

## CASE REPORT

# Recreational nitrous oxide-induced injury to the soft palate

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**Key Clinical Message**

Frostbite arising from nitrous oxide (N<sub>2</sub>O) inhalation is rare. As such, there is no consensus on best treatment for these injuries. In all published reports, judicious use of corticosteroids and antibiotics has resulted in positive clinical outcomes; we endorse these agents in our case of a young man with oropharyngeal burns.

**KEYWORDS**

inhalant injury, nitrous oxide, oropharyngeal frostbite, volatile substance abuse

## 1 | INTRODUCTION

The euphoric properties of inhaled nitrous oxide (N<sub>2</sub>O) lend to its frequent recreational use. N<sub>2</sub>O was the first drug used as a surgical anesthetic, and through modulation of opioid receptor and spinal nociceptive processing, and  $\gamma$ -aminobutyric acid type A (GABA<sub>A</sub>) receptor activation, has additional analgesic and anxiolytic effects.<sup>1</sup> Onset of action is quick, within seconds, and generally lasts only minutes.<sup>2</sup> In Australia, an annual survey of regular illicit drug users found concurrent use of N<sub>2</sub>O had risen to 53% of those sampled in 2019, from 23% 5 years earlier.<sup>3</sup> N<sub>2</sub>O now ranks as the second most popular recreational drug in Britain.<sup>2</sup> While commonly perceived to be safe, N<sub>2</sub>O inhalation at high concentrations causes hypoxia and possible asphyxiation, and prolonged use has been shown to induce functional vitamin B12 deficiency.<sup>1,2</sup> The latter may progress to cause peripheral neuropathy and megaloblastic anemia.<sup>2</sup>

Given its boiling point of  $-128^{\circ}\text{F}$  ( $-89^{\circ}\text{C}$ ) at atmospheric pressures,<sup>4</sup> the gas must be stored carefully in pressurized steel cylinders. Where there is accidental or intentional contact with the pressure-reducing valves of these cylinders, frostbite injuries can occur. Oropharyngeal frostbite secondary to volatile inhalant abuse has been described only in a small number of case reports; far

fewer have been attributed to N<sub>2</sub>O exposure specifically. Below, we describe a case of upper aerodigestive tract injury following intentional recreational use of N<sub>2</sub>O.

Written informed consent was obtained from the patient; single case reports are exempt from institutional review board evaluation at our service.

## 2 | CASE REPORT

A 30-year-old male was referred by his general practitioner to a small metropolitan hospital with a worsening sore throat,odynophagia, subjective dysphonia, and sensation of throat swelling 2 days following inhalation of N<sub>2</sub>O from a whipped cream canister at a party. The patient reported his symptoms to be of immediate onset at the time of inhalation, but delayed seeking medical attention until the next day in the context of concurrent amphetamine use. On initial review, the patient did not show any increased work of breathing, and maintained oxygen saturations of 98% without any supplemental requirement. He had a hoarse voice, with desquamation of the left tonsil and adjacent soft palate, and associated anterior neck tenderness. There was no trismus or subcutaneous emphysema. He was able to tolerate liquids but unable to swallow any solids, and experienced moderate pain. He

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**FIGURE 1** Computed tomography appearance of left oropharyngeal burn (Green arrow).

had no systemic symptoms and had not suffered burns to any other region of his body. The patient had no significant past medical history, nor any regular medications.

Initial management consisted of single-dose 8 mg intravenous dexamethasone, and intravenous 1.2 g amoxicillin-clavulanic acid Q8H. Cross-sectional computed tomography (CT) imaging with contrast demonstrated left-sided oropharyngeal mucosal swelling and oedema, and slight narrowing of the oropharyngeal airway (Figure 1). There was no subcutaneous gas. The patient was then transferred to a tertiary hospital for specialist otolaryngology review. Flexible nasendoscopy performed 72 hours post-injury showed only desquamation of the left tonsil and adjacent soft palate. By this stage, the patient's symptoms had largely resolved, and he was not requiring any form of analgesia; clinical appearances were stable (Figure 2). The next morning, 86 hours post-injury, his dysphonia had resolved and he was comfortably tolerating oral intake. He was accordingly discharged with a course of oral amoxicillin-clavulanic acid (875–125 mg BD for 5 days).

### 3 | DISCUSSION

The sequelae of N<sub>2</sub>O misuse are well-documented and include frostbite, polyneuropathy, and hypoxia; the latter in particular has proven fatal.<sup>2</sup> Oropharyngeal frostbite,



**FIGURE 2** Clinical appearance of left oropharyngeal burn (90 h post-injury).

however, is rarely described. On a review of the literature, we were able to identify six cases of upper aerodigestive tract frostbite secondary to volatile inhalant use, of which two were N<sub>2</sub>O-related.

The treatment and outcome of N<sub>2</sub>O-induced oral frostbite are not well-established, given its rarity. In 1996, Svartling et al reported a case of third-degree frostbite to the mouth, oral cavity, and upper airways.<sup>5</sup> The patient required tracheostomy for airway safety and underwent a protracted course of debridement of necrotic tongue, hard palate, and buccal tissue.<sup>5</sup> While the patient was able to be discharged after 18 days, they required ongoing review over months for oral cavity scarring with associated trismus.<sup>5</sup> Although the extent of injury is significantly different from our case, several treatment modalities were utilized by the treating teams in both instances. Following commencement on ventilatory support, Svartling's patient also received intravenous steroids and antibiotics (methylprednisolone, cefuroxime and metronidazole), although dose and duration of therapy was unspecified.<sup>5</sup>

Chan et al described a case of aerodigestive tract injury following N<sub>2</sub>O inhalation from an automotive canister; this was mixed with sulfur dioxide to deter recreational inhalation, which carries its own corrosive properties.<sup>6</sup> In this instance, the patient presented with voice change, edema and erythema affecting the lips, buccal mucosa, palate, and oropharynx.<sup>6</sup> Due to a six-liter supplementary oxygen requirement to maintain saturations >85%, with associated edema of the nasopharynx and supraglottis, a decision was made to intubate via an awake fiberoptic method.<sup>6</sup> As with our case, this patient received intravenous dexamethasone, of unspecified dose and duration.<sup>6</sup> It is unclear whether the patient received antibiotics at any stage, but topical sucralfate was applied to his oral cavity

burns to good effect.<sup>6</sup> The peak of airway edema appears to have passed quickly; the patient's airway remained stable following self-extubation 24 hours post-injury.<sup>6</sup> Subsequent follow-up was encouraging, but was only reported to 2 weeks.<sup>6</sup>

Although the causative agent in all these cases is N<sub>2</sub>O, ours is the first case involving a whipped cream dispenser as the method of delivery into the oral cavity. This is significant, as pressures within whipped cream canisters are much lower (30 psi)<sup>7</sup> relative to storage canisters for medical use in anesthesia (as in the first case)<sup>5</sup> and automotive canisters (causative in the second); the pressures in the latter device are estimated at 950 psi.<sup>6</sup> While degree of injury across these cases approximately correlates with force of pressure delivered, our case increases the index of suspicion for significant oropharyngeal frostbite injury even at low pressures of barotrauma.

## 4 | CONCLUSION

Otolaryngologic sequelae of inhaled N<sub>2</sub>O use are rare. However, we have identified a case of frostbite to the soft palate as an example requiring acute otolaryngologic assessment and management. We have shown that even the relatively low pressures applied through N<sub>2</sub>O inhalation can result in clinically significant frostbite, although degree of barotrauma seems to influence degree of subsequent edema. Given the paucity of published literature, there is no consensus on management of such injuries, but with their known effects in amelioration of airway edema, administration of intravenous steroids is considered fundamental to management.

## AUTHOR CONTRIBUTIONS

**Antonia C Rowson:** Data curation; writing – original draft. **Matthew X Yii:** Conceptualization; writing – review and editing. **Hannah B Tan:** Writing – review and editing. **Jessica Prasad:** Supervision; writing – review and editing.

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## CONFLICT OF INTEREST STATEMENT

The authors report no commercial or proprietary interest in any product or concept discussed in this article.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## CONSENT STATEMENT

Written informed consent was obtained from the subject of this report.

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