# Serum Lactate is Not a Useful Predictor of Injury in Blunt Trauma Patients

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Biomarkers can be used as adjuncts to clinical decision making in the Emergency Department (ED) (e.g., troponin[1] or D-dimer levels[2]). Serum lactate levels have been used in conjunction with clinical criteria to risk stratify and manage patients at risk of sepsis, and there has been an interest in establishing a similar role of acidosis (base deficit) and lactate levels in trauma care.[3,4] Lactate predicts mortality in trauma and pre-hospital lactate may be beneficial in determining triage to trauma centers.[5] However, it is unknown if lactate may be used as a surrogate marker for injury and whether it might be useful as a decision aid in determining which patients might benefit from whole body computed tomography (WBCT).

Injury detection in the trauma patient is of paramount importance as early detection and intervention decreases morbidity and mortality.[6] Computed tomography (CT) imaging is one method used to identify the acute injury in blunt trauma patients. This modality is not without risk for the patient, and these risks include but are not limited to radiation exposure and increased costs.[7,8] There have been multiple attempts to enhance this reduction in imaging with the development of clinical criteria.[9,10] However, there remains some controversy surrounding both the development and execution of clinical criteria and determining who would benefit most from CT imaging based on these criteria.[11] Although some progress has been made in the decrease of radiation associated with CT, the risk of adverse effects from radiation is still present and is patently greater when using whole-body computed tomography (WBCT) than targeted imaging.[9] We hypothesized that serum lactate elevation, a marker of anaerobic glycolysis and tissue hypo-perfusion[12] could be a marker for visceral or bony injury in ED trauma patients, and that lack of this elevation is correlated with negative WBCT.

We evaluated the sensitivity and specificity of elevated blood lactate in predicting patients who will have acute traumatic findings on WBCT. We conducted a retrospective electronic health record (EHR) review of ED visits and trauma team activations for blunt trauma during a one-year period from January 1, 2016–December 31, 2017. The study was conducted at a large, urban, academic Level-1 trauma center. Participants were adults who had both a serum lactate and WBCT imaging during their initial trauma evaluation (n=1035), WBCT and lactate are standard practice at the study institution for those with the highest level of trauma team activation, "Level A" (e.g., serious mechanism, unstable vital signs) and lower levels of trauma team activation with clinical suspicion for serious injury, "Level B or "C."

Data were extracted electronically (e.g., demographics, laboratory values, WBCT). WBCT findings were categorized based on the presence of any acute intrathoracic, intrabdominal, intracranial injury or fracture based on the radiologist final interpretation. We calculated measures of association and receiver operating characteristic curve analysis between lactate levels and findings on CT.

**Table 1** displays demographic and trauma characteristics for those with and without acute findings on WBCT. This population comprised 64.3% of those receiving WBCT compared to 35.7% of those with lower graded trauma, the majority of whom had positive findings on imaging 68.9%. Among those patients with a positive finding on WBCT mean lactate was 3.0 (SD ± 2.1) compared to a mean lactate of 2.5 (SD ± 2.2) among those a negative finding on WBCT (p=0.0047).

Although there was a significant difference between mean lactate levels in patients with and without positive WBCT findings (2.5 (SD ± 2.2) vs. 3.0 (SD ± 2.1)), we failed to identify a clinically useful cut-off that might indicate the need for advanced imaging. While levels >=2.5 were associated with the presence of acute injury, this value was neither sensitive nor specific in this population (46.3% and 66%, respectively (**Table 2**). **Figure 1** displays an ROC curve generated using the continuous values (0.4–17.1 mEq/L) for the lactate levels. The area under the curve (AUC) was 0.594 (95% CI: 0.55-0.63; Figure 1). Utilizing a higher cutoff (≥4 mEq/L) improved the specificity (87.6%), but also had poor utility as a screening with a sensitivity of 20.0% (+LR of 1.6, –LR of 0.91).

It should be noted that these findings may not generalize to other settings and populations. Additionally, we did not differentiate by severity of injury or injury scores (e.g., AIS, ISS). It is also notable that there was a high admission rate among patients with negative WBCT, likely indicated concomitant medical diagnoses. The presence of an acute medical conditions could confound the association between elevated lactates and injury findings on CT.

Though higher lactate levels are more specific for acute finding, the poor sensitivity makes this biomarker a weak-screening test for identifying ED trauma patients who may need imaging. There is still a need to identify other screening tests (e.g., biomarkers, clinical decision aids) to reduce unnecessary imaging. Unfortunately, these findings suggest that researchers and clinicians will need to look beyond lactate levels.

**Table 1.** Demographic characteristics of among those patients with negative and positive whole-body imaging.

| | Negative WBCT | Positive WBCT | P value |
|---|---|---|---|
| **Age**, m (± SD) | 53.4 (21.4) | 53.5 (22.0) | 0.9009 |
| **Gender**, n (%) | | | 0.086 |
| Male | 161 (63.6) | 543 (69.4) | |
| Female | 92 (36.4) | 239 (30.6) | |
| **Race**, n (%) | | | 0.806 |
| White | 200 (79.1) | 607 (78.3) | |
| Non-white | 53 (21.0) | 168 (21.9) | |
| **Language**, n (%) | | | 0.622 |
| English | 223 (88.1) | 698 (89.3) | |
| Other | 30 (11.9) | 84 (10.7) | |
| **Trauma Level** | | | 0.0001 |
| Level A | 129 (54.6) | 487 (65.8) | |
| Level B | 26 (11.0) | 98 (13.2) | |
| Level C | 81 (34.3) | 155 (21.0) | |
| **Trauma Type** | | | 0.001 |
| MVC | 61 (24.2) | 285 (36.5) | |
| Fall | 142 (56.4) | 345 (44.1) | |
| Assault | 7 (2.8) | 36 (4.6) | |
| Other | 42 (16.7) | 116 (14.8) | |
| **Disposition**, n (%) | | | 0.0001 |
| Admitted | 88 (35.3) | 54 (6.9) | |
| Discharged | 161 (64.7) | 725 (93.1) | |
| **Lactate** (mEq/L), m (± SD) | 2.5 (2.2) | 3.0 (2.1) | 0.0047 |

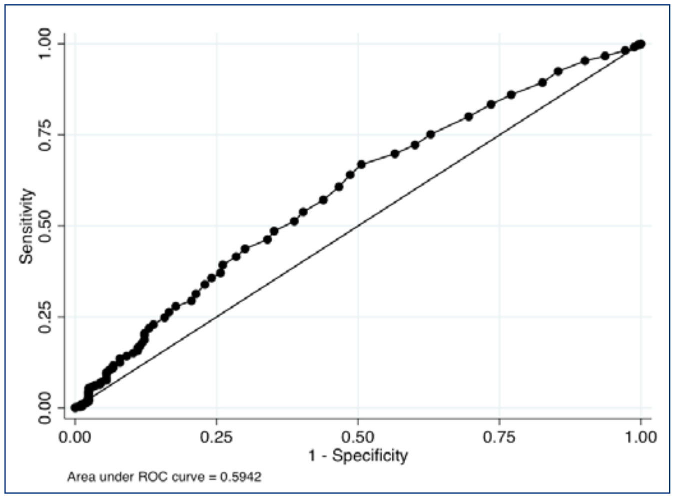
WBCT = Whole Body Computed Tomography
SD = standard deviation
MVC = motor vehicle collision
Trauma level: A = most severe criteria of injury, B = moderate, C = least severe

**Table 2.** Whole-body computed tomography findings (WBCT) and versus dichotomous lactate levels with associated test performance characteristics.

| | Lactate + (<2.5mEq/L) | Lactate – (>=2.5mEq/L) | Total |
|---|---|---|---|
| WBCT+ | 362 | 420 | 782 |
| WBCT– | 86 | 167 | 253 |
| **Total** | 448 | 587 | 1035 |
| | Sensitivity=46.3 | Specificity= 66 | |

WBCT = Whole Body Computed Tomography

**Figure 1.** Receiver operating characteristic (ROC) curve of continuous values of lactate levels among patients with negative and positive whole-body computed tomography.




## References


1. McCord J, Cabrera R, Lindahl B, et al. Prognostic Utility of a Modified HEART Score in Chest Pain Patients in the Emergency Department. *Circ Cardiovasc Qual Outcomes.* 2017;10(2):e003101.
2. Sethwala A, Wang X, Sturm EE, Collins KL, O'Donnabhain R, Friedman ND. Predictive value of symptoms, signs and biomarkers on computed tomography pulmonary angiogram results. *Intern Med J.* 2018;48(1):55-59.
3. Zingg T, Bhattacharya B, Maerz LL. Metabolic acidosis and the role of unmeasured anions in critical illness and injury. *J Surg Res.* 2018;224:5-17.
4. Raux M, Le Manach Y, Gauss T, et al. Comparison of the Prognostic Significance of Initial Blood Lactate and Base Deficit in Trauma Patients. *Anesthesiology.* 2017;126(3):522-533.
5. St John AE, McCoy AM, Moyes AG, Guyette FX, Bulger EM, Sayre MR. Prehospital Lactate Predicts Need for Resuscitative Care in Non-hypotensive Trauma Patients. *West J Emerg Med.* 2018;19(2):224-231.
6. Sharples A, Brohi K. Can clinical prediction tools predict the need for computed tomography in blunt abdominal? A systematic review. *Injury.* 2016;47(8):1811-1818.
7. Goodman TR, Mustafa A, Rowe E. Pediatric CT radiation exposure: where we were, and where we are now. *Pediatr Radiol.* 2019;49(4):469-478.

8. Bellolio MF, Bellew SD, Sangaralingham LR, et al. Access to primary care and computed tomography use in the emergency department. *BMC Health Serv Res.* 2018;18(1):154-154.
9. Davies RM, Scrimshire AB, Sweetman L, Anderton MJ, Holt EM. A decision tool for whole-body CT in major trauma that safely reduces unnecessary scanning and associated radiation risks: An initial exploratory analysis. *Injury.* 2016;47(1):43-49.
10. 1Bent C, Lee PS, Shen PY, Bang H, Bobinski M. Clinical scoring system may improve yield of head CT of non-trauma emergency department patients. *Emerg Radiol.* 2015;22(5):511-516.
11. Hussein W, Mullins PM, Alghamdi K, Sarani B, Pines JM. Trends in advanced computed tomography use for injured patients in United States emergency departments: 2007-2010. *Acad Emerg Med.* 2015;22(6):663-669.
12. Gladden LB. Lactate metabolism: a new paradigm for the third millennium. *J Physiol.* 2004;558(Pt 1):5-30.



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