Original Article

Cukurova Anestezi ve Cerrahi Bilimler Dergisi

Limited Prognostic Value of 12-Hour Lactate Clearance After Cardiac Arrest: A Retrospective Observational Study

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Abstract

Purpose: This study aimed to evaluate the association between 12-hour lactate clearance and mortality in adult patients who achieved return of spontaneous circulation (ROSC) after cardiopulmonary arrest and were monitored in the intensive care unit. **Methods:** This retrospective study included adult patients admitted to the intensive care unit after cardiopulmonary arrest between January 2023 and January 2025. Lactate clearance was calculated in patients with available baseline and 12-hour lactate measurements. Patients who died within the first 12 hours were included in early mortality analyses but excluded from lactate clearance analyses. The predictive value of baseline lactate was assessed using ROC analysis, and multivariable logistic regression analysis was performed in patients with calculable lactate clearance. **Results:** A total of 229 patients were included. During ICU stay, 180 patients (78.6%) died, including 52 who died within the first 12 hours. Baseline lactate levels were markedly elevated in patients who died within the first 12 hours (median 14.1 mmol/L; IQR 9.9–16.0). Mortality was 79.5% in patients with negative lactate clearance and 69.9% in those with positive clearance. Lactate clearance was not independently associated with mortality. Baseline lactate demonstrated good predictive performance for 12-hour mortality (AUC = 0.75) and moderate performance for ICU mortality (AUC = 0.69). **Conclusion:** Admission lactate levels were effective predictors of early mortality, whereas lactate clearance was not independently associated with mortality.

Keywords: Cardiopulmonary arrest; Lactate clearance; Mortality; Intensive care

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1. Introduction

Cardiopulmonary arrest (CPA) is a serious clinical condition associated with high mortality and morbidity. Although return of spontaneous circulation (ROSC) can be achieved in some patients, a substantial proportion die during the intensive care process or develop permanent neurological sequelae[1,2]. There is a substantial need to identify reliable prognostic markers that can support clinical decision-making during the post-ROSC period.

Serum lactate is commonly used as a marker of tissue hypoperfusion and anaerobic metabolism[3]. Previous studies have reported a clear association between elevated lactate concentrations and increased mortality following cardiac arrest[4,5]. Nevertheless, reliance

on a single lactate measurement has been questioned, as it may fail to capture the dynamic metabolic changes occurring after resuscitation[6]. For this reason, lactate clearance has been proposed as an alternative prognostic measure. In septic patients, improvements in lactate clearance have been linked to better survival outcomes[7,8].

The prognostic significance of lactate clearance following cardiopulmonary arrest continues to be debated. Although certain studies suggest early reductions in lactate are associated with improved survival[9], others indicate that lactate clearance assessed at later intervals provides limited prognostic information[10]. Further studies employing clearly defined assessment intervals and direct comparisons between lactate clearance and admission lactate levels are still warranted[11].

2. Materials and Methods

This study was conducted by retrospectively reviewing data from patients who achieved ROSC after cardiopulmonary arrest and were followed in the intensive care unit between January 2023 and January 2025. All eligible patients during the study period were consecutively included.

Patients aged 18 years and older admitted to the ICU after achieving ROSC following cardiopulmonary arrest were included. Patients younger than 18 years and those with unavailable essential clinical or laboratory data were excluded.

Of the 229 patients included, 52 died within the first 12 hours and could not undergo serial lactate measurements; therefore, they were excluded from lactate clearance analyses but included in early mortality analyses. The final study population for lactate clearance analyses consisted of 177 patients.

Serum lactate levels were recorded at ICU admission (0 hour) and at the 12th hour. Lactate clearance was calculated as: (baseline lactate level − 12-hour lactate level) / baseline lactate level × 100. Patients were classified into positive and negative lactate clearance groups. Admission lactate levels were used in ROC analyses to assess their predictive value for mortality.

Statistical Analysis

Data distribution was assessed using the Shapiro–Wilk test. Normally distributed data are presented as mean ± SD; non-normally distributed data as median (IQR). Group comparisons used the Student's t-test, Mann–Whitney U test, one-way ANOVA, or Kruskal–Wallis test as appropriate. Categorical variables were compared using the chi-square test. Multivariable logistic regression included lactate clearance (per 10% decrease), age, and CPR duration. ROC analysis was performed with AUC estimated using 2,000-iteration bootstrap resampling. Optimal thresholds were identified using the Youden index. A two-tailed $p < 0.05$ was considered statistically significant.

Ethics Approval

Ethical approval was obtained from the Clinical Research Ethics Committee of Elazig Fethi Sekin City Hospital (18 September 2025; Decision No: 2025/15-11). The study was conducted in accordance with the Declaration of Helsinki and reported in compliance with the STROBE guidelines. Due to the retrospective design, the requirement for informed consent was waived.

3. Results

A total of 229 patients were included. Of these, 180 (78.6%) died during their ICU stay, while 49 (21.4%) were discharged alive. Patients who died were older and had a longer CPR duration compared with survivors; however, these differences did not reach statistical significance (Table 1).

Table 1. Baseline characteristics of the study population according to clinical outcome

Variable	Non-survivors (n=180)	Survivors (n=49)	p value
Age, years	74.0 (65.0–83.0)	70.0 (53.0–80.0)	0.0876
CPR duration, min	20.0 (15.0–30.0)	20.0 (12.0–22.0)	0.0898
Sex (Female/Male)	85/95	17/32	0.1608

Continuous variables are presented as median (IQR). Categorical variables as counts. Group comparisons used the Mann–Whitney U test or chi-square test.

Among the 229 patients, 52 died within the first 12 hours after ICU admission. Lactate clearance could be calculated in 177 patients. Among these, 44 had negative and 133 had positive lactate clearance. Mortality was 79.5% in the negative clearance group and 69.9% in the positive clearance group. Admission lactate levels were highest in the early mortality group (Table 2).

Table 2. Clinical outcomes and admission lactate according to early mortality and lactate clearance groups

Group	n	Mortality n (%)	Admission lactate median (IQR) mmol/L
≤12-hour mortality	52	52 (100.0%)	14.1 (9.9–16.0)
Negative lactate clearance	44	35 (79.5%)	4.9 (2.0–13.0)
Positive lactate clearance	133	93 (69.9%)	7.9 (4.4–11.3)

In multivariable logistic regression analysis, lactate clearance was not independently associated with mortality (OR per 10% decrease 1.012; 95% CI 0.969–1.057; p = 0.595). Age and CPR duration were also not identified as independent predictors (Table 3).

Table 3. Multivariable logistic regression analysis of factors associated with mortality

Variable	OR	95% CI Lower	95% CI Upper	p value
Lactate clearance (per 10% decrease)	1.012	0.969	1.057	0.595
Age	1.018	0.997	1.040	0.097
CPR duration, min	1.023	0.993	1.054	0.132

Lactate clearance entered as continuous variable scaled per 10% decrease. Analysis restricted to patients with calculable lactate clearance. OR: odds ratio; CI: confidence interval.

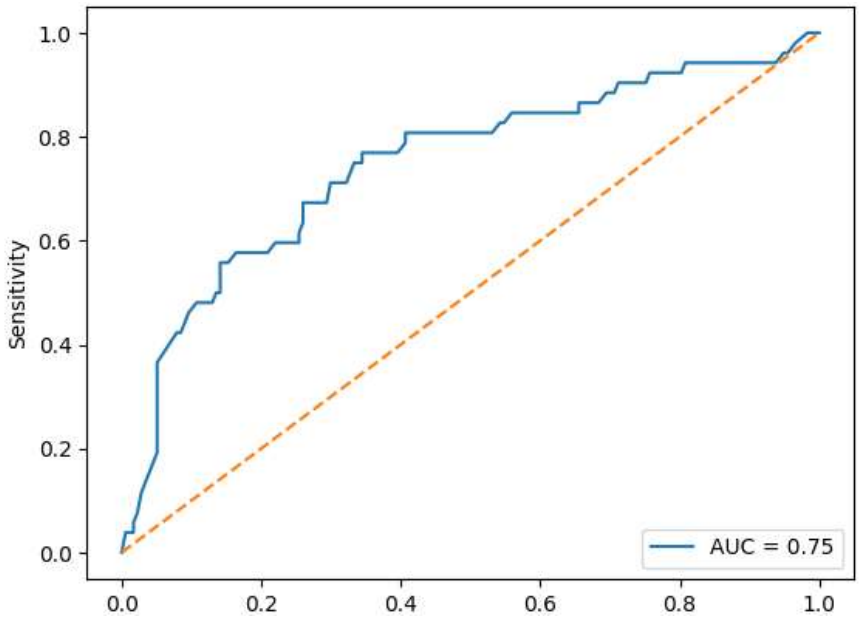

Figure 1. ROC curve of admission lactate for prediction of ≤12-hour mortality. The area under the curve (AUC) was 0.75 (95% CI 0.66–0.83).

Admission lactate demonstrated good discriminative performance for predicting ≤12-hour mortality (AUC = 0.75; 95% CI 0.66–0.83) and moderate performance for overall ICU mortality (AUC = 0.69; 95% CI 0.60–0.78) (Table 4). The ROC curve for 12-hour mortality is presented in Figure 1.

Table 4. ROC analysis of admission lactate for early and ICU mortality

Outcome	AUC	95% CI Lower	95% CI Upper
≤12-hour mortality	0.75	0.66	0.83
Intensive care unit mortality	0.69	0.60	0.78

Early mortality defined as death within the first 12 hours after ICU admission. ICU mortality defined as death during the index ICU stay. AUC: area under the curve; CI: confidence interval.

4. Discussion

In this retrospective cohort, 12-hour lactate clearance was not independently associated with ICU mortality. In contrast, admission lactate levels demonstrated greater prognostic value. Admission lactate showed good discriminative ability for predicting mortality within the first 12 hours (AUC = 0.75) and moderate performance for overall ICU mortality (AUC = 0.69). These findings are consistent with previous studies reporting that admission lactate levels have greater prognostic value than lactate clearance after cardiopulmonary resuscitation[12,13].

Cardiopulmonary arrest is characterized by oxidative stress, mitochondrial dysfunction, and impaired oxygen utilization at the cellular level. Factors such as arrest duration, location, etiology, and resuscitation effectiveness directly influence lactate production[14,15,16]. These mechanisms support the prognostic relevance of admission lactate levels[17].

In patients with sepsis, several studies have demonstrated an association between lactate clearance and early mortality[18,19], prompting consideration of whether a similar approach could be applied after cardiac arrest. However, the post–cardiac arrest population is inherently more heterogeneous. The presence of global ischemia–reperfusion injury, post–cardiac arrest syndrome, and hypoxic–ischemic neurological damage substantially limits the predictability of lactate kinetics in this context[20].

While early reductions in lactate levels have been linked to improved survival in some reports[21], other investigations suggest that lactate clearance assessed at later intervals provides limited predictive value[18]. These inconsistencies likely reflect methodological differences, including timing of lactate measurements, variability in clearance calculation approaches, and heterogeneity among study populations[22].

Our findings suggest that absolute lactate values or time-weighted lactate metrics may provide superior prognostic information compared with lactate clearance alone[23,24]. The modest prognostic performance of lactate clearance may partly reflect its sensitivity to ICU interventions such as fluid resuscitation and vasopressor administration, which can substantially affect circulating lactate levels[6].

Rather than disregarding lactate clearance entirely, incorporating it alongside other clinical and laboratory indicators may allow for a more comprehensive prognostic assessment[24,25].

Strengths and Limitations

Strengths of this study include the assessment of lactate clearance at a clearly predefined 12-hour interval and the direct comparison with admission lactate levels. Limitations include the retrospective single-center design, which may limit generalizability. Lactate clearance could not be determined in patients who experienced early mortality. The

lack of neurological outcome evaluation limits conclusions regarding functional prognosis.

Future Directions

Future multicenter, prospective investigations should assess lactate clearance across varying time intervals alongside admission lactate levels and additional biomarkers. Further research exploring the relationships between lactate kinetics, neurological outcomes, and long-term survival may help clarify remaining gaps in the current understanding.

5. Conclusion

In this retrospective observational study of patients admitted to the ICU after cardiopulmonary arrest, 12-hour lactate clearance was not independently associated with mortality. Admission lactate levels, in contrast, demonstrated better prognostic performance, particularly for early mortality prediction. These findings suggest that admission lactate may serve as a more practical and reliable marker for early risk stratification than lactate clearance alone. Future prospective, multicenter studies are needed to validate these findings and further define the role of lactate kinetics in post-cardiac arrest prognostication.

Author Contributions: Sevim Şenol Karataş: conceptualization, study design, data collection and analysis, statistical analyses, drafting of the initial manuscript. Sait Fatih Öner: data analysis and interpretation, literature review, critical revision of the manuscript. Oğuz Kağan Bulut: methodology development, clinical data verification, manuscript revision and finalization. All authors read and approved the final version of the manuscript.

Ethical Approval: Ethical approval was obtained from the Clinical Research Ethics Committee of Elazig Fethi Sekin City Hospital (Date: 18 September 2025; Decision No: 2025/15-11). The study was conducted in accordance with the Declaration of Helsinki. Informed consent was waived due to the retrospective design.

Conflict of Interest: The authors declare that they have no conflicts of interest.

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Data Availability: The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

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