

# Sodium nitrite–induced methemoglobinaemia: a case report

CY Yeung<sup>1</sup>, FHKCEM, FHKAM (Emergency Medicine), HG Lam<sup>1</sup>, MB, BS, FL Lee<sup>1</sup>, FHKCEM, FHKAM (Emergency Medicine), Francis KC Chu<sup>1\*</sup>, FHKCEM, FHKAM (Emergency Medicine), CK Chan<sup>2</sup>, FHKAM (Emergency Medicine), FHKCEM (Clinical Toxicology)

<sup>1</sup> Accident and Emergency Department, Queen Elizabeth Hospital, Hong Kong SAR, China

<sup>2</sup> Hong Kong Poison Control Centre, Hospital Authority, Hong Kong SAR, China

\* Corresponding author: ckc01@ha.org.hk

This article was published on 9 Oct 2024 at www.hkmj.org.

Hong Kong Med J 2024;30:Epub

<https://doi.org/10.12809/hkmj2311153>

This version may differ from the print version.

## Case presentation

A 27-year-old man with a history of previous suicide attempts, depression and borderline personality disorder intentionally ingested 10 g of sodium nitrite (NaNO<sub>2</sub>) in a suicide attempt. The patient reported learning about this method of suicide through the internet and was aware of fatal cases that had occurred overseas. He checked the lethal dosage of NaNO<sub>2</sub> and purchased the NaNO<sub>2</sub> salt online. He dissolved 10 g of NaNO<sub>2</sub> in beer and consumed the mixture. He vomited immediately and then instructed his girlfriend to call an ambulance. He denied co-ingestion of any other substances. After consulting the Hong Kong Poison Information Centre, the ambulance crew administered 50 g of activated charcoal to the patient on the way to the emergency department.

The patient arrived at the emergency department 30 minutes following the ingestion. Upon arrival, the patient complained of dizziness and dyspnea. He denied any chest pain, syncope or loss of consciousness. Physical examination revealed mild respiratory distress and both peripheral and central cyanosis. He was fully alert with a Glasgow Coma Scale score of 15/15. There was no fever. Tachycardia with heart rate 124 beats per minute was noted and blood pressure was 104/58 mm Hg. His respiratory rate was 26 breaths per minute and oxygen saturation 79% on oxygen was administered via a non-rebreathing mask. The methemoglobin (met-Hb) level measured by a pulse CO-oximeter was 21.7%. A point-of-care venous blood gas showed pH 7.37, partial pressure of carbon dioxide of 6.24 kPa, partial pressure of oxygen of 1.9 kPa, and a base excess of 1 mmol/L. Electrocardiogram showed normal sinus rhythm with no ischaemic changes. Chest X-ray showed no consolidation and abdominal X-ray revealed no radiopaque foreign body.

In view of the potential lethal ingestion, the patient was intubated for airway protection and gastric lavage was performed using a total of 6-L normal saline until the effluent became clear. The methemoglobinaemia was treated with 100-mg methylene blue given intravenously (2 mg/kg body

weight). The initial blood met-Hb level and lactate level were 69.9% and 4.2 mmol/L, respectively. The patient was admitted to the intensive care unit where an additional dose of 100-mg methylene blue was administered. The met-Hb level decreased from 69.9% to 49.4%, 2.3%, and 0.2% after 2 hours, 6 hours, and 14 hours, respectively. Lactate level also decreased from 4.2 to 2.1 mmol/L. After a night in the intensive care unit, the patient was extubated and transferred to the emergency medicine ward. The patient was later assessed by a psychiatrist and was discharged home after 2 days.

## Discussion

Sodium nitrite is a white-to-yellow, odourless, water-soluble compound that is used as a pharmaceutical precursor, in food processing, and as a therapeutic agent for the treatment of cyanide poisoning. Worldwide, there is a growing trend of NaNO<sub>2</sub> being used for suicidal intentions.<sup>1,2</sup> It is a highly toxic substance that is rapidly absorbed after ingestion. The reported lethal dose of ingested NaNO<sub>2</sub> ranges from 0.7 g to 6 g.<sup>2</sup>

Sodium nitrite oxidises ferrous iron to ferric iron in the haemoglobin, leading to methemoglobinaemia. Methemoglobin reduces the oxygen-carrying capacity of haemoglobin and causes a left shift in the oxyhaemoglobin dissociation curve with consequent tissue hypoxia.

Clinical features of methemoglobinaemia depend on the level of met-Hb, ranging from asymptomatic to headache, dizziness, anxiety, tachypnoea and, in more severe cases, coma, seizures, lactic acidosis, and death. The clinical features corresponding to the associated met-Hb level are shown in the Table.<sup>3</sup>

The management of NaNO<sub>2</sub> poisoning includes supportive treatment and administration of an antidote for methemoglobinaemia. The source of oxidative stress should be identified and further exposure should be avoided. Although the efficacy is unproven, activated charcoal may be considered for gastrointestinal decontamination if the patient presents early (within 2 hours) at the hospital with

TABLE. Clinical features at different methemoglobin levels<sup>3</sup>

Methemoglobin level	Clinical features
<3%	Normal
3%-15%	Possibly asymptomatic except for low SpO <sub>2</sub> level
15%-20%	Mild cyanosis, asymptomatic otherwise
20%-50%	Anxiety, headache, dizziness, weakness, tachypnea, sinus tachycardia
50%-70%	Myocardial ischaemia, dysrhythmia, seizures, coma, lactic acidosis
>70%	Generally incompatible with life

Abbreviation: SpO<sub>2</sub> = oxygen saturation

no contraindications.<sup>4</sup> Supplementary oxygen is administered to patients who experience hypoxia and cyanosis.

Methylene blue is an effective antidote for methemoglobinemia. It acts as an oxidising agent and is converted to leukomethylene blue by NADPH methemoglobin reductase, which can increase the metabolism of met-Hb through the nicotinamide adenine dinucleotide phosphate pathway. It is indicated in patients with symptomatic methemoglobinemia who exhibit signs of tissue hypoxia or have a met-Hb level >20%. For patients with underlying anaemia and cardiovascular, pulmonary or central nervous system compromise, methylene blue can be considered at a lower met-Hb level. Glucose-6-phosphate dehydrogenase deficiency is a relative contraindication for methylene blue due to the potential risk of methylene blue-induced haemolysis. Nonetheless a single dose use is generally acceptable in severe cases.

There is a rising trend of suicidal attempt using NaNO<sub>2</sub> in western countries resulting in severe methemoglobinemia and, in some cases, death.<sup>1,2</sup> In Hong Kong, two young ladies committed suicide and NaNO<sub>2</sub> was found at the scene; both were certified dead before reaching the hospital.<sup>5</sup> With the ease of purchasing items online and the widespread promotion of suicide methods on the internet, more cases can be expected in the near future. Imposing regulations on the consumer sale of highly concentrated NaNO<sub>2</sub>, which is lethal when ingested, is important in poison control. In 2024, the United States banned the sale of consumer products with a concentration of NaNO<sub>2</sub> >10%.<sup>6</sup>

## Conclusion

Intentional ingestion of NaNO<sub>2</sub> is an emerging and life-threatening cause of methemoglobinemia. Early recognition, gastrointestinal decontamination, and

treatment with methylene blue along with supportive measures can be life-saving. This case report serves as a reminder for healthcare providers to be vigilant in their assessment of patients who present with unexplained respiratory distress, cyanosis, and desaturation despite oxygen supplementation. It is important to consider methemoglobinemia as a possible cause.

## Author contributions

All authors contributed to the concept or design, acquisition of data, analysis or interpretation of data, drafting of the manuscript, and critical revision of the manuscript for important intellectual content. All authors had full access to the data, contributed to the study, approved the final version for publication, and take responsibility for its accuracy and integrity.

## Conflicts of interest

All authors have disclosed no conflicts of interest.

## Funding/support

This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## Ethics approval

The patient was treated in accordance with the tenets of the Declaration of Helsinki. Patient consent has been obtained for all treatments and procedures, and verbal consent for publication was obtained from the patient.

## References

- Stephenson L, Wills S, van den Heuvel C, Humphries M, Byard RW. Increasing use of sodium nitrite in suicides—an emerging trend. *Forensic Sci Med Pathol* 2022;18:311-8.
- McCann SD, Tweet MS, Wahl MS. Rising incidence and high mortality in intentional sodium nitrite exposures reported to US poison centers. *Clin Toxicol (Phila)* 2021;59:1264-9.
- Hong Kong College of Emergency Medicine Clinical Toxicology Course Book. Hong Kong College of Emergency Medicine; 2023: 222.
- Nelson LS, Howland MA, Lewin NA, editors. *Goldfrank's Toxicological Emergencies*. 11th ed. McGraw-Hill Companies; 2019.
- Two 22-year-old women in suicide pact at Ching Ping House in Sheung Shui consumed alcohol, drugs and sodium nitrite moments before their death. *Dimsum Daily Hong Kong* 2023 Jan 5: Local. Available from: <https://www.dimsumdaily.hk/two-22-year-old-women-in-suicide-pact-at-ching-ping-house-in-sheung-shui-consumed-alcohol-drugs-and-sodium-nitrite-moments-before-their-death/>. Accessed 5 Jan 2023.
- Darby M. U.S. House passes legislation banning the sale of a poison. *Utah Rep*. Celeste Maloy was co-sponsor. *Desert News* 2024 May 17. Available from: <https://www.deseret.com/utah/2024/05/17/house-passes-legislation-banning-sale-of-poison-linked-to-suicide/>. Accessed 2 Oct 2024.