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Breaking Bad Delirium: Methamphetamine and Boric Acid Toxicity with Hallucinations and Pseudosepsis

Kayla Johnson, PharmD, BS, Joanna L. Stollings, PharmD, BCPS, and E. Wesley Ely, MD, MPH

Lipscomb University College of Pharmacy, the Department of Pharmaceutical Services, Vanderbilt University Medical Center, and the Division of Allergy/Pulmonary and Critical Care Medicine, Vanderbilt University School of Medicine, Nashville, Tennessee

Abstract

Objectives—A 30-year-old patient presented with hallucinations and profound shock. He was initially misdiagnosed as having severe sepsis; once ingestions were considered, he was diagnosed as potentially having arsenic toxicity.

Summary—The clinical story reveals many instructional lessons that could aid in the evaluation and management of future patients. This man presented with large amounts of blue crystals around his nose and lips from inhaling and eating boric acid (an ant poison) so he could, as he put it, kill the ants “pouring into my mouth and nose and up into my brain.” His profound pseudosepsis and sustained delirium were induced by co-ingestion of methamphetamine and a large quantity of boric acid. Delirium is a form of acute brain dysfunction that often is multifactorial in critical illness and, when seen in septic shock, is associated with prolonged mechanical ventilation, increased length of hospital stay, medical costs, higher mortality, and long-term cognitive impairment resembling dementia. Pseudosepsis is a noninfectious condition most commonly seen with ingestions such as salicylate (aspirin) toxicity.

Conclusions—This report emphasizes the need to recognize agents that contain boric acid as an etiology of unexplained delirium and profound shock.

Keywords

methamphetamine; boric acid; delirium; pseudosepsis

Case Report

Two hours after presentation, a 30-year-old white man was transferred from a 25-bed, acute care hospital to the emergency department and then to the medical intensive care unit

Correspondence to Dr Joanna L. Stollings, 1211 Medical Center Dr, BUH-131, Nashville, TN 37232. joanna.stollings@vanderbilt.edu. To purchase a single copy of this article, visit sma.org/smj-home. To purchase larger reprint quantities, please contact reprints@wolterskluwer.com.

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(MICU) of a tertiary medical facility with a presumptive diagnosis of mental status changes resulting from sepsis. The patient had no personal medical, surgical, or family medical history; home medications; or drug allergies. His social history was significant only for documented methamphetamine intravenous (IV) drug use. Vital signs at the outside facility were significant for fever of 38.7°C, tachycardia with a maximum pulse rate of 134 bpm, maximum respiratory rate of 24 breaths per minute, and blood pressure of 130/103 mm Hg. Pertinent laboratory values included 3.2×10^3 white blood cells per microliter, serum creatinine of 1.8 mg/dL, creatinine kinase of 260 U/L, and aspartate transaminase/alanine transaminase of 183/303 U/L. The patient had one episode of red-tinged emesis, diarrhea, and displayed acute agitation. He received a 2.6-L bolus of normal saline for the treatment of hypotension, a lorazepam 2-mg IV push for agitation, and 1 g ceftriaxone because fever resulting from infection was suspected.

Hospital Course

MICU Service Comment—Admission

The patient's urine drug screen was positive for amphetamines, acetaminophen, and salicylates, with follow-up toxicology panels showing undetectable acetaminophen and salicylates levels. The patient met the severe sepsis criteria (tachycardiac at 115 bpm, hypotensive at 78/39 mm Hg, tachypneic at 27 breaths per minute, 12.8×10^3 white blood cells per microliter, and lactic acid of 3.1 mg/dL). Upon examination, the patient was oriented only to person and blue crystals were present around his mouth and nares. The differential diagnosis included endocarditis, bacteremia, pneumonia, central nervous system infection, and pseudosepsis, based on the patient's history of IV drug use. The patient received fluid resuscitation and ceftriaxone and required vasopressors.

Psychiatry Service Comment—Day 1

The patient expressed suicidal ideation and continued to exhibit paranoia, altered mental status, and agitation as assessed by the Richmond Agitation Sedation Scale (RASS, a scale used to measure sedation or agitation levels),¹ with scores of 1 to 3, and was positive for delirium via the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU), a validated tool used to assess for the presence of delirium).² Upon obtaining further history from the authorities and his friends, it was determined that the patient had been transported by police to an outside facility after an injection of methamphetamine had left him having profound hallucinations of ants crawling on his skin and up into his nose. As a result, he began to ingest ant killer orally and nasally in order to rid himself of the imaginary bugs. The boric acid package was labeled as "ant killer" and the patient had reached for these crystals during his vivid hallucinations.

Toxicology Service Comment—Day 2

Based on the reports by police officers and friends of ant poison ingestion, arsenic seemed to be the most likely cause of the patient's symptoms because the ant killer being sold on the market uses this ingredient as the toxic agent in the formula. Other than arsenic, ant killer formulas on the market use boric acid salts as the toxic agent of choice. These formulations typically are sold as a powder that can degrade into blue crystals.

MICU Service Comment—Day 2

The progression of the sepsis caused the team to reconsider ingestions as playing a role in the patient's presentation. The influence of recently watching an episode of the television series *Breaking Bad* and seeing Walter White's "crystal blue" methamphetamine led us to investigate the possibility of toxicity from the patient's ingesting both methamphetamine (his urine drug screen had been positive) and arsenic, as recommended by the toxicology team. It was noted, however, that arsenic containing ant killer presents as white crystals in appearance.³

Psychiatry Service Comment—Day 2

The patient admitted to attempting suicide via methamphetamine injection and having hallucinations about ants "pouring into my mouth and nose and up into my brain." During the previous 2 days, he received a total of 18 mg of lorazepam, 10 mg of haloperidol, and 10 mg of olanzapine, for RASS scores of 1 to 3. The patient remained positive for delirium as assessed by the CAM-ICU. During the course of the patient's hospital stay, signs and symptoms of sepsis continued to be displayed; however, all cultures and viral panels remained negative for infection. The patient continued to display hemodynamic improvement each day. Although the agitation did resolve, he continued to experience altered mental status changes, with RASS scores of -1 to -2 and remained positive for delirium as assessed by the CAM-ICU. On day 3, the patient was transferred to a ward bed but one-to-one observation was continued because of his persistent altered mental status and intermittent delirium. On day 4, he was deemed medically and mentally stable and transferred to an inpatient psychiatric facility because symptoms of major depressive disorder persisted.

Discussion

Methamphetamine is a highly addictive, illicit substance that works on the reward system of the brain by activating the dopaminergic system and inhibiting the movement of dopamine from the synaptic cleft into storage vesicles. Methamphetamine has a 10- to 12-hour-long half-life, and clinical signs of acute use include hypertension, fever, tachycardia, and tachypnea. Long-term use may lead to "binge" episodes in which the consumer uses a dose every few hours to overcome tolerance and can result in psychiatric manifestations.^{4,5}

Boric acid is a weak acid and one of the most common formulations of boron. It has been used as a topical bacteriostatic compound for antimicrobial therapy to treat conditions such as vulvovaginal candidiasis and is easily absorbed through the gastrointestinal tract, nonintact skin, and serious dental cavities. Boric acid was withdrawn from the market over concerns of toxicity; however, it is still a common ingredient in household pesticides and ant repellants in products such as plant fertilizer, household cleaners, and human and animal insect repellants. Boric acid is a source of both acute and fatal ingestions in children and adults.^{6,7} One case series of 784 acute ingestions determined the urinary elimination half-life of boric acid to be up to 28 hours.⁸ Another case report of boric acid toxicity found that blue-green vomiting and stools were observed.⁹

Common signs and symptoms of methamphetamine and boric acid ingestion are listed in the Table. To our knowledge, no reports exist of this combination of methamphetamine and boric acid ingestion followed by delirium and shock.

The main teaching point about this case report is that exposure to boric acid, whether by inadvertent exposure through using it as a pesticide or by intentional ingestion, presents the risk of toxicity including profound delirium and hypotension, mimicking sepsis. In a patient such as ours, the entire spectrum of adverse clinical manifestations is possible, including intense and lasting organ dysfunction and profound cardiovascular instability. It is not possible to know how much of our patient's brain organ dysfunction (delirium) was the result of the methamphetamine or the boric acid, because they were both likely culprits. Obviously, the former (methamphetamine) is the more well-known psychoactive agent, but in this case, the severe hypotension (contributed to by boric acid and catecholamine depletion) was a huge exacerbating risk factor for the patient's ongoing delirium.

Because numerous articles have been written about methamphetamine toxicity during the current epidemic of its use in our society, we focus our discussion on the patient's ingestion of boric acid crystals. The primary route of excretion is through the kidneys as an unchanged compound; however, small amounts also are excreted into the sweat, saliva, and feces. Boric acid is found to concentrate in two primary sites in the body, the brain and the liver,¹⁰ and it is an ingredient still commonly found in household pesticides, with up to a 99% concentration in the powder formulations used to kill insects.⁴ Boron has an unknown mechanism of toxicity when ingested, with acute poisoning usually affecting the renal, neurological, and gastrointestinal systems as a result of local tissue irritation.^{10,11} Dermal involvement occurs primarily through an intense generalized erythroderma that can be most noticeable on the palms, soles, and buttocks. Around the same time of dermal involvement, central nervous system effects begin to manifest in the form of seizures, delirium, or coma.^{10,11} Delirium has been associated with long-term cognitive impairment, prolonged mechanical ventilation, increased hospital stays, increased medical costs, and higher mortality rates.^{12–18} Although each of these adverse events has been documented in case reports, the mechanism of action has not been elucidated.

In a review of 784 cases of boric acid exposure, the most common symptoms upon presentation were vomiting, abdominal pain, and diarrhea.^A Blue-green vomit and stools are possible but were not reported in the review. This case series also determined the urinary elimination half-life to be as long as 28 hours compared with methamphetamine's half-life of up to 12 hours.^{5,8} There is no specific treatment for boric acid poisoning and our patient did not receive any treatment other than supportive care. Documented methods used for the treatment of boric acid overdose include forced urinary alkalization and hemodialysis, which can be used to decrease boric acid levels in the body with no, partial, or complete success.¹⁹ Because boric acid is eliminated renally, therapies offering support to maintain or increase urine output are the current methods of treatment.²⁰ One case report²¹ presented an option for forced diuresis with furosemide and IV fluids in a patient who had previously attempted suicide via boric acid ingestion that was treated with hemodialysis. The patient received 100

^AReference needed for the sentence beginning "In a review of 784 cases."

mg of furosemide and 3.25 L of IV fluid during a 4-hour period in an ICU. Both blood and urine concentrations were measured, and an elimination rate similar to that of dialysis was obtained. The patient was sent to a general floor for observation and remained there for 64 hours.²¹

Based on the Naranjo scale, a scale used to assess the likelihood of an adverse event occurring from a specific medication or device, the probability of these adverse events occurring from boric acid and methamphetamine consumption rates are probable, with a score of 7 out of 10.²²

Conclusions

Our patient, who had profound organ dysfunction mimicking severe sepsis (ie, pseudosepsis) after combined ingestion of methamphetamine and boric acid, presented with an initially confusing clinical picture that renders multiple take-home teaching points. Clinicians, especially those in areas of high pesticide and methamphetamine use, should be aware of the possibility of induction of psychological changes that can occur following ingestion of either or both of these compounds. Our report emphasizes the need to recognize agents that contain boric acid and the appropriate treatment following ingestion. Furthermore, clinicians should be aware of a profound hyperactive delirium as a consequence of boric acid overdose.

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Key Points

- Many household agents contain boric acid and this should be recognized when considering toxic ingestions.
- Clinicians, especially those practicing in areas of high pesticide and methamphetamine use, should be aware of the possibility of the induction of psychological changes that can occur following ingestion of methamphetamine or boric acid.
- Boric acid toxicity should be considered in the differential diagnosis when a patient presents with unexplained delirium and sepsis.

Table

Clinical manifestations of methamphetamine and boric acid overdose

Signs and symptoms	Methamphetamine	Boric acid
Seizures	–	+
Delirium	+	+
Coma	+	+
Agitation	+	–
Hallucinations	+	–
Hyperpyrexia	+	+
Cyanosis	–	+
Tachypnea	+	–
Hypotension	–	+
Hypertension	+	–
Tachycardia	+	–
Palpitations	+	–
Shock	+	+
Acute kidney injury	+	+
Abdominal pain	–	+
Vomiting	–	+
Diarrhea	–	+
Blue-green emesis/stools	–	+
Rash	–	+
Metabolic acidosis	+	+
Pseudosepsis	–	– ^a
Rhabdomyolysis	+	–

^a Although boric acid specifically has not been associated with pseudosepsis, other boron-containing compounds have been reported to induce sepsis.⁷