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Effect of blood lactate clearance rate on the prognosis of sepsis patients undergoing continuous renal replacement therapy

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Abstract: Objective To analyze the blood lactate levels and lactate clearance rate in septic patients undergoing continuous renal replacement therapy (CRRT) with different clinical outcomes, and to explore the prognostic value of blood lactate levels and lactate clearance rate on the prognosis of such patients. **Methods** A retrospective analysis was conducted on the clinical data of 60 septic patients who received CRRT treatment at Renmin Hospital of Wuhan University from January 2019 to November 2022. Based on discharge survival status, patients were divided into the survival group and the death group. Arterial blood lactate levels and lactate clearance rates were compared after treatment between the two groups. **Results** Of the 60 patients, 45 survived (75.00%), and 15 died (25.00%). Compared with the survival group, the death group had older age, longer hospital stay, and higher APACHE II and SOFA scores (P<0.05); The death group had a higher respiratory rate, longer CRRT treatment time, and higher admission blood lactate levels, CRP levels, and neutrophil percentage (P<0.05); The blood lactate levels in the death group were higher at 0 and 24 hours after treatment, and the blood lactate clearance rate decreased at 24 and 48 hours after treatment, with statistical significance (P<0.05). **Conclusion** CRRT is an effective treatment for sepsis. The 48-hour lactate clearance rate has significant prognostic value for septic patients undergoing CRRT.

Keywords: Blood lactate; Lactate clearance rate; sepsis; Continuous renal replacement therapy; Prognosis

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Sepsis is a systemic inflammatory response syndrome caused by severe infections, typically occurring in patients who have experienced severe burns, severe pneumonia, or extensive skin injuries [1]. Sepsis-induced inflammation can lead to varying degrees of dysfunction or even failure of multiple important organs such as the heart, liver, and kidneys. The mortality rate for septic patients is 30% to 70%, making it the leading cause of death in critically ill patients in the intensive care unit (ICU) [2].

Continuous renal replacement therapy (CRRT) is currently one of the main treatments for sepsis [3-4]. CRRT involves circulating blood outside the body and using a device to remove toxic substances from the blood, thereby maintaining metabolic functions at normal levels [5-6]. It can replace renal function and, to some extent, compensate for renal dysfunction caused by conditions such as sepsis. The use of CRRT can reduce the burden on the kidneys and help restore renal function. However, the extracorporeal circulation process of CRRT requires sterile conditions; if the circuit becomes contaminated by the environment or human error, the patient may experience reinfection, worsening their condition [7]. Studies have shown that CRRT treatment for septic patients in the ICU can reduce mortality and shorten the duration of sepsis-related treatments and hospital stays. It also helps improve indicators such as blood urea nitrogen, creatinine, C-reactive protein (CRP), procalcitonin (PCT), prothrombin time (PT), activated partial thromboplastin time (APTT), and Acute Physiology and Chronic Health Evaluation II (APACHE II) score [8]. Patients with severe sepsis often exhibit unstable vital signs, and controlling the treatment speed during CRRT while monitoring heart rate and blood glucose levels can help improve patient outcomes [9].

Blood lactate is an intermediate product of glucose metabolism produced by striated muscle, red blood cells, and brain tissue. The lactate level in the blood is related to the synthesis and metabolic rates of the kidneys and liver and can reflect insufficient organ perfusion and diseases like sepsis, aiding in the prognosis evaluation of critical conditions [10]. Research has found that elevated blood lactate is an independent risk factor for the occurrence of sepsis-associated acute kidney injury (AKI) and mortality, and it is closely related to the prognosis of septic patients [11]. Currently, there is limited research on the impact of blood lactate levels on the prognosis of septic patients receiving CRRT.

This study aims to explore the prognostic value of blood lactate levels and blood lactate clearance rate on the prognosis of septic patients undergoing CRRT by analyzing blood lactate levels and clearance rates in patients with different clinical outcomes.

1 Materials and methods

1.1 Data sources

The clinical data of septic patients who were admitted

to the ICU of Renmin Hospital of Wuhan University and received CRRT treatment from January 2019 to November 2022 were retrospectively collected. Patients were divided into the survival group and the death group based on their outcomes at discharge.

Inclusion criteria: The diagnostic criteria for sepsis were based on "The third international consensus definitions for sepsis and septic shock (sepsis-3)" [10]. Sepsis is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection. For patients with suspected or confirmed infections, sepsis can be diagnosed if the Sequential Organ Failure Assessment (SOFA) score increases by ≥2 points from baseline. Due to the complexity of SOFA score operations, the quick SOFA (qSOFA) score can also be used clinically to identify critically ill patients. If at least two of the qSOFA criteria are met, further evaluation is required to determine if the patient has organ dysfunction.

Exclusion criteria: (1) Age <18 years; (2) Pregnant or lactating women; (3) Participation in other studies; (4) Diseases that could affect immune-related indicators, such as systemic lupus erythematosus and other autoimmune diseases, leukemia, or recent use of immunosuppressive drugs; (5) Diseases that could affect the observation of prognostic indicators, such as severe brain injury, post-cardiopulmonary resuscitation, or late-stage malignancies; (6) Death or discharge within 24 hours of treatment; (7) Severe chronic organ dysfunction present at admission; (8) Severe renal insufficiency requiring maintenance hemodialysis; (9) Patients unable to sign informed consent or with poor compliance.

This study was approved by the Ethics Committee of Renmin Hospital of Wuhan University (2022NL-11-01), and all patients and their families signed informed consent.

1.2 CRRT treatment

Patients underwent CRRT using the Plasauto E-type blood purification device (manufactured by Asahi Kasei Corporation, Japan). The preferred vascular access for CRRT was the femoral vein or right internal jugular vein using a double-lumen catheter. The continuous venovenous hemodialysis filtration mode was selected, with the blood flow rate maintained at 180-200 mL/min. Anticoagulation methods included regional citrate anticoagulation (RCA), systemic heparin anticoagulation, or no anticoagulation, depending on the protocol determined by the treating physician. Filters were replaced within 72 hours as recommended by the manufacturer, provided there was no clotting. CRRT indications and treatment parameters were based on existing guidelines and individualized adjustments for each patient.

1.3 Data collection

Retrospective data collection included demographic information (gender, age), APACHE II score, SOFA score, treatment outcomes, CRRT treatment duration, and various clinical indicators such as heart rate, temperature, respiratory rate, PCT, CRP, white blood cell count, neutrophil percentage before CRRT treatment. Additionally, blood lactate levels and lactate clearance rates before and after CRRT treatment were measured, with a decrease of >35% defined as a significant reduction. Lactate clearance rate was calculated as follows: (blood lactate value before CRRT - blood lactate value after CRRT) / blood lactate value before CRRT × 100%.

1.4 Statistical methods

Data were collected using Excel 2019 and analyzed with SPSS 26.0 software. Normally distributed continuous data were expressed as mean ± standard deviation ($\bar{x}\pm s$), and comparisons were made using independent sample *t*-tests. Categorical data were expressed as case (%), and comparisons were made using the chi-square test or Fisher's exact test. A *P*-value of <0.05 was considered statistically significant.

2 Results

2.1 General characteristics of patients

The general characteristics of the patients were shown in **Table 1**. A total of 60 patients were included, of whom 34 were male (56.7%) and 26 were female (43.3%). There were 45 patients in the survival group (75.0%) and 15 patients in the death group (25.0%). There was no statistically significant difference in gender between the two groups ($P > 0.05$). Compared with the survival group, the death group had older age, longer hospital stays, and higher APACHE II and SOFA scores ($P < 0.05$).

Tab. 1 Comparison of general data between two groups ($\bar{x}\pm s$)

Group	*n*	Male/female (case)	Hospital stays (d)	Age (year)	APACHE II score (point)	SOFA score (point)
Survival group	45	25/20	25.55 ± 3.25	51.68 ± 15.34	12.15 ± 3.24	6.28 ± 1.25
Death group	15	9/6	28.65 ± 2.45	63.12 ± 18.29	17.24 ± 4.51	8.35 ± 2.66
χ^2/t value		0.090	3.380	2.383	4.758	2.909
P value		0.764	<0.001	0.020	<0.001	0.010

2.2 Vital signs and some biochemical test results

The vital signs and biochemical test results of septic patients receiving CRRT treatment were shown in **Table 2.** There was no statistically significant difference in heart rate, temperature, PCT, or white blood cell count between the two groups ($P > 0.05$). However, compared with the survival group, the death group had higher respiratory rate, longer CRRT treatment duration, and higher blood lactate levels, CRP levels, and neutrophil percentage at admission ($P < 0.05$).

Tab. 2 Comparison of vital signs and some laboratory results between two groups ($\bar{x}\pm s$)

Indicator	Survival group (n=45)	Death group (n=15)	t value	P value
Heart rate(beats/min)	78.85 ± 8.24	81.33 ± 5.28	1.090	0.280
Body temperature (℃)	36.94 ± 1.54	37.12 ± 1.53	0.393	0.696
Respiratory rate (times/min)	15.24 ± 1.58	19.25 ± 5.43	2.821	0.013
CRRT treatment time (d)	3.75 ± 1.25	5.25 ± 2.25	2.459	0.025
Blood lactate level (mmol/L)	4.47 ± 1.34	5.82 ± 1.01	3.570	0.001
PCT（ng/mL）	9.65 ± 2.15	10.26 ± 2.54	0.909	0.367
CRP（mg/L）	82.23 ± 16.54	96.37 ± 18.18	2.798	0.007
White blood cell count （$\times10^9$/L）	14.25 ± 5.67	16.44 ± 6.29	1.261	0.212
Percentage of neutrophils (%)	33.26 ± 3.25	38.58 ± 2.96	5.607	<0.001

2.3 Comparison of arterial blood lactate levels and lactate clearance rates

Compared with the survival group, the death group had higher blood lactate levels at 0 hours and 24 hours post-treatment, and lower lactate clearance rates at 24 hours and 48 hours post-treatment. These differences were statistically significant ($P < 0.05$). See **Table 3.**

Tab. 3 Comparison of blood lactate levels and lactate clearance ($\bar{x}\pm s$)

Group	Blood lactate level after treatment (mmol/L)		Lactate clearance rate after treatment (%)	
	0 h	24 h	24 h	48 h
Survival group	4.22±1.23	3.06±0.81	26.5±5.2	45.3±2.6
Death group	5.62±1.09	4.87±0.62	12.4±6.1	16.5±3.3
t value	3.921	7.900	8.708	34.684
P value	<0.001	<0.001	<0.001	<0.001

3 Discussion

Sepsis is a severe, life-threatening disease characterized by a systemic inflammatory response syndrome (SIRS) leading to multiple organ dysfunction. Approximately 20% of global deaths annually are associated with sepsis [13]. Despite decades of research, the treatment of sepsis remains supportive rather than curative. The measurement of blood lactate levels is widely used in sepsis and septic shock. Yang *et al.* [14] found that changes in microcirculatory blood flow and tissue perfusion parameters, as well as fluctuations in blood lactate levels, were closely related to the prognosis of patients with sepsis and septic shock, and these changes were of significant value in assessing the prognosis of septic shock patients. Suo *et al.* [15] conducted a retrospective analysis showing that serum lactate, PCT, brain natriuretic peptide, and APACHE II scores were all higher in sepsis patients compared to non-sepsis patients, with even higher expression levels observed in the deceased group. This study found a lower blood lactate levels at admission in the survival group than in the death group. Therefore, real-time monitoring of blood lactate levels in the clinical management of sepsis may allow for better tracking of disease progression, aiding physicians in making timely interventions, preventing further deterioration, and improving patient outcomes.

CRRT is a slow and steady form of continuous extracorporeal blood purification that can simulate renal function. It is typically implemented over a period of 24 hours to several days, with the goal of gently removing fluid overload and excess toxins. Currently, CRRT is commonly used in ICU settings for the treatment of critically ill and hemodynamically unstable adult and pediatric patients due to its precise volume control, stable acid-base and electrolyte correction, and hemodynamic stability [16]. CRRT treatment has become the preferred choice for clinicians and patients, especially when the patient has acute kidney injury and/or multiple organ failure, sepsis/shock, acute brain injury, or other causes of increased intracranial pressure or systemic brain edema in the ICU, and when the patient cannot tolerate the relatively rapid removal of fluids (and solutes) via conventional hemodialysis).

A retrospective analysis divided 92 septic patients into early and late groups, with the early group starting CRRT treatment within 24 hours of ICU admission, and the late group starting CRRT between 24 and 48 hours of ICU admission. The results indicated that early initiation of CRRT in septic patients effectively improved symptoms, enhanced treatment outcomes, and contributed to better prognosis [17]. Huang *et al.* [18] identified poor prognosis risk factors for septic patients with severe pulmonary infections, including high APACHE II scores, PCT levels, blood lactate, endotoxin levels, and low albumin levels. The construction of a nomogram model based on these risk factors demonstrated good predictive accuracy and can provide a reference for clinicians in screening high-risk populations and formulating relevant preventive and therapeutic measures. This study found that, compared to the death group, the survivors had lower arterial blood lactate levels after CRRT treatment. The lactate clearance rate was also reduced in the survivors ($P < 0.05$). This suggests that the dynamic changes in blood lactate levels following CRRT treatment are of significant importance for predicting the prognosis of septic patients.

This study confirmed that CRRT treatment had a

significant effect on the prognosis of septic patients, with 75% of patients successfully weaned from mechanical ventilation after CRRT treatment. In this study, the arterial lactate clearance rates at 24 and 48 hours after CRRT can serve as one of the early indicators for assessing the prognosis of septic patients, providing a timely and accurate reflection of changes in organ function. However, the study included a relatively small number of cases and was a single-center study. The small sample size may lead to selection bias, and most of the patients were transferred from general wards to the ICU, with some not undergoing early bundle therapy during the onset of shock. This may affect the accuracy of the results. Future studies will further explore these findings through large-scale, prospective, randomized trials.

The authors report no conflict of interest

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·论　著·

血乳酸清除率对连续肾脏替代疗法治疗的脓毒症患者预后的影响

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摘要：目的　通过分析不同临床结局的接受 CRRT 治疗的脓毒症患者的血乳酸水平以及血乳酸清除率，探讨血乳酸水平和血乳酸清除率对此类患者预后的影响。**方法**　回顾性分析 2019 年 1 月至 2022 年 11 月在武汉大学人民医院接受 CRRT 治疗的 60 例脓毒症患者的临床资料，根据出院存活情况分为存活组和死亡组，比较两组患者治疗后动脉血乳酸水平和乳酸清除率。**结果**　60 例患者中存活 45 例（75.00%），死亡 15 例（25.00%）。与存活组相比，死亡组年龄大，住院时间长，APACHEⅡ评分和 SOFA 评分高（$P<0.05$）；死亡组呼吸频率高，CRRT 治疗时间长，入院血乳酸水平、CRP 水平、中性粒百分比高（$P<0.05$）；死亡组治疗后 0 h 和 24 h 的血乳酸水平高，治疗后 24 h 和 48 h 的血乳酸清除率降低，差异有统计学意义（$P<0.05$）。**结论**　CRRT 是治疗脓毒症的有效方法，48 h 血乳酸清除率对 CRRT 治疗的脓毒症患者预后的判断具有应用价值。

关键词：血乳酸；乳酸清除率；脓毒症；连续肾脏替代疗法；预后

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Effect of blood lactate clearance rate on the prognosis of sepsis patients undergoing continuous renal replacement therapy

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Abstract: Objective　To analyze the blood lactate levels and lactate clearance rate in septic patients undergoing continuous renal replacement therapy (CRRT) with different clinical outcomes, and to explore the value of blood lactate levels and lactate clearance rate on the prognosis of such patients. **Methods**　A retrospective analysis was conducted on the clinical data of 60 septic patients who received CRRT treatment at Renmin Hospital of Wuhan University from January 2019 to November 2022. Based on discharge survival status, patients were divided into the survival group and the death group. Arterial blood lactate levels and lactate clearance rates were compared after treatment between the two groups. **Results**　Of the 60 patients, 45 survived (75.00%), and 15 died (25.00%). Compared with the survival group, the death group had older age, longer hospital stay, and higher APACHEⅡ and SOFA scores ($P<0.05$); the death group had a higher respiratory rate, longer CRRT treatment time, and higher admission blood lactate levels, CRP levels, and neutrophil percentage ($P<0.05$); the blood lactate levels in the death group were higher at 0 and 24 hours after treatment, and the blood lactate clearance rate decreased at 24 and 48 hours after treatment, with statistical significance ($P<0.05$). **Conclusion**　CRRT is an effective treatment for sepsis. The 48-hour lactate clearance rate has significant prognostic value for septic patients undergoing CRRT.

Keywords: Blood lactate; Lactate clearance rate; Sepsis; Continuous renal replacement therapy; Prognosis

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脓毒症是由严重感染引起的全身性炎症反应综合征，通常发生于经历过严重烧伤、严重肺炎或大面积皮肤损伤的患者[1]。严重脓毒症引起的炎症可导致机体多个重要器官如心脏、肝脏、肾脏等出现不同程度的功能障碍甚至衰竭。脓毒症患者的病死率高达 30%～70%，是重症监护室（ICU）危重症患者的主要死因[2]。

连续肾脏替代疗法（continuous renal replacement therapy，CRRT）是目前脓毒症的主要疗法之一[3-4]。CRRT 将血液引入体外循环并借助装置清除血液中的有毒物质，从而维持机体的代谢功能处于正常水平[5-6]，可替代肾脏功能，在一定程度上弥补因败血症等导致的肾脏功能障碍。CRRT 的使用可减轻肾脏的负担，有助于肾脏功能的恢复。然而，CRRT 的体外循环过程需无菌条件，若回路出现环境或人为污染，就可能使患者再次感染，加重病情[7]。研究表明，ICU 中脓毒症患者应用 CRRT 治疗可降低死亡率并缩短脓毒症相关的治疗时长和住院时长，同时还可更好地改善患者的尿素氮、肌酐、C 反应蛋白（CRP）、降钙素原（PCT）、凝血酶原时间（PT）、活化部分凝血活酶时间（APTT）和急性生理与慢性健康（APACHE Ⅱ）评分等指标[8]。严重脓毒症患者的生命体征多不稳定，在 CRRT 期间控制治疗速度，监测患者的心率和血糖，有助于患者的治疗[9]。

血乳酸是由横纹肌、红细胞和脑组织产生的糖代谢中间产物，血液中的乳酸水平与肾脏、肝脏的合成和代谢速率有关，能够反映器官组织灌注不足和脓毒症等疾病，有助于重症疾病的预后评估[10]。研究发现，血乳酸升高是脓毒症相关性急性肾损伤发生和死亡的独立危险因素，与脓毒症患者预后密切相关[11]。目前，国内外关于血乳酸水平对 CRRT 治疗的脓毒症患者预后影响的相关研究较少，本研究通过分析不同临床结局的接受 CRRT 治疗的脓毒症患者的血乳酸水平以及血乳酸清除率，探讨血乳酸水平和血乳酸清除率对此类患者预后的影响。

1　资料与方法

1.1　*资料来源*　收集 2019 年 1 月至 2022 年 11 月入住武汉大学人民医院 ICU 并接受 CRRT 治疗的脓毒症患者 60 例的临床资料进行回顾性分析，根据患者出院时结局分为存活组和死亡组。纳入标准：脓毒症的诊断标准参考 2016 年脓毒症和脓毒性休克诊断与治疗第三次国际共识[12]。脓毒症是指因感染引起的宿主反应失调导致的危及生命的器官功能障碍。对于感染或疑似感染的患者，当脓毒症相关序贯器官衰竭（sequential organ failure assessment，SOFA）评分较基线上升≥2 分可诊断为脓毒症。由于 SOFA 评分操作复杂，临床上也可以使用床旁快速 SOFA（quick SOFA，qSOFA）评分识别重症患者。如果符合 qSOFA 标准中的至少 2 项时，应进一步评估患者是否存在脏器功能障碍。排除标准：（1）年龄<18 岁；（2）怀孕或哺乳期妇女；（3）同时参与其他研究；（4）患有可能影响免疫功能的疾病，如系统性红斑狼疮等自身免疫性疾病，白血病等血液疾病，以及近期接受免疫抑制剂治疗者；（5）可能影响预后指标观察的疾病，如特重型颅脑损伤患者，心肺复苏术后，恶性肿瘤晚期等；（6）治疗未超过 24 h 即死亡或出院者；（7）已存在严重慢性脏器功能不全患者；（8）严重肾功能不全需进行维持性血液透析者；（9）未能签署知情同意书或依从性差者。本研究经武汉大学人民医院伦理委员会批准（2022NL-11-01），所有患者及家属签署知情同意书。

1.2　*CRRT 治疗*　患者接受 CRRT，血液净化机为 Plasauto E 型血液净化装置（日本旭化成公司生产），双腔导管首选股静脉或右颈静脉作为血管通路，选择连续静脉-静脉血液透析滤过治疗模式，血流量维持在 180～200 mL/min。抗凝方法包括局部柠檬酸盐抗凝（RCA）、全身肝素抗凝或非抗凝，具体抗凝方案由治疗医师依据指南决定。过滤器在没有凝血的情况下，按照制造商的建议在 72 h 内常规更换。CRRT 指征和治疗参数参考现有指南并针对患者做出个体化调整。

1.3　*数据收集*　回顾性收集入组患者的资料，包括性别、年龄、APACHE Ⅱ 评分、SOFA 评分、治疗结局、CRRT 治疗时间，及 CRRT 治疗前患者心率、体温、呼吸次数、PCT、CRP、白细胞计数、中性粒细胞百分比，CRRT 治疗前后患者血乳酸水平，计算血乳酸清除率（下降率>35% 定义为显著下降）。血乳酸清除率 =（CRRT 治疗前血乳酸值-CRRT 治疗后血乳酸值）/CRRT 治疗前血乳酸值×100%。

1.4　*统计学方法*　采用 Excel 2019 收集数据，使用 SPSS 26.0 软件分析数据。正态分布计量资料以 $\bar{x}\pm s$ 表示，比较采用独立样本 t 检验。计数资料以例（%）表示，采用 χ^2 检验或 Fisher's 精确概率法比较。$P<$

0.05为差异有统计学意义。

2 结　果

2.1　患者一般资料比较　患者一般资料如表 1 所示。共纳入 60 例患者,其中男性 34 例(56.70%),女性 26 例(43.30%)。存活组 45 例(75.00%),死亡组 15 例(25.00%)。与存活组相比,死亡组年龄大,住院时间长, APACHE Ⅱ 评分和 SOFA 评分高($P<0.05$)。但两组性别差异无统计学意义($P>0.05$)。

2.2　生命体征和部分生化检查结果　接受 CRRT 治疗脓毒症患者的生命体征和部分生化检查结果如表 2 所示。两组患者心率、体温、PCT、白细胞计数差异无统计学意义($P>0.05$);与存活组相比,死亡组呼吸频率高,CRRT 治疗时间长,入院血乳酸水平、CRP 水平、中性粒细胞百分比高($P<0.05$)。

2.3　动脉血乳酸水平和血乳酸清除率比较　接受 CRRT 治疗后,与存活组比较,死亡组治疗后 0 h 和 24 h 的血乳酸水平高,治疗后 24 h 和 48 h 的血乳酸清除率降低,差异有统计学意义($P<0.05$)。见表 3。

表 1　两组患者的一般资料比较 ($\bar{x}\pm s$)
Tab. 1　Comparison of general data between two groups ($\bar{x}\pm s$)

组别	例数	男/女(例)	住院时间(d)	年龄(岁)	APACHE Ⅱ 评分(分)	SOFA 评分(分)
存活组	45	25/20	25.55±3.25	51.68±15.34	12.15±3.24	6.28±1.25
死亡组	15	9/6	28.65±2.45	63.12±18.29	17.24±4.51	8.35±2.66
χ^2/t 值		0.090	3.380	2.383	4.758	2.909
P 值		0.764	<0.001	0.020	<0.001	0.010

表 2　两组患者的生命体征和部分实验室检查结果比较($\bar{x}\pm s$)
Tab. 2　Comparison of vital signs and some laboratory results between two groups ($\bar{x}\pm s$)

项目	存活组($n=45$)	死亡组($n=15$)	t 值	P 值
心率(次/min)	78.85±8.24	81.33±5.28	1.090	0.280
体温(℃)	36.94±1.54	37.12±1.53	0.393	0.696
呼吸频率(次/min)	15.24±1.58	19.25±5.43	2.821	0.013
CRRT 治疗时间(d)	3.75±1.25	5.25±2.25	2.459	0.025
入院血乳酸水平(mmol/L)	4.47±1.34	5.82±1.01	3.570	0.001
PCT(ng/mL)	9.65±2.15	10.26±2.54	0.909	0.367
CRP(mg/L)	82.23±16.54	96.37±18.18	2.798	0.007
白细胞计数($\times10^9$个/L)	14.25±5.67	16.44±6.29	1.261	0.212
中性粒细胞百分比(%)	33.26±3.25	38.58±2.96	5.607	<0.001

表 3　血乳酸水平和乳酸清除率比较　($\bar{x}\pm s$)
Tab. 3　Comparison of blood lactate levels and lactate clearance　($\bar{x}\pm s$)

组别	例数	治疗后血乳酸水平(mmol/L)		治疗后乳酸清除率(%)	
		0 h	24 h	24 h	48 h
存活组	45	4.22±1.23	3.06±0.81	26.5±5.2	45.3±2.6
死亡组	15	5.62±1.09	4.87±0.62	12.4±6.1	16.5±3.3
t 值		3.921	7.900	8.708	34.684
P 值		<0.001	<0.001	<0.001	<0.001

3 讨　论

脓毒症是一种严重致死性的全身炎症反应失调导致多脏器功能障碍的疾病。每年全球约 20%的死亡病例与脓毒症有关[13]。尽管经过几十年的研究,目前对脓毒症的治疗仍然是支持性治疗,而不是治愈性治疗。血乳酸浓度的测量在脓毒症及脓毒症休克中应用广泛。Yang 等[14]研究发现,微循环血流组织灌注参数的变化和血乳酸水平的变化与脓毒症及脓毒症休克患者的预后密切相关,对评估脓毒症休克患者的预后具有重要价值。一项回顾性分析结果表明,脓毒症患者血清中乳酸、PCT、脑钠肽和 APACHE Ⅱ 评分均高于非脓毒症患者,且表达水平在死亡组更高[15]。本研究发现,接受 CRRT 治疗的脓毒症患者存活组入院血乳酸水平低于死亡组。因此,在脓毒症患者的临床治疗过程中,实时监测血乳酸水平可以掌握患者的病情进展,这有助于医生及时采取有效干预措施,防止疾病的进一步发展,改善患者的预后。

CRRT 是一种缓慢而平稳的连续体外血液净化,可模拟肾脏功能,通常在 24 h 至数天内实施,目的是温和清除液体超载和过量的毒素。目前,CRRT 因其具有精确的容量控制、稳定的酸碱和电解质校正以及血流动力学稳定性,在医院 ICU 中通常用于重症和血流动力学不稳定的成人和儿童患者治疗[16]。尤其是当患者患有急性肾损伤和/或多器官功能衰竭、脓毒症/休克、急性脑损伤或 ICU 中颅内压升高或全身性脑水肿的其他原因,以及患者无法忍受通过常规血液透析相对快速地清除体液(和溶质)时,CRRT 治疗便成了主管医生和患者的首选。有回顾性分析将 92 例脓毒症患者分为早期组与晚期组,其中早期组在进入 ICU 24 h 内启动 CRRT 治疗,晚期组进入 ICU 24~48 h 启动 CRRT 治疗,结果表明早期行 CRRT 治疗脓毒症能有效改善症状,提高治疗效果,有利于改善患者预后[17]。研究发现,CRRT 治疗重症肺部感染合并脓毒症患者预后不良的危险因素,主要有高水平的 APACHE Ⅱ 评分、PCT、血乳酸、内毒素水平和低水平的白蛋白等,基于危险因素构建列线图模型具有良好的预测准确性[18],可为临床人员筛查高危人群和制定相关防治措施提供参考。本研究发现,接受 CRRT 治疗后,与死亡组相比,存活组患者 0 及 24 h 动脉血乳酸水平低,血乳酸清除率高,差异有统计学意义($P<0.05$)。这提示评估 CRRT 治疗后血乳酸水平的动态变化对脓毒症患者预后的影响具有重要意义。

本研究证实 CRRT 治疗对脓毒症患者预后的疗效明显,75%的患者在接受 CRRT 治疗后能够成功撤机。本研究中脓毒症患者 CRRT 治疗 24 h、48 h 的动脉血乳酸清除率可以作为早期评估脓毒症患者预后的指标之一,能更及时准确地反映患者器官功能的变化。但本研究纳入的病例数量相对较少,且为单中心研究,样本量小会导致选择性偏倚,且本研究纳入的患者都是 ICU 患者,大部分患者都由普通病房转入,当休克发生时,部分患者第一次未能进行集束化治疗,这可能会影响结果的准确性。今后的将进一步开展大样本、前瞻性随机研究来论证结果。

利益冲突　无

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