Case Report

Pediatric Fatality from Gun Bluing Solution: The Need for a Chemical Equivalent of the One-Pill-Can-Kill List†

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† *Presented as a short case in the lecture entitled "Unique Poisonings in Developing Country" at the Asian Congress of Emergency Medicine meeting at Centara Grand Hotel, Bangkok, Thailand on July 3rd, 2011*
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Gun bluing solution is commonly used to polish guns and prevent rusting. The authors report a case of a 2-year-old boy who inadvertently ingested approximately 15 ml of his father's Fox Gun Blue solution. The patient subsequently developed acidosis, hypotension, and coma. He died within four hours after ingestion. His plasma selenium level was 857 ng/ml. A brief review of other reported ingestion of gun bluing liquid in both adults and children is also included.

Keywords: *Gun Blue, Selenius acid, Fatal ingestion*

J Med Assoc Thai 2012; 95 (6): 821-4
Full text. e-Journal: *http://jmat.mat.or.th*

In 1993, an article was published in the former Journal of Toxicology Clinical Toxicology called *Medication Which Can Kill a Toddler with One Table or Teaspoon* which detailed medications that can cause fatality with the ingestion of one pill or one swallow in a 10-kg child[1]. The article had since been updated and several other similar publications regarding the lethal thread that medications posed to young children had followed, which included the more 'updated' pharmaceuticals such as the SSRIs and synthetic opioids[2] (Table 1). This led to the increased awareness on the part of physicians and parents in offsetting such tragedies. Unfortunately, no such list had been compiled for chemicals, whether household or industrial, which when otherwise present in the environment of children, had been shown to cause significant morbidity and mortality with one gulp or swallow. The authors hereby report such a case, an accidental ingestion of a little-known chemical, Fox Gun Blue™ solution, which resulted in the death of a child.

Case Report

A 1-year-11-month-old Thai male ingested approximately 10 ml Fox Gun Blue™ solution (Fig. 1). His father stated that he had decanted the solution from its original container into an empty M-150™ energy drink bottle, to be used as copper polish. The workspace was on the first floor of their home and that morning the patient had been playing around in the area.

At 10:30, the patient took a drink from the bottle, thinking that it contained the original M-150 sports drink, which he had been allowed to drink from time to time. His older brother immediately told his father what happened. Subsequently, the patient vomited 10 times and was taken to the emergency room in a private hospital. There, his vital signs were blood pressure 90/60 mmHg and oxygen saturation 100%. He was noted to be slightly lethargic. The physician suspected hydrocarbon ingestion and referred the patient to Siriraj Hospital for further management.

At 11:00, the patient arrived at Siriraj Hospital Emergency Department. He was noted to be drowsy but responsive. His vital signs were body temperature

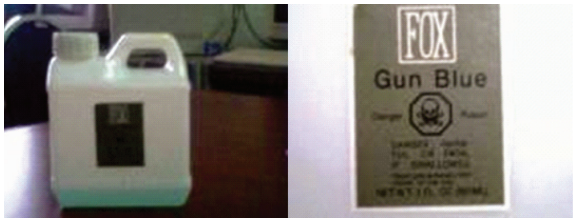

Fig. 1 The original container of Fox™ Gun Blue

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Table 1. Literature review of pediatric gun-bluing liquid ingestion cases

Reference	Amount ingested	Circumstances	Symptoms/signs	Serum selenium level in ng/ml	Outcome
2 year old[4]	15 ml	In a cup	Vomiting/garlic-odor breath/abdominal distention/coma	285 (5 hrs after ingestion)	Died 17 days after ingestion
2 year old[12]	11 ml "Klever Schnellbrfimierung™"		Hypersalivation, vomiting, diarrhea, muscle spasm	1,580	Full recovery
22 month old[13]	15 ml		Hypotension Desaturation Cardiopulmonary arrest	30,000	Died upon arrival to the emergency room
23-month-old (our case)	Fox™ Gun Blue 1 gulp	M-150 energy drink bottle	Hypotension Metabolic acidosis Desaturation Cardiopulmonary arrest	857	Died 2 hours and 20 minutes after ingestion
24-year-old male	2 oz. of G-96 Instant Gun Blue	Suicide	EKG-non-specific ST-Twave changes, prolong QTc Sudden cyanosis and CP arrest	30,000	Died 3 hours after ingestion

36°C, heart rate 150 bpm, respiratory rate of 38 per minute, blood pressure 101/57 mmHg, and oxygen saturation was 99% on room air. He was noted to have questionable central cyanosis. At that time, the Siriraj Poison Center was consulted and the treating physician was informed that gun blue solution could contain high amounts of both selenius acid and copper sulfate (POISINDEX™ 2007). The physician was advised to have 5% methylene blue by the bedside in the case that the cyanosis worsened.

At 11:35, intravenous hydration was started and patient was moved to the inpatient ward.

At 11:58, the patient arrived at the inpatient ward and the initial blood pressure was 90/35 mmHg and the heart rate was 150 bpm. Oxygen saturation was 88% on room air. Patient was placed on 100% oxygen non-rebreather mask and normal saline 10 ml/kg rapid bolus was given. The patient became increasingly lethargic, with worsening oxygen saturation.

At 12:30, positive pressure ventilation was started, with subsequent endotracheal tube placement. At that time, the blood pressure was 50/21 mmHg with heart rate of 80 bpm. Methemoglobinemia was suspected and methylene blue was administered empirically. Cardiopulmonary resuscitation was initiated. At that time, the results of serum electrolytes sent from the emergency room became available.

Serum electrolyte results

Sodium 134 mEq/L, potassium 3.9 mEq/L, chloride 105 mEq/L, bicarbonate 11 mEq/L, total calcium 9.3 mEq/L, ionized calcium 4.3 mEq/L, magnesium 1.9 mEq/L

Patient became asystolic but cardiopulmonary resuscitation continued for a total of 1½ hours with no sustained improvement.

At 14:20, 3 hours and 50 minutes after the initial ingestion, the patient was pronounced dead.

The plasma selenius acid level obtained pre-mortem was 857 ng/ml (0.04-0.6 ng/ml). Methemoglobin level was 0%. The pH of Fox Gun Blue™ solution was 8.7.

Discussion

Acute selenium toxicity can occur after an ingestion of any number of selenium-containing inorganic salts such as sodium selenate, sodium selenite, hydrogen selenide, selenic acid and the most toxic form, selenous acid. Elemental and Organic selenium compound, however, do not cause acute toxic(3). Bluing is a process whereby a chemical is

applied to the metal surface to help the metal resist rust or corrosion. Composition of gun-bluing solution can vary from copper sulfate or nitrate to nitric acid[4]. However, it invariable will contain seleneus acid, which can cause oxidation of metals such as steel, bronze, or brass to give a dark-colored finish[5]. Our patient's father had been using the solution on a bronze Buddha he was polishing.

Most cases of selenium toxicity in humans have been results of overdose of dietary supplements and commonly occur in adults[6-9]. So far, in the literature, there have been six cases of acute selenium toxicity from gun bluing solution. Of these, four, including our case, are reports of children[4,7,10-13]. Of these, three cases resulted in mortality. Clinically, these cases exhibit some striking similarity in their clinical presentation. The onset of symptoms is rapid and characterized by incessant vomiting, abdominal pain, and profound metabolic acidosis. Death ensues within three hours of ingestion in the presented case and within three and four hours in two other reports. However, in the case report by Nantel, the patient died of respiratory failure 17 days after the initial exposure. It is worth noting, however, that the presented patient received aggressive circulatory and ventilation support that included extracorporeal membrane oxygenation. Details of each case are provided in Table 1[8,12,13].

Normal whole blood selenium is 0.1-0.34 ng/ml and 0.04-0.6 ng/ml in plasma[3]. There seems to be a relationship between plasma level and clinical severity. Among the mortality cases, measured selenium levels range from 285 ng/ml in the case where the patient survives for 17 days, to 30,000 ng/ml where the patient dies upon arrival to the hospital.

These four case reports involving pediatric fatal ingestion of gun bluing liquid illustrate the quintessential features of pediatric toxic ingestion. Typically, only one substance is involved and the amount of ingestion is small. The fact that the chemicals have been either inappropriately stored in food containers or not kept out of reach of children contributes to the likelihood of accidental ingestion. The amounts ingested are usually within 1 to 2 dosing units (1 or 2 teaspoon), which could easily be accounted for by just one swallow by a 10-kg child. However, unlike the majority of pediatric accidental ingestions where the patients are either asymptomatic or mildly symptomatic, the small-amount-yet-lethal nature of this chemical have resulted in significant morbidities and mortalities. Fortunately, fatal drug or chemical ingestions are exceptions rather than rules, even in a developing country such as Thailand. Thus far, Siriraj Poison Control Center, the one of only two 24-hour poison consultation services in Thailand, has seen very few deaths in children. While a list of medications that can cause fatality in a 10-kg child with one tablet or teaspoon can be extensive, no such list exists for chemicals. Table 2 shows a list of drugs and chemicals reported to the Siriraj Poison Center that have resulted in death in children younger than five years of age.

Table 2. Drugs and chemicals which, when ingested in small amount, have been known to cause fatality in Thai children. The data is compiled from Siriraj Poison Center and personal communication with toxicologists in Thailand

Medications	Chemicals/toxins
Quinidine	Cyanide (silver polish solution)
Propanolol	Cyanogenic compound (Casava)
Methadone	Organophosphate
Methyl salicylate (oil of winter green)	Gun-bluing solution Amanita phalloides mushroom

Conclusion

The present report illustrates the need for a chemical equivalent of a one-pill-can-kill list that can be made available to parents and health care professionals in order to raise the awareness regarding chemical safety in the homes. Emergency physicians working with acutely poisoned children need to be aware of the deadly nature of such ingestion in order to initiate timely clinical observation and intervention.

Potential conflicts of interest

None.

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จุฬธิดา โฉมฉาย, ธนกร ศิริสมุทร, อุไรวรรณ ศิลปศุภกรวงศ์

กรดซีลีเนียมเป็นส่วนผสมของน้ำยาขัดปืนและมีการใช้ขัดโลหะอื่น ๆ เพื่อป้องกันการเกิดสนิม เด็กชายวัย 2 ปี ดื่มน้ำยาขัดปืนยี่ห้อ Fox™ ประมาณ 15 มิลลิลิตร โดยไม่ได้ตั้งใจ ผู้ป่วยมีปัญหา acidosis และต่อมามีความดันโลหิตต่ำและเกิดอาการโคม่า เสียชีวิตภายใน 4 ชั่วโมงหลังกิน ระดับซีลีเนียมในพลาสมาก่อนเสียชีวิตเท่ากับ 857 นาโนกรัม/มิลลิลิตร น้ำยาขัดปืนมีกรด selenious ซึ่งเป็นรูปแบบซีลีเนียมที่เป็นพิษมากที่สุด โดยพบว่าเกิดอาการระบบไหลเวียนโลหิตล้มเหลวอย่างเฉียบพลันสามในสี่ของรายงานกรณีเด็กที่ตีพิมพ์จะมีการเสียชีวิต บทความนี้ทบทวนการรายงานอาการทางคลินิกของทั้งเด็กและผู้ใหญ่ที่กินน้ำยาขัดปืน และพยาธิสรีรวิทยาของกรด selenious ในร่างกาย