Lactate Clearance at 6 Hours of Admission as a Predictor of Mortality in Critically Ill Children

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INTRODUCTION

- ▶ The concentrations of arterial lactate represent the balance between lactate production and clearance. Hyperlactatemia occurs when production exceeds clearance, which has been confirmed to be associated with worse clinical outcomes in critically ill patients. ⁽¹⁾ In critically ill patients, failure of oxygen delivery to meet oxygen demand results in tissue hypoxia and increases anaerobic metabolism. Elevated serum lactate levels reflect the anaerobic metabolism related to cellular hypoxia and are thought to be an important marker of impaired tissue perfusion. ⁽²⁾ Unresolved global tissue hypoxia, as indicated by inadequate lactate clearance, is associated with multi-organ dysfunction and increased mortality during the early phase of resuscitation. ^(2, 3)

AIM OF THE WORK

- ▶ To evaluate the use of lactate clearance at 6 hours of admission to Pediatric Intensive Care Unit as a predictor of mortality in critically ill children.

METHODS

- ▶ A prospective observational study conducted in PICU of a tertiary care teaching hospital over 6 months. Lactate levels were measured in arterial blood samples of 76 patients at the time of admission and six hours later. According to lactate clearance after 6 hours, patients were divided into group A (lactate clearance > 0 %) and group B (lactate clearance ≤ 0 %). Routine care and investigations were performed and Pediatric Index of Mortality 2 (PIM 2) score was calculated.

RESULTS

- ▶ There were 54 patients in group A (71%) and 22 patients in group B (29%). Using Kaplan-Meier survival curve group A had significant higher overall survival than group B (p <0.001). Mean PIM2 score and risk of mortality was significantly higher in group B (p= 0.001), while there was no significant difference in the duration of PICU admission between the two groups (p= 0.657). Using the ROC curves, the area under the ROC curves (AUC) indicated a strong significant predictive power for the PIM2 score, which represents the largest AUC (0.935, p <0.001) followed by that of lactate clearance after 6 hours of admission (0.766, p <0.001). Lactate clearance after 6 hours of admission predicted mortality with sensitivity of 70.8%, specificity of 90.4%, Positive predicting value of 77.3%, and negative predicting value of 87%. Using logistic regression model, both lactate clearance after 6 hours and PIM2 score had independent prognostic significance as regard fate. (p= 0.030, 0.001 respectively).

Kaplan Meier survival curve of the studied groups

ROC curve for lactate on admission, lactate clearance and PIM2 score

	AUC	p	Cutoff	Sensitivity	Specificity	PPV	NPV
Serum Lactate On Admission	0.519	0.789	>1.3	62.5	51.9	37.5	75.0
Lactate clearance after 6 h.	0.766*	<0.001*	≤0	70.8	90.4	77.3	87.0
PIM2 score	0.935*	<0.001*	>-0.92	91.7	94.2	88.0	96.1

AUC: area under the curve; PPV: positive predictive value; NPV: negative predictive value; PIM2: Pediatric Index of Mortality 2

Comparison between groups as regard demographic data, diagnosis and fate

	Group A (n= 54)	Group B (n= 22)	P value
Sex n (%)			
Males	29(53.7%)	14(63.6%)	FEp = 0.428
Females	25(46.3%)	8(36.4%)	
Age (months) n (%)			
1-6	22(40.7%)	12(54.5%)	MCp = 0.116
>6 - 12	13(24.1%)	3(13.6%)	
>12 - 24	5(9.3%)	3(13.6%)	
>24 - 36	8(14.2%)	1(4.5%)	
>36 - 48	5(9.3%)	0	
>48 - 60	1(1.9%)	3(13.6%)	
Diagnosis n (%)			
Pulmonary diseases	19(35.4%)	4(18.2%)	FEp=0.14
Neurological diseases	8(14.8%)	7(31.8%)	FEp=0.11
Gastrointestinal diseases	8(14.8%)	3(13.6%)	FEp=1.00
Renal diseases	5(9.3%)	3(13.6%)	FEp=0.68
Cardiovascular diseases	4(7.1%)	2(9.1%)	FEp=1.00
Sepsis and septic shock	3(5.6%)	5(22.7%)	FEp=0.04*
Diabetic ketoacidosis	4(7.4%)	0	FEp=0.37
Others	3(5.6%)	0	FEp=0.43
PIM2 score ^a	-2.52(-6.10-1.42)	-0.22(-3.10-1.86)	Up=0.001*
PIM2 risk of mortality ^a	7.40(0.20-80.50)	44.55(4.10-86.50)	Up=0.001*
Length of PICU stay(days) ^a	4.0(1.0-98.0)	3.50(1.0-137.0)	Up=0.657

Comparison between groups as regard laboratory findings

	Group A (n= 54)	Group B (n= 22)	P value
White Blood Cells (×10 ³ / μL) ^a	13.15(4.30-76)	15.49(3.40-99.10)	^u p=0.492
Hemoglobin (g/dl) ^b	6.50±17.20	2.80±12.7	^t p=0.308
Platelets (×10 ³ / μL) ^a	386.50(0.41-711)	365(12-692)	^u p=0.292
ALT (U/L) ^a	0.31(9-6651)	28(13-692)	^u p=0.614
AST (U/L) ^a	48.50(10-10038)	45(18-1235)	^u p=0.722
Serum Albumin (g/dl) ^b	3.06±0.78	2.59±0.94	^t p=0.026*
Total Bilirubin (mg/dL) ^a	0.34(0.10-4.60)	0.32(0.10-5.10)	^u p=0.836
Direct Bilirubin (mg/dL) ^b	0.10(0.0-4)	0.10(0.0-1.76)	^u p=0.676
Prothrombin time (seconds) ^a	12.8(9.7-56.8)	15.1(11.3-41.4)	^u p=0.125
Partial thromboplastin time (seconds) ^a	33.2(20-120)	37.45(16-120)	^u p=0.488
International normalized ratio (INR) ^a	1.18(1.0 - 5.10)	1.34(1.0 - 4.0)	^u p=0.184
Blood Urea Nitrogen (mg/dL) ^a	12.0(3.0 - 92)	13.5 (1.0 - 130)	^u p=0.859
Serum Creatinine(mg/dL) ^a	0.47(0.16 - 6.9)	0.44(0.04 - 3.8)	^u p=0.709
C-Reactive protein (mg/mL) ^a	5(0.0 - 263.0)	12.4 (0.0- 243.0)	^u p=0.146
Serum Sodium(mmol/L) ^b	140.4 ± 12.2	144.1 ± 16.2	^t p=0.286
Serum Potassium(mmol/L) ^b	4.06 ± 0.88	3.43 ± p0.92	^t P=0.007*
Serum Calcium(mg/dL) ^b	8.70 ± 0.88	7.64 ± 1.79	^t p=0.013*
Serum Phosphorus (mg/dL) ^a	4.60(2.1 - 10.6)	5.5(1.8 - 10.4)	^u p=0.136
Alkaline phosphatase (U/L) ^a	169.5(28 - 534)	156.5 (64 - 276)	^u p=0.689
Admission Lactate (mmol/L) ^a	1.60(0.50-19.0)	1.20(0.20-3.60)	^u p=0.010*
Lactate after 6 hrs (mmol/L) ^a	0.90(0.30-11.50)	1.95(0.50-15.0)	^u p=0.001*
Admission Lactate/pyruvate ratio ^a	24.0(8.0-322.0)	19.0(4.0-61.0)	^u p=0.025*
Lactate/pyruvate ratio after 6 hrs ^a	15.0(4.0-230.0)	33.50(9.0-229.0)	^u p=0.001*

a: median(minimum-maximum), b= mean± SD , Up: p value of Mann Whitney test, tp= p value for Student t-test *: Statistically significant at p ≤ 0.05

CONCLUSION

- ▶ Lactate clearance is fundamental in prediction of mortality; as early and effective lactate clearance is associated with decreased mortality. Serial evaluations of serum lactate may have greater value over measuring serum lactate only at the time of presentation. It was found that PIM2 score still a better predictor of mortality.

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