Management of nitrobenzene poisoning in a resource-constrained setting: A case report

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ABSTRACT

INTRODUCTION

Nitrobenzene poisoning is an uncommon but potentially fatal cause of acquired methemoglobinemia, particularly in agricultural regions. We report an 18-year-old male presenting with acute hypoxia, cyanosis, and refractory low oxygen saturation following unknown pesticide ingestion. Despite limited diagnostic resources, characteristic clinical features, chocolate-colored blood, and a marked saturation gap supported the diagnosis of methemoglobinemia. Prompt empirical treatment with oxygen, methylene blue, and ascorbic acid resulted in rapid recovery. This case highlights the importance of clinical recognition and early intervention in suspected nitrobenzene poisoning, especially in resource-limited settings.

KEYWORDS

Nitrobenzene poisoning, Methemoglobinemia, Resource-constrained setting, Pesticide.

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INTRODUCTION

Nitrobenzenes are aromatic nitro compounds used in agricultural fertilizers, synthetic rubber, dye, and paint industries.[1] It potently oxidizes the iron moiety of hemoglobin, causing methemoglobinemia, leading to impaired oxygen transport and hypoxia.[2] In the Terai region of Nepal, 20% nitrobenzene emulsion is widely used as a pesticide and found to be marketed under the "Boom Flower" brand name. Different studies have reported that the lethal dose ranges from 1 to 10 grams.[3] Clinical features are dose-based and primarily result from hypoxia. Early treatment with methylene blue, oxygen and vitamin C is crucial for survival. This article emphasizes the clinical diagnosis of methemoglobinemia based on presenting symptoms and signs, highlighting the necessity for prompt intervention, especially when laboratory testing for methemoglobin levels and co-oximetry is not immediately accessible. This case report has been reported in line with the SCARE Criteria.[4]

CASE REPORT

An 18-year-old boy was brought to the emergency department with an alleged history of unknown poison ingestion three hours prior to hospital presentation, which was suicidal in nature. The patient was found in a restless state in his farming field. On a family member's inquiry, he confessed to the ingestion of around 200 ml of liquid poison. However, he could neither mention the name of the poison nor was there any evidence of a poison bottle. He had developed four episodes of vomiting after ingestion of the compound, followed by shortness of breath. On presentation, the patient was restless and cyanosed with a respiratory rate of 28 minute and oxygen saturation of only 80%, even under 15 liters of high-flow oxygen with a reservoir mask. He had a pulse rate of 120 beats/minute and a blood pressure of 100/70 mmHg. His GCS (Glasgow Coma Scale), was E3V1M5. The patient had an estimated body weight of approximately 60 kg. Other respiratory and cardiovascular examinations were unremarkable. Complete blood count and renal function test were normal. Baseline laboratory evaluation revealed a hemoglobin level of 12.4 g/dL and a serum LDH level of 380 U/L. The arterial blood gas sample drawn from the radial artery was chocolate brown with a pH of 7.41, PCO2 (Partial Pressure of Carbon Dioxide) of 33.6 mmHg, and HCO3 of 22.2 mmol/L with a normal PaO2 (Partial Pressure of Oxygen) of 100 mmHg but a calculated oxygen saturation of 72%. The ECG (Electrocardiogram) revealed ST depression with T wave inversion on leads II, III, aVF and V4-V6. The cardiac enzymes were positive with Troponin I 2.6 ng/ml and CPK-MB (Creatine Phosphokinase-MB) 100.0 ng/ml. The patient was resuscitated with gastric lavage using 50 grams of activated charcoal. Other possible causes of acute hypoxia considered included organophosphate poisoning, aluminum phosphide toxicity, cyanide poisoning, and carbon monoxide exposure.

Based on the history and clinical findings, a working diagnosis of methemoglobinemia was made within approximately one hour of hospital presentation and he was immediately shifted to the intensive care unit. He was administered one dose of injectable methylene blue at a dosage of 2 mg/kg over 30 minutes. He also received vitamin C tablets via a Nasogastric tube at 500 mg thrice daily. Oxygen support was continued on the reservoir mask. G6PD testing showed a normal value of 9.8 U/g Hb, confirming suitability for safe administration of methylene blue. However, methemoglobin estimation and co-oximetry could not be carried out due to the lack of these testing facilities at our center.

Following methylene blue administration, the patient gradually showed improvement, with respiratory rate settling down to 18 breaths per minute and oxygen saturation maintained at 98% under only 3 liters of oxygen supply via nasal prong. The patient became oxygen-free over the next 24 hours with no symptoms. His ECG also became normal. Echocardiography was also normal. The raised cardiac biomarkers were interpreted as secondary to hypoxia-induced myocardial injury, as there was no prior cardiac history, and echocardiography was normal following stabilization. The next day, the family member brought a poison bottle that was found somewhere near the field, and the patient confirmed the ingestion of the same. The bottle was of agricultural fertilizer named "Boom Flower," containing 20% nitrobenzene. The patient was then observed for the next 24 hours and discharged.

DISCUSSION

This case demonstrates various clinical features of nitrobenzene toxicity leading to methemoglobinemia. However, the definitive diagnosis couldn't be made initially due to a lack of investigations, clinical presentation, and improvement with specific medications, including methylene blue and vitamin C, which correlated with later findings of poison bottle containing the same compound. Nitrobenzene ($C_6H_5NO_2$) is an aromatic nitro compound, which contains a nitro group (-NO_2) attached to a benzene ring compound that have an ability to oxidize iron from its ferrous to ferric form in the hemoglobin molecule, causing methemoglobinemia. Among many causes of methemoglobinemia, nitrobenzene poisoning is one of the acquired causes.

Methemoglobinemia symptoms are correlated with methemoglobin levels. Methemoglobin concentrations below 1.5 g/dL (<10%) show no symptoms; 1.5–3.0 g/dL (10–20%) show cyanosis; 3.0–4.5 g/dL (20–30%) show anxiety, lightheadedness, headache, and tachycardia; 4.5–7.5 g/dL (30–50%) show fatigue, confusion, dizziness, tachypnea, and increased tachycardia; 7.5 g/dL (50–70%) show coma, seizures, arrhythmias, and acidosis; and >10.5 g/dL (>70%) is typically fatal.[5] As our patient had ingested

approximately 200ml of a 20% nitrobenzene solution, corresponding to an estimated 40 grams of nitrobenzene, and had signs of tachypnea and ECG changes, the possibility of methemoglobin concentration exceeding 50% could not be excluded. However, definitive testing and quantification were not feasible.

Co-oximeter is the gold standard for diagnosing methemoglobinemia.[6] It utilizes a peak absorbance of light at 630 nm to identify methemoglobin and utilizes different wavelengths to detect hemoglobin, deoxyhemoglobin, oxyhemoglobin, and carboxyhemoglobin.[5] Because SaO_2 (Arterial Oxygen Saturation) is computed from PaO_2, which is normal in methemoglobinemia, interpreting ABG (Arterial Blood Gas) results without co-oximetry can lead to an incorrectly increased SaO_2. On the other hand, pulse oximetry uses wavelength to detect oxyhemoglobin and deoxyhemoglobin to determine oxygen saturation (SpO_2), and methemoglobinemia causes wavelength interference that lowers and distorts SpO_2. Patients exhibit refractory hypoxemia as a result, and in methemoglobinemia, the saturation gap (SaO2-SpO_2) is greater than 5%. A saturation gap greater than 5% is an important diagnostic clue and a hallmark feature of methemoglobinemia, particularly in settings where co-oximetry is not available.[7] In our case also, the patient had refractory hypoxemia with SpO_2 (Peripheral Capillary Oxygen Saturation) of only 72%, even on 15 liters of oxygen supplementation. Conversely, the patient's ABG revealed a PaO2 of 100%. This discrepancy between SPO_2 and PaO2 of 28% also suggested the possibility of methemoglobinemia. In addition, bedside tests such as placing 1–2 drops of blood on white filter paper and the appearance of dark brown color can help diagnose methemoglobinemia.[5] Our patient's blood also showed the same result. Our patient also exhibited ischemic ECG changes accompanied by elevated cardiac biomarkers. There is limited evidence to suggest direct cardiotoxic effects of nitrobenzene. The observed cardiovascular abnormalities, which resolved completely following treatment were most likely secondary to hypoxia induced myocardial ischemia. Echocardiography performed after stabilization on room air demonstrated a normal study.

Methylene blue infusion along with oxygen is used to treat acquired methemoglobinemia. Methylene blue is converted to leukomethylene blue, an electron donor that converts methemoglobin to hemoglobin, using NADPH (Nicotinamide Adenine Dinucleotide Phosphate) generated from the G6PD dependent hexose monophosphate shunt. Dextrose can therefore be administered in cases of methemoglobinemia, increasing the effectiveness of methylene blue because it is necessary for the hexose monophosphate shunt to generate NADPH. Considering the critical stage of the patient, immediate treatment with oxygen supplementation, methylene blue infusion and oral ascorbic acid was implemented empirically, to which the patient responded well. The diagnosis was later confirmed when the pesticide bottle containing 20% nitrobenzene was found near the field.

CONCLUSION

Nitrobenzene poisoning is rare but treatable. A major limitation in this case was the lack of co-oximetry and quantitative methemoglobin estimation, which is the gold standard for diagnosis. In poisoning cases where the history is unclear and the ingested substance is unknown, recognition of the typical clinical presentation becomes crucial. Especially in resource poor settings where advanced diagnostic testing may not be readily available.

AUTHOR CONTRIBUTIONS

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(4) Drafting of the article: Sudhan Devkota, Subodh Bashyal, Manoj Karki.
(5) Critical revision for important intellectual content: Subodh Bashyal, Manoj Karki, Niraj Kumar Jaiswal

PATIENT'S CONSENT

Written informed consent was obtained from the patient for the study, collection of data and publication.

CONFLICT OF INTEREST

None

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