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Original Research Article

Study on Lactate Levels in Critically Ill Patients with Septic Shock Admitted in Tertiary Care Hospital, AIMS, BG Nagar

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Abstract

Background: Sepsis and septic shock are one of the leading causes of death worldwide. Rapid and precise diagnosis and appropriate antibiotic therapy are necessary to reduce mortality and morbidity in patients with septic shock. Acid and base abnormalities are common in critically ill patients. This study was carried out in patients with septic shock with single arterial blood gases and lactate levels admitted to medical intensive care in AIMS, BG Nagar. In this study, we wanted to evaluate the lactate levels in critically ill patients with septic shock patients and compare survivors and non-survivors.

Materials and Methods: It is a prospective observational study that was conducted among 100 subjects admitted to MICU who met the criteria for sepsis and septic shock (according to Surviving Sepsis Campaign International Guidelines for Management 2018 update). Lactate levels with other relevant investigations were done within the first 24 hrs of ICU admission. Patients were followed up until the end points i.e., discharge by the treating physician or in-hospital death.

Results: Out of 100 subjects, 50 were males and 50 were females. The majority of patients were in the age group of 20-40 years. The majority of sources of infection at presentation were lower respiratory tract infections (42%). SOFA Score was highest at 64%. Out of 100 critically ill patients, 53 were dead and 47 patients were discharged in stable condition. Out of 87 patients who had high lactate levels, 57 patients expired, and 30 patients were discharged.

Conclusion: This study shows higher mortality in critically ill patients with high serum lactate on admission which is an excellent predictor of mortality.

Keywords: Acid-Base Disorders, Critical Illness SOFA Score, Serum Lactate.

Introduction

Sepsis is a life-threatening organ dysfunction resulting from dysregulated host responses to infection.[1] Data from the Centre for Disease Control and Prevention reveals that sepsis is the leading cause of death in noncoronary intensive care unit patients and the tenth most common cause of death worldwide, the first being heart disease. Despite advances in intensive care and

antimicrobial therapy, the incidence of sepsis and the related mortality rate has increased over the last thirty years. [2] The mortality rate is estimated at 30% in sepsis and 80% in septic shock in the USA [3] and 12.8% in sepsis and 45.7% in septic shock in Europe. [4]

Without consistent and reproducible criteria, the extensive pathophysiology associated with sepsis is difficult to diagnose and treat. A delay in the diagnosis and treatment of sepsis will result in the rapid progression of circulatory failure, multiple organ dysfunction and eventually death.

High anion gap metabolic acidosis is the dominant anomaly. Arterial blood gases showed complex metabolic acidosis at intensive care unit admission due to increased lactate levels, unmeasured anions & hyperchloremia. Early ABG shows pH↑-pCO2↓, and modest pO2↓. The late presentation shows pH↓, Pco2 normal/↑, and pO2↓. [4] Lactate is an important source of energy, formed from the reduction of pyruvate generated largely by anaerobic glycolysis. Metabolised mainly in the liver (60%) and kidney (30%). Septic shock status with liver dysfunction & acute kidney injury elevated lactate levels due to decreased lactate clearance. Lactate is an excellent prognostic biomarker for the severity of sepsis. Hyperlactatemia >22 mg/dl is associated with extremely high mortality.

Normal lactate levels are less than 2 mmol/L, with hyperlactatemia defined as lactate levels between 2 mmol/L and 4 mmol/L. Sepsis with lactate levels greater than or equal to 4 mmol/L is associated with high mortality and is an indication to initiate treatment protocols and care bundles. [5]

Objectives

To study lactate levels in critically ill patients with septic shock patients and compare survivors and non-survivors.

Material and Methods

This was a prospective observational study, conducted among patients admitted with septic shock in MICU in the AIMS, BG Nagar, for a period of six months from September 2021 to February 2022 after obtaining ethical committee clearance from the institutional ethical committee and written informed consent from the study participants.

Inclusion Criteria

- Subjects who gave written informed consent
- Subjects aged more than 18 years
- Subjects were admitted to MICU with criteria for sepsis and septic shock.

Exclusion Criteria

- Pregnancy
- Malignancies
- HIV-positive cases on treatment
- Chronic liver diseases

Sample Size Calculation

Estimated based on the formula 4pq/d2 where p is the prevalence of septic shock in AIMS hospital for one year and q =1-p and d=1.5.

It will come to 97 and it was rounded off to 100.

Study Procedure

After taking informed written consent, patients with septic shock satisfying the inclusion and exclusion criteria were registered in the study. Age, gender, presenting symptoms and signs, diagnosis relevant investigation reports, treatment, duration of stay in the hospitals and mortality were recorded. Arterial blood gas analysis was done within 24 hrs of admission. Initial pH level, initial pCO2, initial HCO3, lactate levels, anion gap, and SOFA score were noted and routine investigations like complete hemogram, liver function tests, renal function tests, electrocardiogram, serum electrolytes, random blood sugar and ABG were done.

Statistical Methods

Statistical analysis was performed using the statistical software package SPSS Version 20. The non-parametric t-test and ANOVA test were applied in comparative analysis results between different groups to find significant (p) values. Mean values and standard deviation were assessed wherever relevant.

Results

A total of 100 patients with septic shock admitted to MICU, AIMS, BG Nagar was studied for six months.

Table 1: Age distribution of subjects in the present study

Age Group (Yrs.)	Survivors	Non Survivors	Total
20-40	15 (31.9%)	18 (34.0 %)	33 (33%)
41-60	15 (31.9%)	17 (32.1%)	32 (32%)
>61	17 (36.2%)	18 (34%)	35 (35%)
Total	47	53	100

In our study, among the 100 subjects, the mean age for males was 49.7± 2.5 years and for females 53.6 ± 2.5 yrs. Out of 50 male subjects, 19(40.4%) were survivors and 31 (58.6%) were non-survivors. Out of 50 female subjects, 28(58.6%) were survivors and 22 (40.4%) were non-survivors.

Among both, the groups, respiratory tract infections, urinary tract, GIT, and soft tissue were common sources of infections. Lower respiratory tract infections were observed commonly in both survivors and non-survivors groups.

Table 2: Source of Infections at Presentation

Source	Survivors	Non Survivors	Total
LRTI	16(34%)	26(49%)	42(42%)
GIT	10(21.3%)	7(13.2%)	17(17%)
UGT	15(32%)	5(5%)	20(20%)
SOFT TISSUE	1(2.1%)	8(15.1%)	9(9.1%)
LIVER	2(4.3%)	2(3.8%)	4(4%)
DENGUE	0	1(1.9%)	1(1.9%)
PANCREAS	0	1(1.9%)	1(1.9%)
CNS	3(6.4%)	1(1.9%)	4(4%)
OTHERS	0	2(3.8%)	2(3.8%)

SOFA score analysis showed that the SOFA score was <5 for 68.1% of the survivors, the mean SOFA score being 3.6. The SOFA score for non-survivors was high with a mean of 11.7±3.6 showing the high significance of the SOFA score in predicting the outcome of patients during the hospital stay. The higher the SOFA score, the higher will be the mortality rate.

Table 3: Sequential organ failure assessment score

Sofa	Survivors	Non Survivors	Total
<5	32(68.1%)	4(7.5%)	36(36%)
6-10	15(31.9%)	13(24.5%)	28(28%)
11-15	0	26(49.1%)	26(26%)
>15	0	10(18.9%)	10(10%)

Among 100 subjects, the mean lactate levels of survivors were 1.6 ± 0.50 and a mean of 4.3 ± 2 was seen in non-survivors. The maximum number of deaths occurred with lactate levels above 6 (71.1%).

Table 4: Lactate levels

Lactate	Survivors	Non Survivors
1-5	40(94%)	20(28.3%)
6-10	4(4%)	37(71.7%)

Discussion

In this study, we investigated the lactate levels in critically ill patients with septic shock patients and compared survivors and non-survivors. The results of this study showed higher mortality in critically ill patients with high serum lactate on admission is an excellent predictor of mortality.

In our study, the mean age of males was 49.7± 2.5 years and for females 53.6 ± 2.5 yrs. Out of 50 male subjects, 19(40.4%) were survivors and 31 (58.6%) were non-survivors. Out of 50 female subjects, 28(58.6%) were survivors and 22 (40.4%) were non-survivors. The mean age of the survivors was lower compared to non-survivors. This is in contrast to the study of Asati et al. the mean age of survivors was statistically higher than non-survivors. [6] The majority of subjects in both sepsis and control groups were males in the study of Asati et al. Whereas in our study we included 50 male and 50 female patients in the sepsis group. [6]

According to Food and drug administration (FDA), sepsis is the second leading cause of death in the USA in non-coronary ICU patients. The morbidity and mortality associated with sepsis are very high with at least 1 out of 4 cases resulting in death. [7,8] The presence of infection is a confirmatory feature of sepsis. [9,10] The accurate confirmation of sepsis is based on systemic inflammatory response syndrome (SIRS) criteria which include features such as tachycardia, hypothermia or fever and leukopenia, leukocytosis, or bandemia. [11] Among both, groups, respiratory tract infections, urinary tract, GIT, and soft tissue were common sources of infections. Lower respiratory tract infections were observed commonly in both survivors and the non-survivors in the present study.

Organ dysfunction is usually assessed on basis of a sepsis-related organ failure assessment (SOFA) score. A higher SOFA score is associated with mortality. The SOFA score is a six-organ dysfunction/failure score, which is graded from 0 (Normal) to 4 (the most abnormal) providing a maximum of 24 points. SOFA criteria for assessment of sepsis include three major considerations which are respiratory rate ≥ 22/min, altered mentation and systolic blood pressure ≤ 100 mmHg. [12-14] In our study, the SOFA score analysis showed that the SOFA score was <5 for 68.1% of the survivors, the mean SOFA score being 3.6. The SOFA score for non-survivors was high with a mean of 11.7±3.6 showing the high significance of the SOFA score in predicting the outcome of patients during the hospital stay. The higher the SOFA score, the higher will be the mortality rate. Non-survivors were older and had higher SOFA scores in the study of Asati et al. [15]

The interpretation of single lactate measurements has several limitations. First, blood lactate concentrations reflect the interaction between the production and elimination of lactate. For example, a sepsis patient with hepatic dysfunction may have a higher lactate level compared with a patient without liver disease but may have a similar degree of stress. Second, an increased lactate concentration may indicate mechanisms other than cellular hypoxia, such as up-regulation in epinephrine-stimulated Na/K-adenosine triphosphatase activity in skeletal muscle and inhibition of pyruvate metabolism or an increase in its production. Therefore, serial lactate measurements are more

important as an outcome prognosticator than a single lactate measurement. [16-18] Lactate is produced by most tissues in the body with muscles producing the highest amount. The serum lactate is usually cleared very rapidly. The main organ for clearance is the liver followed by the kidney. Any lactate level above 4 mmol/L is considered high and between 2-2.5 mmol/L is considered to be elevated. Elevated lactate is a multi-factorial, highly patient-specific and disease-specific phenomenon. Lactate elevation is usually due to decreased clearance or increased production of lactate or a combination of both. Several other factors such as hypoperfusion, mitochondrial dysfunction, liver dysfunction and hypermetabolic state can also elevate levels of lactate in the blood. [19,20] Septic shock is often associated with enhanced lactate levels and lactate in fact serves as a useful biomarker in such cases. In a study of 1278 patients admitted with infection, it was found that lactate levels could correctly stratify patients according to mortality. Lactate levels of 0-2.4, 2.5-3.9 and ≥ 4 mmol/L were associated with mortalities of 4.9%, 9.0% and 28.4% respectively. [21] This is in line with our study results, among 100 subjects, the mean lactate level of survivors was 1.6 ± 0.50 and a mean of 4.3 ± 2 was seen in non-survivors. The maximum number of deaths occurred with lactate levels above 6 (71.1%). [22]

Conclusion

Respiratory and cardiovascular failures are common in critically ill patients, and monitoring and evaluation of respiratory gas exchange are routine in clinical illness. Higher serum lactate on admission is an excellent predictor of mortality. Lactate is the by-product of anaerobic metabolism; lactate measurement has an important role in the diagnosis, risk stratification and potentially the treatment of septic shock.

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