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Independent Study Project – Blog Post

Lactated Ringer's Influence On The Lactate Laboratory Test: A Beautiful Mystery No Longer

A flag on the patient tracking board in the ED suddenly goes off. The classic constellation of signs of low blood pressure, compensatory tachycardia, fever, with a significantly elevated white count as well as abnormally high lactate level was just recognized and classified as sepsis. Every physician has been trained to systematically approach sepsis by casting a wide net to identify the infectious pathogen and its location. However, one important question remains ever elusive in the process of managing the detrimental systemic inflammatory response syndrome associated with sepsis:

When I'm resuscitating my patient with a fluid bolus, which fluid should I use?

Here at Jefferson, our sepsis order set in the emergency room defaults to 0.9% normal saline or, simply, "NS." This fluid has an osmolality of approximately 286 mOsm/L which is on the high end of normal for blood osmolality, achieving this by containing osmoles of only two of the electrolyte constituents of blood. Nationally, normal saline is commonly utilized for fluid resuscitation both in general and for sepsis. However, that might not always be the right choice for every patient. There is a steadily building stock of evidence suggesting that normal saline fluid resuscitation can lead to both increased mortality rate and kidney injury. Specifically, the hyperchloremic metabolic acidosis caused by the higher than physiologic concentration of sodium chloride in normal saline. Hyperchloremia has been shown to lead to afferent arteriole constriction thereby reducing renal perfusion and the overall glomerular filtration rate. This is a bitter pill to swallow when the kidneys are already struggling with the distributive shock of sepsis.

In contrast, there is a common alternative to normal saline, the famed Lactated Ringer's balanced solution ("LR") of electrolytes utilized for the very same purpose: fluid resuscitation in general and sepsis. The most immediately obvious benefit of LR is its close approximation of the electrolyte balance of plasma by including approximately 130 mmol/L of sodium, 109 mmol/L of chloride, 28 mmol/L of lactate, 4 mmol/L of potassium, and 1.5 mmol/L of calcium with an overall osmolality of 273 mOsm/L, in the middle of the normal range of osmolality for blood.

So, Lactated Ringer's solution closely approximates blood in some ways! Wow. Why the hesitation to use it, especially in the setting of sepsis?

Basically, it comes down to the choice of including lactate in this crystalloid solution. Even at rest, humans have a baseline rate of anaerobic metabolism that generates lactate. This capability at rest means we have an additional buffer for the acids in the blood and an energy production capability that can be tapped in moments of physiological stress like the anaerobic microvascular environments that occur during sepsis. Unfortunately, lactate is utilized as a biomarker for sepsis. So, there's a concern that infusions of Lactated Ringers can throw off this lab result. However, we are indeed fortunate because this is more

myth than reality. The lactate generated endogenously by the human is produced in the form of lactic acid -- what is actually being tested. In contrast, sodium lactate found in Lactated Ringer's solution does not tend to combine with hydrogen *in vivo* and has not been demonstrated to skew the laboratory test that is colloquially termed "lactate test" because blood is carefully maintained in a pH range that does not drive a shift in the chemical equilibrium that would drive the lactate in LR to become lactic acid. Rest easy knowing that you have options when fluid resuscitating septic patients from members of the crystalloid class of intravenous fluids.

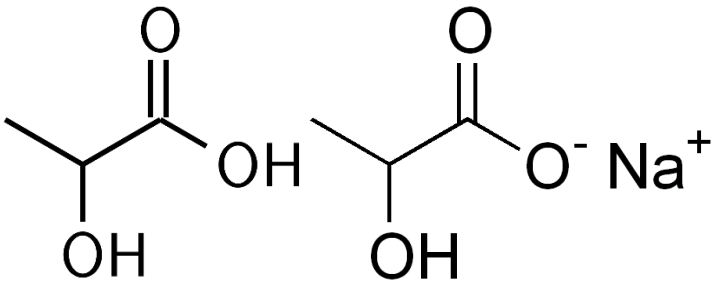

Figure 1: Lactic acid (right) vs. sodium lactate (left).

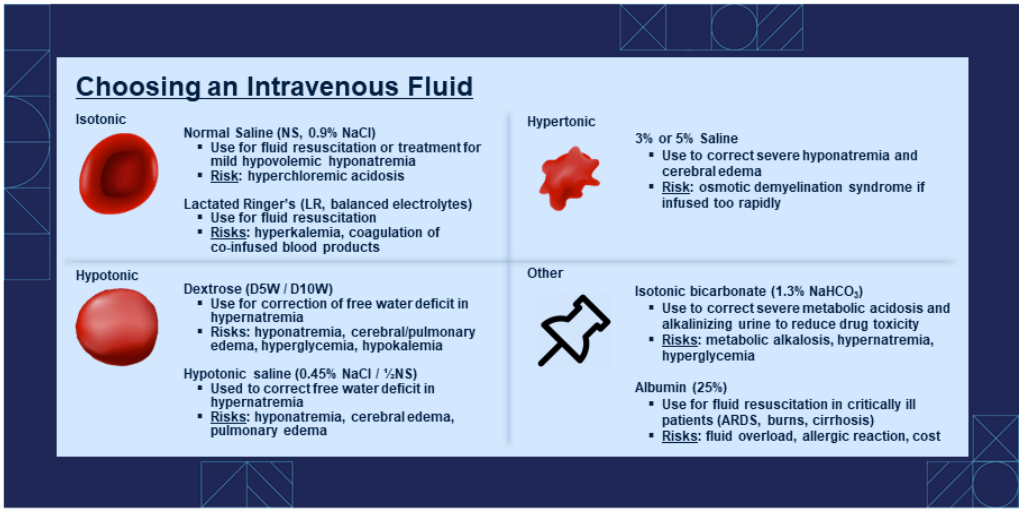

Figure 2: An incredible summarizing resource for students becoming familiar with the wonderful world of intravenous fluids.

Sources:

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