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ORIGINAL RESEARCH

Lactate clearance predicts outcome after major trauma

La clairance du lactate permet de prévoir l'évolution de l'état de santé après un traumatisme important



Essi Heinonen ^{a,b}, Timothy Craig Hardcastle ^{b,c,*}, Hans Barle ^d, David James Jackson Muckart ^{b,c}

^a Clinical Medical Student: Karolinska Institute, Sweden

^b Trauma Service, Inkosi Albert Luthuli Central Hospital, 800 Vusi Mzimela Rd, Mayville, Durban, South Africa

^c University of KwaZulu-Natal Trauma Unit, 800 Vusi Mzimela Rd, Mayville, Durban, South Africa

^d Karolinska Institute, Stockholm, Sweden

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Introduction: To determine a correlation between lactate clearance within 48 h and survival in trauma patients at a Level I trauma centre in a developing country and compare to previous international lactate clearance studies.

Methods: We conducted a retrospective study of a prospectively collected database at a Level I trauma centre from March 2007 to November 2010. Patients of all ages were included. Metabolic parameters from initial arterial blood gas were measured in all patients, an abnormal lactate being defined as >2.5 mmol/L. A subgroup analysis of blunt versus penetrating injury was performed.

Results: Of the 657 patients in the database, 493 had complete lactate data. The survival rate of patients with lactate values <2.5 mmol/L was 88%. Of the patients with high lactate levels that cleared within 24 and 48 h the survival rates were 81% and 71%, respectively. The survival rate amongst patients not achieving a normal lactate within 48 h was 46% but was higher in those with penetrating as opposed to blunt injury (67% versus 38%). The overall survival was 81%.

Conclusion: The present results confirm previous studies showing that prolonged lactate clearance predicts increased mortality in severely injured trauma patients. Thus, the measurements of arterial serum lactate trends are simple and effective predictors of outcome.

Introduction: Déterminer la corrélation entre la clairance du lactate dans les 48 heures et la survie des patients souffrant de traumatisme dans un centre de traumatologie de niveau 1 dans un pays en développement, et comparer cette corrélation aux études internationales antérieures sur la clairance du lactate.

Méthodes: Nous avons réalisé une étude rétrospective d'une base de données constituée de manière prospective dans un centre de traumatologie de niveau 1 de mars 2007 à novembre 2010. Des patients de tous âges ont été inclus. Les paramètres métaboliques tirés des gaz du sang artériel initiaux ont été mesurés chez tous les patients, la concentration anormale de lactate étant fixée à >2,5 mmol/L. Une analyse par sous-groupe des blessures fermées par rapport aux blessures pénétrantes a été réalisée.

Résultats: Sur les 657 patients de la base de données, 493 disposaient de données complètes sur la concentration de lactate. Le taux de survie des patients présentant des concentrations de lactate <2,5 mmol/L s'élevait à 88%. Chez les patients présentant des concentrations élevées de lactate qui diminuaient au bout de 24 et 48 heures, les taux de survie s'élevaient respectivement à 81% et 71%. Le taux de survie chez les patients dont la concentration en lactate ne revenait pas à la normale sous 48 heures était de 46%, mais était plus élevé chez les patients présentant des blessures pénétrantes que chez les patients présentant des blessures fermées (67% contre 38%). Le taux général de survie s'élevait à 81%.

Conclusion: [Les résultats de l'étude confirment les études antérieures indiquant qu'une clairance prolongée du lactate est associée à une mortalité plus élevée chez les patients en traumatologie victimes de blessures graves. Par conséquent, la mesure des tendances du lactate dans le sérum artériel constitue une variable prédictive fiable et efficace de l'état de santé.]

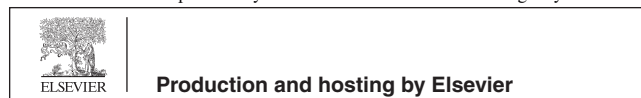
African relevance

- Point of care blood-gas devices are common in the Emergency Centre and should be configured to detect lactate levels.

- The earlier the lactate clears during resuscitation, the better the prognosis.
- Children and adults can be assessed equally by the use of lactate clearance.

* Correspondence to Timothy Craig Hardcastle. hardcastle@ukzn.ac.za, timothyhar@ialch.co.za

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Introduction

Lactate levels in the blood are a function of the balance between lactate production and clearance, with a normal value of less than 2.5 mmol/L. Clearance of lactate is a surrogate marker of improvement and survival in critically ill patients. This clearing process occurs mostly in the liver (60%) and

the kidney (30%).¹ Under aerobic conditions, lactate is produced in skeletal muscle, skin, brain, intestine, and red blood cells.² Woods and Cohen created a classification model for lactic acidosis that is still used today.³ High lactate values correlated with mortality in early smaller study populations.⁴ Bakker and co-workers demonstrated that in septic patients, measuring lactate levels and lactate clearance was superior to other parameters for outcome prediction.^{5,6}

In 2006, Pal et al. undertook a large-scale study with 5995 trauma patients, comparing the admission lactate value to mortality. This large study did not demonstrate a correlation between a single elevated lactate value and survival. Since overall mortality was only 3%, the researchers suggested that the initial lactate value might be worth measuring in more severe trauma cases, but should not be obtained routinely.⁴ A BEST-BET-analysis from 2008 by Hung compares six studies all looking at the initial lactate value. It suggests that the initial lactate value does not identify patients at high risk of death, but it may have a role in identifying patients at low risk of death following blunt trauma.⁷

Abrahamson's team initiated research on serial lactate values in trauma patients in 1993. In their study, all patients who normalized their serum lactate levels within 24 h survived, and 75% of those that normalized by 48 h had an increased survival. Of those patients not clearing lactate within 48 h, only 14% survived.⁸ McNelis and partners conducted a study of 95 trauma patients in 2006 that showed similar outcomes.⁹ In a study by Blow and co-workers, the researchers not only detected hypoperfusion in admitted trauma patients, but also corrected it within 24 h. They showed that early aggressive correction of occult hypoperfusion (as demonstrated by increased lactate levels) led to fewer cases of multi-organ failure, respiratory complications, and death in severely ill trauma patients.¹⁰

The trauma unit in Durban, KwaZulu-Natal (KZN), South Africa, is a modern facility equipped to Level 1 standards and currently is the only public facility of this type in the city.¹¹ It is situated within a subspecialist hospital and acts as a referral hospital for around 25 district and regional hospitals in more rural areas of KZN, parts of Eastern Cape, and some parts of Mozambique.¹² Cases are received either from referring hospitals or directly from the scene, provided admission criteria are met—namely, haemodynamic instability or severe mechanism of injury. Around 25% of the patients included in the study were admitted directly from the scene.

Upon admission, patients are managed by a trauma team consisting of a consultant attending certified in critical care and trauma surgery and a resident each from orthopaedics, anaesthetics, and general surgery, in addition to nurse and critical care technicians. Initial assessment and resuscitation are as per the Advanced Trauma Life Support approach with the use of permissive hypotension where applicable. Early placement of invasive monitoring is performed when necessary. Focussed assessment with ultrasound is used in the initial assessment and further imaging is undertaken with the in-house 128 slice CT-scanner (Siemens, Germany). Immediate access is available to two operating theatres within 20 metres from the resuscitation base. Point of care blood gas analysis and thrombelastography are available within the unit.

Ongoing care is provided by the same team of physicians in a trauma intensive care unit (ICU) with eight ICU beds and eight high-dependency beds. Once patients are stable, they are referred back to their base hospitals for further manage-

ment. All non-survivors undergo medico-legal post-mortem examination, as required by the legal provisions for all unnatural deaths.

This study aims to determine whether there is a correlation between lactate clearance and the outcome of severely injured trauma patients admitted to a recently opened Level 1 Trauma Centre in South Africa, a developing country, with the hypothesis being that decreased lactate clearance in these patients will be associated with increased mortality.

Methods

Following class-approval from the University of KZN ethics committee (BREC Class Approval BE207/09), patient data were collected from the approved databank using retrospective analysis of a prospectively collected dataset. Data were collected prospectively for all patients admitted to the Trauma ICU during the period from March 2007 to November 2010. Patients of all ages were included if they had daily lactate levels recorded at admission and thereafter, were admitted via direct or inter-hospital transfer routes. They were excluded if death occurred before blood sampling, injury mechanism was unclear, or the injuries were minor (no blood taken). Patients with incomplete data were also excluded. Gunshot wounds (GSW) and stab wounds (SW) were classified as penetrating trauma, whereas blunt intentional or unintentional injury, motor vehicle accidents, and fall from height counted as blunt trauma.

Data were collected for all patients regarding gender, age, injury severity score (ISS), new injury severity score (NISS),¹³ type of trauma (blunt vs. penetrating), length of stay at ICU, referral hospital, and lactate levels measured at admission, after 0–24 h, after 24–48 h, and after 48–72 h from admittance to ICU. Since the trauma service provides the only tertiary trauma care facility for injured children in KZN, these patients are included in this study. Children admitted to trauma ICU are mostly over two years old. Those younger than two years are generally referred to a paediatric ICU due to greater technical skill and better access to age appropriate equipment, but are co-managed by the Trauma Service.

The serum lactate was measured in arterial blood. The first sample was taken upon arrival at the trauma unit, within the first hour of care; thereafter, the lactate was measured daily or more frequently, when needed. The range of normal values for the method for measurement is from 0.5 to 2.20 mmol/L. 2.5 mmol/L and less was accepted as the limit for clearance.

The collected data were analysed using GraphPad InStat (Graphpad Software, La Jolla, CA). Continuous variables (age, stay, ISS, NISS, lactate levels) were analysed with Student's *t*-test for each group, calculating the mean, standard deviation, and the *p*-value. Contingency tables were created for the outcomes for the categorical variables (clearance vs outcome, trauma mechanism vs outcome). *p*-Values for these were calculated with the Chi-Squared test for trend and independence and Fisher's exact test.

Results

657 patients (495 men and 162 women) were included in the study. 113 children ranging from 1 to 17 years old are included in the data set. 164 patients were excluded from this study. 45 of the excluded patients died in the resuscitation area before

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