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A comparison of initial lactate and initial base deficit as predictors of mortality after severe blunt trauma

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ABSTRACT

Background: After injury, base deficit (BD) and lactate are common measures of shock. Lactate directly measures anaerobic byproducts, whereas BD is calculated and multifactorial. Although recent studies suggest superiority for lactate in predicting mortality, most were small or analyzed populations with heterogeneous injury severity. Our objective was to compare initial BD with lactate as predictors of inhospital mortality in a large cohort of blunt trauma patients all presenting with hemorrhagic shock.

Materials and methods: The Glue Grant multicenter prospective cohort database was queried; demographic, injury, and physiologic parameters were compiled. Survivors, early deaths (≤ 24 h), and late deaths were compared. Profound shock (lactate ≥ 4 mmol/L) and severe traumatic brain injury subgroups were identified *a priori*. Chi-square, t-test, and analysis of variance were used as appropriate for analysis. Multivariable logistic regression and area under the receiver operating characteristic curve analysis assessed survival predictors. $P < 0.05$ was significant.

Results: A total of 1829 patients met inclusion; 289 (15.8%) died. Both BD and lactate were higher for nonsurvivors ($P < 0.00001$). After multivariable regression, both lactate (odds ratio [OR] 1.17; 95% confidence interval [CI]: 1.12–1.23; $P < 0.00001$) and BD (OR 1.04; 95% CI: 1.01–1.07; $P < 0.005$) predicted overall mortality. However, when excluding early deaths ($n = 77$), only lactate (OR 1.12 95% CI: 1.06–1.19; $P < 0.0001$) remained predictive but not BD (OR 1.00 95% CI: 0.97–1.04; $P = 0.89$). For the shock subgroup, ($n = 915$), results were similar with lactate, but not BD, predicting both early and late deaths. Findings also appear independent of traumatic brain injury severity.

Conclusions: After severe blunt trauma, initial lactate better predicts inhospital mortality than initial BD. Initial BD does not predict mortality for patients who survive >24 h.

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Introduction

Both base deficit (BD) and serum lactate are common post-injury measures of metabolic acidosis.^{1–4} Serum lactate directly measures a byproduct of the anaerobic metabolism induced during periods of shock.⁵ In contrast, BD is a calculated value and is a more global assessment of acid–base status,⁶ being influenced by not only lactic acidosis but also other affecters such as minute ventilation and various therapies (i.e., sodium bicarbonate, intravenous fluids, and blood products⁷ and others).

Although results of both tests are known to reflect a patient's degree of shock and hypoperfusion, there is a continuing debate as to which initial measurement is more useful clinically.^{8–10} Specifically, it is unknown whether initial BD values or initial serum lactate levels, obtained during early resuscitation, better predict overall mortality for patients with severe injury—and whether any predictions apply to early or late mortality. Although recent studies confirm the utility of lactate clearance in predicting outcomes after injury,^{3,4,11} surprisingly few directly explore the predictive value of initial lactate compared with initial BD; furthermore, existing studies are often small^{5,12} or include very heterogeneous populations.^{6,13} In the present study, we used a large well-established database of very severely injured blunt trauma patients, all of whom presented in hemorrhagic shock, to investigate the predictive value of these two commonly used tests for both early (<24 h) and later

mortality in patients with and without severe metabolic derangement. We hypothesized that compared with initial BD, initial serum lactate is a better overall predictor of in-hospital mortality after severe blunt trauma.

Materials and methods

The patient population was selected from the Glue Grant Trauma-Related Database (TRDB): a large-scale multicenter collaborative research program entitled *Inflammation and the Host Response to Injury* conducted from 2002 to 2011 and supported by the National Institute of General Medical Sciences (NIGMS). This database is available online.¹⁴ The TRDB contains clinical, laboratory, and outcomes data for more than 2000 severely injured blunt trauma patients from eight major urban level 1 trauma centers. Inclusion criteria for the Glue Grant study, from which the TRDB derives, were:

1. Blunt trauma mechanism
2. Abbreviated Injury Scale (AIS) severity score >2 outside the head region
3. Emergency department (ED) arrival <6 h from time of injury
4. Systolic blood pressure (SBP) < 90 mm Hg or BD > 6 mEq/L (prehospital or within 60 min of arrival)
5. Blood transfusion within 12 h of injury
6. Intact cervical spinal cord

Table 1 – Study population characteristics.

	Total	Survivors	Nonsurvivors	P value
Demographics	1829	1540	289	
Age, y (mean ± SD)	42.8 ± 18.7	41.4 ± 17.8	50.4 ± 21.6	<0.00001
Gender (males, %)	66.6	66.5	67.1	0.83
Race (%)				
White	77.3	77.3	76.8	0.31
Black	6.2	6.4	5.2	
Hispanic	12.0	12.1	11.4	
Other	4.6	4.2	6.6	
Blunt mechanism (%)				0.23
Motor vehicle crash	53.4	53.3	54.0	
Pedestrian struck	16.1	15.3	20.4	
Motor cycle crash	15.0	15.5	12.8	
Fall	8.6	9.0	6.6	
Other	4.4	4.5	4.2	
Assault	2.4	2.5	2.1	
Initial parameters (mean ± SD)				
Head AIS > 3	22.9%	21.3%	31.5%	<0.0002
Initial GCS	8.4 ± 5.6	8.8 ± 5.6	6.4 ± 5.1	<0.00001
Lowest ED SBP (mm Hg)	84.0 ± 23.9	86.0 ± 22.9	73.7 ± 26.2	<0.00001
ISS	38.9 ± 14.0	37.7 ± 13.5	45.2 ± 15.1	<0.00001
APACHE II	29.1 ± 7.2	27.9 ± 6.7	35.4 ± 6.2	<0.00001
Initial BD (mEq/L)	8.81 ± 4.80	8.45 ± 4.38	10.75 ± 6.10	<0.00001
Initial lactate (mmol/L)	4.57 ± 2.86	4.20 ± 2.48	6.54 ± 3.78	<0.00001

SD = standard deviation.

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