

Early Increases In Blood Lactate Following Injury

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ABSTRACT

Current pre-hospital trauma triage systems are based mainly on physiological parameters, but in compensated shock injury severity may not be immediately obvious, as the physiological parameters remain normal for some time. Serum lactate, measured in hospital, is known to be a predictor of injury severity and outcome. The technology for easy field lactate measurement has recently become available. We found that capillary lactate is elevated in trauma patients in the early phase of the response to injury. There is a moderate correlation ($R^2 = 0.44$) between early lactate levels and injury severity, in patients who might otherwise be difficult to triage.

Objectives

Our aims were:

- To determine if lactate levels are elevated in the pre-hospital phase of trauma, and to establish whether there is a correlation between pre-hospital lactate and injury severity.
- To determine if there is a relation-

ship between pre-hospital lactate and injury severity in patients with normal blood pressure and Glasgow Coma Score of greater than 12 ("difficult to triage" group).

Methods

Prospective analysis of pre-hospital capillary lactate levels and Injury Severity Score (ISS) in 23 trauma patients attended by the London Helicopter Emergency Medical Service.

Results

Capillary lactate is elevated in trauma patients in the early phase of the response to injury. There is a moderate correlation ($R^2 = 0.44$) between early lactate levels and injury severity, in patients who might otherwise be difficult to triage.

Conclusions

Lactate is elevated in the earliest pre-hospital phase of injury following trauma. The potential contribution of this biochemical parameter to field triage requires further evaluation.

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Fig 1. Lactate analyser and test strip.

Introduction

It has been well established that serum lactate is elevated in patients who are severely ill or injured (1-3). In-hospital lactate has been shown to be a predictor of injury severity and outcome following trauma (3,4). However, the measurement of serum lactate in the pre-hospital phase of injury has not previously been described. No previous study has examined the pre-hospital lactate in the severely injured, and it is not known if this parameter is abnormal within the first minutes following injury in man.

Current methods of field triage are based on mechanism of injury and easily measured physiological parameters such as level of consciousness, blood pressure and respiratory rate (5,6). They are sensitive but not specific, leading to considerable over-triage of patients. No current field triage system uses a biochemical parameter, due to the difficulties in performing an assay in the pre-hospital environment. However, a rapid and cheap hand held analyser for measuring capillary lactate has recently become available (Accusport, Boehringer PLC), and was utilised in our study. The machine resembles the familiar device used to read a 'BMstix' in the measurement of blood glucose (Figure 1). It is light, cheap, easy to use, and gives a result in 60 seconds.

Patients with a decreased level of consciousness or a decreased blood pressure are easy to rapidly identify in the field and therefore easy to triage. However, in both, military and civilian systems, patients with compensated shock, with normal physiological parameters and level of conscious-

ness, present a significant diagnostic challenge to paramedics and medical technicians. The measurement of capillary lactate using a hand held analyser in the pre-hospital phase could aid triage decisions in these patients. Before starting the study we decided that we were particularly interested in looking at patients who were 'normal' on the conventional triage parameters, yet had severe injuries.

We performed this initial study to determine (a) if lactate levels were raised during the pre-hospital phase and to determine if any elevation was related to injury severity and (b) if raised lactate levels might identify the "difficult to triage" group of patients (GCS < 12 and blood pressure > 90 mmHg).

Methods

Ethical oversight of the study was obtained. 23 adult patients attended by the London Helicopter Emergency Medical Service and triaged to the Royal London Hospital were included. Patients were excluded if they were under 18 years of age or had received Hartmann's solution (a resuscitation fluid containing lactate) prior to the arrival of the pre-hospital team. A capillary (finger prick) blood sample was taken at the incident scene and processed using a hand held analyser (Accusport, Boehringer PLC). The result was not utilised in the clinical management of the patients. An Injury Severity Score (ISS) was measured in the standard way (7).

The data was inspected to see if patients had an elevated lactate during the pre-hospital phase. The relationship between capillary lactate and ISS was plotted, and the

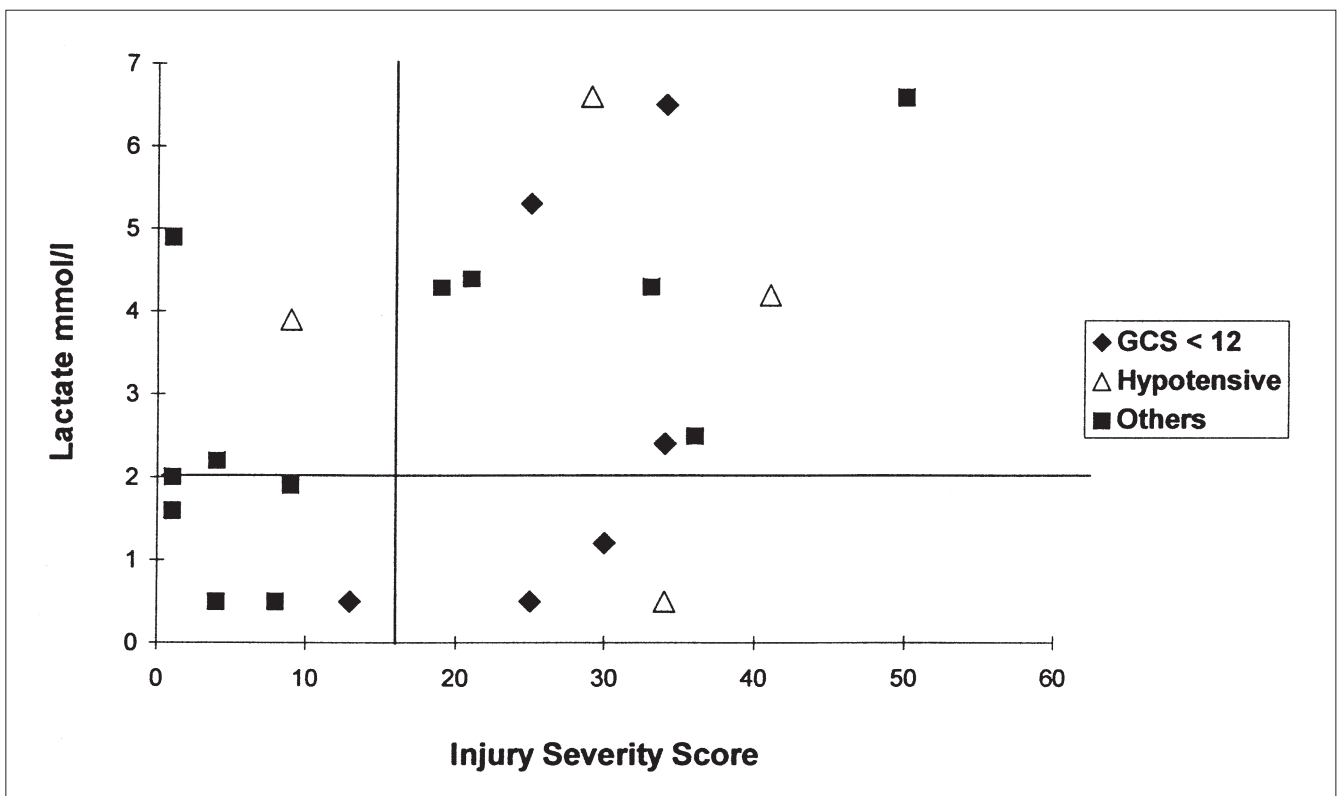


Fig 2. Relationship between early capillary lactate and Injury Severity Score.

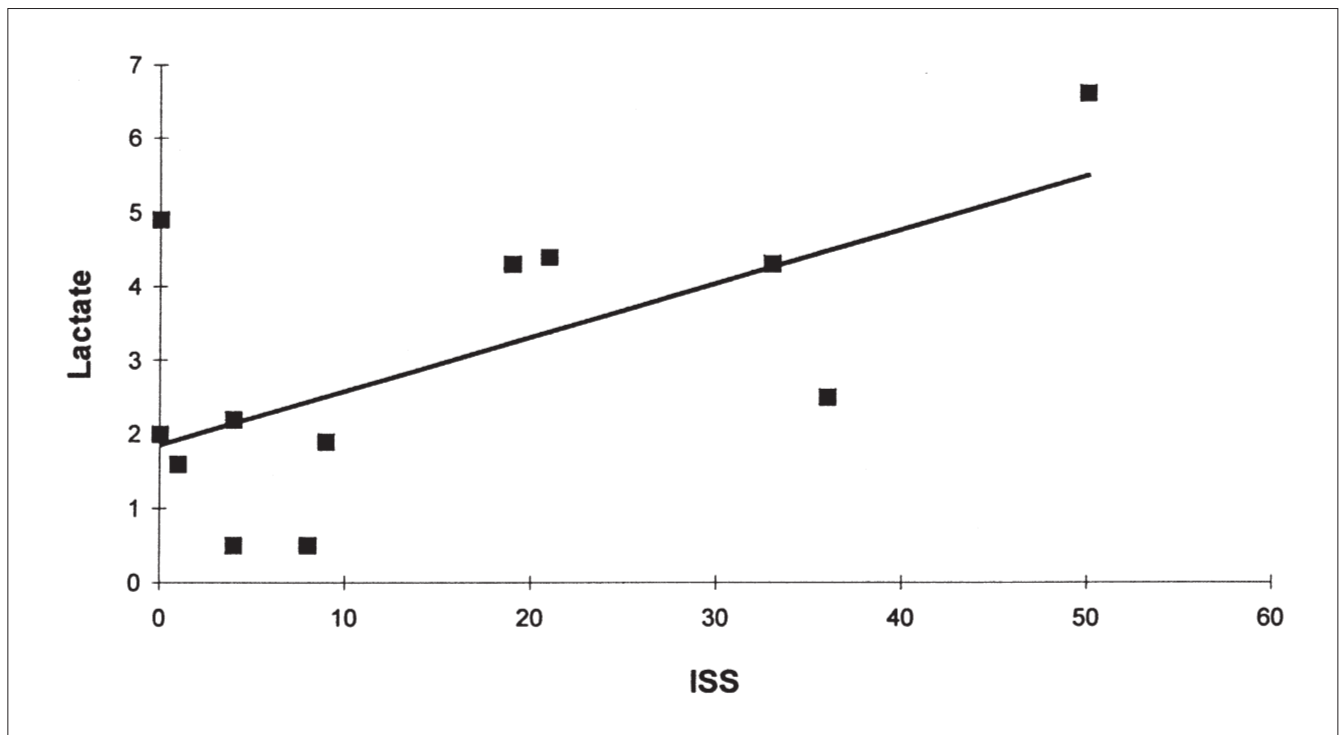


Fig 3. Relationship between early capillary lactate and Injury Severity Score in "difficult to triage" group.

correlation coefficient (R^2 value) calculated.

A subgroup of patients who were "difficult to triage" was then established by removing those patients who had obvious abnormality of conscious level (Glasgow Coma Score less than 12) or were hypotensive (systolic blood pressure less than 90). The relationship between capillary lactate and ISS was plotted for the remaining patients, and the correlation coefficient (R^2 value) calculated.

Results

A population of 22 patients were included in the study. The patients had a median age of 30 years (range 19 to 90 years). The median ISS in the study population was 23 (range 1 to 50). The relationship between early lactate and ISS is shown in Figure 2. The correlation coefficient (R^2 value) between lactate and ISS was 0.170. There were 12 patients in the "difficult to triage" group. The relationship between early capillary lactate and ISS in these patients is shown in Figure 3. The correlation coefficient (R^2 value) for this group of patients was 0.44.

Discussion

This study has shown that lactate levels are raised during the earliest phase of the human response to injury. The early rise in lactate level is positively related to the Injury Severity Score.

The ideal triage tool would be rapid and easy to use in the field, with a high specificity and sensitivity. There is a plethora of pre-hospital triage tools, giving an indication that none are ideal (8,9). Severely injured patients can be divided into those with respiratory problems (identified by abnormal respiratory parameters), those with a neurological

problem (identified by an altered level of consciousness) and those with circulatory shock (who can be identified by abnormal cardiovascular parameters if the shock is uncompensated). However, the group who have compensated shock or occult injuries remain difficult to identify.

Patients with compensated shock or occult injuries may have raised lactate levels. Inadequate organ perfusion and tissue oxygenation leads to anaerobic metabolism, which produces lactate. In humans, serum lactate has been established as a measure of the degree of tissue oxygenation and end organ perfusion, and is used as a measure of the magnitude of hypoperfusion and hence an indirect measure of 'shock'. Lactate levels have been used as a component of injury/illness severity scoring systems (10), as a predictor of survival in shocked patients (11), and as an end point (or goal) for resuscitation (2). In one animal study lactate levels were shown to rise within 30 minutes of injury (11). This all points towards lactate being a potentially important parameter in the pre-hospital phase of trauma care.

The results of our pilot study indicate that rises in lactate levels occur within the first 30 minutes following injury, and that a rapid and cheap method of measurement is available. Considerable further work needs to be done before the exact place of lactate measurement in field triage (if any) is established. However, we conclude that capillary lactate measurement merits further investigation as a biochemical parameter to add to the mechanism and physiological criteria that are currently used in field trauma triage.

References

1. Stacpoole PW. Lactic acidosis. *Endocrinol Metab Clin North Am* 1993; **22**: 221-45.
2. Porter JM, Ivatury RR. In search of optimal endpoints of resuscitation in trauma patients: a review. *J Trauma* 1998; **44(5)**: 908-14.
3. Manikis P, Stanislaw J, Zhang H, Kahn RJ, Vincent J-L. Correlation of serial blood lactate levels to organ failure and mortality after trauma. *Am J Emerg Med* 1995; **13**: 619-22.
4. Abramson D, Scalea TM, Hitchcock R *et al*. Lactate clearance and survival following injury. *J Trauma* 1993; **35**: 584-9.
5. Morris JA Jnr, Auerbach PS, Marshall GA *et al*. The Trauma Score as a triage tool in the prehospital setting. *JAMA* 1986; **256(10)**: 1319-25.
6. Trunkey DD, Siegel J, Baker SP *et al*. Panel: current status of trauma severity indices. *J Trauma* 1983; **23**: 185-201.
7. Baker SP, O'Neill B, Haddon W Jnr *et al*. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma* 1974; **14**: 187-96.
8. Champion HR, Sacco WJ, Copes WS. Injury severity scoring again. *J Trauma* 1995; **38(1)**: 94-5.
9. Demetriades D, Chan LS, Velmahos G *et al*. TRISS methodology in trauma: the need for alternatives. *Br J Surg* 1998; **85(3)**: 379-84.
10. Oda S, Hirasawa H, Sugai T, Shiga H, Matusuda K and Ueno H. Cellular injury score for multiple organ failure severity scoring systems. *J Trauma* 1998; **45(2)**: 304-10.
11. Moomey CB Jr., Melton SM, Croce MA, Fabian TC, Proctor KG. Prognostic value of blood lactate, base deficit, and oxygen-derived variables in an LD50 model of penetrating trauma. *Crit Care Med* 1999; **27(1)**:154-61.