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Original Article

Predictive Value of Base Deficit in Outcomes of FAST Positive Patients with Multiple Trauma

Mohammad Mohammadi Arbati[1], Hossein ArabAhmadi[1], Mohammad Hadi Molseghi[3*]

1 Department of General Surgery, Ayatollah Mousavi Hospital, School of Medicine, Zanjan University of Medical Sciences, Zanjan, Iran

*** Corresponding Author**: Mohammad Hadi Molseghi, Department of General Surgery, Ayatollah Mousavi Hospital, School of Medicine, Zanjan University of Medical Sciences, Zanjan, Iran. Tel: +982433131851, Email: molseghi@gmail.com.

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Abstract

Background: Decreased tissue perfusion is a predictor of mortality in trauma patients, and measured by serum lactic acid, which isn't possible at all centers. The reduction of Base Deficiency (BD) in trauma patients is mainly due to lactic acidosis. We sought to assess the predictive value of base deficit in outcomes of FAST positive patients with multiple trauma.

Methods: In this study, 88 trauma patients were referred to the emergency department with acute abdomen reqiuring surgery. Free intra-abdominal fluid on fast ultrasound, abdominal injury on CT scan, and candidates for either surgery or non-operative management, and their data were statistically analyzed.

Results: Out of 88 participants, eight patients (9.1%) died, and 24 of them (27.3%) required surgical intervention. Mortality rate and hospitalization days increased with increasing BD (P = 0.001), but the increase in mortality rate and BD increase did not show a significant relationship. The best BD cut-off point for predicting the need for surgery in patients was BD> 4.45 (sensitivity 79.2% and specificity 65.6%).

Conclusion: BD predicts the need for surgery and the length of hospital stay. Because a low number of deaths in our study, we suggeste that further studies be done with some larger statistical populations.

Keywords: Base deficit; Trauma; Surgery; Shock.

Introduction

Trauma is the leading cause of death and one of the leading causes of disability inactive populations in developing countries[1,2,3]. Unfortunately, the importance of this issue in these countries has received less attention [4]. This situation is getting worse. According to the World Health Organization, by 2020, traumas caused by accidents alone will be the second leading cause of lost years of life worldwide [5].

A study of the death rate due to trauma per 100,000 population shows that this rate was 99 people globally and 58 people in Iran [6]. On the other hand, trauma also imposes many direct and indirect economic and social costs on society. This has forced policymakers and those involved in health care systems to take basic measures in this regard. Today, the policy of these systems is based on the preventive measures and care required by these patients [7,8,9]. Reduction of mortality, final recovery of patients with severe injuries, and reduction of socio-economic burden are the benefits obtained from these policies that have been done in different countries [10,11].

Without the need for clear clinical signs, Occult hypo perfusion has been reported as a predictor of mortality[12], and its criterion has been the measurement of serum lactic acid. Still, the amount of this parameter in all Trauma centers is not available. A base deficiency is an amount of base in millimoles needed to titrate one liter of whole blood to reach pH = 4.7 under conditions of complete oxygen saturation of the blood at 37 ° C and PaCO2 = 40 mm Hg. This criterion is usually calculated by arterial blood gas analysis, and its average values are zero to two[13]. Factors affecting base deficiency include bicarbonate consumption, hypocapnia hypothermia, heparin, ethanol, and ketoacidosis[14] and on the other hand, since the reduction of base deficiency in the absence of diabetes, alcohol consumption and chronic kidney disease in

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trauma are mainly due to lactic acidosis, the mortality rate of trauma patients can be predicted according to base deficiency in the first 24 hours after trauma. In the present study, this variable (BD) was used to predict the need for surgery in trauma patients. A base deficiency is divided into mild (3-5), moderate (6-14), and severe (more than or equal to 15) [14].

A large group of trauma patients will experience abdominal trauma. In these cases, a careful intra-abdominal evaluation is needed to assess any possible damage to the intra-abdominal structure that may affect patient outcomes [15,16]. A concomitant decrease in consciousness is common in patients with abdominal trauma. This change in the mental state makes the physical examination of the abdomen unreliable, so using FAST (Focus Assessment with Sonography for Trauma patients) ultrasound in the early stages can be beneficial [17,18].

According to the current guidelines of the surgical community, patients with abdominal trauma and concomitant loss of consciousness should be referred to the Intensive Care Unit (ICU) and monitored [19]. On the other side of the spectrum, patients with evidence of peritonitis on abdominal examination or unstable hemodynamics undergo laparotomy and are offered more surgical treatments [20,21]. Increased risk of adhesions and incisional hernias can affect the prognosis of patients and increase the length of hospital stay and mortality [22]. Targeted evaluation of trauma patients using FAST as part of the initial examination is valuable for emergency care of patients with blunt abdominal trauma. Because not all FAST-positive patients undergo surgery and, in the ICU (intensive care unit) due to the stable hemodynamic conditions may be only monitored in this case, it may be possible to use the base deficit as a factor to predict the need for surgery. Given that no study has been done in this field so far and in previous studies, only factors such as mortality or concomitant complications have been measured, it is possible to use this laboratory factor which is made of ABG (atrial blood gas) at the time of arrival of patients with multiple traumas to make surgical decisions and measure other outcomes.

Methods

Study population

All patients older than 18 years with multiple trauma were referred to the emergency department of Ayatollah Mousavi Hospital (Zanjan, Iran). The study was conducted under the Declaration of Helsinki and International Council for Harmonization Good Clinical Practice guidelines and approved by the independent ethics committee at Zanjan University of Medical Sciences before patient enrollment was commenced. (Ethic Code: IR.ZUMS.REC.1398.293 in 2019.10.01). Inclusion criteria were: 1) FAST positive patients, 2) abdominal tenderness, 3) substantial organ damage or free fluid in abdomen CT (Computed Tomography) scan results. Patients with liver failure, renal failure, diabetes mellitus, and COPD (Chronic Obstructive Pulmonary Disease) were excluded from the study. After simple random sampling, 88 patients were included for further examination. After admitting the patients, the primary and secondary survey were done. For each patient admitted to a study center, the following data were recorded by a physician during the prehospital phase: age, sex, trauma characteristics, systolic arterial blood pressure, heart rate, respiratory rate, Glasgow Coma Scale, and peripheral oxygen saturation. Then, the history (mechanism of trauma, presence of the underlying disease, vital signs, and patient's demographic information) and complete physical examination data were recorded in a checklist.

Base Deficit Measurements

An arterial blood sample was taken from the radial artery using a heparinized insulin syringe. Arterial blood base deficit was calculated using the following equation:

Base deficit = 125.58 − (13.77 × arterial pH) − (0.02786 × Carbon dioxide partial pressure × 10pH-6.1) and categorized in four ranges from normal (above -3 mmol/L), mild deficiency (between -3 to -5 mmol/L), moderate (-6 to -9 mmol/L) and severe (-10 mmol/L or less) [23,24].

Endpoints

Patients then received appropriate treatment (including surgical or non-surgical management). The primary endpoint was in-hospital mortality, defined as death before discharge when the discharge occurred

within 30 days. Deaths occurring after hospital discharge were not considered, the analyses were censored, and the patients being recorded as alive.

The secondary endpoint was the length of hospital stay and the rate of conversion of non-surgical treatment to surgery.

Statistical analysis

In descriptive statistics, for quantitative data, mean, and standard deviation and for nominal qualitative data, percentage and frequency were reported. The Chi-square test was used to determine the relationship between qualitative-nominal variables. ROC curves were utilized to determine the predictive power of the base deficit, and the area under the curve will be reported accordingly. The iodine index is used to determine the cutting point. SPSS version 18 was used for all statistical analysis and generation of the graphs. P<0.05 was considered to indicate a statistically significant difference.

Result

Among the studied patients, 58 were male, and 30 were female. 65(73.8%) cases had no underlying disease, and 23(26.2%) reported a history of at least one underlying disease. The mean age of patients was 45.8±8.5 years (Table 1).

Out of 88 patients participating in the study, eight patients (9.1%) died before hospital discharge, 39 (44.3%) required surgical intervention, and the others were discharged from the hospital without any surgical intervention.

The relationship between baseline deficiency, variables of hospitalization duration, mortality, and need for surgery was investigated. As can be seen in Table 2, the rate of mortality was higher in severe base deficits, and patients with more dysfunctional baseline deficits were hospitalized longer. At least our results showed a greater need for surgery in patients with higher basal defects. All the relationships were statistically significant.

ROC curves were employed to determine the predictive power of Base deficit (BD). Accordingly, the area under the ROC curve for BD and the need for surgery was 0.769, which indicates the relatively suitable ability of base deficit to predict the need for surgery. The best BD cut-off point for predicting the need for surgery of patients is BD > -4.45 (sensitivity 79.2% and specificity 65.6%). By data disaggregation, the area under the ROC curve was 0.763 for men and 0.845 for women, indicating a good BD prediction of the need for surgery. The significance level for all analyzes is considered to be 5 % (Fig1).

Table 1: Frequency distribution of gender, age, and underlying disease of study participants

		Surgical treatment	Non-surgical treatment	P-Value
Gender	Male	64.1% (25)	67.3% (33)	0.05<
Age	< 39 yr	74.3% (29)	73.4% (36)	0.05<
	40 – 59 yr	15.3% (6)	16.3% (8)	0.05<
	60yr <	10.4% (4)	10.3% (5)	0.05<
Underlying Disease	Negative	71.7% (28)	75.5% (37)	0.05<
	Positive	28.3% (11)	24.5% (12)	0.05<
Mechanism	Falling	23% (9)	24.4% (12)	0.05<
	Car Accident	46.1% (18)	49.1% (24)	0.05<
	Motor Accident	17.9% (7)	20.4% (10)	0.05<
	Pedestrian Accident	13% (5)	6.1% (3)	0.03*
Base Deficit	Mean	-9.38±3.57	-6.72±4.61	<0.05*
Mortality		12.8% (5)	6.1% (3)	<0.05*

Table2: Frequency distribution of deaths, days of hospitalization, and need for surgery based on base deficiency classification

Variable	Type	Base Deficiency				P-Value
		Negative	Mild	Moderate	Severe	
Mortality	Yes	1 (12.5%)	0 (0%)	2 (25%)	5 (62.5%)	0.01
	No	31 (38.8%)	20 (25%)	17 (21.2%)	12 (15%)	
Days Of Hospitalization	Less Than A Week	31 (53%)	16 (27%)	4 (6%)	7 (12%)	0.001
	More Than A Week	1 (3%)	4 (9%)	15 (53.3%)	10 (30%)	
Need For Surgery	Yes	8 (20.7%)	9 (23%)	10 (25.6%)	12 (30.7%)	0.02
	No	24 (48.7%)	11 (22.4%)	9 (18.3%)	5(10.6%)	

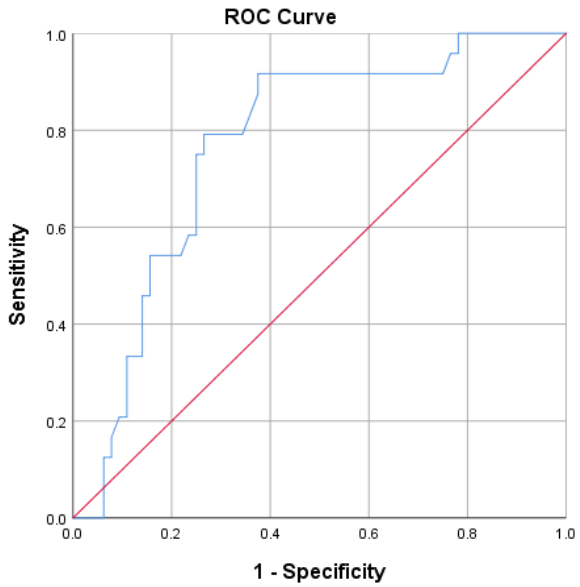

Figure 1: ROC Curve of the predictive power of Base deficit and the need for surgery.

Discussion

The use of Base deficit criteria in the evaluation of patients with trauma has incredible efficiency, especially in providing good information about the degree of shock and resuscitation adequacy. The study showed that higher values of Base deficit are also associated with a higher chance of mortality in trauma patients.

Some studies have shown its effectiveness in predicting mortality and length of hospital stay. In this study, BD was used as a marker of lactate accumulation in the blood and reduction of tissue perfusion.

The results showed that the Base deficit (-4.45) is significant, which is an entirely new finding. The presence of the effect of four factors of respiratory rate, GCS, pelvic fracture, and heart disease in BD also shows that in these cases, special attention should be paid to the amount of BD, and in case of crossing the crisis point, the use of ICU and monitoring facilities must be considered.

It was observed that some kinds of trauma, such as pedestrian accidents, was required more surgical treatment than other trauma mechanisms, which can be due to the high energy transferred to the patient and the severity of the injury in this type of trauma, which detailed results indicated more damage to solid organs. This study showed that higher base deficit (moderate and severe) patients are more likely to require emergency surgical intervention. Of the 39 patients requiring surgical intervention in this study, 22 patients had moderate to severe open defects in the initial evaluation. On the other hand, more open defects were associated with a higher probability of mortality in trauma patients.

In recent years, many studies have been conducted to predict the outcomes of trauma patients, and some of these studies have tried to provide appropriate predictions in this regard by multi-factor modeling. Unfortunately, none of these studies suggested an efficient model. In numerous of these studies, much attention was paid to blood lactate levels. It should be noted that isolated blows to the head (without injury to the abdomen and chest) can cause loss of consciousness, hypoventilation, and disruption of carbon dioxide pressure and blood lactate levels. Due to the influence of this index on the mechanism of trauma and ventilation of the patient, blood lactate levels were not examined. [23-27]

Based on previous studies and the findings of this study, it can be stated that trauma causes a chain of inflammatory reactions in the patient's body, and many

cytokines are activated. Exacerbation of inflammatory reactions over time, as well as increased hypovolemic shock due to bleeding, can disrupt tissue perfusion and result in Base defects. Since the vital signs index is highly affected by variables such as age, the patient's physical fitness, medication, and other variables, the base deficit index can be a good predictor of the severity of the injury and the measures required for the patient. Paying attention to this index can cause more readiness of medical staff in trauma treatment centers, better classification of patients in terms of priority of treatment measures, and provide more effective and timely medical services to patients.

Conclusion

BD predicts the need for surgery and the length of hospital stay. Due to a low number of deaths in our study, it is suggested that studies be repeated with a larger statistical population to achieve higher accuracy in the assessments.

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Not applicable.

Authors' contributions

Mohammadi Arbati and Molseghi: Manuscript writing, literature research, Management of case and final approval of manuscript. Arab Ahmadi, and Molseghi: Management of the case, editing the manuscript. All authors have read and approved the manuscript.

Conflict of interest

The authors declare that they have no conflict of interests.

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Ethical consideration

This study was approved by the independent ethics committee at Zanjan University of Medical Sciences, Ethic Code: IR.ZUMS.REC.1398.293 in 2019.10.01 (https://ethics.research.ac.ir).

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