Sodium nitrite–induced methaemoglobinaemia: a case report

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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 ($NaNO_2$) 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 $NaNO_2$ and purchased the $NaNO_2$ salt online. He dissolved 10 g of $NaNO_2$ 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 dyspnoea. 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 methaemoglobin (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 methaemoglobinaemia 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 $NaNO_2$ being used for suicidal intentions.[1,2] It is a highly toxic substance that is rapidly absorbed after ingestion. The reported lethal dose of ingested $NaNO_2$ ranges from 0.7 g to 6 g.[2]

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

Clinical features of methaemoglobinaemia 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.[3]

The management of $NaNO_2$ poisoning includes supportive treatment and administration of an antidote for methaemoglobinaemia. 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

no contraindications.[4] Supplementary oxygen is administered to patients who experience hypoxia and cyanosis.

Methylene blue is an effective antidote for methaemoglobinaemia. It acts as an oxidising agent and is converted to leukomethylene blue by NADPH methaemoglobin reductase, which can increase the metabolism of met-Hb through the nicotinamide adenine dinucleotide phosphate pathway. It is indicated in patients with symptomatic methaemoglobinaemia 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 $NaNO_2$ in western countries resulting in severe methaemoglobinaemia and, in some cases, death.[1,2] In Hong Kong, two young ladies committed suicide and $NaNO_2$ was found at the scene; both were certified dead before reaching the hospital.[5] 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 $NaNO_2$, 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 $NaNO_2$ >10%.[6]

Conclusion

Intentional ingestion of $NaNO_2$ is an emerging and life-threatening cause of methaemoglobinaemia. 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 methaemoglobinaemia 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.

TABLE. Clinical features at different methaemoglobin levels[3]

Methaemoglobin level	Clinical features
<3%	Normal
3%-15%	Possibly asymptomatic except for low SpO_2 level
15%-20%	Mild cyanosis, asymptomatic otherwise
20%-50%	Anxiety, headache, dizziness, weakness, tachypnoea, sinus tachycardia
50%-70%	Myocardial ischaemia, dysrhythmia, seizures, coma, lactic acidosis
>70%	Generally incompatible with life

Abbreviation: SpO_2 = oxygen saturation

Conflicts of interest

All authors have disclosed no conflicts of interest.

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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.

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