Original Article

Short-term consequences of continuous renal replacement therapy on body composition and metabolic status in sepsis

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Background and Objectives: Fluid overload and hypermetabolism frequently occur in sepsis patients in the intensive care unit (ICU) setting. These abnormalities correlate with inflammatory mediators released under stressful conditions. Continuous renal replacement therapy (CRRT) is an extracorporeal life support technology that persistently and stably eliminates overhydration and cytokines. This study investigated the short-term consequence of CRRT on body composition and pattern of energy expenditure. **Methods and Study Design:** We prospectively observed 27 sepsis patients in our ICU treated with CRRT. Bioelectrical impedance analysis and indirect calorimetry were determined at admission and before and after CRRT. All parameters considered to affect body composition and metabolic state with short-term CRRT were recorded. We used correlation analysis to evaluate the relationship between the change of nutritional state and other parameters. **Results:** Patients had a decreased total body water load and an improved metabolic pattern, but the nutritional parameters had no significant change between pre- and post-CRRT. Furthermore, we observed the percentage variation of resting energy expenditure (REE) was positively correlated with intracellular water change (r=0.547, p=0.003) and CRRT duration (r=0.515, p=0.006). A negative correlation was found between the percentage variation of REE and dialysate temperature (r=−0.668, p=0.001). **Conclusion:** These results suggest that short-term CRRT reduces systemic volume in sepsis patients with overhydration and hypermetabolism, but has no significant impact on acute nutritional status. Meanwhile, CRRT may exert its optimum efficiency when accompanied by other medical practices and support methods.

Key Words: intensive care unit, sepsis, body composition, metabolic state, continuous renal replacement therapy

INTRODUCTION

Sepsis remains one of the leading causes of death in critically ill patients. It has been universally accepted that sepsis is a symptom of the host response to infection, triggered by pathogenic microorganisms and/or their toxic products.[1,2] This response results in a fulminant release of pro-inflammatory and anti-inflammatory mediators into the bloodstream. Prolonged activation of mediators is potentially detrimental to the body because of oxidative stress and hypercatabolism.[3] Consequently, multisystem organ failure can develop if effective control of this cascade reaction is not achieved.[4] The septic response is viewed as a complicated network process wherein absolute values are less relevant than relative ones within a series of interconnected and interactional mediators. Even a slight decrease of one mediator may induce widespread changes.[5,6] Given the complexity of sepsis, an ideal therapeutic strategy must be able to attenuate the overproduction of both forms of inflammatory mediators, downregulate the overwhelmingly activated inflammatory signaling network, and recover homeostasis of the internal environment.[7]

Metabolic implications of sepsis include hypercatabolism/hypermetabolism and fluid and electrolyte abnormalities associated with increased production of stress mediators that enhance proteolysis, gluconeogenesis, and lipolysis.[8] The final results are accelerated catabolism and reduced synthesis of structural and functional proteins, leading to a negative nitrogen balance, hyperglycemia, and hypertriglyceridemia.[9] Because of its non-selective and broad-spectrum eliminating characteristics, continuous renal replacement therapy (CRRT) can also cause activation of the catabolic response through loss of calories and amino acids in the effluent as well as chronic plasma protein loss; however, this status is considered negligible when compared with the pre-existing hyperca-

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tabolism caused by critical illness.[9,10]

Several previous studies have assessed the long-term changes of nutritional and fluid status in end-stage renal disease (ESRD) patients treated by chronic hemodialysis or peritoneal dialysis.[11-14] In these studies, the multifrequency bioimpedance analysis (BIA) technique was used to evaluate the body composition of hemodialysis and peritoneal dialysis patients before and after dialysis. BIA is based on differences in the electrical conductive properties of various tissues and reflects the hydration and nutritional state of the human body.[15,16] The sensitive parameters in BIA are total body water, extracellular water, intracellular water, fat-free mass, and body cell mass. Total body, extracellular, and intracellular water indicate fluid distribution and volume load of the whole body. Fat-free mass and especially body cell mass reflect the nutritional status and metabolic rate.[17]

The purpose of this study was to evaluate short-term changes of nutritional status, volume distribution, and metabolic levels in sepsis patients before and after CRRT and whether metabolism would be related to changes in body composition and other parameters. Consequently, the results of this study may be helpful for planning nutritional support protocols for these patients.

MATERIALS AND METHODS

Patients and ethics

This study was a prospective observational case series of adult patients enrolled over a 6-month period and approved by the Ethics Committee of Jinling Hospital. The study was conducted in a 22-bed surgical intensive care unit (ICU). We evaluated adult patients who developed sepsis and required CRRT for refractory hyperpyrexia (defined as body temperature ≥39°C despite administration of antipyretics) or fluid overload during their ICU stay. The protocol was clearly explained to the patient's next of kin, and verbal consent was obtained. According to the International Guidelines for Management of Severe Sepsis and Septic Shock: 2012, sepsis is defined as the presence (probable or documented) of infection together with systemic inflammatory response syndrome manifestations of infection. For obtaining relatively accurate measurements, patients were included when their conditions met the following criteria: a) relatively stable hemodynamics, b) no pain or agitation, c) fraction of inspired O_2 (FiO_2) <60% and positive end expiratory pressure (PEEP) <12 cm H_2O when on mechanical ventilation. Exclusion criteria were pregnancy or any clinical conditions resulting in false data of body composition parameters as previously described:[21] a) pacemaker or implanted defibrillator, b) amputated limb or metal prosthesis, c) abnormal body geometry (scoliosis or kyphosis), d) massive ascites, or e) skin lesions at the site where the BIA electrode should be adhered.

Patient management

The body weight of each patient was measured at ICU admission and on the day of CRRT (before and within 1 hour after the treatment) using a medical electronic bed-scale. Patients' heights were determined at admission in the supine position using a measuring tape.

CRRT was set up following a standardized institutional protocol. Namely, a double-lumen, 14-F catheter was positioned in the femoral (20 to 25 cm) or internal jugular vein (20 cm) under ultrasonic location. The ultrafiltration rate was set to 25-35 mL/kg/h with a corresponding adapted blood flow between 150 and 200 mL/min, and the dialysate flow was adjust to 2 L/h to prevent a sudden volume shift of patients under critical conditions. An Aquarius machine (Baxter, Germany) and AN69 polysulfone filter were utilized. Sterile citrate-buffered solution was used as the dialysate fluid, and the temperature was set at 36.0-37.0°C according to each patient's body temperature. Fluid balance was adjusted by the ICU doctors in charge of each patient. The filter was changed every 24 hours or earlier in case of thrombosis in the filter; the heparinized extracorporeal circuit was changed every 96 hours by full-time nephrology department nurses.

Body composition was measured at the same time points and conditions as body weight using a multi-frequency (1, 5, 50, 250, 500, and 1,000 kHz) BIA machine (InBody 4.0, Korea). Fluid load, bone mineral content, and body component were measured. We recorded the fluid indices with the ratio between every two components, including extracellular water: intracellular water and extracellular water: total body water, and regulated the nutritional indices by the square of the body height in m^2, namely fat-free mass/height^2 and body cell mass/height^2, respectively.

The use of indirect calorimetry is fundamental for the clinical application of the measurement of resting energy expenditure (REE) for guiding daily nutrition support in critical illnesses such as sepsis.[18] The O_2 and CO_2 gas fractions were measured in the total expired gas volume using specific gas sensors and transformed into values for volume of inspired oxygen (VO_2) and volume of exhaled carbon dioxide (VCO_2) in mL/min. Using the abbreviated Weir's equation (REE [kcal/d] = 3.941 × VO_2 [L/d] + 1.106 × VCO_2 [L/d]), REE was calculated per minute, and REE in kcal/day was calculated by averaging all the measurements.[19] The respiratory quotient (RQ), which is equal to the ratio of VCO_2 to VO_2, implies the substrate oxidation of tissues and organs.[20] The IC test was performed for each patient at admission, immediately before CRRT, and 6 hours after CRRT using a metabolic cart (Cosmed, Italy). We gave the patient a 6-hour duration to recover a relatively normal situation of blood gas, as CO_2 could abundantly diffuse from the blood side of the filter membrane to the ultrafiltrate side during CRRT, which may greatly impact the accuracy of the indirect calorimetry measurement involving VCO_2 quantification. Enteral or parenteral nutrition was suspended at least 1.5 hours before measurements to minimize diet-induced thermogenesis.

BIA and indirect calorimetry were performed by specially trained nurses from the Center of Clinical Nutrition, Jinling Hospital.

Data collection

Data (at admission, pre- and post-CRRT) and variables of interest included demographics, vital signs, infection source, sequential organ failure assessment (SOFA) score, anthropometrics, BIA measurements, REE and RQ obtained via indirect calorimetry, CRRT machine parameters, administration of diuretics, and energy intake and fluid balance during CRRT. All data were recorded by blinded ICU staff and rechecked for missing or implausible values by an investigator involved with the study.

Statistical analysis

Results are expressed as numbers (%) or (means ± standard deviation). The Statistical Package for Social Sciences (SPSS, Chicago, IL, USA) 20.0 was used for data analysis. Categorical data were compared using the chi-square test or Fisher exact test. Continuous variables were compared using Student's t test. Spearman's correlation coefficient r was calculated using linear regression analysis. Statistical significance was defined as $p<0.05$.

RESULTS

Study population

Enrollment started in December 2013, and the last patient was recruited in May 2014. Of the 56 patients considered for the study, 29 did not meet the entry criteria or refused to provide consent. Therefore, 27 patients (11 women and 16 men) were enrolled. Demographic characteristics and clinical values of the 27 patients are summarized in Table 1. Based on body composition measured using BIA, all patients had total body water overload (measurement/normal value ≥120%); this was especially present in the extracellular water. Twenty (74%) patients exhibited abdomen-induced sepsis. Patients received parenteral (n=10) or enteral (n=8) nutrition or both (n=9). Energy intake of each patient was calculated by an ICU clinician. All patients had a negative balance for the restricted fluid infusion protocol.

Change of body composition and metabolic status during CRRT

Table 2 shows the clinical assessments, body composition, and metabolic measurements of 27 patients. Body temperature, breathing, and heart rate were more regular in patients after CRRT. We also saw a decreased trend of hydration status (extracellular, intracellular, and total body water), a significant down-regulation of REE/body weight, and a more physiological RQ after CRRT (all $p<0.05$).

Differences of variations between subgroups

Based on patients' demographics and other characteristics before CRRT and during treatment in the ICU, percentage changes of extracellular water, intracellular water, REE, and RQ were compared between subgroups (Tables 3 and 4). With the "dehydration effect" of CRRT, a larger percentage change of extracellular water was found in younger (age ≤60 years) patients, and less change was found in non-abdomen-related sepsis and spontaneous breathing subgroups. Intracellular water was profoundly increased in younger and lower energy intake (≤25 kcal/kg/day) subgroups and decreased in women and lower BMI (≤20 kg/m^2) patient subgroups. In lower BMI and spontaneous breathing subgroups, there were smaller reductions in REE/body weight (all $p<0.05$).

Table 1. Characteristics of the sepsis patients (n=27) evaluated for body composition and indirect calorimetry assessment

Characteristics	Values
Demographics and health status	
Age, years (mean±SD)	48.2±22.0
Men, n (%)	16 (59)
SOFA at ICU admission (mean±SD)	10.2±3.3
Weight at ICU admission, kg (mean±SD)	62.8±14.7
Height, cm (mean±SD)	168±8.1
Body mass index at ICU admission, kg/m^2 (mean±SD)	22.0±1.4
Mechanical ventilation, n (%)	13 (48.1)
Infection source	
Abdomen, n (%)	20 (74)
Non-abdomen, n (%)	7 (26)
Day of BIA and IC assessment	
Length of ICU stay before CRRT, days (mean±SD)	6.7±4.8
Mechanical ventilation, n (%)	13 (48.1)
Diuretic, n (%)	15 (55.5)
Body temperature, °C (mean±SD)	37.8±1.5
Systolic blood pressure, mmHg (mean±SD)	98.3±38.4
Diastolic blood pressure, mmHg (mean±SD)	55.2±11.3
Breathing, /min (mean±SD)	17.3±5.4
Heart rate, /min (mean±SD)	77.1±57.8
CRRT machine parameters	
Ultrafiltration, L/day (mean±SD)	-1.8±1.1
Dialysate sodium concentration, mmol/L (mean±SD)	140±3.4
Dialysate temperature, °C (mean±SD)	36.5±0.5
CRRT duration, hours (mean±SD)	88.4±36.8
During CRRT process	
Energy intake, kcal/kg·day (mean±SD)	28.6±11.5
Fluid balance, L/day (mean±SD)	-2.5±1.3

CRRT: continuous renal replacement therapy; SOFA: sequential organ failure assessment; ICU: intensive care unit; SD: standard deviation.

Table 2. Demographics, vital signs, BIA and IC measurements of 27 patients at admission, pre- and post-CRRT

Measurements	Admission	Pre-CRRT	Post-CRRT
SOFA score	10.2±3.3	9.8±5.2	7.4±3.9
BW, kg	62.8±14.7	62.5±14.6	61.1±13.7
BMI, kg/m^2	22.0±4.4	21.9±4.3	21.4±4.0†‡
BT, °C	37.8±1.5	37.9±1.8	36.4±0.8†‡
SBP, mmHg	98.3±38.4	96.9±29.8	94.7±41.2
DBP, mmHg	55.2±11.3	49.7±10.2	51.3±13.2
Breathing, /min	17.3±5.4	20.9±7.2	11.2±3.8†‡
HR, /min	77.1±57.8	99.3±22.4†	69.8±10.3‡
ECW, L	16.3±4.7	16.6±5.0	15.6±4.2†‡
ICW, L	21.9±5.2	22.4±6.6†	20.1±3.2†‡
TBW, L	37.2±9.7	38.7±10.9†	35.3±8.4†‡
ECW/ICW	0.72±0.16	0.75±0.12†	0.70±0.13‡
ECW/TBW	0.40±0.06	0.43±0.04†	0.41±0.05‡
BMC, kg	2.7±0.8	2.7±0.9	2.8±0.8
FFM/height^2, kg/m^2	18.4±4.4	18.4±4.2	18.0±3.7
BCM/height^2, kg/m^2	13.1±3.4	11.3±2.6†	11.1±2.2†
REE/BW, kcal/kg	27.9±5.9	29.9±5.6†	26.6±4.3†‡
RQ	0.81±0.06	0.82±0.06	0.86±0.05†‡

Data are expressed as mean±SD.

CRRT: continuous renal replacement therapy; SOFA: sequential organ failure assessment; BW: body weight; BMI: body mass index; BT: body temperature; SBP: systolic blood pressure; DBP: diastolic blood pressure; HR: heart rate; ECW; extracellular water; ICW: intracellular water; TBW: total body water; BMC: bone mineral content; FFM: fat-free mass; BCM: body cell mass; REE: resting energy expenditure; RQ: respiratory quotient.

† $p<0.05$ vs admission; ‡ $p<0.05$ vs pre-CRRT.

CRRT-induced change in REE/body weight

Table 5 shows the relationship between the CRRT-induced percentage change of REE/body weight and other calorie-related variables of the 27 patients during CRRT. The percentage variation of metabolic downregulation was positively correlated with the percentage variation of extracellular water decrease and CRRT duration (r=0.547 and 0.515, p=0.003 and 0.006, respectively; Figures 1 and 2) and negatively related to dialysate temperature (r=−0.668, p=0.001; Figure 3). No significant correlation was found in other considered parameters.

DISCUSSION

As a life support technique, CRRT allows extracorporeal treatment in critical illness patients with hypercatabolism and volume overload.[20] CRRT was initially designed to treat patients with acute renal failure for removing cumulative waste products and water. Theoretically, since most of the mediators in sepsis are water-soluble and of middle molecular weight, including leukotriene, complement, cytokines, and other important vasoactive substances, it makes sense that these substances could be cleared from the blood using a hemofiltration membrane by means of diffusion, convection, and adsorption.[8] CRRT has been an alternative auxiliary therapy for clinical sepsis patients despite some existing controversies.[20,21] Several studies have described the relationship between volume overload and harmful outcomes in critically ill patients.[21-23] It was also demonstrated that a restriction of fluid infusion reduces the rate of mechanical ventilation and length of ICU stay.[24] In a prospective assessment of hydration status using the BIA technique, it was found that at ICU admission, patients presented a marked tendency (more than 70%) towards overhydration, which persisted during the ICU stay.[25] This study also shows that non-survivors had worse hyperhydration patterns compared to survivors, and this relationship still existed even when the patient's clinical condition was under control (evaluated by ICU scoring systems including SOFA score).[21]

Table 3. Intra-subgroup comparisons of CRRT-induced percentage changes of ECW and ICW

Subgroup	Change (%) in ECW	Change (%) in ICW
Age, years		
>60 (n=18)	-4.5±3.2	-8.1±3.6
≤60 (n=9)	-6.3±2.3*	-9.3±3.9*
Gender		
Men (n=16)	-5.1±1.8	-9.2±2.8
Women (n=11)	-5.5±1.3	-8.2±4.1*
BMI, kg/m^2		
>20 (n=20)	-4.7±2.1	-9.9±3.5
≤20 (n=7)	-4.9±1.9	-8.0±3.1*
Infection source		
Abdomen (n=20)	-6.6±2.2	-9.2±3.6
Non-abdomen (n=7)	-4.6±1.8*	-9.4±3.1
Ventilation		
Mechanical (n=13)	-5.8±2.1	-8.9±4.2
Spontaneous (n=14)	-4.8±1.9*	-9.4±2.8
Energy intake, kcal/kg·d		
>25 (n=22)	-5.6±2.4	-8.7±2.9
≤25 (n=5)	-5.7±2.8	-9.5±3.6*

Data are expressed as mean±SD.

ECW: extracellular water; ICW: intracellular water; BMI: body mass index.

*$p<0.05$ of intra-subgroup comparison.

Repeated body weight measurement is one of the most commonly used methods to evaluate volume change in ICU patients. However, the lack of weighing equipment on most ICU beds has limited the application of body weight monitoring.[25] Furthermore, an observational study indicated that body weight measured by ICU staff may not accurately reflect fluid balance owing to multiple factors.[26] Therefore, clinical decisions regarding fluid bal-

Table 4. Intra-subgroup comparisons of CRRT-induced percentage changes of REE/BW and RQ

Subgroup	Change (%) in REE/BW	Change (%) in RQ
Age, years		
>60 (n=18)	-9.8±2.9	6.5±1.1
≤60 (n=9)	-10.1±2.8	5.9±1.9
Gender		
Men (n=16)	-10.5±3.6	5.5±2.0
Women (n=11)	-10.8±2.9	6.0±1.6
BMI, kg/m^2		
>20 (n=20)	-11.9±4.4	6.4±1.6
≤20 (n=7)	-8.9±2.4*	6.2±2.1
Infection source		
Abdomen (n=20)	-10.6±2.9	6.4±2.3
Non-abdomen (n=7)	-11.1±3.5	6.1±1.8
Ventilation		
Mechanical (n=13)	-11.7±3.8	4.4±1.4
Spontaneous (n=14)	-9.8±2.7*	6.8±2.2*
Energy intake, kcal/kg·d		
>25 (n=22)	-10.8±3.9	6.7±2.7
≤25 (n=5)	-11.2±2.7	4.2±2.1*

Data are expressed as (mean±SD).
REE: resting energy expenditure; BW: body weight; RQ: respiratory quotient; BMI: body mass index.
*$p<0.05$ of intra-subgroup comparison.

Table 5. Relationship between CRRT-induced percentage change of REE/BW and other calorie-related variables of the patients (n=27) during CRRT

Variables	Change (%) in REE/BW	
	r	*p* value
Change (%) in ECW	0.026	0.898
Change (%) in ICW	0.547	0.003*
CRRT duration	0.515	0.006*
Energy intake	0.033	0.667
Dialysate temperature	-0.668	0.001*
Fluid balance	0.074	0.714

REE: resting energy expenditure; BW: body weight; ECW: extracellular water; ICW: intracellular water; CRRT: continuous renal replacement therapy.
*Considered significant.

ance should be based on techniques that sensitively reflect changes of each component of body water. BIA as a dynamic measurement could directly assess the ICU patient's hydration status and bypass certain errors when recording body fluid balance.[27]

Under septic conditions, whole-body protein catabolism occurs, with accelerated loss of muscle proteins, due to both direct and indirect effects of cytokines and stress hormone release. Numerous studies described sepsis as a hypermetabolic state (defined as measured REE at least 1.3-fold greater than the predicted value),[28] which was consistent with our present finding. In this context, metabolic downregulation may be considered as a protective response. We found that patients had a significant reduction of REE/body weight after CRRT, which is positively related to the length of CRRT treatment and negatively correlated with dialysate temperature. This suggests that downregulation of hypermetabolism may primarily be caused by the "clean effect" and "cooling effect" of CRRT.[29] Several studies have shown that these protective

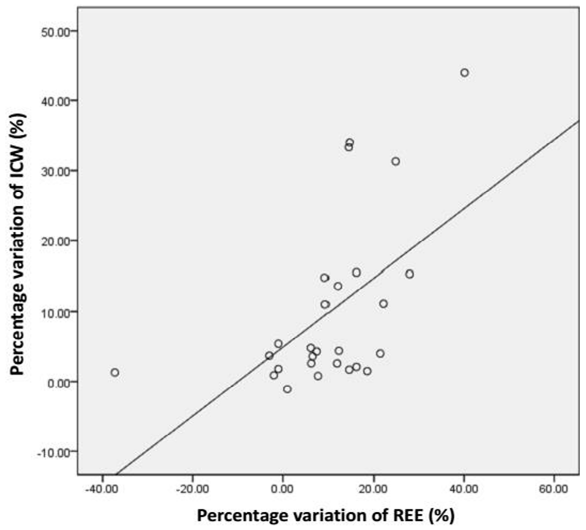

Figure 1. Relationships between pre- and post-CRRT percentage variation of REE/BW and percentage change in ICW in 27 sepsis patients (r=0.547, p=0.003)

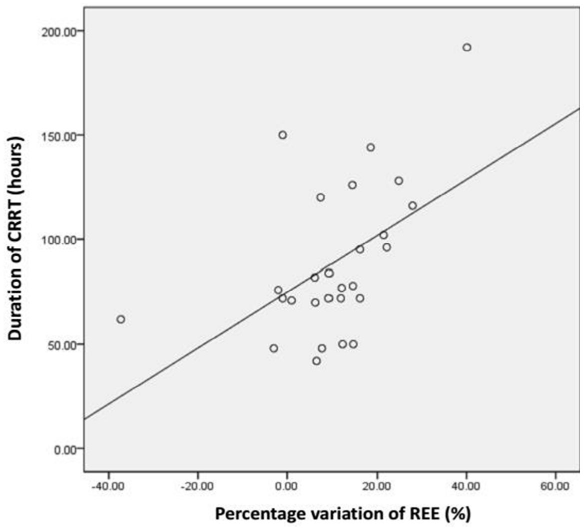

Figure 2. Relationships between pre- and post-CRRT percentage variation of REE/BW and duration of CRRT in 27 sepsis patients (r=0.515, p=0.006).

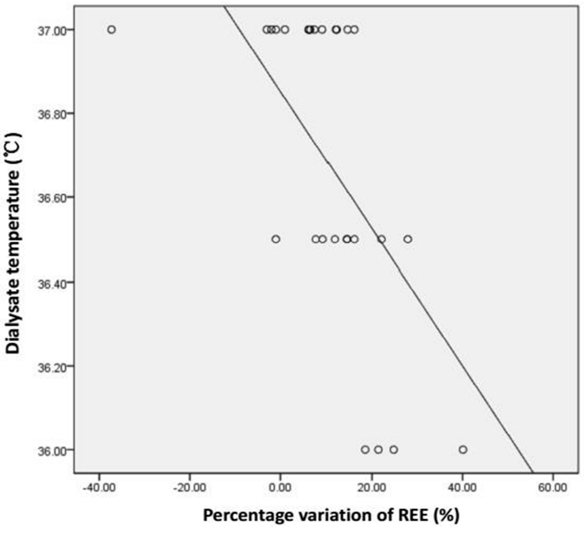

Figure 3. Relationships between pre- and post-CRRT percentage variation of REE/BW and dialysate temperature in 27 sepsis patients (r=-0.668, p=0.001).

effects were beneficial for maintaining hemodynamic stability and organ function.[30-34] In sepsis model animal studies, data showed that lowering excessive energy expenditure may result in better outcomes by sustaining mitochondria activity and cytoplasmic membrane integrity.[35]

The consequences of hemodialysis on body composition have been extensively examined. During hemodialysis, variations of extracellular and intracellular water are influenced by multifarious factors, such as serum electrolyte (especially sodium) balance, reduction of volume velocity, and decrease in plasma albumin or urea concentration. Nakao et al[36] observed 448 consecutive ESRD patients under maintenance hemodialysis or peritoneal dialysis and developed a nutritional index they named the Body Protein Index, which was calculated as body protein mass (determined by BIA) divided by the square of the patients' height in the same manner as the calculation of BMI. They found that ESRD patients had a high frequency (53.3%) of malnutrition during hemodialysis sessions, primarily caused by nutrient loss and poor appetite. However, they did not establish a correlation between the Body Protein Index and other nutritional parameters (including serum albumin and transferrin concentrations).[36]

Compared with chronic hemodialysis patients, CRRT patients have a relatively acute pathophysiology, but stable hemodynamic and nutritional changes result from extracorporeal life support technique.[37] We found that although total body water (both extracellular and intracellular water) of sepsis patients significantly decreased after CRRT, accompanied by the downregulation of REE, which suggests that CRRT exerts some dehydration and cooling effect on these patients. However, parameters reflecting nutritional state, such as fat-free mass and body cell mass, were not impacted by the non-specific elimination of CRRT. This is partly due to a short duration between the two-point BIA measurements, but we considered that the early and sufficient energy intake may also play a key role. A large portion (20 of 27) of our patients had hypoalbuminemia through the entire course of the disease, but it is unclear whether it was induced by the medical intervention, the sepsis-initiated hypercatabolism, or both.

The RQs measured using indirect calorimetry, which signify the substrate oxidation level, were distinctly elevated after CRRT. We cautiously speculate that this may reflect a transformation of nutrition substrate utilization resulting from CRRT. In the acute phase of disease, the main energy resource is lipid, thus the RQ is closer to 0.71.[38] In the present study, the RQ of sepsis patients was closer to a mixed-substrate RQ (0.85) after CRRT. This suggests that CRRT may have a certain metabolic regulation effect for hypermetabolic patients.

The current findings are supported by previous studies, which concluded that ICU mortality and 60-day mortality strongly correlated with the high incidence of overhydration and hypermetabolism in sepsis patients. We found that CRRT may improve volume load and fluid balance and ameliorate the metabolic state, but has no significant impact on the short-term nutritional status in sepsis patients. Additionally, it implies that CRRT may provide a beneficial outcome in ICU patients as a persistent and stable supportive treatment for critical illness, if accompanied by other medical interventions and nutrition regimens.

Three primary limitations of our study were found when analyzing the results. Firstly, as a short-term self-control study in a surgical ICU setting, we did not follow up the mortality outcomes of enrolled patients. Secondly, we performed a small-size study at a single department; this may result in some error in the data. In addition, we did not test for plasma and ultrafiltrate cytokine concentration because of operational difficulties, thus we were unable to determine whether the metabolic change accords with the elimination of cytokines.

Conclusion

We performed a prospective assessment of hydration and nutritional and metabolic changes using BIA and indirect calorimetry measurements in sepsis patients admitted to the ICU, pre- and post-CRRT; the data confirm that 1) sepsis patients exhibiting overhydration and hypermetabolism may improve with CRRT and 2) CRRT may be most effective when used in conjunction with other sound medical practices and supportive methods.

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AUTHOR DISCLOSURES

The authors have no conflicts to report.

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Original Article

Short-term consequences of continuous renal replacement therapy on body composition and metabolic status in sepsis

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连续性肾替代治疗在短期内对脓毒症患者机体组成和代谢状态的影响

背景和目的：重症监护接收治疗的脓毒症患者由于炎症介质的大量生成，往往会出现液体超负荷和代谢亢进的表现。连续性肾替代治疗是一种可以持续缓慢清除机体内过多的液体和细胞因子的有效的体外生命支持技术。本研究目的在于研究连续性肾替代治疗在短期内对机体组成成分和能量代谢的影响。**方法和研究设计**：本研究共纳入 27 名重症监护接受连续性肾替代治疗的脓毒症患者，在入院时、肾替代治疗前后分别进行机体成分分析和间接能量消耗检测，并记录其他可能对检测结果造成影响的临床因素，对各种因素与结果进行了相关性分析。**结果**：与肾替代治疗前相比，治疗后的患者液体超负荷和代谢亢进明显改善，患者静息能量消耗下降程度与细胞内水的变化及肾替代治疗持续时间呈正相关（r=0.547，p=0.003；r=0.515，p=0.006），而与置换液温度呈负相关（r=–0.668，p=0.001）。**结论**：连续性肾替代治疗可以在短期内显著改善脓毒症患者的液体负荷与代谢亢进状态，但对其营养状态并无显著影响；连续性肾替代治疗联合其他辅助支持治疗或许会发挥其最大临床优势。

关键词：重症监护病房、脓毒症、机体组成、代谢状态、连续性肾替代治疗