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

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Abstract

Background: Urine and serum alkalization 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 alkalization 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 alkalization.

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

Introduction

Urine and serum alkalization 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 alkalization 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 intoxication 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$_3$ IV infusion was replaced with a sodium acetate (SA) continuous intravenous (IV) infusion. 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.

<table>
<thead>
<tr>
<th>Hospital Day</th>
<th>Time</th>
<th>Event</th>
<th>Serum Salicylate Level (mcg/mL)</th>
<th>Venous Blood Gas pH</th>
<th>Plasma Bicarbonate Level (mMol/L)</th>
<th>Urine pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1300</td>
<td>Initial Labs</td>
<td>648</td>
<td>7.33</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td>2033</td>
<td>After 4 hours of Sodium bicarbonate</td>
<td>Not Done</td>
<td>Not Done</td>
<td>11</td>
<td>5</td>
</tr>
</tbody>
</table>
Discussion

Fluid resuscitation with alkalized 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 alkalize parenteral nutrition and has been shown to be as effective as NaHCO₃ 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 NaHCO₃ for the resuscitation of metabolic acidosis secondary to cholera [5]. Furthermore, it has been shown to be as effective as NaHCO₃ for the correction of metabolic 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 NaHCO₃ in various poisonings, including one salicylate intoxication [8]. Physiologically, SA is converted to acetyl-CoA and processed through the Krebs cycle, producing CO₂ 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.

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

<table>
<thead>
<tr>
<th>Hours of Sodium acetate</th>
<th>Sodium bicarbonate infusion continues</th>
<th>Sodium bicarbonate infusion</th>
<th>Not Done</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>100</td>
<td>311</td>
<td>7.39</td>
</tr>
<tr>
<td>2</td>
<td>Ending of Sodium bicarbonate infusion</td>
<td>238</td>
<td>Not Done</td>
</tr>
<tr>
<td>2</td>
<td>After 4</td>
<td>97</td>
<td>7.48</td>
</tr>
</tbody>
</table>

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 NaHCO₃. 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