Original Article

Eurasian Journal of Toxicology

# The Relationship between Blood Lactate Levels and Clinical Outcomes in Patients Taking Drugs for Suicide: A Retrospective and Descriptive Study

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## Abstract

**Introduction:** Acute poisoning that causes significant morbidity and mortality worldwide is a preventable public health problem. In the evaluation of critically ill patients in emergencies, lactate is a useful biomarker. This study aims to investigate whether the mortality, morbidity, and intensive care hospitalization of patients presenting to the emergency department with drug intake for suicide can be determined by the blood lactate levels measured on admission.

**Material-Method:** Patients over the age of 18 who presented to the emergency department between 1 January 2019 and 1 January 2020 due to acute poisoning were included in this single-center retrospective study. The relationship between the blood lactate levels measured on admission and the clinical outcome of the patient was examined. The student t-test was used to compare groups with normally distributed data, while the chi-square test was used for non-normally distributed or ordinal data. $p<0.05$ was considered statistically significant.

**Findings:** The data of 223 patients were analyzed. The median age was 28, and the female ratio was 68.6%. The most commonly ingested drugs were analgesics with 35%, other drugs with 33.6%, antidepressants with 24.7%, and other psychotropics with 22.4%. 192 of the patients were discharged following the treatment, 31 patients were admitted to the service or intensive care unit, and 3 patients died within the first 24 hours after the intensive care unit admission. When the factors related to hospitalization were examined, male gender, high mean age, high lactate level, and analgesic and other psychotropic drug intake were found to be related to hospitalization. On the other hand, old age (48.00, ±16.70), high lactate levels (6.77, ±6.52), and low bicarbonate levels (17.40, ±3.05) were associated with mortality.

**Conclusion:** Blood lactate measured on admission is an important biomarker to predict both mortality and morbidity in patients presenting to the emergency department due to the use of drugs for suicidal purposes.

**Keywords:** emergency department, lactate level, mortality, suicidal drug intake.

## Özet

**Giriş:** Dünya çapında önemli morbidite ve mortaliteye neden olan akut zehirlenme, önlenebilir bir halk sağlığı sorunudur. Acil durumlarda kritik hastaların değerlendirilmesinde laktat yararlı bir biyobelirteçtir. Bu çalışmada intihar amaçlı ilaç alımı ile acil servise başvuran hastaların mortalite, morbidite ve yoğun bakım yatışlarının başvuru sırasında ölçülen kan laktat düzeyleri ile belirlenip belirlenemeyeceğini araştırmak amaçlanmıştır.

**Gereç-Yöntem:** Bu tek merkezli retrospektif çalışmaya 1 Ocak 2019 ile 1 Ocak 2020 tarihleri arasında akut zehirlenme nedeniyle acil servise başvuran 18 yaş üstü hastalar dahil edildi. Başvuru sırasında ölçülen kan laktat düzeyleri ile hastanın klinik sonucu arasındaki ilişki incelendi. Normal dağılan verilere sahip grupları karşılaştırmak için öğrenci t testi, normal dağılmayan veya sıralı veriler için ki-kare testi kullanıldı. $p<0,05$ istatistiksel olarak anlamlı kabul edildi.

**Bulgular:** 223 hastanın verileri analiz edildi. Ortanca yaş 28, kadın oranı %68,6 idi. En sık alınan ilaçlar %35 ile analjezikler, %33,6 ile diğer ilaçlar, %24,7 ile antidepresanlar ve %22,4 ile diğer psikotroplardır. Hastaların 192'si tedavi sonrası taburcu edildi, 31 hasta servise veya yoğun bakıma alındı ve 3 hasta yoğun bakıma yatıştan sonraki ilk 24 saat içinde öldü. Hastaneye yatış ile ilgili faktörler incelendiğinde erkek cinsiyet, yaş ortalamasının yüksek olması, laktat düzeyinin yüksek olması, analjezik ve diğer psikotrop ilaç alımının yatışla ilişkili olduğu saptandı. Öte yandan yaşlılık (48.00, ±16.70), yüksek laktat seviyeleri (6.77, ±6.52) ve düşük bikarbonat seviyeleri (17.40, ±3.05) mortalite ile ilişkilendirildi.

**Sonuç:** Acil servise intihar amaçlı ilaç kullanımı nedeniyle başvuran hastalarda, başvuru sırasında ölçülen kan laktatı hem mortalite hem de morbiditeyi öngörmede önemli bir biyobelirteçtir.

**Anahtar kelimeler:** acil servis, laktat düzeyi, mortalite, intihar amaçlı ilaç alımı

## Introduction

Acute poisoning is a preventable public health problem that causes significant morbidity and mortality worldwide[1]. Acute poisonings can be either intentional (suicide attempt) or unintentional (accidental). Intentional poisoning is usually encountered in adults. Acute poisoning is estimated to be responsible for more than one million diseases worldwide annually and continues to increase each year[1-3]. In Turkey, the types of poisoning cases differ due to geographical diversity, socio-economic status, and differences in cultural practices. While drugs are the most common causes of poisoning, carbon monoxide, alcohol, food, fungi, organophosphate, and corrosive substances are the other common causes of poisoning[4,5]. The mortality rate due to poisoning is 1% in developed countries, whereas this rate is between

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**Received:** 02.06.2022 • **Revision**: 06.06.2022 • **Accepted:** 07.06.2022

**Cite this article as:** Güllüpınar B, Sağlam C, Ünlüer EE. The Relationship between Blood Lactate Levels and Clinical Outcomes in Patients Taking Drugs for Suicide: A Retrospective and Descriptive Study. Eurasian J Tox. 2022;4(2): 35-39

3-5% in developing countries[4]. Patients who attempt suicide generally have higher mortality[6]. Therefore, effective and prompt medical intervention is vital to prevent morbidity and mortality in acute poisoning.

In the emergency department, lactate is a useful biomarker in the evaluation of critically ill patients[7]. Hyperlactatemia is seen in hypoxic conditions such as circulatory failure and severe anemia as well as in conditions that are not hypoxic but cause oxygen use problems such as malignancies, liver or kidney failure, and serious infections[8]. The most common causes of lactic acidosis are sepsis, shock, severe heart failure, and severe trauma[9]. The value considered abnormal in hyperlactatemia is 2 mmol/L and above. Mortality is higher in patients with lactate levels between 2 and 4 mmol/l compared to patients with lower lactate levels[10]. Hyperlactatemia >4 mmol/l is significantly associated with in-hospital mortality[11].

To our knowledge, there are no studies evaluating the relationship between blood lactate levels and clinical outcomes in patients who ingest drugs for suicide. This study aimed to investigate whether the mortality, morbidity, and intensive care hospitalization of patients presenting to the emergency department with drug intake for suicide can be determined by the blood lactate levels measured on admission.

## Material and Methods

In this single-center retrospective study, patients presenting to the emergency department of a 700-bed tertiary training and research hospital to which an average of 200,000 patients present annually between January 1, 2019 and January 1, 2020 were included. The study was approved by the Bozyaka Training and Research Hospital Ethics Committee (Ethics committee decision number: 2022/90).

Patients over 18 years who presented to the emergency department due to acute poisoning were included. Patients who were under 18, were pregnant, had trauma, experienced circulatory failure, had severe anemia, suffered from malignancies, had a previous history of liver or kidney failure, had serious infections, used alcohol and recreational drugs, used rat poison, organophosphate, and caustic substance, and whose laboratory data could not be obtained were excluded from the study. According to the ICD 10 system, coding T36-T50 (poisoning by drugs, drugs and biological substances), T51-T65 (toxic effects of major non-medicinal substances according to the source), and X60-X84 (intentional self-harm) were used. For this purpose, age, gender, drug or drugs that cause poisoning, the amount taken by the patient, complete blood count (leukocyte, hemoglobin, platelet and biochemical values; urea, creatinine, alanine aminotransferase, and aspartate aminotransferase)) and blood gas analysis (pH, lactate) parameters on admission to the emergency department and clinical outcome (discharge, ward and intensive care admission) were reached using the hospital information management system database. Additionally, the patient's history, physical examination findings, and vital signs during admission were obtained from patient records.

Blood gas analysis was measured on the autoanalyzer (XN-1000, Sysmex Corp. Kobe, JAPAN) after venous blood gas collection.

### *Statistical Analysis*

Statistical analysis was performed with the IBM SPSS Statistics Version 26. Quantitative data were expressed as mean±standard deviation, while qualitative data as frequency and percentage. Normality analysis was performed for continuous variables. The student t-test was used to compare two groups with normally distributed data, whereas the chi-square test was used for non-normally distributed or ordinal data. $p<0.05$ was considered statistically significant.

## Results

A total of 223 patients who met the criteria were included in the study covering the period between 1 January 2019 and 1 January 2020 (Figure 1). The median age of the patients was 28 (min-max: 18-67), and the female ratio was 68.6% (153/223). Considering taken drugs, the frequency of analgesics was 78 (35%), other drugs 75 (33.6%), antidepressants 55 (24.7%), and other psychotropics 50 (22.4%) (Table 1). The mean systolic blood pressure of the patients on admission was 124.94 (±15.10) mmHg, diastolic blood pressure was 73.48 (±10.37) mmHg, and the pulse rate was 90.39/min (±19.82). In the blood gas measured on admission, the mean pH was 7.38 (±0.52), $HCO_3$ 23.12 (±2.46), and lactate 2.24 (±1.46) (Table 1). 192 of the patients were discharged after follow-up and treatment in the emergency department, 31 patients were admitted to the service or intensive care unit, and 3 patients died within the first 24 hours after hospitalization in the intensive care unit (Table 1).

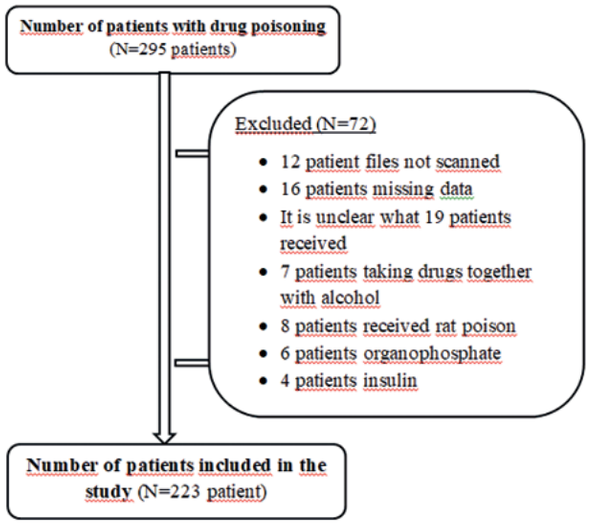


**Figure 1:** Study flow diagram

**Table 1:** Characteristics of study subjects

| Characteristics | Number (%), mean, median, SD± |
|---|---|
| Age, y, median (range) | 28(18-67) |
| Female sex | 153/223(68.6%) |
| **Comorbidity** | |
| Hypertension | 7/223 (3.1%) |
| Diabetes Mellitus | 3/223 (1.3%) |
| OCD* | 3/223 (1.3%) |
| Depression | 3/223 (1.3%) |
| Asthma /COPD* | 5/223 (2.2%) |
| Bipolar | 3/223 (1.3%) |
| Others | 14/223(6.5%) |
| **Drugs** | |
| Antidepressants | 55/223 (24.7%) |
| Other psychotropics | 50/223 (22.4%) |
| Analgesics | 78/223(35%) |
| Antibiotics | 41/223(18.4%) |
| Antiepileptic | 14/223(6.3%) |
| Antihypertensive | 11/223(4.9%) |
| Others | 75/223(33.6%) |
| **Clinics** | |
| Discharge | 192/223(86.1%) |
| Service + intensive care hospitalization | 31/223(13.9%) |
| Mortality | 3/223 (1.3%) |
| Vitals | |
| Systolic BP* | 124.94(±15.10) |
| Diastolic BP* | 73.48(±10.37) |
| Pulse rate | 90.39(±19.82) |
| RR* | 18.37(±5.12) |
| Saturation,% | 97.39(±5,.67) |
| GCS* | 15.00(3-15) |
| Laboratory | 7.38(±0.52) |
| pH | 23.12(±2.46) |
| HCO3* | 2.24(±1.46) |
| Lactate | |

*OCD: Obsessive Compulsive Disease, COPD: Chronic Obstructive Pulmonary Disease, BP: Blood Pressure, RR: Respiratory Rate, GCS: Glaskow Coma Score, $HCO_3$: Bicarbonate

**Table 2:** Demographic and laboratory findings related to hospitalization

| | Hospitalization | | |
|---|---|---|---|
| | No (n=192) | Yes (n=31) | |
| | N,%, mean, ±SD | N,%, mean, ±SD | P value |
| Gender | | | |
| Female | 137 (89.5%) | 16 (10.5%) | **0.028** |
| Male | 55 (78.6%) | 15 (21.4%) | |
| Age, mean | 30.24 (±10.78) | 35.65 (±11.69) | **0.011** |
| Systolic BP* | 124.77 (±15.21) | 125.94 (±14.59) | 0.690 |
| Diastolic BP* | 73.64 (±10.24) | 72.55 (±11.31) | 0.589 |
| Pulse rate | 89.50 (±18.13) | 95.94 (±18.13) | 0.222 |
| Respiratory rate | 18.42 (±5.42) | 18.10 (±2.68) | 0.748 |
| Saturation | 97.34 (±6.07) | 97.68 (±1.74) | 0.758 |
| GCS* | 14.97 (±0.36) | 13.81 (±2.85) | **0.030** |
| pH | 7.38 (±0.048) | 7.38 (±0.078) | 0.853 |
| $HCO_3$ | 23.22 (±2.43) | 22.52 (±2.59) | 0.142 |
| Lactate | 2.15 (±1.41) | 2.80 (±1.70) | **0.021** |
| The number of drugs | | | |
| 1 | 128 (66.7%) | 16 (51.6%) | 0.104 |
| >=2 | 64 (33.3%) | 15 (48.4%) | |
| Antidepressant | 45 (23.4%) | 10 (32.3%) | 0.290 |
| Other psychotropics | 38 (19.8%) | 12 (38.7%) | **0.019** |
| Analgesics | 72 (37.5%) | 6 (19.4%) | **0.049** |
| Antiepileptic | 11 (5.7%) | 3 (9.7%) | 0.420 |
| Antihypertensive | 9 (4.7%) | 2 (6.5%) | 0.653 |
| Antibiotic | 35 (18.2%) | 6 (19.4) | 0.881 |
| Others | 63 (32.8%) | 12 (38.7%) | 0.519 |

*BP: Blood Pressure, GCS: Glaskow Coma Score

When the factors related to hospitalization were examined, there was a statistical difference in favor of male patients (p=0.028) in terms of hospitalization. While 21.4% of male patients were hospitalized, only 10.5% of female patients were hospitalized. We observed that the mean age of hospitalized patients was statistically significant compared to non-hospitalized patients, 35.65 (±11.69) and 30.24 (±10.78) (p=0.011), respectively. Patient vitals other than low glaskow coma score (GCS) on admission were not significant in terms of hospitalization (Table 2). In addition, we found that the lactate level at the time of admission was statistically correlated with hospitalization (p=0.021). When the intensive care or ward hospitalizations of the patients were examined according to the drug group, other psychotropic drugs intake and analgesic drugs intake were associated with hospitalization (p=0.019 and p=0.049, respectively) (Table 2).

In our study, only three patients died. All 3 patients died within 24 hours after they were admitted to the intensive care unit from the emergency room. 2 of these three patients who developed mortality had comorbid disease, one patient had DM and the other had COPD. When we examine the factors associated with mortality, we observed that the mean age of these three patients was 48 years, the mean HCO3 on admission was 17.4 (±3.05), and the initial blood lactate level was 6.77 (±6.52). These three factors were statistically significant in terms of mortality (p= 0.007, <0.001, and <0.001, respectively). We could not observe any relationship between all other factors and mortality (Table 3)

## Discussion

In this study, we found that the blood lactate level measured on admission is useful in identifying critically ill patients presenting to the emergency with drug intake for suicide. We also showed that blood lactate levels are an independent variable of mortality in those patients. In addition, we found that age and $HCO_3$ values were associated with mortality. In our results, gender, age, low GCS, and blood lactate levels were statistically significant between hospitalized and non-hospitalized patients. These results contribute to identifying critically ill patients so that earlier action can be taken for the patient.

**Table 3:** Examination of demographic and laboratory findings related to mortality

| | Mortality | | |
|---|---|---|---|
| | No (n=220) | Yes (n=3) | |
| | N,%, mean, ± SD | N,%, mean, ±SD | P value |
| Gender<br>Female<br>Male | <br>151 (68.6%)<br>69 (31.4%) | <br>n/a<br>n/a | 0.942 |
| Age, mean | 30.76 (±10.82) | 48.00 (±16.70) | **0.007** |
| Systolic BP* | 124.92 (±15.19) | 125.67 (±5.13) | 0.932 |
| Diastolic BP* | 73.48 (±10.37) | 73.67 (±13.01) | 0.976 |
| Pulse rate | 90.46 (±19.93) | 85.67 (±8.37) | 0.678 |
| RR | 18.41(±5.14) | 15.33 (±3.06) | 0.320 |
| Saturation | 97.39 (±5.70) | 97.00 (±3.61) | 0.906 |
| GCS* | 14.87 (±0.86) | 10.33 (±6.43) | 0.346 |
| pH | 7.38 (±0.05) | 7.23 (±0.07) | 0.062 |
| $HCO_3$* | 23.20 (±2.36) | 17.40 (±3.05) | **<0.001** |
| Lactate | 2.18 (±1.23) | 6.77 (±6.52) | **<0.001** |
| The number of drugs<br>1<br>>=2 | <br>142 (64.5%)<br>78 (35.5%) | <br>n/a<br>n/a | 0.939 |
| Antidepressant | 45 (23.4%) | 10 (32.3%) | 0.726 |
| Other psychotropics | 38 (19.8%) | 12 (38.7%) | 0.649 |
| Analgesics | 72 (37.5%) | 6 (19.4%) | 0.202 |
| Antiepileptic | 11 (5.7%) | 3 (9.7%) | 0.652 |
| Antihypertensive | 9 (4.7%) | 2 (6.5%) | 0.692 |
| Antibiotic | 35 (18.2%) | 6 (19.4) | 0.502 |
| Others | 63 (32.8%) | 12 (38.7%) | 0.991 |

*BP: Blood Pressure, RR: Respiratory Rate, GCS: Glaskow Coma Score, $HCO_3$: Bicarbonate

Lactate is the end product of the glycolytic breakdown of glucose during anaerobic respiration. It is produced by the tissues in the body in cases of insufficient oxygen supply to the tissues, increased oxygen demand, and inadequate oxygen use[9]. Hyperlactatemia is associated with increased morbidity and mortality[12]. In a systematic review, Kruse et al. reported that blood lactate level is useful for risk assessment in patients admitted to the hospital acutely and is valuable in estimating in-hospital mortality, especially with serial lactate sampling[12]. In a retrospective study of 6098 patients conducted to define unexpected death within 24 hours of hospital admission, Blum et al. showed that lactate is the strongest independent parameter predicting death within 24 hours of admission[13]. In our study, similar to the literature, we found that blood lactate levels were significantly higher in both hospitalized patients and patients who died [2.18 (1.23) vs. 6.77(6.52), p<0.001].

The blood lactate concentration reflects the balance between lactate production and excretion in tissues. In healthy and resting humans, the blood lactate concentration is normally 0.5-1.8 mmol/L[13]. Blum et al. reported that mortality is predicted in patients with blood lactate higher than 2 mmol/L, and the death rate increases as the level increases[13]. Bou Chebl et al found that the mortality rate was 7.1 times higher when lactate levels were >2 mmol/L in critically ill patients, and 29.4 times higher if lactate levels were >4 mmol/L[14]. Schollin-Borg et al. considered the normal lactate level <2.44 mmol/L and found that the 30-day mortality was 3.54 times higher for lactate 2.44-5.0 mmol/L and 4.45 for lactate >5.0 mmol/L[15]. In a retrospective study, Pedersen et al. divided lactate levels into three groups; low lactate (0-1.9 mmol/L), medium lactate (2-3.9 mmol/L), and high lactate (≥4 mmol/L), and reported that 7-day mortality was 2.9% in low-lactate patients, 7.8% in moderate lactate patients, and 23.9% in high lactate patients[10]. In our study, the lactate values of hospitalized and non-hospitalized patients were 2.80 and 2.15, respectively. Additionally, the lactate values of patients with and without mortality were 6.77 and 2.18, respectively.

In a retrospective cohort study of 5360 adult patients whose lactate was measured within 4 hours after admission to the emergency department, Petersen et al. revealed that age is a very important prognostic factor for mortality[10]. In a prospective observational cohort study conducted on 747 patients, Data et al. reported that mortality increases significantly among age groups[7]. In their retrospective study on 450 patients, Bou Chebl et al. emphasized that higher lactate levels are associated with higher hospital mortality and longer emergency room and hospital stays. They also emphasized that mortality increases with age and that there is an important relationship between the increase in lactate values and mortality in patients under 65 [14]. Similarly, in our study, we showed that age was significantly higher in predicting mortality both in hospitalized patients and in patients who died.

In their study of 211 patients in whom a Medical Emergency Team call was received, Schollin-Borg et al. found significant differences in age, lactate, and oxygen saturation between survivors and non-survivors, but did not find any significant relationship between systolic blood pressure, respiratory rate, and heart rate. Accordingly, they stated that the first blood lactate measurement is useful in the evaluation of the severity of the disease and a better indicator of mortality compared to traditional vital signs[15]. In their study on 348 critically ill patients, Jansen et al. showed that serum lactate level has a better prognostic value than vital signs such as blood pressure[16]. Similar to the aforementioned studies, in our study, we could not find a significant difference between traditional vital signs between hospitalized and non-hospitalized patients, and between those with and without mortality.

In a prospective observational cohort study conducted on 747 patients, Data et al. reported that there is a statis-

tically significant difference in bicarbonate levels in terms of 30-day mortality, and low bicarbonate levels significantly increase mortality[7]. In our study, we showed that there was a statistically significant difference between survived patients and patients who died.

**Limitations**

The study had several limitations. First, the data were collected retrospectively. Second, it is a single-center study. Third, the study population was relatively small. Fourth, it can be stated that only blood lactate levels were evaluated on admission and serial serum lactate levels could not be measured. In addition, the relationship between the presence of comorbid disease and lactate elevation has not been evaluated.

## Conclusion

Blood lactate level is an important determinant of mortality in the emergency department. In patients presenting to the emergency department with drug ingestion for suicide, both mortality and intensive care hospitalization decisions can be made with the blood lactate levels measured during admission. Further multicenter research to be conducted with more patients is needed.

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