RADIOMETER

LACTATE

An important parameter at the point of care

OVERVIEW

Lactate measurements are widely used to monitor the effect of treatment in critically ill patients, as elevated lactate levels are associated with higher morbidity and mortality rates in this population [1,2]. Utilized early at the point of care (POC), lactate measurements can provide clinicians with important additional information to support critical treatment decisions [3,4].

LACTATE FACTS

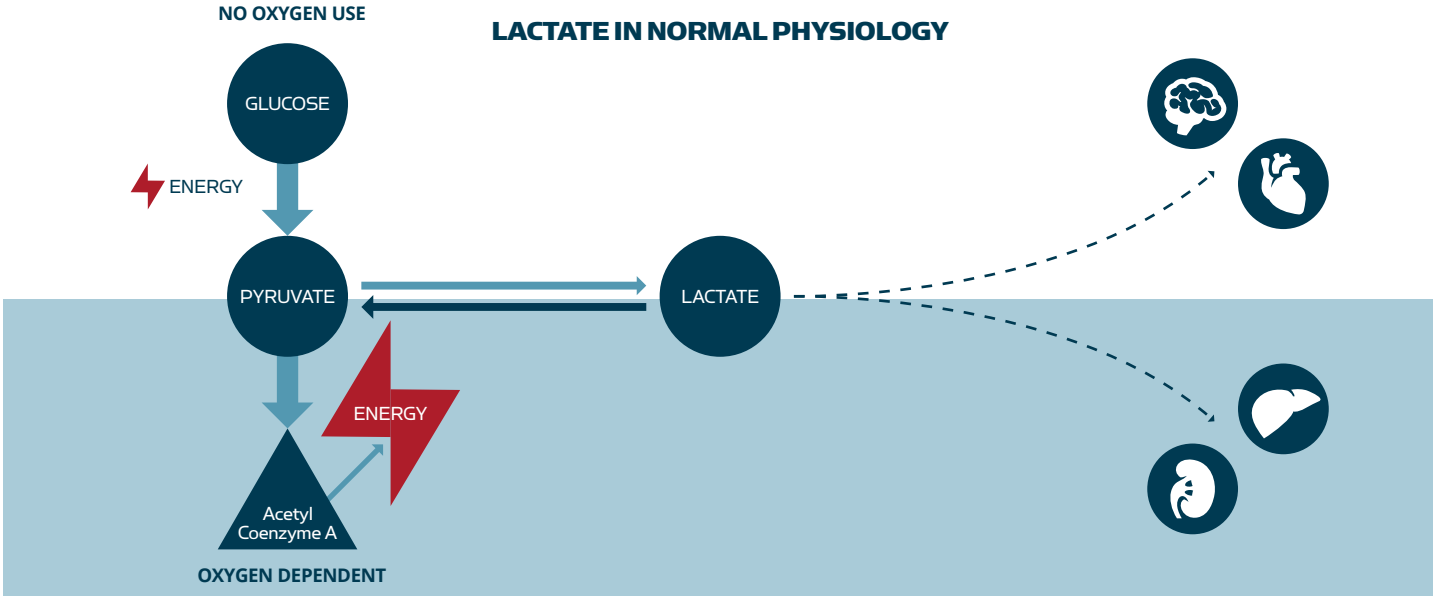
- **Produced at low levels in normal glucose metabolism [5]**
- **A sign of biological stress when elevated [6]**
- **> 2 mmol/L may indicate critical illness [3]**

LACTATE PHYSIOLOGY

ROLE OF LACTATE IN NORMAL PHYSIOLOGY

The body's cells produce energy by converting glucose into pyruvate, which is then converted into Acetyl Coenzyme A – the body's main energy source [5]. The last part of the process is oxygen dependent. When oxygen levels are insufficient, pyruvate is metabolized into lactate [5].

Excess lactate is normally reverted to glucose by the liver (gluconeogenesis), or via oxidation as a direct energy source for cells [6]. This makes lactate an important fuel molecule, enabling energy shuttling between tissues, especially from the muscles to the heart and brain [7].



LACTATE AS A SCREENING PARAMETER

Blood lactate measurements are commonly used to guide treatment at the point of care [8]. The normal concentration of lactate is around 0.6–1.4 mmol/L9 and levels increase upon biological stress. Hyperlactatemia is often an indicator of tissue hypoxia, as seen in patients with sepsis, but can also be present in patients with diabetes, liver disease, malignancies, intoxication, or inborn metabolic disorders [8,10].

In septic patients, a cut-off at 2 mmol/L can be used as indication of possible septic shock [11]. High lactate levels are also shown to be associated with worse outcomes in other patient groups admitted to emergency departments [8].

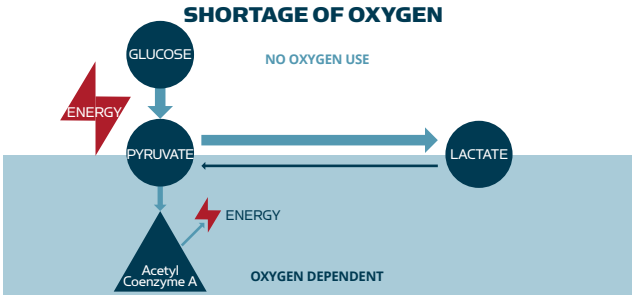
LACTATE IS RELEVANT IN:

- Sepsis / septic shock
- Trauma
- Liver disease
- Diabetes mellitus
- Malignancies
- Intoxications
- Inborn metabolic disorders

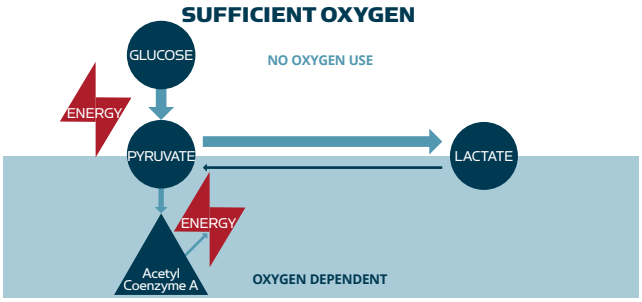
PATHOPHYSIOLOGY

ROLE OF LACTATE IN SEPSIS, TRAUMA AND SHOCK STATES

Elevated lactate is common in patients presenting in the emergency department with sepsis, trauma and other shock states [6,12].



Lactate concentration increases as physiological factors cause higher glucose-to-pyruvate and pyruvate-to-lactate conversion while reducing the capacity for lactate clearance [6,12].



High energy demand in shock states triggers higher glucose consumption, saturating the oxygen-dependent metabolism. Excess pyruvate is converted into lactate, despite sufficient oxygen supply [6, 12]

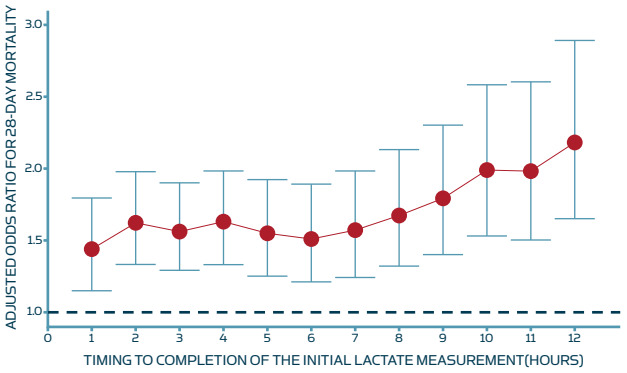
LACTATE AS A SCREENING PARAMETER IN SEPSIS

SUPPORTING TIMELY INTERVENTIONS AT THE POC

Sepsis is a leading cause of in-hospital death [4]. Measuring lactate aids in the management of sepsis and, because lactate levels correlate with disease severity, provides prognostic and monitoring value for patients with sepsis and septic shock [13]. The negative correlation between lactate level and prognosis is evident even at very high levels of lactate [14].

Early lactate measurement is associated with reduced mortality and better outcomes in septic patients, with a specific benefit seen when initial measurements are made within one hour of ICU admission, and repeated within three hours [4]. Lactate POC testing has been shown to provide fast and accurate results within recommended timeframes[15,16].

TIME MATTERS: EARLY LACTATE MEASUREMENTS ARE ASSOCIATED WITH REDUCED MORTALITY IN SEPTIC PATIENTS [4]



Adapted from Chen et al. Early lactate measurement is associated with better outcomes in septic patients with an elevated serum lactate level. Crit Care. 2019;23: 351

GUIDELINES ON LACTATE MEASUREMENT

Guidelines from the Surviving Sepsis Campaign (Hour-1 Bundle) and UK Sepsis Trust recommend measuring lactate within one hour of recognizing sepsis or septic shock, and remeasuring if lactate is elevated (> 2 mmol/l) [17, 18, 19]. The UK Sepsis Trust also recommends lactate measurement in prehospital screening, if available [19].

1. Vincent et al. The value of blood lactate kinetics in critically ill patients: a systematic review. *Crit Care.* 2017;20: 257. **2.** Mikkelsen ME, Miltiades AN, Gaieski DF et al. Serum lactate is associated with mortality in severe sepsis independent of organ failure and stock. *Crit Care.* Med 2009;37: 1670-77. **3.** Freund Y et al. Serum lactate and procalcitonin measurements in emergency room for the diagnosis and risk-stratification of patients with suspected infection. *Biomarkers.* 2012;17: 590-5. **4.** Chen et al. Early lactate measurement is associated with better outcomes in septic patients with an elevated serum lactate level. Crit Care. 2019;23: 351. **5.** Rabinowitz JD, Enerbäck S. Lactate: the ugly duckling of energy metabolism. *Nat Metab.* 2020; 2:566–571. **6.** Garcia-Alvarez M et al. Sepsis-associated hyperlactatemia. *Crit Care.* 2014;18: 503. **7.** Ferguson et al. Lactate metabolism: historical context, prior misinterpretations, and current understanding. *Eur J Appl Physiol.* 2018;118: 691–728. **8.** Nouland et al. Prognostic value of plasma lactate levels in a retrospective cohort presenting at a university hospital emergency department. 2017. *BMJ Open*;7:e011450. **9.** Burtis CA et al. *Tietz Textbook of Clinical Chemistry and Molecular Diagnostics.* London: Elsevier Health Sciences. 2012.**10.** Suetrong B, Walley KR. Lactic Acidosis in Sepsis: It's Not All Anaerobic: Implications for Diagnosis and Management. *Chest.* 2016;149(1):252-61. **11.** Singer M et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA.* 2016;315(8): 801–810. **12.** Kreymann et al. Oxygen consumption and resting metabolic rate in sepsis, sepsis syndrome, and septic shock. *Crit Care Med.* 1993;21(7):1 012-9. **13.** Dettmer MR et al. Sepsis-associated pulmonary complications in emergency department patients monitored with serial lactate: An observational cohort study. *J Crit Care.* 2015;30(6): 1163-1168. **14.** Haas SA et al. Severe hyperlactatemia, lactate clearance and mortality in unselected critically ill patients. *Int Care Med*;42: 202–210.**15.** Singer AJ et al. ED bedside point-of-care lactate in patients with suspected sepsis is associated with reduced time to iv fluids and mortality. *Am J Emerg Med.* 2014; 32, 9: 1120-1124. **16.** Tolan NV et al. Analytical performance of three whole blood point-of-care lactate devices compared to plasma lactate comparison methods and a flow-injection mass spectrometry method. *Clin Biochem.* 2017 Mar;50(4-5):168-173 **17.** Rhodes, A., Evans, L.E., Alhazzani, W. et al. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. *Int Care Med.* 2017;43: 304–377. **18.** Surviving Sepsis Campaign. Hour-1 Bundle: Initial resuscitation for sepsis and septic shock. *Society of Critical Care Medicine and the European Society of Intensive Care Medicine.* (2019). **19.** Daniels R et al. The sepsis manual. *The UK Sepsis Trust.* 2019.

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