

Original Research Article

A study of lactate and pyruvate levels as reliable indicator of impaired tissue perfusion

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ABSTRACT

Background: Inadequate tissue perfusion leads to raised plasma lactate and pyruvate levels in human body due to anaerobic oxidation in state of shock. Till date, lactate and pyruvate levels have not been extensively used as an indicator for the detection of severity of shock and its outcome. **Aims and Objective:** This study is an attempt to co-relate Lactate and Pyruvate levels as reliable indicator of severity of impaired tissue perfusion and its outcome in shock patients.

Methods: This is a retrospective analysis of a prospective study in which 172 patients were studied in different groups and randomization was done on first come first enrolment basis after having informed consent from the patient or attendants or both. The data collection and storage was done on pre-formed working Performa sheets. Results were analyzed by applying Students –‘t’ test.

Results: It was found that Plasma lactate and pyruvate levels are excellent and reliable indicators of impaired tissue perfusion.

Conclusions: The study concluded that an early rise in plasma lactate and pyruvate levels is seen in shock patients. Detection of these biochemical parameters value can be taken as a reliable prognostic indicator, which can influence the outcome in the management of shock.

Keywords: Lactate level, Lactate: pyruvate ratio, Pyruvate levels, Shock

INTRODUCTION

‘Shock’ is a term used to describe path-physiological state in which cardiovascular insufficiency leads to inadequate tissue perfusion.¹⁻³

The mainstay of detection of shock till is mainly based on clinical examination supported with pulse, respiratory rate and blood pressure as an indicator of shock.

To know the severity of shock and its associated mortality/ morbidity, we are co-relating plasma lactate and pyruvate levels as indicators for severity of shock.

Aims and objectives

In this study, present study objectives/ aims were to study the changes in lactate and pyruvate levels as indicators of impaired tissue perfusion with reference to severity of shock and to co-relate increased L: P (Lactate: Pyruvate) ratio as mortality indicator in shock patients.

METHODS

This is a retrospective analysis of a prospective study conducted during September 2013 to February 2016 (3½ years). This study includes a comparison between a

random control group and the study groups. All the admitted patients presenting with shock during our study period were taken in the study group.

The control group 'C' (n=57; male=31 and female=26) were otherwise healthy volunteers with systolic blood pressure (SBP) > 90 mmHg recorded by a Mercury sphygmomanometer in supine position. The three test groups were defined as T1- mild shock* (n1=58 and SBP = 71 – 90 mm Hg); T11-moderate shock* (n11=53 and SBP=51–70 mm Hg) and T111= severe shock* (n111=61 and SBP≤50mm Hg or unrecordable) (Total= 172 patients: male=91 and female=81). (*=nomenclature for the purpose of discussion). The study groups were divided based on readings of systolic blood pressure.

Control group

It comprises of a volunteer who is >10 years of age and normotensive, non-diabetic, not pregnant, not suffered any recent viral/bacterial/fungal or other infections or trauma within last 6 months, not on Beta-blockers/antihypertensive drugs with no significant family history.

Test group

An individual presented in emergency room with SBP≤90 mm Hg with following inclusion and exclusion criteria –

Inclusion criteria

- Patients of shock who were >10 years of age irrespective of sex
- Patients who had not received any significant primary care in the form of hospitalization/intravenous fluid/electrolyte administration outside Hospital

Exclusion criteria

- Patients presenting with features suggestive of cardiogenic shock
- All these patients were examined clinically and ABC management of ATLS system started simultaneously with blood samples taken before administration of intravenous crystalloids/colloids and patients catheterized with Foley's self-retaining catheter.

Sample Collection

- Required blood samples for lactate and pyruvate levels were collected with following protocols
- Blood samples in control group members were taken around 9.00 A.M. on day '0' (day of entry in the study) and on day '5' in vacutainers for the purpose
- Blood samples in test groups were taken on day '0' just before starting any intravenous fluids/electrolytes and around 9.00 A.M. on day '5' to exclude any diurnal variation.

- All the samples were subjected for analysis within 15 minutes of collection. Every possible care was taken for blood samples not to get contaminated during collection and transportation.

Statistical analysis

Patient's findings for these parameters were recorded in the working Performa and analyzed by applying student-'t' test. Following steps were followed by applying standard statistical formulae:

1. Calculation of mean for a particular parameter in different groups on day '0' and day '5' [Mean = $(x_1+x_2+x_3+...+x_n)/n$].
2. Calculation of standard deviation. S.D. = $[\sqrt{\Sigma(x-\text{Mean})^2/n_x}]$.
3. Comparison of parameters in two different groups by applying student-'t' test.
4. Calculation of 't' value. $[\text{Mean}_x - \text{Mean}_y] / [S\text{-value} * \sqrt{1/n_x + 1/n_y}]$.
5. Obtaining equivalent p-value for calculated 't' value. (From standard table)
6. Finding the significance level as follows, for that parameter in compared groups:
 - P < 0.001 - highly significant
 - P < 0.01 - Significant at level p < 0.01
 - P < 0.02 - Significant at level p < 0.02
 - P < 0.05 - Significant at level p < 0.05
 - P > 0.05 - Not significant

By applying this strategy, observations drawn and conclusion made.

RESULTS

Almost linear relationship was found between the plasma lactate level and the severity of shock. In survivors of all the three test groups, even after 5 days of hospital stay, plasma lactate level did not completely return to normal control value although it did show a decreasing tendency. The decreasing tendency of plasma lactate level in survivors of moderate to severe shock on 5th day was faster than that of mild shock.

(Table 1) Pyruvate levels increased as the severity of shock increased on the day of admission. In survivors of the entire three test groups, even after 5 days of treatment, pyruvate levels did not completely return to

normal control value, however it did show a decreasing tendency. As the severity of shock increased, the tendency of pyruvate levels to revert back to normal value also increased, being fastest in severe shock. (Table 2) As the severity of shock increases, the L: P ratio also increased significantly. In survivors of the entire three

test groups, even after 5 days of treatment, the lactate: pyruvate ratio did not match the control value (Table 3). Control groups on day '0' up to day '5' remained the same (C '0' v/s C '5' = p>0.05; Not Significant for Table 1-3).

Table 1: Compared groups for plasma lactate level (mg/dl).

Groups compared	Mean ±S.D.	't' – value	'p' – value	significance
C '0' vs. T – I '0'	10.37±1.27 vs 19.75±2.81	10.75	<0.001	Highly significant
C '0' vs. T – II '0'	10.37±1.27 vs 19.48±4.22	7.17	<0.001	Highly significant
C '0' vs. T – III '0'	10.37±1.27 vs 20.86±2.10	15.26	<0.001	Highly significant
T-I '0' vs.T-II '0'	19.75±2.81 vs 19.48±4.22	0.21	>0.05	Not significant
T-I '0' vs.T-III '0'	19.75±2.81 vs 20.86±2.10	1.27	>0.05	Not significant
T-II '0' vs.T-III '0'	19.48±4.22 vs 20.86±2.10	1.14	>0.05	Not significant
C '5' vs. T-I '5'	10.63±1.07 vs 18.06±3.61	6.87	<0.001	Highly significant
C '5' vs. T-II '5'	10.63±1.07 vs 15.94±2.89	5.92	<0.001	Highly significant
C '5' vs. T-III '5'	10.63±1.07 vs 17.29±3.89	5.69	<0.001	Highly significant
T-I '5' vs. T-II '5'	18.06±3.61 vs 15.94±2.89	1.55	>0.05	Not significant
T-I '5' vs. T-III '5'	18.06±3.61 vs 17.29±3.89	0.50	>0.05	Not significant
T-II '5' vs. T-III '5'	15.94±2.89 vs 17.29±3.89	0.88	>0.05	Not significant
C '0' vs. C '5'	10.37±1.27 vs 10.63±1.07	0.54	>0.05	Not significant
T-I '0' vs. T – I '5'	19.75±2.81 vs 18.06±3.61	1.48	>0.05	Not significant
T-II '0' vs. T-II '5'	19.48±4.22 vs 15.94±2.89	2.26	<0.05	Significant at <0.05
T-III '0' vs. T-III '5'	20.86±2.10 vs 17.29±3.89	3.04	<0.01	Significant at <0.05

(Normal plasma lactate level = 5 – 15 mg/dl)

Table 2: Compared groups for plasma pyruvate level (mg/dl).

Groups compared	Mean ±S.D.	't' – value	'p' – value	significance
C '0' vs. T – I '0'	1.02±0.12 vs 1.81±0.17	13.38	<0.001	Highly significant
C '0' vs. T – II '0'	1.02±0.12 vs 1.73±0.26	8.45	<0.001	Highly significant
C '0' vs. T – III '0'	1.02±0.12 vs 1.90±0.16	16.00	<0.001	Highly significant
T-I '0' vs.T-II '0'	1.81±0.17 vs 1.73±0.26	0.98	>0.05	Not significant
T-I '0' vs.T-III '0'	1.81±0.17 vs 1.90±0.16	1.52	>0.05	Not significant
T-II '0' vs.T-III '0'	1.73±0.26 vs 1.90±0.16	2.12	<0.05	Significant at <0.05
C '5' vs. T-I '5'	1.05±0.10 vs 1.69±0.26	8.00	<0.001	Highly significant
C '5' vs. T-II '5'	1.05±0.10 vs 1.53±0.26	5.78	<0.001	Highly significant
C '5' vs. T-III '5'	1.05±0.10 vs 1.61±0.30	5.95	<0.001	Highly significant
T-I '5' vs. T-II '5'	1.69±0.26 vs 1.53±0.26	1.48	>0.05	Not significant
T-I '5' vs. T-III '5'	1.69±0.26 vs 1.61±0.30	0.70	>0.05	Not significant
T-II '5' vs. T-III '5'	1.53±0.26 vs 1.61±0.30	0.62	>0.05	Not significant
C '0' vs. C '5'	1.02±0.12 vs 1.05±0.10	0.66	>0.05	Not significant
T-I '0' vs. T – I '5'	1.81±0.17 vs 1.69±0.26	1.53	>0.05	Not significant
T-II '0' vs. T-II '5'	1.73±0.26 vs 1.53±0.26	1.78	>0.05	Not significant
T-III '0' vs. T-III '5'	1.90±0.16 vs 1.61±0.30	3.15	<0.01	Significant at <0.05

(Normal plasma pyruvate level = 0.5 – 1.5 mg/dl)

DISCUSSION

It was found that as the severity of shock increased, the plasma lactate and pyruvate levels also increased and as the severity of shock increased the tendency of plasma

lactate and pyruvate levels to revert back to normal value also increased (Table 1 and 2). Lactate: Pyruvate ratio indicated more increased in lactate level as compared to increase seen in pyruvate levels as a particular test group and it takes longer than 5 days for L: P ratio to return to normal control value in survivors of shock (Table 3).

The changes seen in plasma lactate level, pyruvate levels and L: P ratio were due to anaerobic oxidation of glucose going inside the body when there is impaired perfusion to the tissues.²⁻⁸ Fiddian-Green reported similar change and

stated that increase in lactate level is a reliable marker for impaired tissue perfusion.^{9,10} It can be used as a prognostic indicator in patients presenting with features of impaired tissue perfusion.

Table 3: Compared groups for lactate: pyruvate ratio.

Groups compared	Mean ±S.D.	't' – value	'p' – value	significance
C '0' vs. T – I '0'	10.15±0.27 vs 10.88±0.74	13.38	<0.001	Highly significant
C '0' vs. T – II '0'	10.15±0.27 vs 11.20±0.69	8.45	<0.001	Highly significant
C '0' vs. T – III '0'	10.15±0.27 vs 10.95±0.44	16.00	<0.001	Highly significant
T-I '0' vs.T-II '0'	10.88±0.74 vs 11.20±0.69	0.98	>0.05	Not significant
T-I '0' vs.T-III '0'	10.88±0.74 vs 10.95±0.44	1.52	>0.05	Not significant
T-II '0' vs.T-III '0'	11.20±0.69 vs 10.95±0.44	2.12	<0.05	Significant at <0.05
C '5' vs. T-I '5'	10.11±0.33 vs 10.61±0.70	8.00	<0.001	Highly significant
C '5' vs. T-II '5'	10.11±0.33 vs 10.40±0.32	5.78	<0.001	Highly significant
C '5' vs. T-III '5'	10.11±0.33 vs 10.72±0.68	5.95	<0.001	Highly significant
T-I '5' vs. T-II '5'	10.61±0.70 vs 10.40±0.32	1.48	>0.05	Not significant
T-I '5' vs. T-III '5'	10.61±0.70 vs 10.72±0.68	0.70	>0.05	Not significant
T-II '5' vs. T-III '5'	10.40±0.32 vs 10.72±0.68	0.62	>0.05	Not significant
C '0' vs. C '5'	10.15±0.27 vs 10.11 ±0.33	0.66	>0.05	Not significant
T-I '0' vs. T – I '5'	10.88±0.74 vs 10.61±0.70	1.53	>0.05	Not significant
T-II '0' vs. T-II '5'	11.20±0.69 vs 10.40±0.32	1.78	>0.05	Not significant
T-III '0' vs. T-III '5'	10.95±0.44 vs 10.72±0.68	3.15	<0.01	Significant at <0.05

(Normal lactate : pyruvate ratio = 10:1)

CONCLUSION

During the study, following conclusions were drawn Raised plasma lactate, plasma pyruvate and L: P ratio values usually do co-relate with the severity of shock. Patient with mild shock had better outcome when compared with patient presenting with severe shock (37.50% mortality seen in severe shock group v/s 0% mortality seen in mild shock group). Elderly age was poor prognostic indicator itself when combined with highly raised plasma lactate levels in patients of shock. Plasma lactate level is a reliable indicator of impaired tissue perfusion in all types of shock irrespective of the etiology.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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