distribution) or Wilcoxon signed-rank tests (non-normal distribution). All tests were two-sided, with p-values <0.05 considered statistically significant. Statistical analyses were performed using R software (version 4.2.2; R Foundation for Statistical Computing, Vienna, Austria).

Results

Patient Characteristics

A total of 30 patients with sepsis-associated acute kidney injury were included, and data on planned or unplanned suspension of CRRT were discarded, as shown in Figure 1. The cohort included 20 men (66.7%) and 10 women (33.3%), with a mean age of 56.2 ± 12.3 years. All patients required mechanical ventilation, and 26 (86.7%) required prolonged ventilation for more than 96 hours. The mean APACHE II score at ICU admission was 26.0 ± 5.8, indicating severe illness. All baseline clinical parameters were measured at the time of patient admission, and CRRT was initiated as soon as possible after diagnosis to avoid disease progression delays, as shown in Table 1. The patient's hospitalization outcome is shown in Table 2.

Laboratory Parameters

Changes in key laboratory and physiological parameters before and after combined CRRT–hemoperfusion therapy are presented in Table 3.

Procalcitonin (PCT)（normal range: 0-0.5ng/mL） level significantly decreased post-treatment (PCT: median : 3.83 [1.79, 17.92]ng/mL vs. 2.16 [1.67, 5.11]ng/mL; p<0.001). In contrast, the reduction in C-reactive protein (CRP) shown no difference before and after treatment (160.74 ± 131.55mg/L vs. 158.62 ± 80.40mg/L; p=1.0).

Substantial improvements in acid-base status were observed, including elevated blood pH (7.32 ± 0.10 vs. 7.38 ± 0.05; p=0.01) and base excess (-3.39 ± 4.56mmol/L vs. 1.72 ± 3.63mmol/L; p<0.001). Serum creatinine and blood urea nitrogen levels decreased but without reaching statistical significance (creatinine: median 185.0 [74.57, 4262.75]μmol/L vs. 135.5 [61.83, 260.50]μmol/L, p=0.51; urea nitrogen: 12.06 ± 8.03mmol/L vs. 10.56 ± 8.37mmol/L, p=0.5). The levels of serum Alanine Aminotransferase(ALT) （ normal range: 7-40U/L ） and Aspartate Aminotransferase(AST) （normal range: 13-35U/L） decreased, but the reduction in AST did not reach statistical significance (ALT: median 24.65 [10.00, 47.55]U/L vs. 21.15 [6.30, 40.90]U/L, p = 0.03; AST: median 46.05 [25.52, 61.92]U/L vs. 42.75 [21.48, 48.90]U/L, p = 0.1). No statistically significant changes were detected in APTT, PT, INR, total bilirubin, lactate levels, or PaO2/FiO2 ratio.

IL-6 Clearance Kinetics

IL-6 clearance data at different intervals (every 2 hours over 24 hours) are presented in Table 4 and Figure 2. The IL-6 concentrations at different time points are shown in the original data (see supplementary material). Clearance rates peaked at 2 hours (90.02%) and exhibited significant declines after 12 hours compared to baseline (all p<0.05). Specifically, compared to the baseline, there was a significant decrease of 13.32% at 14 hours (p = 0.004), 26.12% at 16 hours (p = 0.002), 25.88% at 18 hours (p = 0.002), 32.52% at 20 hours (p = 0.001), 47.40% at 22 hours (p < 0.001), and 83.90% at 24 hours (p < 0.001). Reductions at 4-12 hours were not statistically significant.

Electron microscopy scan results

Figure 3 displays scanning electron microscope (SEM) images of HA380 adsorption beads at various magnifications. The low-magnification image (Figure 1a, 9.6mm×50 LM(L)) reveals spher ical beads with relatively uniform size. High-magnification images (Figure 1h, 9.3mm×30.0k SE(UL); Figure 1i, 9.3mm×40.0k SE(UL)) show

abundant pores on the bead surface, varying in size and distributed uniformly. These pores range from 1 to 2 μm in diameter, creating a porous structure that provides a large specific surface area for adsorbing IL-6 molecules.

Discussion

Sepsis-associated acute kidney injury (SA-AKI) represents a distinct clinical entity characterized by complex inflammatory and immunologic mechanisms that differ from other forms of AKI [18],[19],[20]. Rather than resulting solely from renal hypoperfusion, SA-AKI often arises from systemic inflammation, microvascular dysfunction, and mitochondrial injury driven by pathogen- and damage-associated molecular patterns (PAMPs and DAMPs) [21],[22],[23]. These pathophysiologic features have led to increasing interest in extracorporeal therapies designed to attenuate the overwhelming cytokine response that contributes to multiorgan failure [24],[25].

In this study, we examined the time-dependent kinetics of interleukin-6 (IL-6) removal using the HA380 hemoperfusion cartridge combined with CRRT in critically ill patients with SA-AKI. Our results showed that IL-6 clearance reached its highest efficiency during the initial two hours of treatment and began to decline after approximately 12 hours, suggesting the onset of cartridge saturation. This time-dependent decrease in adsorption capacity aligns with previous observations from studies using other hemoadsorption devices, such as CytoSorb, in which cytokine removal efficiency diminishes progressively as the adsorption surface becomes saturated [26],[27],[28],[29].

The significant reductions in procalcitonin (PCT) counts after treatment support the concept that combined CRRT–hemoperfusion can effectively lower circulating inflammatory mediators. In contrast, the lack of a significant change in C-reactive protein (CRP) is likely attributable to its longer plasma half-life and slower hepatic synthesis, which make it less sensitive to short-term fluctuations in cytokine levels. Taken together, these findings suggest that IL-6 and PCT may serve as more

responsive biomarkers for evaluating the immediate anti-inflammatory effects of extracorporeal blood purification.

The observed improvements in acid-base parameters (including pH and base excess) further suggest that modulation of systemic inflammatory responses may be one of the mechanisms underlying enhanced metabolic and perfusion stability. Cytokine removal could reduce microcirculatory dysfunction and lactate production, facilitating metabolic recovery. In addition to these indirect effects, CRRT itself exerts an inherent impact on pH through the continuous delivery of a bicarbonate- or lactate/bicarbonate-buffered replacement fluid, which directly replenishes buffer capacity and corrects metabolic acidosis. The effluent clearance of organic acids and the maintenance of stable electrolyte composition further contribute to the stabilization of acid-base equilibrium independent of inflammatory modulation. The reduction in serum alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels, though less pronounced, may reflect alleviation of hepatic stress through improved hemodynamics and toxin clearance. This is also related to the fact that the levels of ALT and AST are partly within the normal range. Nonetheless, the nonsignificant changes in serum creatinine and urea nitrogen suggest that the renal recovery process may lag behind systemic improvement, reflecting the multifactorial nature of renal injury in sepsis.

From a clinical perspective, our findings have practical implications for optimizing the use of the HA380 cartridge. There was no statistically significant difference in the IL6 clearance rate within 4-12 hours. However, a significant difference was observed after 12 hours ($p<0.05$). This indicates that a significant decrease in the clearance rate of white blood cell interleukin-6 suggests that prolonging the blood perfusion time may offer limited benefits. Timely cartridge replacement could therefore maintain adsorption efficiency and improve overall cytokine control. This conclusion is consistent with the general consensus emerging from recent studies on cytokine adsorption therapy, which emphasize the importance of individualized timing and dosing rather than prolonged, continuous use.

Several limitations should be acknowledged. First, this was a single-center observational study with a relatively small sample size, which limits the generalizability of our findings. Second, only IL-6 was measured as a representative cytokine; other pro- and anti-inflammatory mediators such as TNF-α, IL-1β, and IL-10 were not evaluated. A broader cytokine profile might better characterize the immunomodulatory effects of hemoperfusion. However, due to significant individual differences, no statistical analysis was conducted on IL-6 before and after treatment. We will improve this aspect in our subsequent research. Third, the study design did not include a control group receiving CRRT alone, so causal inferences regarding clinical outcomes cannot be made. Future multicenter randomized controlled trials are warranted to validate these results and determine whether improved cytokine clearance translates into survival or organ function benefits. Fourth, whether the decline in cytokine concentration and reduced clearance rate over time are initially correlated with this factor will be further investigated in subsequent studies. In addition, due to the influence of factors such as nursing and others, the accurate start time of CRRT + HP could not be determined. We will conduct more in-depth research on the start time of CRRT in future studies.

In summary, this study demonstrates a clear time-dependent decline in IL-6 adsorption during HA380 hemoperfusion combined with CRRT, with a likely saturation point occurring after approximately 12 hours. These data provide a rational basis for cartridge replacement strategies and may help refine the clinical use of hemoadsorption therapy in septic patients with AKI.

Conclusion

HA380 hemoperfusion combined with continuous renal replacement therapy can achieve the maximum IL-6 clearance within the first 2 hours, the clearance rate shows an increasing trend from 4 to 12 hours and then decreases, after 12 hours, the adsorption efficiency will decline, indicating that the filter has reached saturation. Timely replacement within this window may optimize treatment efficacy in SA-AKI.

Larger multicenter studies are warranted to confirm these findings and explore their impact on patient outcomes.

Statement of Ethics

The protocol was approved by the ethics committee of the First Affiliated Hospital of Harbin Medical University (IRB-AF/SC-04/02.0), and the study was performed in accordance with the Declaration of Helsinki. Written informed consent was obtained from each patient's legally authorized representative prior to enrollment.

Conflict of Interest Statement

The authors declare no competing interests.

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Author Contributions

Research idea and study design: Xinyue Ma, Haichao Zhang, Guangting Cong and Wei Yang; data acquisition: Xinyue Ma, Haichao Zhang, Yunlong Wang, Huiwen Sun, Jingjing Liang and Yuhang Wang; data analysis/interpretation: Guangting Cong, Huiwen Sun, Jingjing Liang and Yuhang Wang; statistical analysis: Haichao Zhang; supervision or mentorship: Xinyue Ma, Haichao Zhang, Guangting Cong and Wei Yang. Each author contributed important intellectual content during manuscript drafting or revision and agrees to be personally accountable for the individual's own contributions and to ensure that questions pertaining to the accuracy or integrity of any portion of the work, even one in which the author was not directly involved, are appropriately investigated and resolved, including with documentation in the literature if appropriate.

Data Availability Statement

The data that support the findings of this study are not publicly available due to privacy reasons but are available from the corresponding author upon request.

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Figure 1 Research participant flowchart. From July 2023 to July 2024, at the First Affiliated Hospital of Harbin Medical University, a total of 50 patients who received CRRT + HP treatment were initially recruited to participate in this prospective single-center observational study. According to the inclusion and exclusion criteria, a total of 30 patients were finally included.

Figure 2 Filter efficiency - time fitting curve. The time-fitting curve of IL-6 clearance efficiency of HA380 at different time intervals.

Figure 3 Scanning electron microscope images of HA380 adsorption beads at different magnifications. A Results of a 9.6mm×50 LM(L) electron microscope scan. B Results of a 9.6mm×150 LM(L) electron microscope scan. C Results of a 9.6mm×500 LM(L) electron microscope scan. D Results of a 9.4mm×1.00k SE(UL) electron microscope scan. E Results of a 9.4mm×5.00k SE(UL) electron microscope scan. F Results of a 9.3mm×10.0k SE(UL) electron microscope scan. G Results of a 9.3mm×20.0k SE(UL) electron microscope scan. H Results of a 9.3mm×30.0k SE(UL) electron microscope scan. I Results of a 9.3mm×40.0k SE(UL) electron microscope scan.

Table 1 Patient Baseline Characteristics

Variable	Value
Age (years)	56.23±12.29
Gender	
male	20(66.67%)
APACHE II score	25.97±5.82
Heart rate (bpm)	96.07±21.81
Systolic blood pressure (mmHg)	125.50(104.00,140.00)
Diastolic blood pressure (mmHg)	58.50±9.54
Respiratory rate (breaths/min)	15.00(13.00,21.00)
Lactate (mmol/L)	2.60 (1.62, 3.18)
relevant comorbidities	
sepsis	30(100%)
biliary	9(56.25%)
respiratory	2(12.5%)
abdominal	3(18.75%)
urinary	2(12.5%)
chronic respiratory disease	29(96.67%)
chronic liver disease	29(96.67%)
Administration of vasoactive agents	
norepinephrine	22(73.33%)

Table 2 Patient outcomes during hospitalization

Variable	Value
ICU duration (days)	21.00(8.00,66.00)
Hospital duration (days)	29.00(12.00,76.00)
hospital mortality	0(0%)

Table 3 Changes of Laboratory Parameters Before and After CRRT-HP Treatment

Parameter	Before CRRT-HP	After CRRT-HP	p-value
Procalcitonin (ng/mL)	3.83 (1.79, 17.92)	2.16 (1.67, 5.11)	<0.001
WBC(109/L)	12.83 (8.04, 17.33)	14.45 (9.79, 21.39)	0.01
C-reactive protein (mg/L)	160.74 ± 131.55	158.62 ± 80.40	1.0
Blood pH	7.32 ± 0.10	7.38 ± 0.05	0.01
Base excess (mmol/L)	-3.39 ± 4.56	1.72 ± 3.63	<0.001
Creatinine (μmol/L)	185.00 (74.57, 262.75)	135.50 (61.83, 260.50)	0.5
Blood urea nitrogen (mmol/L)	12.06 ± 8.03	10.56 ± 8.37	0.5
ALT (U/L)	24.65 (10.00, 47.55)	21.15 (6.30, 40.90)	0.03
AST (U/L)	46.05 (25.52, 61.92)	42.75 (21.48, 48.90)	0.1
Total bilirubin (μmol/L)	42.60 (16.95, 75.21)	42.64 (24.90, 70.27)	0.7
Lactate (mmol/L)	2.60 (1.62, 3.18)	1.85 (1.48, 2.90)	0.40
PaO2/FiO2 ratio	115.50 (82.28, 213.00)	91.35 (73.28, 239.00)	0.3
PT(s)	14.57 ± 2.42	14.23 ± 2.02	0.5
APTT(s)	39.30 (31.25, 51.05)	37.05 (32.88, 43.48)	0.2
INR	1.31 ± 0.23	1.28 ± 0.19	0.5

Table 4 IL-6 Clearance Rates at Different Time Points

Time (hours)	IL-6 Clearance Rate (%)	p-value
2	90.02 (Reference)	<0.001
4	43.88	0.2
6	41.90	0.2
8	64.28	0.4
10	34.12	0.1
12	26.11	0.07
14	-13.33	0.004
16	-26.12	0.002
18	-25.88	0.002
20	-32.52	0.001
22	-47.40	<0.001
24	-83.90	<0.001

Figure 1

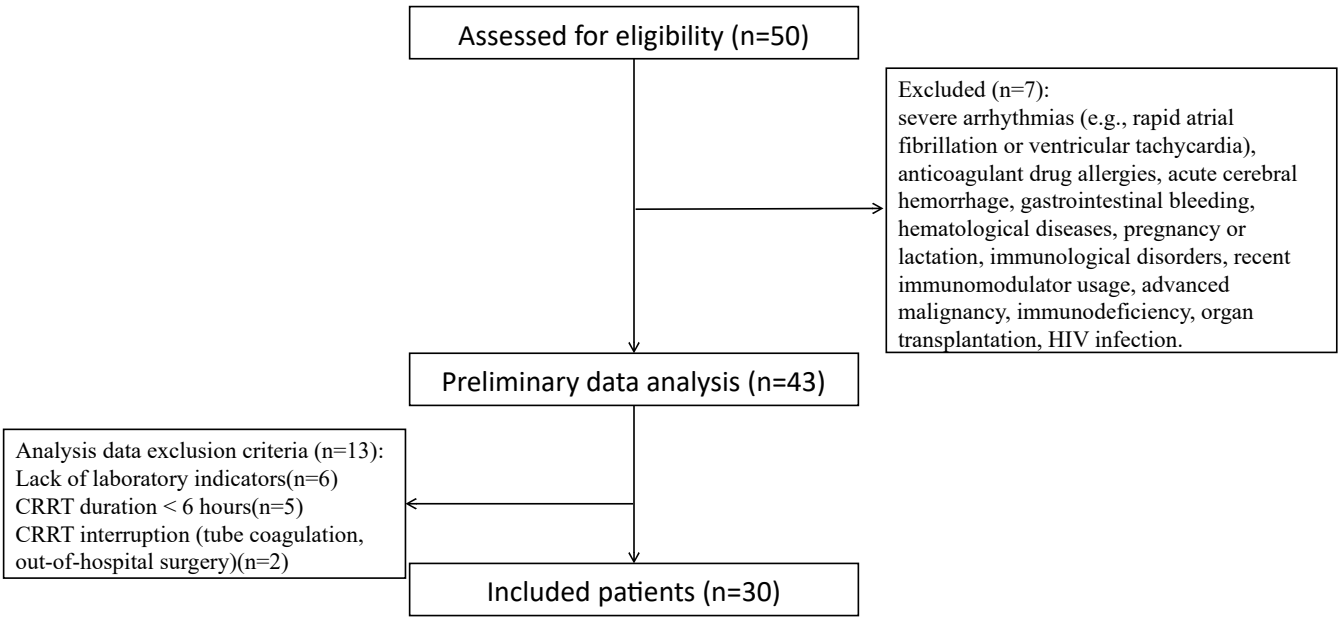

Assessed for eligibility (n=50)
Excluded (n=7):
severe arrhythmias (e.g., rapid atrial fibrillation or ventricular tachycardia), anticoagulant drug allergies, acute cerebral hemorrhage, gastrointestinal bleeding, hematological diseases, pregnancy or lactation, immunological disorders, recent immunomodulator usage, advanced malignancy, immunodeficiency, organ transplantation, HIV infection.
Preliminary data analysis (n=43)
Analysis data exclusion criteria (n=13):
Lack of laboratory indicators(n=6)
CRRT duration < 6 hours(n=5)
CRRT interruption (tube coagulation, out-of-hospital surgery)(n=2)
Included patients (n=30)

Figure 2

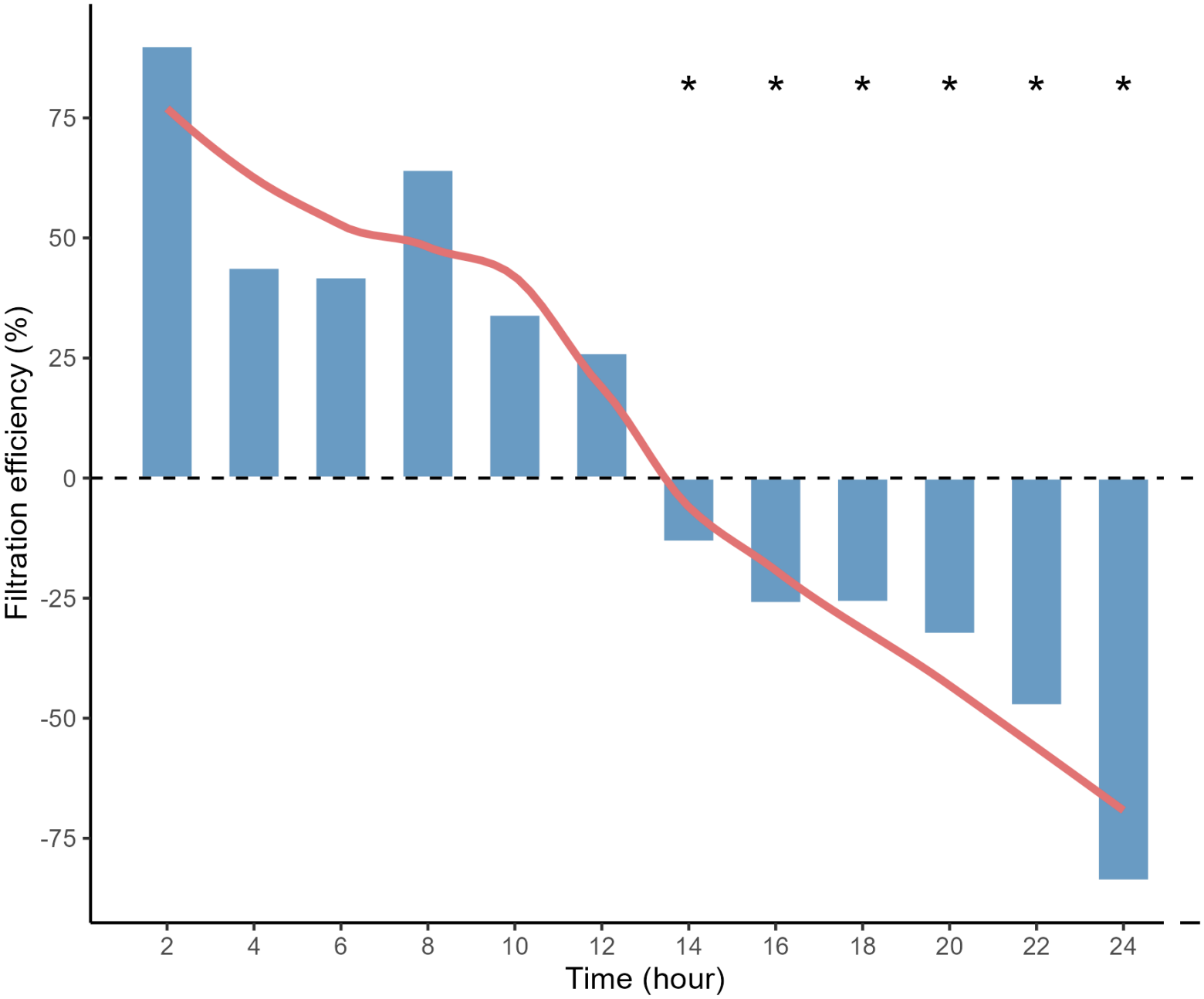
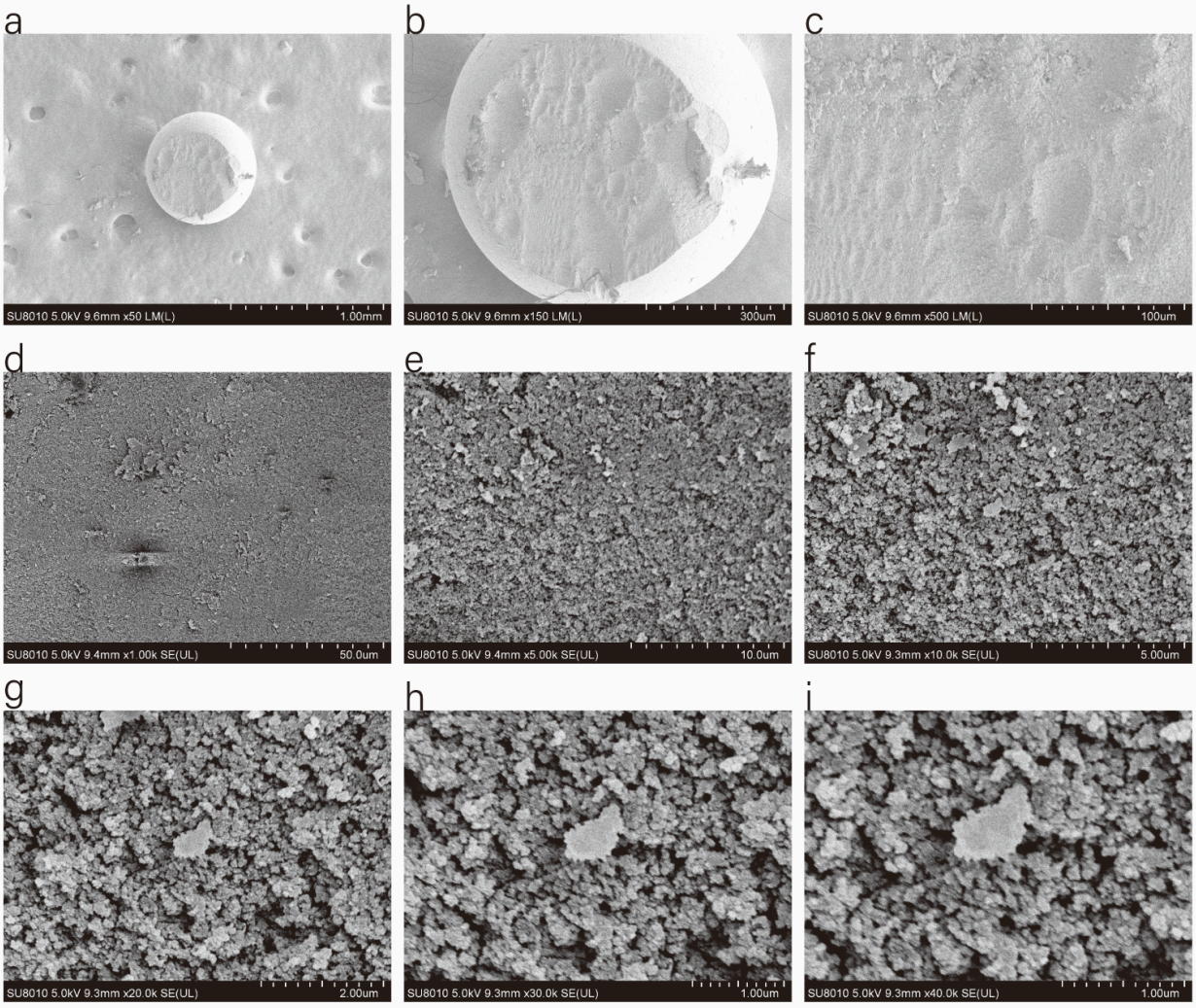

*
*
*
*
*
*
75
50
25
0
-25
-50
-75
Filtration efficiency (%)
2
4
6
8
10
12
14
16
18
20
22
24
Time (hour)

Figure 3


a
SU8010 5.0kV 9.6mm x50 LM(L) 1.00mm
b
SU8010 5.0kV 9.6mm x150 LM(L) 300um
c
SU8010 5.0kV 9.6mm x500 LM(L) 100um
d
SU8010 5.0kV 9.4mm x1.00k SE(UL) 50.0um
e
SU8010 5.0kV 9.4mm x5.00k SE(UL) 10.0um
f
SU8010 5.0kV 9.3mm x10.0k SE(UL) 5.00um
g
SU8010 5.0kV 9.3mm x20.0k SE(UL) 2.00um
h
SU8010 5.0kV 9.3mm x30.0k SE(UL) 1.00um
i
SU8010 5.0kV 9.3mm x40.0k SE(UL) 1.00um