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Evaluation of Blood Lactate Concentrations as A Marker for Resuscitation and Prognosis in Patients with Major Burns

Thesis

Submitted for Partial Fulfillment of Master Degree of Plastic, Burn and Maxillofacial Surgery

By

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ABSTRACT

Background: Severe burns require appropriate fluid management in the acute phase. A massive volume of intravenous fluid is usually required to ensure adequate end-organ perfusion. Lactate is a product of anaerobic metabolism. A high level of lactate in tissue is direct indication of tissue hypoxia. The correlation between serum lactate and clinical outcome has been well accepted in hemorrhagic and septic shock. However, studies on its use in predicting mortality and morbidity of major burn patients in particular is sparse. Early prediction of outcome in patients with major burn is very likely to aid suitable modification of management strategies.

Objective: To assess the role of serum lactate measurement as the predictor burn patient's outcome (survivors and non-survivors).

Patients and Methods: 30 patients with major burn (more than 20% of TBSA) were included. This includes operated/ non-operated patients. Of the 30 patients, 20 were males and 10 were females. All adult burned patients admitted within the first 24h post burn were included in the study. Patients admitted after 24h from the thermal injury, or those who were discharged or died 48h after admission were excluded.

Results: Serial blood lactate measures were better as a prognostic tool than isolated measure. Reduction or normalization of lactate levels 24 hours after admission was significantly associated with a higher probability of survival. This study confirms the prognostic value of serum lactate for mortality in patients with major burns as serial blood lactate measurements predict mortality in these patients.

Conclusion: Although many studies reiterate the importance of blood lactate and lactate clearance in predicting mortality in burn patients, the role of these markers in therapy titration is ambiguous. Overzealous fluid resuscitation can cause fluid overload and acute respiratory distress syndrome. little regional data are available to establish the importance of blood lactate. We have demonstrated the association of blood lactate in the first 36 hours of the burn injury with mortality. Further large multicenter prospective studies are required.

Keywords: Lactate, resuscitation, prognosis, biomarker, major burn

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List of Abbreviations

Abb.	Full term
ABA	American Burn Association
Bpm	Beats per minute
DAMPs	Damage-associated molecular patterns
ROS	Reactive oxygen species
SVR	Systemic vascular resistance
FDA	Food and drug administration
FiO2	Fraction of inspired oxygen
ICU	Intensive Care Unit
IL	Interleukin
LDH	Lactate dehydrogenase
MAP	Mean arterial pressure
MCT	Mono-carboxylate transporters
NF-κB	Nuclear factor kappa B
NLRs	Nucleotide like receptors
NOD	Nucleotide oligomerization domain
PAMPs	Pathogen-associated molecular pattern molecules
PaO2	Partial pressure of arterial oxygen
PiCCO	Pulse Contour Cardiac Output
RL	Ringer's lactated
SIRS	Systemic inflammatory response syndrome
SOFA	Sequential Organ Failure Assessment
TBSA	Total body surface area
TLRs	Toll-like receptors
TNF	Tumor necrosis factor
WHO	World Health Organization

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INTRODUCTION

Burn trauma is caused by a wide variety of substances and external sources such as exposure to flame, chemicals, friction, electricity, radiation. It is one of the most common injuries, mainly in developing countries. Two main factors define burn severity: depth of burn injury (which depends on the temperature and exposure time) and burnt body surface. Burn injury, affecting more than 20% of the body surface requires special intensive care, because not only the thermally injured skin and the underlying anatomical structures are affected, but there are some pathophysiological changes that influence the whole body ***(Houschyar et al., 2020).***

Severe burn results in a devastating and unique derangement called burn shock. Fluid resuscitation is the foundation of immediate burn care and the primary goal of resuscitation is to restore and preserve tissue perfusion ***(Suresh and Dries, 2018).*** Historically, resuscitation has been guided by a combination of basic laboratory values, invasive maneuvers and clinical data, but the optimal guide to the end point of resuscitation remains controversial ***(Kamolz et al., 2005).***

Hourly urine output is the most commonly used endpoint to guide titration of fluid resuscitation. The most recent practice guidelines of the American Burn Association recommend that fluid infusion be titrated to achieve urine output of 0.5-1.0 ml/kg/h. As a resuscitation end point, urine output is practical

and works well in many circumstances, but it is imperfect. Correlation between urine output and various hemodynamic variables or measures of oxygen delivery or tissue perfusion is poor. Furthermore, optimum hourly urine output has never been accurately defined. A permissive oliguria approach has been suggested as appropriate. However, in inexperienced hands, urine output may be prone to misuse and misinterpretation, particularly in the presence of intra-abdominal hypertension or acute compartmental syndrome where oliguria may be caused by diminished renal perfusion rather than hypovolemia. This may lead to erroneous administration of additional fluid creating a vicious cycle involving edema formation, rising intra-abdominal pressure, and oliguria ***(Suresh and Dries, 2018).***

It is a fact that most centers providing initial care to burn patients in developing countries are not equipped with the resources needed to guide resuscitation by goal-directed therapy techniques, and to date, these methods have not shown survival benefits relative to use of the Parkland formula ***(Guilabert et al., 2016).***

In patients with severe trauma or burns, failure to establish an adequate organ and cellular perfusion results in a cellular hypoxic state and shift to anaerobic metabolism on the cellular level. This increases the production of lactic acid denoting inadequate resuscitation. Lactic acidosis is frequently seen in critically ill patients. Despite large number of potential etiologies, tissue hypo- perfusion is by far its most common

etiology. Aggressive cardio-respiratory resuscitation designed to restore tissue perfusion is the fundamental approach to these patients. Accordingly, certain metabolic variables as lactate, lactate/pyruvate ratio and base deficit have been specifically investigated and suggested as resuscitative endpoint parameters ***(Sánchez et al., 2013).*** They were found to be of prognostic value and may be used to guide the quality of initial resuscitation.

Sepsis is the leading cause of death in the non-cardiac ICU patients. Mortality in Septic Shock ranges from 40 to 60% despite advances in treatment and provision of intensive care. According to Food and drug administration (FDA) sepsis is the second leading cause of death in USA in non-coronary ICU patients. The morbidity and mortality associated with Sepsis is very high with at least 1 out of 4 cases showing death ***(Westphal and Lino, 2015; Asati et al., 2018).*** The presence of infection is a confirmatory feature of Sepsis ***(McIntyre et al., 2013; Singer et al., 2016).*** The accurate confirmation of sepsis is based on systemic inflammatory response syndrome (SIRS) criteria which include features such as tachycardia, hypothermia or fever and leukopenia, leukocytosis, or bandemia ***(Singer et al., 2016).***

The normal lactate value was defined as 1.4–2.3 mmol/L ***(Wacharasint et al., 2012).*** Lactate elevation in blood is seen only in conditions such as hyperlactatemia and lactic acidosis. The values in such cases varies from 2 mmol/L to 5 mmol/L in