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Use of Lactate and Base Excess as a Tool for Predicting Prognosis in Emergency Care Patients-A Retrospective Cohort Study

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ABSTRACT

Objective: *To assess the lactate and base excess values taken on admission and after 24 hours can be used as a prognostic marker of patient outcome.* ***Patients and methods:*** *A retrospective cohort study was conducted in Indiana Hospital and Heart Institute, emergency unit. Total 60 consecutive patients were treated in 16 bedded emergency units. Arterial blood samples were collected on admission and 24 hours of admission.* ***Results:*** *Lactate level of 1.5 mmol/l or more were having 89.5% sensitivity and 75% specificity for prediction of in-hospital death, with a greater possibility of ventilator support and need of inotropes with multi-organ dysfunction syndrome ($p<0.000$).* ***Conclusions:*** *Prognostic value of lactate can vary considerably depending on the patient population; lactate generally increases the ability to predict non-survival, prognosis and patient outcome. Base excess and lactate are still indicators of severity of disease and can be used to monitor treatment and response.*

Keywords: Lactate, Base excess, Emergency unit, Length of stay, Prognosis

INTRODUCTION

Hyperlactatemia become an emerging trend in recent days as it is used as a tool for a prognostic indicator in patients who are critically ill. An increased lactate level more than 2mmol/L is considered in terms of adverse outcomes such as multi-organ dysfunction score and mortality [1-3].

The benefit of lactate assessment is of simpler technique, easy availability of results, accuracy in information about patient clinical states such as oxygen debt and tissue perfusion. Even though hyperlactatemia can be seen in non-hypoxic states which includes dysfunction of renal and liver and deficiency of pyruvate dehydrogenase deficiency, still multiple studies validate lactate levels as a guiding tool for resuscitation [4-6].

Studies evidenced that even a low threshold of 1.1mmol/L is associated with poor clinical outcomes [7-10]. Lactate level gets elevated in critically ill patients and the cause for elevation may be multifaceted. Even though hypoperfusion is the common cause of increased lactate levels, multiple other etiologies clinician should be aware of before intervening the patient. Level of increased lactate significantly varies according to specific disease states and often helped the physician to know the disease severity and for making decisions on clinical intervention.

The prognostic significance of lactate was first observed by Broder and Weill in shock patients. A clinical decision on hyperlactatemia will be of 2 contexts: hypoperfusion and non-hypo perfusion driven as the goal of therapy vary in each case. Lactate as a diagnostic tool is considered simple and provides essential bedside information when it appropriately fit into the etiology [11-13].

Base excess is also been evidenced as a mortality predictor in several studies. Changes in base excess in hypoxic patients help to make better decisions in their clinical management. Base excess along with lactate is a good predictor for clinical outcome, prognosis, and mortality [15-16].

There are multiple studies done so far to find the prognostic significance of lactate, we are aiming to insist the evidence that lactate as a tool and also to assess the correlation of base excess and lactate in emergency patients with respect to severity of disease and mortality. Our objective is to quantify differences in patient outcome associated with differing levels of initial and 24 hours of lactate and base excess, to identify sub-populations whose lactate and base excess

levels were more associated with mortality and severity of illness. To determine if knowing the change in 24 hours lactate and base excess gave additional predictive value to the initial lactate and base excess value, to correlate base excess (BE) with serum lactate level and demonstrate the independent prognostic significance of each one and to use as a screening tool for future emergency care admissions.

PATIENTS AND METHODS

Study Design

A retrospective cohort study conducted under the Department of Emergency Medicine, Indiana Hospital and Heart Institute Mangalore, Karnataka. The hospital is a 300 bedded multi-specialty hospital with all medical and surgical specialties with 30 bedded Intensive Care Unit and 16 bedded Emergency Unit.

Selection of Participants

Total 60 consecutive patients admitted and who met the inclusion criteria was included in the study. Arterial blood samples were collected immediately and 24 hours post admission of the patient to get their lactate and base excess values. All patients in the study were treated by the same team of critical and emergency care physicians followed the same protocol in managing the patients.

Inclusion Criteria

Patients who were older than 17 years, suspected infection, two or more criteria of the systematic inflammatory response syndrome, hypotension, need for intensive care unit admission were included in the study.

Exclusion Criteria

Patients brought dead and if death occurs within 24 hours, chronic kidney diseases (CKD), acute gastroenteritis (AGE), and age below 17 years were excluded from the study.

Data Collection

We retrospectively retrieved our prospectively collected database from August 2017 to January 2018 and analyzed biochemical and clinical data collected on admission and after 24 hours from unselected consecutive patients who met the inclusion criteria. Laboratory information was routinely obtained from an arterial blood sample gained immediately after the insertion of an arterial catheter on admission to the emergency care unit and after 24 hours. BE and lactate were analyzed in a blood gas analyzer OMNIAVL (Roche Medical Instruments, Indianapolis, Indiana). No additional blood sampling was required.

Ethical consent was waived. The research related to human use has been complied with all the relevant national regulations, institutional policies and has been approved by the institutional review board. Ethical approval was sought from the Research Committee. All information and data obtained during the study were kept confidential. All data were recorded in MS Excel data sheets that were protected from access by unauthorized persons. Hard copy back-up copies were securely locked.

Statistical Analysis

Data are shown as a median and interquartile range. Chi-square analysis was used to study the relationships between variables. Multivariate analysis was performed using a binary logistic regression model to test BE and lactate concomitantly as an emergency care unit death predictor. The areas under the receiver operating characteristic (ROC) curves for the death prediction accuracy of BE and lactate were calculated. It was assessed using commercially available statistical package SPSS version 21.0 (SPSS Inc., Chicago, Illinois). The significance level is considered $p<0.05$*.

RESULTS

Frequencies and percentage of patient characteristics such as gender and age group along with their current diagnosis are represented in Table 1. Majority of the study participants were older and younger adults admitted to a critical care unit for their medical problems and for surgeries.

Table 1 Demographic characteristic of patients

Variables	Frequency	Percentage (%)
Age Group		
Adolescent	2	3.3%
Young Adults	21	35.0%
Older adults	25	41.7%
Old age	12	20.0%
Gender		
Female	21	35.0%
Male	39	65.0%
Department		
Cardiology	5	8.3%
ENT	5	8.3%
Gastroenterology	7	11.7%
Gynaecology	2	3.3%
Medicine	14	23.3%
Neurology	7	11.7%
Orthopaedics	6	10.0%
Pulmonology	3	5.0%
Surgery	10	16.7%
Urology	1	1.7%

Patient characteristics versus patient's resuscitation in the hospital with their survival and mortality status are depicted in Table 2. There was a statistical significance among the survivors and non-survivors in lactate on arrival and at 24 hours, base excess at 24 hours, blood pressure, ventilator support, and MODS.

Table 2 Patient characteristics versus patient resuscitation

Variables	Non-survivors	Survivors	p-value
	Mean ± S.D	Mean ± S.D	
Lactate on arrival	2.00 ± 0.00	1.70 ± 0.46	0.000*
Lactate at 24 hrs	2.00 ± 0.00	1.61 ± 0.49	0.000*
BE on arrival	1.07 ± 0.26	1.00 ± 0.29	0.586
BE at 24 hrs	1.00 ± 0.00	1.04 ± 0.41	0.037*
Ventilator Support	2.00 ± 0.00	1.22 ± 0.41	0.000*
SOFA on arrival	16.14 ± 2.21	5.30 ± 2.88	0.234
SOFA at 24 hrs	16.14 ± 2.21	5.30 ± 2.88	0.234
Resp. PaO_2	2.43 ± 0.64	1.50 ± 0.62	0.936
Blood Sugar	1.29 ± 0.46	1.28 ± 0.45	0.965
BP	1.86 ± 0.36	2.85 ± 1.03	0.000*
Inotropic Support	1.07 ± 0.36	1.85 ± 0.36	0.102
Sex	1.43 ± 0.51	1.33 ± 0.47	0.274
FiO_2	61.42 ± 12.92	46.30 ± 8.78	0.317
GCS	3.36 ± .74	4.41 ± 0.83	0.884
MODS	2.00 ± 0.00	1.15 ± 0.36	0.000*

BE: Base Excess; SOFA: Sequential Organ Failure Assessment; Pao_2: Partial pressure arterial oxygen; Fio_2: Fraction of inspired oxygen; GCS: Glasgow Coma Scale; MODS: Multi-Organ Dysfunction Syndrome

The ROC curve for lactate on admission and at 24 hours demonstrated the good discriminating ability for predicting mortality with AUC for lactate on the arrival of 0.84 (95% CI=0.73-0.95, p< 0.000) and AUC for Lactate at 24 hours of 0.86 (95%CI=0.76-0.96, p< 0.000) (Figure 1, Table 3).

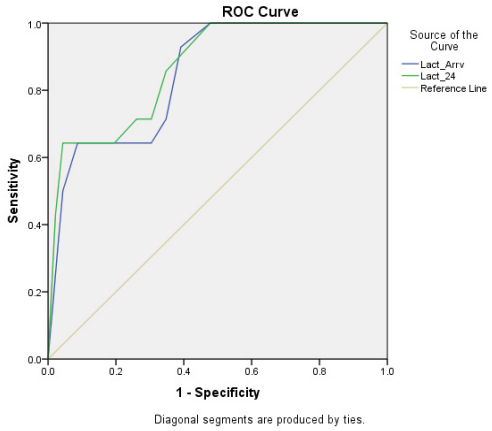

Figure 1 ROC curve for lactate

Table 3 Area under the curve for lactate

Test Result Variable (s)	Area	Std. Error[a]	Asymptotic Sig[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
Lactate on arrival	0.846	0.055	0.000*	0.738	0.954
Lactate at 24 hours	0.866	0.052	0.000*	0.765	0.968

The ROC curve for BE on arrival demonstrated a poor discriminating ability for predicting mortality with AUC BE of 0.10 (95% CI=0.004-0.21, p=0.000) and AUC BE at 24 hours of 0.05 (95% CI=0.001-0.11, p=0.000) (Figure 2, Table 4).

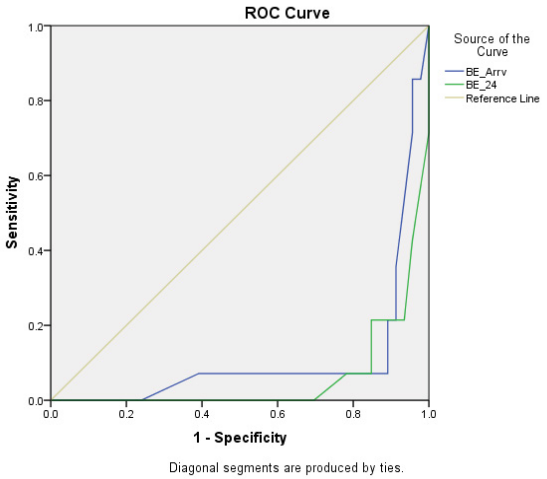

Figure 2 ROC curve for base excess

Table 4 Area under the curve for base excess

Test Result Variable (s)	Area	Std. Error[a]	Asymptotic Sig[b]	Asymptotic 95% Confidence Interval	
				Lower Bound	Upper Bound
BE on Arrival	0.108	0.053	0.000*	0.004	0.212
BE at 24 hours	0.058	0.029	0.000*	0.001	0.115

In order to use this as a screening tool, it is necessary to achieve high sensitivity. The criterion that achieved this mark was the combination of either an admission BE more negative than -4mmol/l or an admission arterial lactate concentration of greater than 1.5 mmol/l. This combination had a sensitivity of 95.7%, as well as a specificity of 92.3% (Table 5).

Table 5 Sensitivity, specificity of lactate and base excess in predicting prognosis

Variable	Sensitivity	Specificity	PPV	NPV
Lactate	89.5	75	93.4	64.2
Base Excess	93.3	73.3	91.3	78.6
Lactate and Base Excess	95.7	92.3	97.8	85.7

A lactate level of 1.5mmol/l or more have 89.5% sensitivity and 75% specificity for prediction of in-hospital death, with a PPV of 93.4% and an NPV of 64.2%. BE levels for prediction of in-hospital death, with a PPV of 91.3% and an NPV of 78.6%.

Patients who had either a BE more negative than -4mmol/l or a lactate of greater than 1.5mmol/l had a mortality rate of 23.3%. This was also associated with being an older age, a greater requirement for inotropic support and higher organ failure scores and ventilator support.

DISCUSSION

Study results reveal that lactate and base excess levels were increased in mortality patients compared to discharged patients and it is statistically significant at $p<0.000$*. As seen in other studies conducted by Ouellet, et al., and Abramson, et al., that died patients exhibit higher lactate and lower PH compared with discharged patients [17].

ROC curves were used as a tool to predict the prognosis. We found that lactate levels predicted the prognosis earlier compared with base excess with the AUC of 0.846 and 0.866 on lactate arrival and lactate at 24 hours respectively whereas, base excess with the AUC of 0.108 and 0.058 on arrival and at 24 hours eliciting poor discriminating ability for predicting prognosis. It is evidenced by the study conducted by Neville, et al. revealed lactate and base excess as strong predictors within 24 hours of mortality. In our study base excess shows poor discrimination as a predictor [18].

Several studies found that a decrease in lactate levels within 24 hours found to be a good sign of prognosis in cases of trauma and sepsis compared with reduced lactate levels by 48 hours. It also elicits that lactate levels took 48 hours to reduce shown increased multi-organ dysfunction score. The emerging concept of hyperlactatemia is largely associated with adverse outcomes, increased the length of stay in ICU, organ dysfunction and increased mortality in patients [19-21].

Early normalization of lactate improves the patient's clinical outcomes and it is the promising available tool in the emergency department to predict the patient prognosis. Furthermore, in our study increased lactate levels also correlated with the patients need for ventilator support with lower Glasgow coma scale and patients with higher multiple organ dysfunction scores and it is statistically significant ($p<0.05$*).

CONCLUSION

To conclude, lactate levels can be used to predict a grave outcome in patients of trauma or sepsis. The significant independent variable that predicted death within 24 hours of admission was arterial blood lactate level on admission. Older age was also an independent variable, but was a less dominant variable. Blood lactate monitoring is useful for risk assessment in patients admitted acutely to the hospital, and especially the trend in serial lactate monitoring is valuable in predicting in-hospital mortality. All patients with a lactate at admission above 2.5 mm should be closely monitored for signs of deterioration, and patients with even lower lactate levels should be considered for serial lactate monitoring. Although the prognostic value of lactate can vary considerably depending on the patient population, lactate generally increases the ability to predict non-survival, both in the ED and ICU. Until recently, there was a lack of clinical trials investigating the value of lactate-guided resuscitation therapy. Base excess and lactate are still indicators of severity of Disease and can be used to monitor treatment and response.

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