ORIGINAL ARTICLE

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Base Excess and Lactic Acid Levels as Success Criteria in Cardiopulmonary Resuscitation

ABSTRACT

Objective: Cardiopulmonary arrest is a condition with high mortality and morbidity. Although the mortality rate in in-hospital arrest cases is high, the mortality rate in cardiac arrest cases outside hospital is even higher. Therefore, it is important to predict the severity of the arrest. Many studies have been performed to understand the mechanism of cardiac arrest, to improve its prevention, and to increase intervention quality. In this study we aimed to analyze the relationship between acidosis parameters and cardiopulmonary resuscitation success.

Methods: We analyzed blood gas data in patients that underwent cardiopulmonary arrest out-of-hospital, had intervention by an ambulance first-aid team and Then were brought to the emergency room for advanced life support.

Results: A significant difference in blood lactate levels between the groups was determined.

Conclusions: Lactate and Base excess levels are parameters that could be used to assess the success of cardiopulmonary resuscitation.

Keywords: Cardiopulmonary Arrest, Lactic Acid, Base Excess.

Kardiyopulmoner Resusitasyon Başarı Kriteri Olarak Baz Seviyesi ve Laktik Asit Düzeylerinin Değerlendirilmesi

ÖZET

Amaç: Kardiyopulmoner arrest, mortalite ve morbiditesi yüksek bir durumdur. Hastane içi arrest vakalarında ölüm oranı yüksek olmasına ragmen hastane dışında kardiyak arrest olgularında ölüm oranı daha da yüksektir. Bu nedenle arrest vakasının ciddiyetini öngörmek önemlidir. Kardiyak arrest mekanizmasını anlamak, önelemek ve müdahale kalitesini artırmak için birçok çalışma yapılmıştır.

Amaç: Bu çalışmada asidoz parametreleri ile kardiyopulmoner resüsitasyon başarısı arasındaki ilişkiyi analiz etmeyi amaçladık.

Gereç ve Yöntem: Hastane ışında kardiyak arrest geçiren, daha sonrasında ilk yardım ekiplerince ilk müdahalesi başlatılan ve hastaneye getirilen vakalar çalışmaya dahil edilmiştir

Bulgular: Gruplar arasında kan laktat düzeylerinde anlamlı fark olduğu belirlendi.

Sonuç: Laktat ve Baz düzeyleri, kardiyopulmoner resüsitasyonun başarısını değerlendirmek için kullanılabilecek parametrelerdir.

Anahtar Kelimeler: Kardiyopulmoner Arrest, Laktik Asit, Baz Fazlalığı

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INTRODUCTION

According to data obtained from studies conducted in Turkey, 100000-150000 cases with cardiopulmonary arrest (CPA) are brought to an emergency room (ER) each year (1, 2). According to international data, the average number of CPA cases is reported as 160,000–200,000 annually (3-5).

CPA is a condition that causes high mortality and morbidity and generally has a sudden onset. Although the mortality rate in in-hospital arrest cases is high, the mortality rate in cardiac arrest cases outside hospital is even higher. The most critical parameters that affect this rate is the time that passes before effective resuscitation intervention starts. While it is incompatible with survival if advanced life support starts 30 minutes after CPA or continues for more than 90 minutes (6), each minute that passes before initiation of adequate resuscitation increases the mortality rate by 7%–10% (7).

Many studies have been performed to understand the mechanism of cardiac arrest, to improve its prevention, and to increase intervention quality (7-11). Despite all of these developments, the survival rate of out-of-hospital arrest patients remains low at an average of 6% (7).

Cessation or reduction of blood flow because of CPA leads to intense hypercapnia and acidosis at the tissue level. The main reason for this is the increased accumulation of carbon dioxide (CO2), lactate (Lac), and hydrogen (H) as end-products of the shift from aerobic metabolism to anaerobic metabolism. It has been proved that cell damage and organ dysfunction resulting from metabolic acidosis increases hospitalization duration, morbidity, and mortality after CPA (12). Even when closed chest massage is performed, the blood flow can reach only one-quarter of the physiological blood pressure, so it remains insufficient to supply the needs of the tissues and to remove the metabolic damage (13, 14).

The decision to initiate buffer treatment during cardiopulmonary resuscitation (CPR) in order to avoid metabolic acidosis depends on the knowledge of the patient's acid-base levels. The best way to determine this is to perform blood gas analyses. Base excess (BE) levels should also be known in order to establish acid-base balance. The primary indicator of acidosis during CPR is a high blood Lac level. In their study, Davis et al. reported that BE is a reliable marker of tissue oxygen use during hemorrhagic shock (15). Some studies report that BE is a valuable indicator in predicting the severity of hypovolemic shock (16). At the same time, the prognostic value of BE, Lac level, and acidosis in CPA, in general, has not yet been sufficiently studied. In our study, we aimed to analyze the relationship between acidosis parameters and CPR success in patients that underwent CPA out-of-hospital, had intervention by an ambulance first-aid team, and were then brought to the ER for advanced life support.

MATERIAL AND METHODS

The present report is a retrospective study that covers the 6-month period. CPA patients who first underwent intervention out-of-hospital by a first-aid team, then were brought to the ER for further advanced life support and died in the hospital, were included in the study.

In the blood gas evaluation of the patients, the pH, pO2, pCO2, BE, and Lac levels were analyzed as laboratory markers of metabolic acidosis. Samples to assess blood gases were taken within the first 10 min after starting CPR.

To compare the blood gas parameters and to evaluate the success of the prehospital intervention by the first-aid team, we formed a control group of patients that were chosen among intensive care unit (ICU) patients. These patients had safe airways or received early advanced life support after experiencing a witnessed cardiac arrest. In both cases, the group consisted of patients that accepted exitus (EX) after CPR.

The data obtained from this study were analyzed with the SPSS version 15.0 statistical program. percent, average, and minimum and maximum values of data were used as descriptive statistics. The comparison of the groups was performed with the T-sample test statistic, and the significance value was $p<0.05$.

RESULTS

During the study period, 52 CPA patients were brought to the ER by ambulance. Twelve patients with insufficient data were excluded from the study. Twenty-five (62.5%) of the 40 patients included in the study were male and 15 (37.5%) were female. The average age of the patients was 60 years (range 1–90).

Cases chosen for the control group were patients from the ICU who underwent early advanced life support but died. The total number of control group patients was 135. Only 22 cases with data sufficient for this research were included in our study; 10 of them were male and 12 were female (45.45% and 54.54%, respectively). The mean age of the control group was 75 years (range 4–96). Demographic characteristics of the study group and the control group are shown in Table 1.

The comparative values of blood gas analyses of the groups are shown in Table 2.

Table 1. The demographic characteristics of patients died in the ER and intensive care unit (ICU).

Number of the cases	Patients dies in ER (n=40)	Patients dies in ICU (n=22)
Male	25	10
Female	15	12
Age (year,mean)	60	75

In 36 out of 40 patients (90%) treated in the ER, acidosis was observed (blood gas pH<7.35). Fourteen of 22 arrest patients (64%) from the ICU were in acidosis. BE data from 6 of the 40 ER group patients were not evaluated, while 17 others (52%) had high BE (>12 mmol/L). BE data was missing for 3 out of 22 patients in the control group, while 8 others (42%) had high BE (>12 mmol/L). 8 of patients in ER blood Lac levels were missing; in all of the remaining 32 patients, blood Lac levels were high (>1.3 mmol/L). In the control group, 19 of 22 patients (86%) had elevated Lac levels. While no significant difference was detected between the pH, pO2, pCO2, BE, and HCO3 values of the groups (p>0.05), There was a significant difference between the groups in blood Lac levels. (p<0.05).

Table 2. The data of blood gas analyzes of the patients during CPR**.**

Data of blood gas analyze (min-max)	Patients dies in ER	Patients dies in ICU	P(<0.005)
pH mean mmol/L	**7,09 (6,80-8,00)**	**7,19 (6,80-7,51)**	**0.004**
pO2 mean mmol/L	**49 (4-223)**	**66 (26-208)**	
pCO2 mean mmol/L	**64 (5-115)**	**37 (2-77)**	
BE mean mmol/L	**-12 (-33 -19)**	**-9 (-27-11)**	**0.001**
Lac mean mmol/L	**13 (2-123)**	**7 (2-15)**	**0.001**
HCO3 mean mmol/L	**8 (6-47)**	**18 (3-38)**	

DISCUSSION

Many studies have been conducted about the importance of providing early airway clearance, appropriate pre-hospital intervention, and early CPR for CPA. As a measure of success, many methods, such as fast transport to the ER (1), onsite intervention (17), and monitoring and replacement of blood electrolytes and metabolites (12), have been evaluated.

In our study, we analyzed CPA patients who had initial intervention out-of-hospital by a first-aid team and were then transported to the hospital for further life support and died after CPR.

Gender distribution of cardiac arrest cases brought to the ER were examined and it was found that most of the cases were men which is consistent with other studies conducted in our country (1). (1). The age distribution and the average age of the CPA patients were consistent with the data of similar studies (8).

In our study, a significant difference was found in lactic acid loads between the groups (p<0.005), and acidosis was found in most patients (90% and 64% for the ER and ICU patients, respectively). According to these data, we can see that no adequate tissue perfusion was supplied to the patients of the ER group, and thus Lac was not sufficiently eliminated from the tissues. In a study conducted by Domino et al., high blood Lac levels in arrest cases and high levels remaining after reperfusion during hospitalization were found to be associated with a high mortality rate (3). Again, even though we did not detect any significant difference between the groups, 50% of the ER group had increased BE. Some studies have shown BE to be a valuable marker in predicting the severity of the hemorrhagic shock, in demonstrating the body's response to fluid resuscitation, and in indicating body fluid deficiency (15). Some studies have shown that BE is valuable in determining mortality in trauma patients, but it is not useful in determining mortality in patients with cardiac arrest (15, 16, 18, 19). Takasu et al. detected increased BE in patients admitted to the ER after cardiac arrest but could not significantly associate it with the mortality rate (17). These results are consistent with our study. Although no significant differences between the BE levels of the groups were shown in our study, further research needs to be performed to examine BE's effect on mortality. We claim that Lac and BE levels are parameters that can be used to assess the success of CPR. Another possible reason these data do not show a significant difference between the groups may be that we selected the wrong control group. There may have been a more accurate comparison of the data if we had selected the control group from patients who were admitted to the ER with CPA but had a good prognosis after CPR.

In conclusion, understanding CPA in order to determine the severity of the condition and its prognosis is one of the most critical issues faced by emergency physicians. The main objective is to reduce mortality. In this context, it is essential to understand the alterations of the arrest patient's metabolism. With this study, we suggest that Lac and BE levels are parameters that could be used to assess the success of

CPR. We believe that if new and more extensive studies are performed, with improvements to the limitations of our study, valuable knowledge can be gained about effective CPR and predicting the survival of CPA patients.

Limitations: There are some limitations in our study, including the retrospective design, missing data, a small sample size, and being performed at one center. In addition, data such as whether the patient was adequately intubated before ER admission, the time passing before the arrival of the first-aid team, and hospital transport time, would provide valuable contributions to the study, and the lack of these limit it.

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