p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

CLINICAL CHARACTERISTICS, PARACLINICAL FEATURES, AND TREATMENT OUTCOMES OF CONTINUOUS RENAL REPLACEMENT THERAPY IN PATIENTS WITH MULTIPLE ORGAN DYSFUNCTION SYNDROME DUE TO SEPTIC SHOCK AT THE INTENSIVE CARE UNIT OF MILITARY HOSPITAL 175

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ABSTRACT

Objective: *To describe the clinical and paraclinical characteristics and evaluate the outcomes of continuous renal replacement therapy (CRRT) in patients with multiple organ failure due to septic shock.*

Subjects and methods: *This was a prospective, longitudinal, uncontrolled, cross-sectional descriptive study conducted on 47 patients diagnosed with multiple organ failure due to septic shock, treated in the Intensive Care Unit of Military Hospital 175 from June 2023 to December 2024.*

Results: *The study included 47 patients with multiple organ failure due to septic shock (63.8% male, mean age 58.3 ± 14.2 years), predominantly with community-acquired infections (76.6%). The mean APACHE II and SOFA scores were 22.4 ± 5.1 and 11.2 ± 3.7, respectively; mean blood lactate was 4.3 ± 2.1 mmol/L. CRRT significantly reduced the number of failed organs in the survival group (from 2.9 ± 0.9 to 1.6 ± 0.8, p < 0.001), but not in the non-survival group (p = 0.08). The shock reversal rate was 57.4%, the mortality rate was 44.7%, and the mean ICU stay was 9.5 ± 4.2 days. Early initiation of CRRT (≤ 24 hours) was associated with improved survival (64.3% vs. 21.1%, p < 0.05). Early initiation of CRRT within 24 hours was an independent protective factor (OR = 0.39; 95% CI: 0.15-0.98; p = 0.045), whereas APACHE II score (OR = 1.11; 95% CI: 1.01-1.28; p = 0.04), SOFA score (OR = 1.21; 95% CI: 1.05-1.48; p = 0.006), and blood lactate level (OR = 1.28; 95% CI: 1.04-1.68; p = 0.03) were independent risk factors.*

Conclusion: *Early CRRT within 24 hours is an independent protective factor that reduces the risk of mortality. In addition, APACHE II and SOFA scores, along with blood lactate levels, are independent risk factors with prognostic value for mortality in patients with septic shock.*

Keywords: *Multiple organ failure, continuous renal replacement therapy, septic shock*

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Ngày gửi bài: 10/8/2025; Ngày nhận xét: 20/11/2025; Ngày duyệt bài: 26/11/2025
https://doi.org/10.54804/

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

1. INTRODUCTION

Septic shock is a critical medical emergency characterized by profound circulatory dysfunction leading to multiple organ failure, requiring prompt and effective intervention. Once multiple organ dysfunction develops, patient prognosis becomes poor, with a markedly increased mortality rate, particularly in cases complicated by acute kidney injury (AKI). Mortality in septic shock can rise from below 40% to over 60% when AKI progresses to the point of requiring renal replacement therapy (RRT) [1]. Continuous renal replacement therapy (CRRT) is considered one of the key treatment strategies, as it helps maintain homeostasis, correct metabolic disturbances, and remove inflammatory mediators-factors implicated in the pathogenesis of septic shock and multiple organ failure [2]. Compared to intermittent hemodialysis, CRRT offers better hemodynamic stability, which is especially beneficial in patients with septic shock and unstable circulation [3].

In Vietnam, there remain certain limitations in research on the clinical and paraclinical characteristics, as well as treatment outcomes of CRRT in patients with multiple organ failure due to septic shock. Therefore, we conducted this study with the aim of describing the clinical and paraclinical characteristics and evaluating the treatment outcomes of continuous renal replacement therapy in patients with multiple organ failure due to septic shock admitted to the Intensive Care Unit of Military Hospital 175.

2. SUBJECTS AND RESEARCH METHODS

** Study subjects*

This study was conducted on 47 patients diagnosed with multiple organ failure due to septic shock who had indications for continuous renal replacement therapy (CRRT) at the Intensive Care Unit, Military Hospital 175, from June 2023 to December 2024.

- Inclusion criteria

+ Patients aged ≥ 18 years.

+ Patients meeting the diagnostic criteria for septic shock according to the 2016 definitions by the Society of Critical Care Medicine (SCCM) and the European Society of Intensive Care Medicine (ESICM) in 2016 [4].

+ Patients presenting with multiple organ failure (≥ 2 organs) as defined by SOFA score criteria, including: Respiratory: PaO_2/FiO_2 < 300; Cardiovascular: requiring vasopressors; Liver: bilirubin > 1.2 mg/dL; Renal: serum creatinine > 1.2 mg/dL or urine output < 500 mL/day; Hematologic: platelet count < 150,000/mm^3; Neurologic: GCS < 15.

+ Patients with clear indications for CRRT.

+ Patients who provided informed consent to participate in the study.

- Exclusion criteria

+ Patients under 18 years of age.

+ Patients with end-stage comorbidities and poor prognosis, such as terminal cancer, Child-Pugh C cirrhosis, or NYHA class IV heart failure.

+ Patients with contraindications to CRRT: Failure to establish vascular access; End-stage disease with no potential for recovery; Severe liver failure; Severe congestive heart failure with impaired tissue perfusion (including cardiogenic shock) [5].

+ Patients who declined to participate in the study.

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

** Research methods*

- Study design:

A prospective, cross-sectional, descriptive study with non-controlled longitudinal follow-up.

- Sample size:

A convenience sampling method was applied. All eligible patients diagnosed with multiple organ failure due to septic shock and indicated for CRRT at the ICU of Military Hospital 175 during the study period were included. A total of 47 patients were enrolled.

- Research criteria:

+ General characteristics: age, sex, medical history, clinical manifestations (source of infection, route of entry), and paraclinical indicators were recorded during the first 24 hours after hospital admission, including blood lactate levels, SOFA score, APACHE II score, and the number of organ failures.

+ Treatment outcomes of CRRT were evaluated through shock reversal rate, in-hospital mortality, and length of ICU stay.

+ Associations between treatment outcomes and selected clinical/paraclinical parameters were analyzed.

- Data analysis:

The collected data were coded, entered, and cleaned using Microsoft Excel 365, and subsequently analyzed with SPSS version 22.0.

3. RESULTS

Table 3.1. Clinical Characteristics and Risk Factors

Characteristics		Number (n = 47)	Percentage (%)
Male		30	63.8
Age ≥ 65 years		18	38.3
Comorbidities	Hypertension	24	51.1
	Diabetes mellitus	13	27.7
	Chronic lung disease	9	19.1
Source of infection	Community-acquired	36	76.6
	Hospital-acquired	11	23.4
Portal of entry	Respiratory tract	25	53.2
	Gastrointestinal tract	12	25.5
	Urinary tract	7	14.9
	Undetermined	3	6.4

Among the 47 patients with multiple organ failure due to septic shock, 63.8% were male. The mean age was 58.3 ± 14.2 years. Community-acquired infections accounted for 76.6%, while hospital-acquired infections comprised 23.4%.

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

Table 3.2. Severity of Illness Before CRRT Initiation

Parameters	Mean ± SD (Min - Max)
APACHE II score	22.4 ± 5.1 (14 - 33)
SOFA score	11.2 ± 3.7 (5 - 18)
Number of failed organs	3.1 ± 1.0 (2 - 5)
Blood lactate (mmol/L)	4.3 ± 2.1 (1.5 - 9.8)

The mean APACHE II and SOFA scores were 22.4 ± 5.1 and 11.2 ± 3.7, respectively. The mean blood lactate concentration was 4.3 ± 2.1 mmol/L. Patients had an average of 3.1 ± 1.0 organ failures.

Table 3.3. Change in the Number of Failed Organs Before and After CRRT

Patient Group	Before CRRT	After CRRT	p
Survivors (n = 26)	2.9 ± 0.9	1.6 ± 0.8	< 0.001
Non-survivors (n = 21)	3.4 ± 1.0	3.1 ± 1.1	0.08

A statistically significant reduction in the number of failed organs was observed in the survivor group (from 2.9 ± 0.9 to 1.6 ± 0.8; $p < 0.001$), while no significant improvement was seen in the non-survivor group (from 3.4 ± 1.0 to 3.1 ± 1.1; $p = 0.08$).

Table 3.4. Treatment Outcomes

Indicator	Value
Shock reversal rate (%)	57.4%
Time to shock reversal (hours)	76.2 ± 41.7 (18 - 168)
Overall mortality rate (%)	44.7%
ICU length of stay (days)	9.5 ± 4.2 (3 - 22)

The shock reversal rate was 57.4% (27/47); the average time to reversal was 76.2 ± 41.7 hours. Overall mortality was 44.7% (21/47), and the mean ICU stay was 9.5 ± 4.2 days.

Table 3.5. Comparison Between Early (≤ 24 Hours) and Late (> 24 Hours) CRRT Initiation

CRRT Timing	Total patients	Survival		Mortality		p-value
		n	(%)	n	(%)	
≤ 24 hours	28	18	64.3	10	35.7	0.012
> 24 hours	19	4	21.1	15	78.9	

The early CRRT group (≤ 24 hours) had a significantly higher survival rate (64.3%) compared to the late group (> 24 hours, 21.1%; $p < 0.05$).

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

Table 3.6. Univariate and multivariate regression analysis of factors associated with mortality

Factor	Univariate OR (95% CI)	p (univariate)	Multivariate OR (95% CI)	p (multivariate)
Age (years)	1.03 (0.99-1.07)	0.12	-	-
Renal replacement therapy ≤ 24 h	0.42 (0.18-0.94)	0.03	0.39 (0.15-0.98)	0.045
APACHE II	1.18 (1.05-1.36)	0.008	1.11 (1.01-1.28)	0.04
SOFA	1.34 (1.15-1.64)	< 0.001	1.21 (1.05-1.48)	0.006
Number of organ failures	1.95 (1.15-3.45)	0.01	1.46 (0.92-2.86)	0.09
Blood lactate (mmol/L)	1.41 (1.10-1.94)	0.009	1.28 (1.04-1.68)	0.03
ICU length of stay (days)	0.79 (0.63-0.96)	0.04	-	-

Multivariate regression identified four independent predictors of mortality. Early renal replacement therapy within 24 hours was a protective factor (OR = 0.39; 95% CI: 0.15-0.98; p = 0.045). In contrast, higher APACHE II score (OR = 1.11; 95% CI: 1.01-1.28; p = 0.04), higher SOFA score (OR = 1.21; 95% CI: 1.05-1.48; p = 0.006), and elevated blood lactate levels (OR = 1.28; 95% CI: 1.04-1.68; p = 0.03) were independent risk factors for mortality.

4. DISCUSSION

In this cohort of 47 patients with multiple organ failure due to septic shock, several clinical and paraclinical characteristics were found to be significantly associated with treatment outcomes. The majority of patients (63.8%) were male, with a mean age of over 58 years, which is consistent with previous studies reporting a higher prevalence of sepsis among men and an age-dependent increase in the risk of septic shock. Nguyen Duc Phuc et al. (2022) studied 32 patients with multiple organ failure due to septic shock who underwent continuous renal replacement therapy, including 23 males and 9 females, with a mean age of 51.6 years; community-acquired infections accounted for 78% of cases [6], which is consistent with our findings.

The mean APACHE II score was 22.4 ± 5.1, and the mean SOFA score was 11.2 ± 3.7, reflecting the severity of illness in this cohort. Both scoring systems have been widely validated for assessing illness severity and mortality risk in patients with sepsis. Previous studies have consistently shown that higher APACHE II and SOFA scores are associated with worse outcomes. However, unlike some earlier reports, our results demonstrated no significant reduction in the number of failed organs among non-survivors, suggesting that more aggressive interventions may be necessary in patients with late-stage septic shock [7].

In this study of 47 patients with multiple organ failure due to septic shock, early initiation of renal replacement therapy (≤ 24 hours) was markedly associated with a higher survival rate (64.3% compared with 21.1% in the late-treatment group). This result is in agreement with previous studies indicating that early initiation of renal replacement therapy may improve prognosis and accelerate organ recovery in

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

patients with sepsis-related organ failure [8]. Additionally, the mean blood lactate level was 4.3 ± 2.1 mmol/L, consistent with previous research supporting lactate as a key biomarker in assessing the severity and predicting mortality in septic shock [9].

The overall mortality rate in our cohort was 44.7%, reflecting the complexity of managing septic shock with multiple organ dysfunction. This figure aligns with findings from similar studies conducted in intensive care settings.

Our multivariate regression analysis identified four independent factors associated with mortality: early continuous renal replacement therapy (≤ 24 hours) was a protective factor, whereas higher APACHE II scores, higher SOFA scores, and elevated blood lactate levels were independent risk factors. These findings strongly correlate with illness severity and are consistent with previously published evidence. In the multivariate model, early initiation of renal replacement therapy significantly reduced the risk of death (OR = 0.39; 95% CI: 0.15-0.98; p = 0.045). This result is similar to that reported by Nguyen Duc Phuc et al. (2022), who found that early continuous renal replacement therapy improved outcomes in patients with septic shock and multiple organ failure [6]. The underlying mechanism may involve early removal of inflammatory mediators and improved control of metabolic acidosis.

Globally, although multiple observational studies have suggested improved survival with early initiation of renal replacement therapy, large randomized controlled trials have yielded inconsistent results. A meta-analysis of nine RCTs (BMC Nephrology, 2017) found no significant mortality benefit associated with early therapy (RR = 0.98; 95% CI: 0.78-1.23) [10]. This discrepancy may reflect differences in patient characteristics (e.g., septic shock vs. other causes of acute kidney injury), sample sizes, and inclusion criteria.

Each one-point increase in APACHE II score was associated with a higher risk of death (OR = 1.11; 95% CI: 1.01-1.28; p = 0.04). This is expected, as APACHE II is a comprehensive severity-of-illness score widely validated for mortality prediction in ICU patients. Numerous international studies have demonstrated the prognostic significance of increasing APACHE II scores. Li et al. (2025) in China reported that APACHE II reliably predicted mortality in infected patients (AUC ≈ 0.806), with higher scores observed in the non-survivor group [11]. Similarly, studies conducted in Vietnam have consistently shown significantly higher APACHE II scores among non-survivors (e.g., in the MOSAICS II analysis, the median APACHE II score was 18, with substantially higher scores in patients with severe clinical deterioration). These concordant findings confirm that APACHE II is an independent risk factor in diverse ICU populations both in Vietnam and internationally.

Each one-point increase in SOFA score was also associated with an increased risk of death (OR = 1.21; 95% CI: 1.05-1.48; p = 0.006), consistent with its established role in assessing organ dysfunction. SOFA remains the most widely used index for predicting mortality in severe sepsis; a recent meta-analysis showed that SOFA had superior sensitivity and specificity for hospital mortality prediction compared with other scoring systems [11]. In Vietnam, the MOSAICS II study (2021) reported a median SOFA score of 7 upon ICU admission, and SOFA ≥ 12 was associated with a markedly increased mortality risk (OR > 7) [12]. Our findings corroborate these reports, further

p-ISSN 1859 - 3461
e-ISSN 3030 - 4008

supporting the role of SOFA as an independent predictor of death, reflecting the degree of multiorgan failure and its strong correlation with mortality.

Elevated blood lactate levels were independently associated with increased mortality (OR = 1.28; 95% CI: 1.04-1.68; p = 0.03). Lactate is a well-recognized biomarker of impaired perfusion and tissue hypoxia and has been identified in many studies as an independent predictor of death in patients with septic shock. Patients with lactate >2 mmol/L during the first 24 hours generally have significantly higher mortality rates. Our results are consistent with this evidence: rising lactate levels reflect worsening hemodynamic and metabolic compromise, contributing to higher mortality risk. International studies have shown that lactate predicts both short- and long-term adverse outcomes [13]. In Vietnam, available reports also indicate increased mortality among patients with elevated lactate levels, although dedicated national studies on lactate in ICU cohorts remain limited.

In univariate analysis, age and the number of failing organs were associated with mortality, but these associations were not sustained after adjustment. This may be explained by the fact that APACHE II and SOFA already account for organ dysfunction, reducing the additional predictive contribution of the number of organ failures. In contrast, many previous studies have shown that multiorgan failure (e.g., ≥ 2 failing organs) is a strong predictor of death; for instance, in patients with hypoxic hepatitis, the development of multiorgan failure increased mortality risk by 3 - 5-fold [14]. Differences between our findings and earlier studies may be attributable to sample size and variations in patient profiles.

Another notable result was that longer ICU length of stay appeared to be associated with lower mortality in univariate analysis (OR < 1), likely due to survival bias: patients who die early inherently have shorter ICU stays. After adjustment, ICU length of stay was no longer an independent predictor. Thus, other indirect variables such as age and treatment duration largely reflect the natural course of illness rather than independent determinants of mortality once severity scores (APACHE II, SOFA) and biochemical markers (e.g., lactate) are incorporated into the model.

5. CONCLUSION

The findings indicate that early continuous renal replacement therapy is associated with improved survival in patients with multiple organ failure due to septic shock. Early initiation of therapy within 24 hours was identified as an independent protective factor, improving survival outcomes (adjusted OR = 0.39; 95% CI: 0.15-0,98; p = 0.045). In contrast, higher APACHE II scores, higher SOFA scores, and elevated blood lactate levels were identified as independent risk factors for mortality (p < 0.05), reflecting the critical role of overall disease severity and tissue hypoxia in determining prognosis.

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