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Journal Club

P: In patients with lactic acidosis

I: Does the addition of bicarbonate

C: Compared to routine resuscitative care

O: Improve morbidity /mortality/ acidemia

Three part question

In [patients with lactic acidosis] does [bicarbonate therapy] improve [mortality]?

Clinical scenario

A 52 yo male is septic and maxed out on two pressors. MAP is still less than 65. PH is 7.2. You wonder if bicarbonate therapy will improve mortality in this patient.

Search strategy

Medline 1966-10/2006 using the Pubmed interface.

"lactic acidosis"[Title] AND bicarbonate[Title] AND English[lang] AND "humans"[MeSH Terms]

Search outcome

22 papers found of which 18 were irrelevant to the study question.

Relevant papers

Author, date and country	Patient group	Study type (level of evidence)	Outcomes	Key results	Study weaknesses
Nielsen H, et al 2002 Denmark	9 healthy young males with exercise induced lactic acidosis	Randomized single- blinded cross over study	serum HCO ₃ , pCO ₂ , blood and intracellular pH, and lactate	↑'d serum HCO ₃ , pCO ₂ , arterial pH, and venous lactate; No further ↓ in intracellular pH	NaHCO ₃ infusion started before acidosis, healthy, hand exercises
Mark N, et al 1993 USA	40 CAD patients w/ mild lactic acidosis during surgery	Prospective double-blind randomized trial	pH, serum bicarb, pCO ₂ , pO ₂ , lactate, cardiac indices	↑'d arterial pH, serum bicarb, and pCO ₂ ; no effect on cardiac indices or total body oxygen use	Mild metabolic acidosis (HCO ₃ ↓ >3mM)
Mathieu D, et al 1991 France	10 patients with metabolic acidosis (lactate >2.45, bicarb <22)	Prospective randomized blinded crossover study	pH, serum HCO ₃ , pCO ₂ , Na, lactate, Hgb affinity for O ₂ cardiac indices, 2,3-DPG, tissue oxygenation, osmolaltiy	↑'d pH, serum HCO ₃ , and pCO ₂ ; ↓'d VO ₂ ; No improvement in hemodynamic variables but did not worsen tissue oxygenation	Only measured up to 60 min after infusion, hemodynamically stabilized before the study
Cooper D, et al 1990 Canada	14 patients with severe metabolic acidosis, 13 on pressors	Prospective randomized blinded crossover study	pH, serum HCO ₃ , pCO ₂ , iCa, PCWP, CO, MAP, hemodynamic response	↑'d pH, serum HCO ₃ , pCO ₂ ; ↓'d iCa; ↑'d PCWP, CO, but no more than NaCl	Hemodynamically stabilized before the study, only a 2 hour study period
Forsythe & Schmidt 2000 USA	Reviewed the literature to answer several questions about bicarbonate for the treatment of lactic acidosis	Review Article	Is low pH bad?	Animal studies inconsistent at showing acidotic effect on contractility	The authors do not condone the use of NaHCO ₃ to treat lactic acidosis, regardless of the degree of academia, due to lack of evidence to support its use.
			Can NaHCO ₃ raise pH in vivo?	Raises blood pH, but inconsistent results regarding intracellular pH.	
			Does NaHCO ₃ and its ↑pH have any salutary effects?	No controlled study has ever demonstrated this.	
			Does NaHCO ₃ have negative side effects?	Potential ones have been identified, but clinical relevance is uncertain.	

Comment(s)

No studies have been done comparing mortality in patients treated with sodium bicarbonate for lactic acidosis. The studies looked at in this review analyze physiologic markers in intubated patients (with the exception of the hand study). There haven't been any human studies done that show a worse outcome in patients treated with sodium bicarbonate for lactic acidosis. In all studies, sodium bicarbonate increased the serum pH to physiologic levels, but there was no clear-cut benefit other than treating a number. Even pressor dependent patients with severe acidosis did not show improved hemodynamic response to bicarbonate, challenging the common theory that pressors will not work in severe acidosis and bicarb is therefore warranted. Many more studies have been conducted with animals than humans. However, these studies are variable in results and do not have any conclusive findings and have not been consistently reproducible. More human studies need to be conducted comparing clinically significant outcomes in patients treated with sodium bicarbonate (ie mortality, ICU length of stay, etc).

Clinical bottom line

Bicarbonate has not been shown to decrease mortality. It does increase pH, however, and no human studies have been able to consistently show a clinically significant downside to its use.

References

1. Nielson H, et al. Bicarbonate attenuates intracellular acidosis. *Acta Anaesthesiol Scand* 2002;46:579-84.
2. Mark N, et al. Safety of low-dose intraoperative bicarbonate therapy: A prospective, double-blind, randomized study. *Crit Care Med* 1993;21(5):659-65.
3. Mathieu D. Effects of bicarbonate therapy on hemodynamics and tissue oxygenation in patients with lactic acidosis: A prospective, controlled clinical study. *Crit Care Med* 1991;19(11):1352-56.
4. Cooper D, et al. Bicarbonate does not improve hemodynamics in critically ill patients who have lactic acidosis. *Ann Int Med* 1990;112:492-98.
5. Forsythe S, Schmidt G. Sodium bicarbonate for the treatment of lactic acidosis. *Chest* 2000;117:260-67.