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Case Report

Dangerous games: Pool shock chemical burn to the face

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ABSTRACT

Today information about fascinating chemical reactions is readily available on the internet. Unfortunately, these experiments can have catastrophic consequences. Pool chemicals account for a significant number of injuries in the United States. Pool Shock (calcium hypochlorite) is a powder widely used to disinfect swimming pools and has the potential to cause injury, as described in previous studies. Here, we report a case of a young male patient with a superficial chemical burn to the face and eyes due to a combined explosion of Pool Shock and regular Coke in a bottle. This type of chemical burn secondary to this chemical combination has not been reported elsewhere. We discuss the chemistry involved in producing significant inadvertent blast injury and present the management to treat these cases.

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Case report

A 17-year-old Caucasian healthy male presented to the Emergency Department, complaining of burning sensation and irritation to his face and eyes four hours after sustaining a superficial chemical burn. The patient is a lifeguard at a swimming pool. He and his friends mixed a packet of Pool

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Figure 1. Patient on admission to the Burn Center (twelve hours post injury).

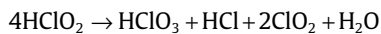
Shock (calcium hypochlorite) and regular Coke in a plastic bottle. The capped bottle exploded releasing the combination of fluid, pressurized vapor, and gas. At the nearest local emergency room, his eyes and face were irrigated with more than two liters of Ringer's Lactate. The pH of his conjunctivas was then measured with Litmus paper and found to be neutral. He was then transferred and admitted to our Burn Center intensive care unit twelve hours post injury (Figure 1). Although the patient reported some improvement with the water irrigation, he continued to suffer from blurry vision and burning sensation. Ophthalmologic evaluation revealed conjunctival injection and clear corneas. He was started on preservative free artificial tears every two hours and his facial wounds were treated with Bacitracin ointment. After twenty-four hours, the patient improved significantly and was discharged home with two weeks follow-up in clinic.

Discussion

Today information is easily available through the internet and social media. Our young generation is granted a great amount of information, including fascinating chemical reactions that could potentially endanger their own health and safety. Unfortunately, these chemical experiments found on the internet are reproduced at home and have the potential to cause catastrophic consequences.

Calcium hypochlorite $\text{Ca}(\text{ClO})_2$ is an inorganic anhydrous salt which is a white-crystalline granular solid with a strong smell of chlorine.¹ It is commercially available in a mixture with calcium carbonate

with different brand names including Swimming Pool Shock, BioGuard Smart Shock, and ProTeam Power Magic AC Shock. It is used as a water sanitizer, swimming pool cleaner, fungicide, algaecide, bleaching agent (paper and textiles), an ingredient of deodorants, and in sanitary installations. It is a strong oxidizing agent that can produce a violent reaction when mixed with glycols, ketoacids, and sugars. When it is combined with regular Coke (Coca-Cola), it produces a spectacular visible reaction (the so-called “volcano effect”) where the fluid increases temperature associated with gas liberation and fluid expansion. When the combination is kept in a closed container, like a capped plastic bottle, the internal pressure rises rapidly producing a potent blast of the container and splash of the mixture to the nearby area. The underlying reaction between the calcium hypochlorite and regular Coke is not well understood. However, it is hypothesized that the calcium hypochlorite interacts with phosphoric acid and carbonic acid. By gaining a proton from this acidic environment, the calcium hypochlorite becomes hypochlorous acid. Then, the protonated hypochlorite (hypochlorous acid) decomposes and produces chlorine dioxide, chloric and hydrochloric acids.^{2,3}



Calcium hypochlorite is also a strong oxidizing agent that reacts with sugar by adding oxygen groups through various oxidation pathways releasing carbon dioxide. Explosions seen on a YouTube video are probably caused by the rapid buildup of chlorine gas and CO₂ (from sugar oxidation) as well as water vapor, in addition to the increase of temperature of the mixture due to the exothermic reaction.

Hypochlorite is an alkaline substance that causes tissue damage by liquefaction necrosis. Fats and proteins are saponified, causing deep tissue destruction. Symptoms can be delayed for hours. Chlorine gas is extremely corrosive and irritating. Depending on the concentration, it can also cause severe reactive airway dysfunction syndrome (RADS) with airway constriction and pulmonary edema from five to twenty hours post exposure.⁴

Chemical burns to the face should be assessed as per the Advance Trauma Life Support protocol. The patient should be removed from the source and quickly assessed for a patent airway in order to ensure adequate respiration and pulse. However, medical personnel should be aware that an initial patent airway does not rule out airway involvement. Respiratory distress may present several hours after exposure. If trauma is suspected, cervical immobilization should be maintained manually until a cervical collar is placed and a full assessment is completed with images. Continuous irrigation of injured skin and eyes should be performed with crystalloid solutions for at least twenty minutes.^{1,5} It is important to check pH's of the conjunctiva every thirty minutes for two hours after irrigation is stopped. If the pH is not neutral, an irrigating contact lens should be used to allow continuous irrigation for several hours until the pH normalizes.

Conclusions

Strong oxidizers in combination with weak acids can create enough explosive energy to cause significant burn injuries. Efforts must be made to better educate our youth about the potential of these “home experiments” to cause harm. Pool chemical injuries account for up to 5000 visits a year to the emergency department across the U.S.⁶ Better advice on the safe handling of these chemicals must be displayed on the product to prevent pool shock chemical disasters.

Author contributions

LQ, MA, SE and JC cared for the patient. All authors contributed to writing this report. Written consent to publication was obtained.

Conflict of interest

None.

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