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RESEARCH ARTICLE / ÖZGÜN ARAŞTIRMA

The relationship between blood lactate levels and mortality in pediatric intensive care patients

Çocuk yoğun bakım hastalarında kan laktat düzeyleri ile mortalite arasındaki ilişki

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ABSTRACT

Objective: To determine relationship between blood lactate level and mortality rate in children admitted to the intensive care unit.

Methods: 298 critically ill patients aged between 28 days and 16 years admitted to Dicle University Hospital, the third step Pediatric Intensive Care Unit in between January 2007 and December 2007 were included. Age, sex, diagnosis, Glasgow coma score points, the first measured blood lactate levels (lactate 1) and the arithmetic average of all measured blood lactate levels during treatment (lactate 2) of cases were evaluated. Patients were divided into group A (lactate < 20 mg/dl) and B (lactate ≥ 20 mg/dl). According to the results, patients were classified as survivors and non-survivors. Both lactate 1 and lactate 2 were compared with mortality rates.

Results: In this study, a total of 298 patients were evaluated, 158 of them were nonsurvivors and 140 were survivors. A significant correlation was found between lactate levels and mortality rates. Lactate levels were higher in non-survivor cases (p<0.001). In group B, lactate 1 had 68% (106/156) sensitivity and 75% (106/142) specificity for determining the risk of mortality. Also in group B, lactate 2 had 85% (134/158) sensitivity and 79% (134/169) specificity for determining the risk of mortality.

Conclusion: There is a strong association between high blood lactate levels and mortality rates in the critically ill patients in pediatric intensive care unit. In these patients blood lactate levels can be used for follow-up and evaluation of the effectiveness of treatment and determining mortality. *J Clin Exp Invest 2013; 4 (3): 269-273*

Key words: Pediatric intensive care unit, critically ill children, blood lactate levels, mortality

ÖZET

Amaç: Çocuk yoğun bakım servisinde takip edilen kritik hasta çocuklardaki kan laktat düzeyi ile mortalite arasındaki ilişkiyi belirlemek

Yöntemler: Ocak 2007 ve Aralık 2007 tarihleri arasında Dicle Üniversitesi Tıp Fakültesi, üçüncü basamak Çocuk Yoğun Bakım Ünitesinde takip edilmiş, kritik hasta 28 günden büyük ve 16 yaşından küçük çocuklar seçildi. Hastaların yaşı, cinsiyeti, tanısı, Glasgow koma skorlaması puanı, ilk ölçülmüş kan laktat düzeyi (laktat 1) ve tedavi sırasında tüm ölçülmüş kan laktat düzeylerinin aritmetik ortalaması (laktat 2) verileri retrospektif olarak değerlendirildi. Hastalar; grup A (laktat ≤19 mg/dl) ve grup B (laktat ≥20mg/dl) olarak iki gruba ayrıldı. Sonlanıma göre, hastalar yaşayanlar ve ölenler olarak iki gruba ayırıldı. Bu grupların mortalite oranları ve laktat düzeylerini karşılaştırıldı.

Bulgular: Çalışmada; 140'ı yaşamış ve 158'i ölmüş olan toplam 298 vaka değerlendirildi. Laktat 1 ve laktat 2 seviyeleri ile mortalite arasında anlamlı bir ilişki bulundu. Ölen hastalarda laktat düzeyi anlamlı olarak daha yüksekti (p<0.001). Grup B'de laktat 1 değerinin mortalite riskini belirlemedeki sensitivitesi % 68 (106/156), spesifitesi %75 (106/142) iken, laktat 2 değerinin mortalite riskini belirlemedeki sensitivitesi %85 (134/158), spesifitesi % 79 (134/169) idi.

Sonuç: Çocuk yoğun bakım servisinde takip edilen kritik hastalarda, kan laktat yüksekliği ile mortalite arasında kuvvetli bir ilişki vardır. Bu hastalarda takip ve tedavinin etkinliğini değerlendirmede ve mortaliteyi belirlemede kan laktat seviyesi kullanılabilir.

Anahtar kelimeler: Çocuk yoğun bakım ünitesi, kritik hasta çocuk, kan laktat düzeyi, mortalite

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INTRODUCTION

Clinical findings and laboratory tests are the early pathophysiological manifestations which determine the mortality risk of intensive care unit patients. Clinical findings and laboratory tests of patients may change within hours. Changes in parameters are used to estimate both the risk of death and the prognosis of patients in pediatric and adult intensive care units, the blood lactate level is one of this parameters [1]. Hyperlactatemia is due to tissue hypoxia or the situation in which lactate production is greater than the consumption without tissue hypoxia (depending on the underlying disease; drugs, toxins, congenital metabolic disorders and etc.). But in most cases, the reason is usually multifactorial [2,3]. The studies indicated a direct correlation between the lactate levels and the oxygen deficit of tissues [4]. In many critically ill patients, hyperlactatemia arises from inappropriate tissue oxygenation. This condition may result from respiratory or circulatory disorders. Tissue hypoxia usually does not cause any clinical signs in the patients. Hyperlactatemia may be the only indicator of this situation [5].

The aim of the study was to demonstrate the relationship between the blood lactate level and the mortality rates of the critically ill children admitted to intensive care unit.

METHODS

In this study, 298 cases that admitted to the Pediatric Intensive Care Unit at Dicle University Hospital in between January 2007 and December 2007. Cases' ages were between 28 day and 16 years. Patient's data were scanned retrospectively. Age, sex, diagnosis, Glasgow coma score (GCS), the first measured blood lactate levels (lactate 1) and the arithmetic average of all measured blood lactate levels during treatment (lactate 2) were included. Blood lactate levels were measured with 2ml of heparinized arterial blood by Radiometer ABL 700 Series blood gas apparatus in Dicle University Hospital's biochemistry laboratory. Patients were divided into group A (Lactate < 20 mg/dl) and group B (Lactate ≥ 20 mg/dl). According to the results, patients were classified into survivors and non-survivors. Both the first measured blood lactate level and the arithmetic mean of all measured lactate levels during treatment were compared with mortality rates.

Statistical analysis

Data was collected, arranged and the results of this data were evaluated using SPSS version 17. Means ± SD were used to describe the data. P value of less than 0.05 was considered as statistically significant. The continuous variables with normal distribution were compared using Student's t test, whereas continuous variables with an asymmetric distribution were compared using Mann-Whitney test. The categorical variables were compared using chi-square test. Binomial test was used for the distribution of cases.

RESULTS

Cases consist of 158 non-survivors and 140 survivors patients (148 females, 150) males). There was no statistically significant difference in the sex distribution (P = 0.954). The mean age was 4±3.96 years (from the range of 7-18 years). 53.9% of the cases were under 2 years of age. There was statistically significant difference between the age of survivors (average age: 5.48 ± 4.5) and non-survivors (mean age: 2.68 ± 2.8) (p <0.001). Mortality rates were higher in the patients with young age.

The diagnosis of the cases was 19.5% (n=58) sepsis, 13.4% (n=40) convulsion, 9.1% (n=27) diabetic ketoacidosis, 5.7% (n=17) metabolic acidosis, 9.4% (n=28) poisoning, 2.7% (n=8) scorpion bite, 9.4% (n=28) pneumonia, 9.1% (n=27) burn, and 21.8% (n=65) non-specific diagnosis. A statistically significant difference in distribution according to diagnosis was found (P<0.001). The rate of death was 53% (n=158) and the healing was 47% (140) in the result. Mortality rates were statistically significant according to the diagnosis of the cases. Sepsis and convulsion have had the highest mortality rates except that the diabetic ketoacidosis in which no fatal condition occurred.

Regardless of diagnosis, there were statistically significant difference between lactate 1, lactate 2, age and GCS of survivors - non-survivors (p<0.001). Mortality rates were higher in patients with high lactate 1, lactate 2 and small age and GCS (Table 1).

There were statistically significant difference between lactate 1, lactate 2 of survivors and non-survivors in the cases of sepsis, convulsion, poisoning, pneumonia, burn and non-specific diagnosis (p <0.001). There were positive correlation between the mortality rates and lactate 1 & 2. There existed statistically significant difference only between lactate 2 of survivors and non-survivors in metabolic acidosis cases. There were no statistically significant difference between lactate 1, lactate 2 of survivors and non-survivors only in scorpion bite cases. Because there were no non-survivor case in diabetic ketoacidosis, statistical analysis could not performed (Table 2).

Whatever the diagnosis is, in group B, lactate 1 (except for cases of diabetic ketoacidosis and scorpion bites) and lactate 2 (except only the cases of diabetic ketoacidosis) had high sensitivity and specificity in predicting the risk of mortality rates (Table 3, 4).

Table 1. The differences between lactate 1, lactate 2, age and Glasgow Coma Score of survivors-nonsurvivors unrelated with diagnoses

	Nonsurvivors (n=158) Mean±SD	Survivors (n=140) Mean±SD	P
Lactate 1 (mg/dl)	38,0±31,5	21,3±18,7	<0,001
Lactate 2 (mg/dl)	38,9±27,2	18,4±11,5	<0,001
Glasgow coma score	9,9±4,3	12,9±2,3	<0,001
Age (year)	2,6±2,8	5,4±4,5	<0,001

SD: Standard deviation

Table 2. Statistical analysis between lactate 1 and lactate 2 of survivors-nonsurvivors dependent (related with) diagnoses

Diagnoses	Outcome	n	Lactate 1		Lactate 2	
			Mean±SD	P	Mean±SD	P
Sepsis	non-S	46	45.2±35.3	0.037	43.9±29.8	<0.001
	S	12	29.1±18.3		23.0±11.1	
Convulsions	non-S	18	26.5±15.1	0.032	32.2±15.7	0.02
	S	22	17.1±10.1		17.7±10.7	
Diabetic ketoacidosis	non-S	0				
	S	27	19.3±11.9		18.7±11.7	
Metabolic acidosis	non-S	11	51.6±51.6	0.446	58.0±49.2	0.023
	S	6	34.0±39.6		17.8±7.9	
Poisonings	non-S	8	30.7±16.9	0.025	37.1±16.1	0.003
	S	20	13.7±6.9		12.45±5.0	
Scorpion bites	non-S	2	17.5±0.7	0.212	21.0±1.4	0.655
	S	6	49.0±53.8		26.3±27.4	
pneumonia	non-S	20	47.2±37.5	0.025	45.1±32.9	0.006
	S	8	22.5±17.1		20.1±11.3	
Burns	non-S	22	26.09±14.1	0.005	28.5±11.4	0.001
	S	5	14.0±5.24		15.6±4.5	
Non-specific	non-S	31	35.0±27.8	0.011	33.7±20.1	0.001
	S	34	20.9±13.1		19.2±11.2	

Non-S: Nonsurvivor, S: Survivor, SD: Standard deviation, n: Number of cases

Table 3. Related diagnoses or unrelated diagnoses in group B, sensitivity and specificity values of lactate 1 in predicting the risk of mortality rates

Diagnoses	Group A (Lactate < 20 mg/dl)		Group B (Lactate ≥ 20 mg/dl)		Group B	
	Non-S (n)	Survivors (n)	Non-S (n)	Survivors (n)	Sensitivity	Specificity
Sepsis	8	4	38	8	%83	%82
Convulsions	10	15	8	7	%45	%53
Diabetic ketoacidosis	0	18	0	9	*	*
M. acidosis	4	4	7	2	%64	%77
Poisonings	3	17	5	3	%63	%62
Scorpion bites	2	3	0	3	*	*
Pneumonia	5	6	15	2	%75	%88
Burns	8	4	14	1	%64	%93
Non-specific	12	21	19	13	%61	%60
Total** (n=271)	50	71	106	36	%68	%75

Non-S: Nonsurvivor, n: Number of cases
* Because of there were no nonsurvivors case in diabetic ketoacidosis, statistical analysis could not performed
** Cases of diabetic ketoacidosis and Scorpion bites did not participate in the sum.

Table 4. Related diagnoses or unrelated diagnoses in group B, sensitivity and specificity values of lactate 2 in predicting the risk of mortality rates

Diagnoses	Group A (Lactate < 20 mg/dl)		Group B (Lactate ≥ 20 mg/dl)		Group B	
	Non-S (n)	Survivors (n)	Non-S (n)	Survivors (n)	Sensitivity	Specificity
Sepsis	3	4	43	8	%94	%85
Convulsions	5	17	13	5	%73	%72
Diabetic ketoacidosis	0	18	0	9	*	*
Metabolic acidosis	3	4	8	2	%73	%80
Poisonings	0	19	8	1	%100	%89
Scorpion bites	0	4	2	2	%100	%50
Pneumonia	2	5	18	3	%90	%86
Burns	5	4	17	1	%77	%96
Non-specific	6	21	25	13	%81	%66
Total** (n=263)	24	78	134	35	%85	%79

Non-S: Nonsurvivors, n: Number of cases
* Because of there were no nonsurvivors case in diabetic ketoacidosis, statistical analysis could not performed
** Cases of diabetic ketoacidosis did not participate in the collection

DISCUSSION

Globally, patient assessment scores are used to determine the risk of death and disease severity as pediatric risk of mortality (PRISM), pediatric index of mortality (PIM) and multi-organ system failure (MOSF) which including many laboratory values and clinical findings. However, there are many factors that affect mortality in critically ill patients and these factors are not well understood. Many researchers reported that lactate level elevation could be a useful indicator for determination of disease severity; prognosis and the mortality risk [6-9]. Broder et al. reported that mortality rate is 89% in patients with persistently increased lactate level in the 24-hour [10]. Vincent et al. reported that the best indicator of the prognosis after resuscitation of shock is decreased lactate levels occurring within one hour [11]. Duke et al. indicated that mortality risk of patients could be determined in 12 and 24 hours with lactate levels [12]. Many researchers found that the organ failure is associated with lactate levels in sepsis, trauma, burns, severe acute pancreatitis patients [13-15]. Mark et al. found that first measured lactate level is associated with mortality in severe sepsis patients without organ failure in the emergency department [16]. In contrast, Hatherill et al. reported that lactate level was a weak predictor of mortality and not useful in practice [17].

In our study Regardless of Diagnoses, was found strong statistically significant difference between lactate 1, lactate 2, age and GCS of survivors & nonsurvivors. Mortality rates were higher in the patients with high lactate 1, lactate 2, small age and GCS. Also there was a statistically significant difference between lactate 1, lactate 2 of survivors and non-survivors with sepsis, convulsion, poisoning, pneumonia, burn and non-specific diagnosis. There were statistically significant difference only between lactate 2 of survivors and non-survivors with metabolic acidosis cases. There were no statistically significant difference between lactate 1, lactate 2 of survivors - non-survivors only in cases with scorpion bite. Dependent diagnoses or Regardless of Diagnoses in group B, lactate 1 (except for cases with diabetic ketoacidosis and scorpion bites) and lactate 2 (except only cases with diabetic ketoacidosis) had high sensitivity and specificity for predicting the risk of mortality rates.

In conclusion, this study demonstrated that easily measured blood lactate levels could be a useful indicator for determination of the disease severity, prognosis and the mortality risk in pediatric intensive care unit patients. In this way, early resuscitation may reduce morbidity and mortality rates. Also resuscitation effectiveness could be appraised. More extensive studies are needed about this subject urgently.

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