



## KEY ADVANCES SUGGESTION FROM THE LITERATURE

# Demystifying Lactate in the Emergency Department

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**Why is this topic important?** Lactate is commonly used in the emergency department as a marker of resuscitation, to identify patients with occult hypoperfusion, and to provide prognostic information. Although lactate can be a useful tool when interpreted correctly, improper interpretation can mislead clinicians and result in inappropriate care and unnecessary therapies.

**How will this change my clinical practice?** Although lactate is commonly assumed to be a waste product that accumulates during times of hypoperfusion, leading to anaerobic metabolism, the role and production of lactate are more complex.

**Focus Point:** An elevated lactate does not always equate to tissue hypoperfusion and is associated with many conditions. Clinicians should determine whether the elevated lactate seems to be related to hypoperfusion, such as shock, arrest, or ischemic limb. If so, resuscitation should proceed while monitoring lactate levels for clearance. A repeat lactate is essential to know whether clearance is occurring. Alternative causes of hyperlactatemia, such as medications, liver failure, or carbon monoxide toxicity, should be sought.

### Background:

Despite a commonly held belief that elevated lactate levels in sepsis occur as a consequence of anaerobic metabolism from tissue malperfusion, evidence indicates that this may not be the primary source of lactate, particularly in patients without overt shock. (1) Lactate was previously assumed to be a waste product, but more recent studies have shown that lactate is actually an important metabolic substrate for energy production and oxidation/reduction reactions. (2) In fact, accelerated aerobic glycolysis from adrenergic stress is thought to be a significant cause of hyperlactatemia in sepsis, with additional contributions from impaired

clearance, medication effects, microcirculatory dysfunction, and tissue malperfusion.

The correlation between hypotension and lactate production is weak. However, elevated lactate levels and an inability to clear lactate are associated with a worse prognosis in many conditions, particularly sepsis, trauma, hemorrhage, shock, and cardiac arrest, even for patients without overt signs of shock. (3-5)

As such, when faced with a patient with hyperlactatemia, the emergency medicine physician should determine whether other signs of shock or hypoperfusion are present. (1) If so, the patient should be resuscitated as indicated. Repeat lactate levels are essential to monitor clearance. (6) If evidence of shock or hypoperfusion are not present, providing resuscitation, such as large volumes of intravenous (IV) fluids, will not necessarily improve outcomes, especially if elevated lactate is due to medications that affect mitochondrial function, such as metformin, or toxins, such as carbon monoxide and cyanide (Table 1).

This is level 5 evidence. (7)

**Table1.** Classification of elevated lactate (1).

| Type      | Cause                                                                          | Consideration                                                                                                                                                                                                                                                                                                                                    |
|-----------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>A</b>  | Lactate elevation due to poor tissue perfusion or hypoxia                      | Global: Any type of shock or profound hypotension, anemia, burns, cardiac arrest, carbon monoxide, cyanide, trauma<br><br>Regional: Compartment syndrome, limb ischemia, local trauma or burn, mesenteric ischemia, necrotizing soft tissue infection<br><br>Exertional: Convulsions, increased work of breathing, seizure, significant exercise |
| <b>B</b>  | Lactate elevation without clinical evidence of tissue hypoperfusion or hypoxia | ---                                                                                                                                                                                                                                                                                                                                              |
| <i>B1</i> | Lactate elevation due to underlying disease process                            | Ketoacidosis (alcoholic and diabetic), liver failure, malignancy, pheochromocytoma, renal insufficiency, sepsis, thiamine deficiency                                                                                                                                                                                                             |
| <i>B2</i> | Lactate elevation due to drug or toxin                                         | Acetaminophen, alcohol, b2-agonists (albuterol, epinephrine), carbon monoxide, cyanide, metformin, nucleoside reverse-transcriptase inhibitors, propofol, sympathomimetics, theophylline, toxic alcohols                                                                                                                                         |
| <i>B3</i> | Lactate elevation due to congenital errors of metabolism                       | Congenital mitochondriopathies, glucose-6-phosphatase deficiency, pyruvate carboxylase deficiency, pyruvate dehydrogenase deficiency                                                                                                                                                                                                             |

## References:

1. Wardi G, Brice J, Correia M, Liu D, Self M, Tainter C. Demystifying lactate in the emergency department. *Ann Emerg Med*. 2020;75(2):287-298. doi:10.1016/J.ANNEMERGEMED.2019.06.027 [https://www.annemergmed.com/article/S0196-0644\(19\)30537-2/fulltext](https://www.annemergmed.com/article/S0196-0644(19)30537-2/fulltext)
2. Brooks GA. Cell-cell and intracellular lactate shuttles. *J Physiol*. 2009;587(Pt 23):5591-5600. doi:10.1113/JPHYSIOL.2009.178350 <https://physoc.onlinelibrary.wiley.com/doi/full/10.1113/jphysiol.2009.178350>
3. Puskarich MA, Illich BM, Jones AE. Prognosis of emergency department patients with suspected infection and intermediate lactate levels: a systematic review. *J Crit Care*. 2014;29(3):334-339. doi:10.1016/J.JCRC.2013.12.017 <https://www.sciencedirect.com/science/article/abs/pii/S0883944114000021?via%3Dihub>
4. Baxter J, Cranfield KR, Clark G, Harris T, Bloom B, Gray. Do lactate levels in the emergency department predict outcome in adult trauma patients? A systematic review. *J Trauma Acute Care Surg*. 2016;81(3):555-566. doi:10.1097/TA.0000000000001156 [https://journals.lww.com/jtrauma/Abstract/2016/09000/Do\\_lactate\\_levels\\_in\\_the\\_emergency\\_department.21.aspx](https://journals.lww.com/jtrauma/Abstract/2016/09000/Do_lactate_levels_in_the_emergency_department.21.aspx)
5. Alshikh SM. Role of serum lactate as prognostic marker of mortality among emergency department patients with multiple conditions: a systematic review. *SAGE Open Med*. 2023 Jan 10;11:20503121221136401. doi: 10.1177/20503121221136401. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9834787/>
6. Yumoto T, Kuribara T, Yamada K, Sato T, Koba S, Tetsuhara K, Kashiura M, Sakuraya M. Clinical parameter-guided initial resuscitation in adult patients with septic shock: a systematic review and network meta-analysis. *Acute Med Surg*. 2023 Dec 26;10(1):e914. doi: 10.1002/ams2.914. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10750303/>
7. Oxford Centre for Evidence-Based Medicine: levels of evidence (March 2009). Centre for Evidence-Based Medicine. <https://www.cebm.ox.ac.uk/resources/levels-of-evidence/oxford-centre-for-evidence-based-medicine-levels-of-evidence-march-2009>

## Resources for Additional Learning:

[PulmCrit: Understanding Lactate in Sepsis & Using it to our Advantage](#)

[RebelEM: Andromeda-Shock: Peripheral Perfusion vs Serum Lactate in Septic Shock](#)

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