

# Herbicide-induced methaemoglobinaemia and the role of methylene blue in its management

Krishna Dayal B 

Emergency Medicine, BLDE  
Deemed to be University, Shri  
BM Patil Medical College,  
Vijayapura, Karnataka, India

**Correspondence to**  
Dr Krishna Dayal B;  
krisnadayal@gmail.com

Accepted 28 October 2022

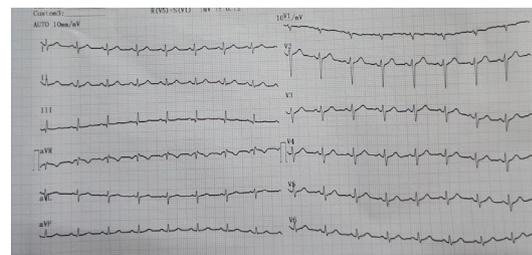
## DESCRIPTION

Modern herbicides are mostly synthetic derivatives of natural plant hormones that interfere with the growth of the target plants. Deliberate ingestion of certain herbicides may lead to methaemoglobinaemia.

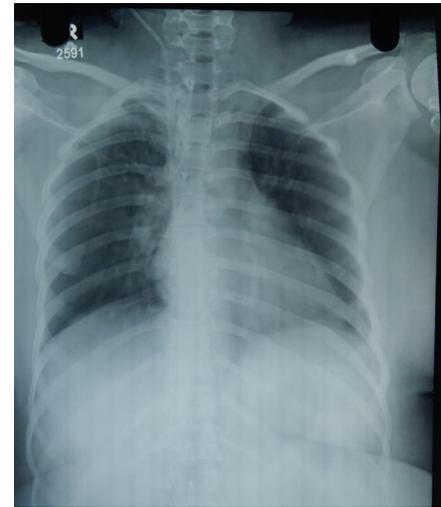
Methaemoglobinaemia can be congenital or acquired, with the latter being more common. When haemoglobin is oxidised to contain one of the four iron species in the ferric (Fe<sup>3+</sup>) state rather than the typical ferrous (Fe<sup>2+</sup>) state, methaemoglobin is produced. These ferric form species are unable to bind oxygen molecules and alter the haemoglobin molecule allosterically. This causes the oxygen-haemoglobin dissociation curve to move to the left, increasing the haemoglobin molecules' affinity for oxygen and impairing oxygen delivery to the tissues. Tissue hypoxia is the outcome.<sup>1 2</sup>

A woman in her late 20s presented to the emergency department with a 2-hour history of deliberate consumption of approximately 100 mL of a herbicide. The history of three episodes of vomiting, malaise and breathlessness was there. On examination, the airway was patent, the chest was clear with no added sounds, the respiratory rate was 22/min, Saturation of peripheral oxygen (SpO<sub>2</sub>) was 76%, the heart rate was 108 bpm, blood pressure was 126/80 mm Hg, the glasgow coma scale score was 15/15 and the central nervous system was within normal limits. The ECG showed sinus tachycardia (figure 1).

Supplemented oxygen via a face mask at a flow rate of 10 L/min increased the saturation to 80% but not beyond that. Gastric lavage was done and intravenous pantoprazole was given. The bedside chest X-ray was normal (figure 2). Arterial blood gas showed a PaO<sub>2</sub> value of 162 mm Hg. The oxygen saturation gap exceeded the normal limit, suggesting methaemoglobinaemia. The G-6PD level was 9.18 U/g haemoglobin (within the normal limit).



**Figure 1** The 12-lead ECG of the patient showing sinus tachycardia.



**Figure 2** Chest X-ray of the patient, A-P (antero-posterior) view. Findings within normal limits.

Injection methylene blue 50 mg in 100 mL NS was given over 10 min. After 1 hour, SpO<sub>2</sub> increased to 91%. The Methylene blue was repeated, increasing the SpO<sub>2</sub> to 98% after one more hour.

Due to its oxidising qualities, methylene blue is a powerful antidote for methaemoglobinaemia. Leukomethylene blue is produced as a reduced by-product after it oxidises nicotinamide adenine dinucleotide phosphate. It then functions as a reducing agent, changing methaemoglobin into haemoglobin to restore oxygen-carrying capacity and reverse tissue hypoxia. The recommended dose is 1–2 mg/kg of a 1% solution over 5–10 min. The maximum total dose is 7 mg/kg.<sup>3</sup>

The patient was transferred to the intensive care unit with intravenous fluids, proton pump inhibitor, ceftriaxone and ondansetron. The next day, she symptomatically improved and was

## Patient's perspective

My daughter had consumed approximately 100 mL of a herbicide marketed as FIRE-007. She had three episodes of vomiting, generalised weakness and breathlessness and was rushed to the hospital within 2 hours. Initial management was done in the emergency department. Considerable symptomatic improvement was there, and she was transferred to ICU after that. She became almost normal the next day. She was transferred to the ward on the third day and was discharged on the fourth day after psychiatric counselling.



© BMJ Publishing Group Limited 2022. No commercial re-use. See rights and permissions. Published by BMJ.

**To cite:** Dayal B K. *BMJ Case Rep* 2022;**15**:e253407. doi:10.1136/bcr-2022-253407

## Learning points

- ▶ Ingestion of certain herbicides can cause methaemoglobinaemia.
- ▶ Methaemoglobinaemia shifts the oxygen dissociation curve to the left, thereby impairing oxygen delivery to tissues and causing tissue hypoxia.
- ▶ Oxygen saturation gap is suggestive of methaemoglobinaemia.
- ▶ Methylene blue is an effective antidote for methaemoglobinaemia (if it is not due to G6PD deficiency).

haemodynamically stable with normal vital parameters. On the third day, she was transferred to the ward and was discharged on the fourth day after psychiatric counselling.

**Contributors** KD is clinical evaluation, literature search and drafting of the case.

**Funding** The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

**Competing interests** None declared.

**Patient consent for publication** Consent obtained directly from patient(s).

**Provenance and peer review** Not commissioned; externally peer reviewed.

Case reports provide a valuable learning resource for the scientific community and can indicate areas of interest for future research. They should not be used in isolation to guide treatment choices or public health policy.

**ORCID iD**

Krishna Dayal B <http://orcid.org/0000-0002-2296-4906>

**REFERENCES**

- 1 Sudheer VR, Krishnapriya R, Kumar NV, *et al*. Management of herbicide induced methemoglobinemia. *J Drug Metab Toxicol* 2018;09:2.
- 2 Ludlow JT, Wilkerson RG, Nappe TM. *Methemoglobinemia*. Treasure Island (FL): StatPearls Publishing, 2022. <https://www.ncbi.nlm.nih.gov/books/NBK537317/>
- 3 Pushparajah Mak RS, Liebelt EL. Methylene blue: an antidote for methemoglobinemia and beyond. *Pediatr Emerg Care* 2021;37:474–7.

Copyright 2022 BMJ Publishing Group. All rights reserved. For permission to reuse any of this content visit <https://www.bmj.com/company/products-services/rights-and-licensing/permissions/>  
BMJ Case Report Fellows may re-use this article for personal use and teaching without any further permission.

Become a Fellow of BMJ Case Reports today and you can:

- ▶ Submit as many cases as you like
- ▶ Enjoy fast sympathetic peer review and rapid publication of accepted articles
- ▶ Access all the published articles
- ▶ Re-use any of the published material for personal use and teaching without further permission

**Customer Service**

If you have any further queries about your subscription, please contact our customer services team on +44 (0) 207111 1105 or via email at [support@bmj.com](mailto:support@bmj.com).

Visit [casereports.bmj.com](http://casereports.bmj.com) for more articles like this and to become a Fellow