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Blood lactate as prognostic marker in critically ill children: a problem related to production or clearance?

Ricardo Ronco*

The temporal evolution of blood lactate levels has been widely used as a prognostic marker in critically ill patients, especially in the unstable phase.

In the study published by Koliski et al.[1] in this issue of *Jornal de Pediatria*, blood lactate levels were serially measured in critically ill children admitted to the ICU during the first 48 hours. The children were divided into group A, with lactate levels ≥ to 18 mg/dl (2 mmol/l) (n = 50), and into group B, with lactate < 18 mg/dl (n = 25).

See related article on page 287

There are too few studies in children comparing objective hemodynamic or laboratory variables with physical examination. The current study shows a powerful and significant correlation between the clinical findings and the lactate level within the first six hours, where 60% of the children with high lactate levels had some sign of hypoperfusion. However, after these six hours, no difference was observed between the groups and the clinical findings. Seemingly, physical examination is a moderately sensitive parameter for investigating overt lactic acidosis, despite its arguable specificity.

There was a significant difference in plasma glucose levels on admission, with mean levels of 181 mg/dl in group A, versus 128 mg/dl in group B (p = 0.01). This was the only difference found in the lab tests. There are two possible explanations for this difference. On the one hand, the more critical state of health of group A patients may explain the higher blood glucose levels, but on the other hand, glucose is a substrate that can facilitate lactate formation under anaerobic conditions. It would be interesting to find out the relationship between hyperglycemia, as an independent factor, and lactate, under anaerobic conditions in another group of patients.

As shown in the study conducted by Dr. Koliski with postoperative children with congenital heart disease submitted to extracorporeal circulation, initial lactate levels were mostly high. In this case, it is the maintenance of these high levels over time, instead of initial levels, that should make us suspect of a poor prognosis, leading to changes in our therapy.

Mortality rates amounted to 30% (15/50) in group A and to 12% (3/25) in group B (p=0.14). Thus, the patients who died within the first 24 hours had presented with significantly higher initial lactate levels than those who died after 24 hours of admission (lactate level of 95 mg/dl on admission versus 28 mg/dl). By using logistic regression, a lactate level equal to 27 mg/dl (3 mmol/l) within the 24 hours of treatment had the best sensitivity (55.6%) and specificity (97.2%) for predicting mortality.

The study does not determine whether the poor prognosis occurs due to the overproduction of lactate or because of its inadequate use.

Arterial blood levels of lactate are determined by its production and clearance.

Lactate production depends on the transformation of pyruvate, which is formed via the glycolytic pathway and by amino acids, mainly alanine, into lactate through lactate dehydrogenase. The lactate/pyruvate ratio reflects the oxidation-reduction potential of cytosol. The normal ratio is 10-15:1. In case of tissue hypoperfusion, the lactate/pyruvate ratio increases. However, in critically ill patients, elevation of blood lactate levels is not explained only by hypoxia. For example, pyruvate/dehydrogenase, which transfers pyruvate into the Krebs cycle, may be inhibited by endotoxin. In this case, the elevation in the lactate level will not be secondary to hypoxemia, but to a rise in pyruvate,

* Chief of the pediatric ICU, Clínica Alemã de Santiago. Professor, Universidad del Desarrollo, Santiago, Chile.

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and the L/P ratio will not increase.[2] Some drugs, such as oral hypoglycemics, ethanes, catecholamines, and beta-2 bronchodilators, elevate blood lactate levels without causing tissue hypoxia. There are probably two types of hyperlactatemia in stable patients with a very different prognostic significance: hyperlactatemia secondary to aerobic overproduction, with a good prognosis, or a "true" hyperlactatemia caused by the inadequate use or insufficient clearance of lactate, with a poor prognosis. As demonstrated by Dr. Koliski in her study, high lactate level was initially a good predictor of death, but only in the initial phase of instability, during the first 24 hours, and not later, when higher stability was achieved. This fact concurs with that which was published by Levy et al.,[3] where initial lactate levels were not different between survivors and those who died after 24 hours. De Backer & Creteur[4] reported that hyperlactatemia in septic adults was equivalent between survivors and those who died immediately after stabilization. It has also been described that septic patients with normal lactate levels may or may not develop complications, that is, normal lactate levels may not have a prognostic value. Another point of view is that some septic patients show normal lactate levels because the low production of lactate is offset by its poor clearance.

Despite the fact that the study carried out by Dr. Koliski investigated a heterogeneous population, it revealed that initially high lactate levels are an important marker for severity. In some situations, they may be more specific than usual macrohemodynamic measurements.[5]

References

1. Koliski A, Cat I, Giraldi DJ, Cat ML. Lactato sérico como marcador prognóstico em crianças gravemente doentes. J Pediatr (Rio J). 2005;81:287-92.
2. Mizock BA. Redox pairs, tissue hypoxia, organ dysfunction and mortality. Crit Care Med. 2000;28:270-2.
3. Levy B, Saudone L. Evolution of lactate/pyruvate and ketone body ratios in the early course of catecholamine-treated septic shock. Crit Care Med. 2000;28:114-19.
4. De Backer D, Creteur J. The hepatoesplachnic area is not a common source of lactate in patients with severe sepsis. Crit Care Med. 2001;29:256-1.
5. Ronco R, Rodríguez J, Castillo A. Intragastric tonometry outcome predictor and monitoring utility in pediatric shock [abstract]. Pediatr Chil J. 1998;69:60-4.

Continuous glucose monitoring: a practice that should be explored

Durval Damiani *

Despite some divergence, most diabetologists have always known that glucose control is extremely important to guarantee the integrity of several tissues, organs and systems of the human body. However, it was only in 1993, with the conclusion of a large research study with diabetic patients, known as the Diabetes Control and Complications Trial (DCCT),[1] that it became clear that glucose control in diabetes mellitus (DM) was one of the key factors to avoid medium- and long-term complications.

See related article on page 293

Several insulin delivery systems were developed in an attempt to mimic what the body usually does, that is, to deliver insulin every time we eat something. The fact that this should occur at the right place (pancreatic islets that provide insulin to the liver first), at the right time and at the right amount, makes the attempt to reproduce in diabetic patients what occurs in nondiabetic ones a reasonably complicated task. In a continuous monitoring study with healthy volunteers, glucose levels oscillated from 46 to 118, showing how masterful the glucose control system has to be in order to maintain an appropriate "metabolic environment" and to avoid complications caused by protein glycation.[2] Today, we use the so-called intensive management of DM, a method that aims to maintain patients with insulin administration during 24 hours, using higher doses of ultrafast insulin at meal times. However, intensive management is synonymous with intensive control of glucose levels, unless we decide to "fly without instruments!"

Monitoring methods have been improved, requiring smaller amounts of blood and delivering results within a shorter time. There are noninvasive methods, which determine interstitial glucose levels, and sensors that allow continuous monitoring for a given period of time. This

* Full professor, Pediatric Endocrinology Unit, Instituto da Criança do Hospital das Clínicas, Universidade de São Paulo (USP), São Paulo, SP, Brazil.

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