Orofacial and Digital Frostbite Caused by Inhalant Abuse

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Practice Points

- Inhalant abuse is a common problem among adolescents.
- Frostbite in a periorofacial and/or unilateral hand distribution should prompt the clinician to consider inhalant abuse.
- It is important to consider internal manifestations of inhalant abuse such as airway injury, electrolyte abnormalities, and cardiac dysrhythmias in inhalant users.

Inhalation of volatile substances is a cheap and accessible way for individuals, most commonly teenagers, to ingest mind-altering substances. The adverse effects of using inhalants, including cardiac dysrhythmia, respiratory tract injury, and asphyxiation, can be devastating. Detection often is difficult, but a high degree of suspicion with patterns of perioral, perinasal, and/or digital lesions can help identify use. We report an uncommon case of severe orofacial and digital frostbite initially mistaken for an allergic reaction in a 20-year-old man following intentional inhalation of a commercial air-dusting agent containing 1,1,1,2-tetrafluoroethane (HFC-134a).

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Inhalants are volatile substances with chemical vapors that can be inhaled to induce psychoactive or mind-altering effects.[1-4] Because of their accessibility and difficulty in detecting their use, inhalants are among the most commonly abused drugs by adolescents in the United States, second only to marijuana. In particular, inhalants are the most frequently reported illicit drug used among adolescents aged 12 to 13 years.[4] Fluorocarbons such as 1,1,1,2-tetrafluoroethane (HFC-134a) have become popular propellants for many aerosolized household-cleaning products and thus have the potential to be abused. When misused as inhalants, fluorocarbons can cause serious freezing injury to the skin and mucosal surfaces as well as life-threatening complications (eg, cardiac dysrhythmia, respiratory tract injury, asphyxiation) that are associated with all inhalants. Skin lesions surrounding the mouth and nose as well as those involving the digits should elevate a practitioner's suspicion of inhalant abuse. We report an uncommon case of severe orofacial and digital frostbite initially mistaken for an allergic reaction in a 20-year-old man following intentional inhalation of a commercial air-dusting agent containing the fluorocarbon HFC-134a.

Case Report

A 20-year-old man presented to the emergency department with pain, edema, and blistering of the lips, cheeks, tongue, and digits on the left hand. He also reported numbness and tingling in the affected areas, most notably on the tip of the left index finger. One hour prior to presentation the patient had been inhaling aerosolized computer cleaner containing the fluorocarbon HFC-134a until he lost consciousness; however, this information was not initially disclosed to the emergency department physician. At presentation, the patient reported that

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he had been camping in the desert and suspected he had been bitten by a spider. Physical examination revealed erythematous and edematous lesions on the lips and fingers. Vital signs showed a temperature of 37.4°C, blood pressure of 151/88 mm Hg, pulse of 102 beats per minute, respiration rate of 24 breaths per minute, and an oxygen saturation of 100% on room air. The remainder of the physical examination was normal, and the patient's mental status was intact. He was admitted for observation and treated with 0.3 mg of subcutaneous epinephrine, 125 mg of intravenous methylprednisolone, and 50 mg of intravenous diphenhydramine for a presumed anaphylactic reaction.

The patient's medical history was remarkable for a second dose of the smallpox vaccine 3 weeks prior to presentation and a second dose of the anthrax vaccine the day before. There was no history of dermatologic disease, allergic reactions, or other notable medical conditions. His family history was remarkable for alcoholism. He was not taking any medications and had no known allergies. He admitted to infrequent alcohol consumption and smoking 2 packs of cigarettes daily.

On examination the following morning the patient was alert, oriented, and cooperative but still complained of pain from the lesions on the face and cheeks. Large geographic and linear bullae filled with clear fluid were noted on the right cheek, right naris, lateral aspect of the upper lip, and lower lip. The right distal end of the tongue had a 3×4-mm vesicle that had spontaneously drained (Figure 1). The index, middle, and ring fingers on the left hand had large tense geographic and linear bullae filled with clear fluid (Figure 2). Bullae were located primarily on the dorsal aspects of the digits but some had circumferential involvement covering the proximal and distal interphalangeal joints. A few bullae had spontaneously ruptured, exposing mild erythema at the base.

By his third day in the hospital the lesions on the face became honey crusted and those on the upper lip became ulcerated. A 3-mm crusted papule corresponding with the location of the patient's smallpox vaccination was noted on the left deltoid muscle. Laboratory results from his admission to the hospital revealed a white blood cell count of 17.8×10^9/L (reference range, 4.5–11.0×10^9/L), creatine kinase level of 388 U/L (reference range, 40–150 U/L), alkaline phosphatase level of 131 U/L (reference range, 30–120 U/L), lactate dehydrogenase level of 208 U/L (reference range, 100–200 U/L), and potassium level of 3.2 mmol/L (reference range, 3.5–5.0 mmol/L). An electrocardiogram was normal. The remainder of his blood count, chemistry panel, liver function test, erythrocyte sedimentation rate, and C-reactive protein tests were within reference range.

Figure 1. Bullae filled with clear fluid on the right cheek, lateral aspect of the upper lip, and lower lip.

Figure 2. Bullae filled with clear fluid on the index, middle, and ring fingers on the left hand.

With persistent questioning and the realization that his injuries were more serious than he first thought, the patient admitted that he had been inhaling a commercial air duster immediately prior to onset of symptoms. Further research regarding the

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product's ingredients revealed the propellant used was the fluorocarbon HFC-134a. Subsequently, a diagnosis of an allergic reaction to frostbite secondary to contact with liquefied HFC-134a was made.

Treatment of frostbite was initiated. The bullae were lanced and drained with the roof left in place to act as a biologic dressing. The patient was treated with clobetasol propionate ointment 0.05% to reduce inflammation as well as bacitracin ointment for secondary infection prophylaxis until reepithelialization occurred. Electrolytes were corrected and laboratory values normalized during inpatient hospitalization. Pain control initially required intravenous opiates, but he was rapidly tapered to oral analgesics. During hospitalization, the patient did not experience any cardiac or respiratory compromise.

The patient was subsequently monitored for 3 days on the inpatient medical ward for internal manifestations of inhalant abuse and compartment syndrome in the left hand. Outpatient follow-up continued for 4 months to monitor for necrosis or infection. Fortunately neither developed, but he did require extensive occupational therapy to regain full function of the left hand. The patient also was enrolled in an outpatient substance abuse program, which he completed. Long-term outcome is unknown, as the patient was lost to follow-up; at last communication, the patient denied further use of inhalants or other substance abuse.

Comment

Because of their accessibility and low cost as well as the difficulty in detecting their use, inhalant abuse continues to be a problem in the United States, especially among adolescents.[1-4] A variety of administration methods may be used to inhale the intended substances. Sniffing or spraying refers to inhaling or spraying the substance into the nose or mouth directly from the container. Huffing refers to the use of a saturated rag that is placed over the mouth or nose and inhaled. Bagging refers to the inhalation of concentrated fumes from a plastic bag.[1,2,4-6]

Tetrafluoroethane and other abused inhalants are extremely lipophilic, are rapidly absorbed into the pulmonary vasculature, and easily cross the blood-brain barrier. Onset of action is rapid, while the effects are dose related and typically are brief, ranging from euphoria, decreased inhibition, motor excitation, and light-headedness with small doses to dysarthria, sedation, anesthesia, and possible death with larger doses.[1,2,4,6-8] The exact mechanism of action is still under investigation, but there is evidence to suggest central nervous system impairment as the primary means of achieving these effects.[7] Current evidence suggests involvement of γ-aminobutyric acid, *N*-methyl-D-aspartate, dopamine, glycine, nicotine, and serotonin receptors.[7,9,10] Ion channels also appear to be affected by inhalants, which could explain the cardiac dysrhythmias that sometimes accompany inhalant abuse.[11]

Medical studies have demonstrated reassuring safety profiles for inhalation of HFC-134a in minimal doses over an extended period, allowing the substance to be used as a propellant for metered-dose inhalers.[12-14] Most other medical uses take advantage of the cooling effects of liquefied HFC-134a. Common uses of HFC-134a include cryosurgery of gingival melanin pigmentation,[15] topical numbing for intravenous catheter insertion and blood draws, and cooling for dermatologic laser surgeries.[16,17] Side effects are minimal when used correctly.

Tetrafluoroethane originally was investigated in the 1960s as an intermediate-potency anesthetic agent but was never developed for human use, possibly due to the increased risk for cardiac dysrhythmias.[18] It is easy to speculate that an abuser could inhale enough HFC-134a to cause anesthetization or loss of consciousness, which may have been the case in our patient.

There have been numerous case reports documenting frostbite caused by inhalant abuse in recent decades, and many more cases likely have gone unreported.[19-23] Aerosol propellants such as HFC-134a are stored as liquid gas under pressure. When the trigger is pulled, the gas exits the canister at temperatures well below freezing and immediately vaporizes. If the canister is shaken or turned upside down, the liquid will be released, causing freezing of any tissues on contact. Our patient admitted to turning the canister upside down and cupping his hands around the valve to concentrate fumes, which explained the distribution of his injuries. Frostbite of the airway and oropharynx requiring endotracheal intubation has been documented secondary to inhalation of similar compounds.[19,20] This risk appears to be greatest when a substance is directly injected into the mouth, as in the sniffing or spraying method.

Our patient responded well to standard treatment. In general, frostbite therapy consists of rapid rewarming in whirlpools at 40°C to 42°C until vascular flushing is present and the area is malleable, usually within 15 to 30 minutes. This regimen is not always possible, depending on the location of the injury. The rewarming process is painful and usually requires analgesia. Because our patient's diagnosis was initially incorrect, no rewarming was provided. After rewarming, treatment consists of daily dressing changes, elevation of the affected areas, and pain control. Clear blisters should be drained and treated with antibiotic ointment. Hemorrhagic blisters imply a

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much deeper level of freezing and should be left intact to prevent infection and desiccation. Tetanus status should be addressed appropriately. Close monitoring for infection as well as compartment syndrome when appropriate is necessary and may require emergent treatment. Amputations should be delayed until clear demarcation of viable tissue is made, which could take several months.[24-26]

Four cases of lethal inhalation exposure to HFC-134a were attributed to cardiac dysrhythmia, hypoxia, depressed mental status, and a suspected pulmonary intraparenchymal hemorrhage.[8,27-29] Sudden sniffing death syndrome, perhaps the most feared side effect of inhalant use, is characterized by myocardial sensitization to catecholamine surges causing dysrhythmias that can be lethal.[30] For this reason, it is recommended that sympathomimetics be used with great caution in patients who abuse inhalants. Fortunately, our patient was given small doses of epinephrine without apparent ill effect.

Signs of inhalant abuse usually are minimal or absent; however, physical examination may reveal nail discoloration, chemical odors, perioral and perinasal eczema, scleral injection, and rhinorrhea.[1,6,9,31-33] Unusual frostbite patterns localized to the face and hands, such as those in our patient, should elevate further suspicion of inhalant abuse. In hindsight, there were no indicators, either in behavior or physical findings, other than the distribution of the lesions that would have suggested inhalant abuse in our patient. Recognizing such subtle findings can help expedite treatment and appropriate referral.

Conclusion

Inhalant abuse continues to be a notable cause of morbidity and mortality in the adolescent population. It is nearly impossible to identify an inhalant abuser during a routine office visit, but a detailed history and a high index of suspicion can help identify these patients and avoid initial misdiagnosis, as was the case in our patient. Our case represents an uncommon yet severe side effect of frostbite related to inhalation of HFC-134a. Dermatologists and other clinicians should have an awareness of inhalant abuse and its complications. Immediate treatment follows the guidelines for frostbite with attention to life-threatening side effects of cardiac dysrhythmias, central nervous system depression, or hypoxia, with long-term therapy focusing on substance abuse treatment.

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