Use of Lactate in Small Animal Clinical Practice

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KEYWORDS

• Lactate • L-Lactate • D-Lactate • Lactic acidosis • Hypoxia • Hypoperfusion • Metabolic acidosis

KEY POINTS

- Lactate concentration is used as an indicator of tissue hypoperfusion and hypoxia, particularly in critical care or perioperative settings.
- Lactate concentration is used to determine the severity of an underlying disorder, assess response to therapy, and predict outcome, especially if serial lactate levels are measured.
- Decreasing levels of lactate suggest improvement, whereas prolonged increases in lactate concentration imply deterioration with a poor prognosis.
- Repeated lactate concentrations should be determined on the same instrument with close attention to sample collection and processing and adherence to recommendations for instrument quality control.

INTRODUCTION

Lactate is formed primarily as the end product of anaerobic glycolysis, although small amounts are produced during aerobic metabolism. Hyperlactatemia refers to mildly increased lactate concentration without concurrent metabolic acidosis. Lactic acidosis occurs when hyperlactatemia is more severe and is accompanied by a decrease in blood pH.[1–3] Lactic acidosis occurs most commonly with tissue hypoperfusion and hypoxia, often as a consequence of systemic or regional hypoperfusion, severe anemia, or hypermetabolic states. Liver disease, kidney disease, diabetes mellitus, sepsis, drugs and toxins, and uncommon mitochondrial defects can cause lactic acidosis from various mechanisms including decreased aerobic metabolism and lactate consumption.[4]

In healthy adult dogs, serum lactate measures 0.3 to 2.5 mmol/L.[5] Puppies have higher lactate concentrations that decrease to adult values by 2 to 3 months of age.[6]

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Serum lactate in healthy adult cats is 0.5 to 2.0 mmol/L.[7] Indications for measuring serum lactate include assessment of tissue perfusion and oxygenation, predicting outcome or response to therapy in critically ill patients, and evaluation of metabolic acidosis. In people, serum lactate concentration has been used as a risk stratification biomarker.[8] Several studies in veterinary medicine indicate that lactate concentration may have similar implications for prognosis.[4,9–11] In dogs, 3 to 5 mmol/L is considered a mild increase; 5 to 8 mmol/L is considered a moderate increase, and greater than 8 mmol/L is considered a marked increase in blood lactate concentration.[12]

LACTATE PHYSIOLOGY AND METABOLISM

Under aerobic conditions, glucose is metabolized to pyruvic acid, which diffuses into mitochondria to enter the Krebs cycle and undergo oxidative phosphorylation for energy production or transformation in glucose via gluconeogenesis (Fig. 1). However, in red blood cells (RBC) and other cells that lack mitochondria, and in other tissues during periods of hypoxia, glucose is metabolized to pyruvic acid by anaerobic glycolysis. In the final step of anaerobic glycolysis, lactic acid dehydrogenase catalyzes the conversion of pyruvic acid to lactic acid, a reaction that favors lactic acid formation by a ratio of 10:1 during normal metabolism (Fig. 2).[8]

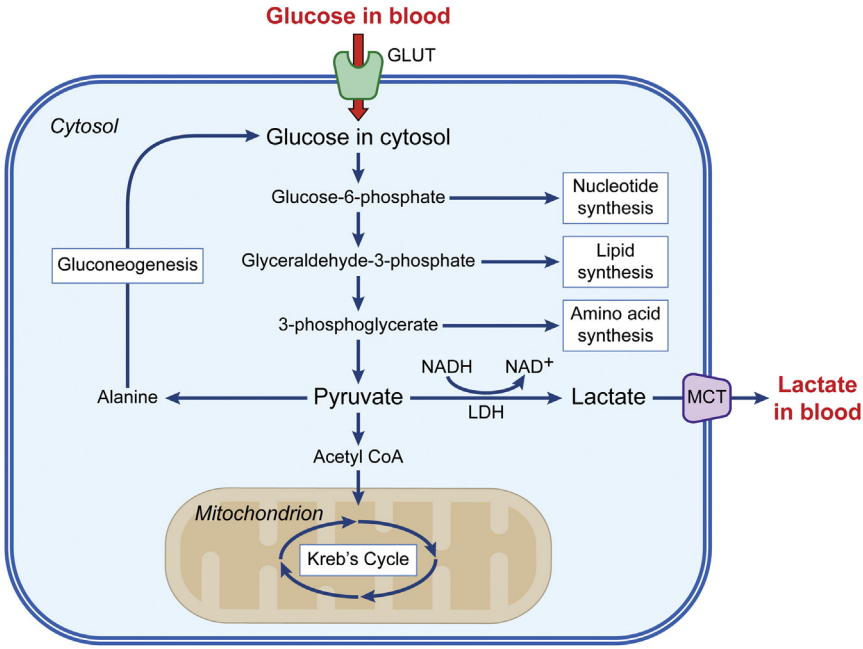

Fig. 1. Glucose metabolism. Glucose enters the cell via the GLUT family of membrane proteins. Glucose is metabolized through several steps (only some of which are shown in the diagram) to pyruvate. Pyruvate can be oxidized via the Kreb's cycle in the mitochondrion or transformed to glucose via the gluconeogenesis pathway. Pyruvate also can be converted to lactate via the enzyme lactate dehydrogenase (LDH), which generates nicotine adenine dinucleotide (NAD). This reaction occurs more readily when there is tissue hypoxia. Lactate in the cytoplasm crosses the cell membrane into the blood via a monocarboxylate-proton cotransporter (MCT), an anion exchange system, and simple diffusion.