

Sodium Acetate as an Alkalinizing Agent for Salicylate Intoxication: A Case Report

Steven F Groke*, Daniel H Jarrell, Christopher J Edwards, Peter B Chase, Mark J Murphy and Frank G Walter

Department of Emergency Medicine, University of Arizona, Tucson, AZ, USA

*Correspondence author: Steven F Groke, Department of Emergency Medicine, University of Arizona Tucson, AZ, USA, Tel: 801-718-8919 E-mail: StevenGroke@cep.com

Received date: Feb 16, 2015; Accepted date: Mar 18, 2015; Published date: Mar 21, 2015

Copyright: © 2015 Groke FS, et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Abstract

Background: Urine and serum alkalinization with sodium bicarbonate (NaHCO_3) is the initial treatment for salicylate toxicity. Due to medication shortages, sufficient quantities of NaHCO_3 may not be available and alternative treatments may be needed.

Case Report: This is an observational case report of a man who presented with chronic, inadvertent aspirin intoxication. Initially, we used a NaHCO_3 continuous intravenous (IV) infusion until the hospital ran out of NaHCO_3 . Thereafter, the NaHCO_3 IV infusion was replaced with a sodium acetate (SA) continuous IV infusion.

"Why should an emergency physician be aware of this?" Sodium acetate's role in serum and urine alkalinization for drug intoxications is not well understood. Physiologically, SA is converted to acetyl-coA and processed through the Krebs cycle, producing CO_2 and later bicarbonate via carbonic anhydrase. In severe salicylism, key enzymes of the Krebs cycle are inhibited, ultimately forming lactate and preventing the conversion of SA to bicarbonate. We hypothesize that in our patient, the Krebs cycle continued to function as evidenced by the normal lactate level, suggesting a mild to moderate degree of chronic salicylate toxicity. At such levels, SA appears to be an effective means of serum and urine alkalinization.

Keywords: Alkalinization; Aspirin; Acetylsalicylic acid; Poisoning; Drug toxicity

Introduction

Urine and serum alkalinization with sodium bicarbonate (NaHCO_3) is a treatment of choice for salicylate toxicity. During this era of medication shortages, sufficient quantities of NaHCO_3 may not be available. Our objective was to achieve urine and serum alkalinization in a salicylate poisoned patient with a NaHCO_3 and then a sodium acetate (SA) continuous intravenous (IV) infusion.

Case Report

This is an observational case report of a 57-year-old male with a history of worsening chronic headaches who presented with chronic, inadvertent aspirin toxicity after increasing his home use of aspirin. No other forms of acetylsalicylic acid was ingested. He presented to the emergency department with a complaint of shortness of breath and

bloody stools. On exam, his vitals included: B/P 147/100, HR 129, RR 30, temperature was 36.3°F, and 100% on room air. He was nontoxic, yet found to be extremely tachypneic, and experiencing diffuse abdominal tenderness without peritoneal signs. There was bright red blood on rectal exam. Significant lab values are included in the Table 1. Additionally, the patient's venous lactate was normal (0.9 mMol/L). The lactate level was not repeated during the hospital course.

Due to the concern for salicylate toxicity, 3 amps of NaHCO_3 (50 mEq/amp) were added to 1 L of 5% dextrose in water (D5W) and given at 200 mL/h until the hospital ran low on NaHCO_3 . Thereafter, the NaHCO_3 continuous IV infusion was replaced with a SA continuous IV infusion (75 mEq/L of SA in D5W at 250 mL/h). Intravenous potassium supplementation occurred throughout the NaHCO_3 and SA infusions to promote urine alkalinization. Lab results improved and the SA continuous intravenous infusion was discontinued (Table 1). The patient's gastrointestinal bleed resolved, and the patient recovered uneventfully.

Hospital Day	Time	Event	Serum	Venous	Plasma	Urine
			Salicylate Level (mcg/mL)	Blood Gas pH	Bicarbonate Level (mMol/L)	pH
1	1300	Initial Labs	484	7.33	11	5
1	2033	After 4 hours of Sodium bicarbonate	Not Done	Not Done	11	5

2	100	Sodium	311	7.39	13	Not Done
		bicarbonate infusion continues				
2	600	Ending of	238	Not Done	19	Not Done
		Sodium				
		bicarbonate infusion				
2	1200	After 4	97	7.48	22	7.5
		Hours of Sodium acetate				

Table 1: Chronological review of labs during the infusion therapy of Sodium bicarbonate and Sodium Acetate.

Discussion

Fluid resuscitation with alkalinized fluids is the first-line treatment for moderate salicylate poisoning and should be initiated early in the treatment course [1,2] SA has long been used to alkalinize parenteral nutrition and has been shown to be as effective as NaHCO_3 as a source of fixed base as early as the 1940s in a healthy canine model [3]. The ability of 300 mMol of acetate to generate 257 mMol of bicarbonate in healthy volunteers has been described previously [4]. In this same study, sodium acetate significantly raised plasma bicarbonate concentrations, increased urinary bicarbonate excretion, and increased serum Ph [4]. SA has also been shown to be as effective as lactate and a viable alternative to NaHCO_3 for the resuscitation of metabolic acidosis secondary to cholera [5]. Furthermore, it has been shown to be as effective as NaHCO_3 for the correction uremic acidosis, even in the presence of liver dysfunction [6]. The safety of SA as a resuscitative fluid to prevent hyperchloremic metabolic acidosis in the management of critically ill trauma patients has also been demonstrated [7].

Despite SA's utility in a variety of clinical conditions and its efficacy in providing a form of free base, its role in serum and urine alkalization for drug intoxications is not well described in the literature. Osterhoudt et al. just published an abstract describing a case series of four pediatric patients in whom SA was successfully substituted for NaHCO_3 in various poisonings, including one salicylate intoxication [8]. Physiologically, SA is converted to acetyl-CoA and processed through the Krebs cycle, producing CO_2 and later bicarbonate via carbonic anhydrase. In severe salicylism, uncoupling of oxidative phosphorylation occurs and key enzymes of the Krebs cycle are inhibited, ultimately forming lactate and preventing the conversion of SA to bicarbonate [9,10]. Specifically, salicylates have the ability to sequester acetyl-CoA and inhibit alpha-ketoglutarate dehydrogenase as well as succinate dehydrogenase. Theoretically, salicylates could decrease the body's ability to utilize acetate as an acetyl-CoA precursor, preventing the formation of bicarbonate from acetate. We hypothesize that in our patient, the Krebs cycle continued to function as evidenced by the normal lactate level, suggesting a mild to moderate degree of chronic salicylate toxicity. At such levels, SA appears to be an effective means of serum and urine alkalization.

“Why Should an Emergency Physician be Aware of This?”

Our patient may be a select case, and it is unknown if all patients with mild, moderate, or severe salicylate intoxication would benefit from the use of SA. Theoretically, severe salicylism may inhibit key metabolic pathways that allow SA to be converted to free base in the form of NaHCO_3 . It is unknown if providing SA in these situations would be beneficial. Until medication shortages of sodium bicarbonate are resolved, this alternative treatment warrants further study with the hypothesis that sodium acetate can be substituted for sodium bicarbonate in select poisoning cases, when necessary.

References

- Brooks DE, Levine M, O'Connor AD, French RN, Curry SC (2011) Toxicology in the ICU: Part 2: specific toxins. *Chest* 140: 1072-1085.
- O'Malley GF (2007) Emergency department management of the salicylate-poisoned patient. *Emerg Med Clin North Am* 25: 333-346.
- MUDGE GH, MANNING JA, GILMAN A (1949) Sodium acetate as a source of fixed base. *Proc Soc Exp Biol Med* 71: 136-138.
- Burnier P, Tappy L, Jéquier E, Schneeberger D, Chioléro R (1992) Metabolic and respiratory effects of infused sodium acetate in healthy human subjects. *Am J Physiol* 263: R1271-1276.
- Watten RH, Gutman RA, Fresh JW (1969) Comparison of acetate, lactate, and bicarbonate in treating the acidosis of cholera. *Lancet* 2: 512-514.
- Eliahou HE, Feng PH, Weinberg U, Iaina A, Reisin E (1970) Acetate and bicarbonate in the correction of uraemic acidosis. *Br Med J* 4: 399-401.
- McCague A, Dermendjieva M, Hutchinson R, Wong DT, Dao N (2011) Sodium acetate infusion in critically ill trauma patients for hyperchloremic acidosis. *Scand J Trauma Resusc Emerg Med* 19: 24.
- Osterhoudt K, Trella J, Henretig F. Sodium acetate substitution for sodium bicarbonate in pediatric poisoning: a case series (abstract). *Clin Toxicol* 2013; 51(7): 592.
- Nulton-Persson AC, Szveda LI, Sadek HA (2004) Inhibition of cardiac mitochondrial respiration by salicylic acid and acetylsalicylate. *J Cardiovasc Pharmacol* 44: 591-595.
- Mogilevskaya E, Demin O, Goryanin I (2006) Kinetic model of mitochondrial Krebs cycle: unraveling the mechanism of salicylate hepatotoxic effects. *J Biol Phys* 32: 245-271.