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Case Study

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FATAL METHEMOGLOBINEMIA AND CARDIAC ARREST FOLLOWING INDOXACARB POISONING: A CASE REPORT

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ABSTRACT

Background: Indoxacarb is a widely used oxadiazine insecticide for general use, low in toxicity to humans. Rarely, however, high ingestion produces conditions which can become fatal, e.g., methemoglobinemia. **Case Presentation:** We report a case of middle-aged male, who entered the emergency department by ingesting the indoxacarb, developed central cyanosis unresponsive to oxygen, chocolate-colored blood, and progressive hypoxia. He underwent supportive management, including high-flow oxygen, gastric decontamination with ascorbic acid, and planned methylene blue therapy (which was unavailable), and later developed pulseless electrical activity and succumbed to cardiac arrest. **Conclusion:** This highlights methemoglobinemia induced by indoxacarb, and not very frequently described, but may be fatal. It also emphasizes the early clinical recognition, the immediate availability of specific antidotes like methylene blue, and emergency preparedness, which allows improved outcomes for patients.

KEYWORDS: Indoxacarb poisoning, Methemoglobinemia, Cardiac arrest, Methylene blue, Insecticide toxicity, Cyanosis, Toxicology emergency.

INTRODUCTION

Indoxacarb, a broad-spectrum and non-systemic oxadiazine insecticide, is widely used in agriculture against lepidopteran pests. The mode of its action is obstruction of voltage-dependent sodium channels in insects leading to cessation of feeding, paralytic state, and death within insects. Indoxacarb claimed to have low human risk because of the selective action of this chemical on sodium channels found in insects. However, in very much high exposure, especially by inducing oral ingestion, significant systemic toxicity can appear and raise serious clinical concerns.[1,2]

In rare instances, indoxacarb poses systemic poisoning in humans and produces several toxic effects, which may include irritation of the gastrointestinal tract, depression of the central nervous system, metabolic acidosis, and, rarely, methemoglobinemia. Methemoglobinemia is a rare, life-threatening state where hemoglobin is oxidized to methemoglobin and becomes incapable of effectively carrying oxygen; hence, tissues experience hypoxia, and oxygen saturation values in the arterial blood gas (ABG) remain normal- a clinical entity termed the saturation gap.[3,4]

On clinical presentation, methemoglobinemia usually leads to cyanosis unresponsive to oxygen supplementation, while blood color would be chocolate-colored along with the tachycardia and progressive neurological and cardiovascular compromise. Finally, in severe cases, seizures, arrhythmias, coma, and even cardiac arrest might develop. Diagnosis is made by co-oximetry, which unfortunately may not be available in many settings, so the diagnosis must be on a high clinical

suspicion and indirect signs such as cyanosis unresponsive to oxygen and the characteristic color of the blood.[5,6]

For moderate to severe methemoglobinemia, methylene blue is the treatment of choice; it acts as an artificial electron carrier for the reduction of methemoglobin back to functional hemoglobin along the NADPH-methemoglobin reductase pathway. Its availability may be limited in some emergency and rural settings. In these instances, alternative therapies, including high-dose vitamin C (ascorbic acid), could be used, albeit at a slower rate and with decreased efficacy in reversing hypoxia.[7,8]

The present report describes an exceptional and lethal case of indoxacarb-induced methemoglobinemia in a middle-aged male patient, which progressed to hypoxia and then to pulseless electrical activity and cardiac arrest. This case emphasizes the importance of early clinical recognition of methemoglobinemia, the rapid initiation of appropriate antidotal therapy, and the critical need for preparedness in emergency toxicology management, especially in resource-poor areas.[9,10]

CASE STUDY

Patient Information

- **Age:** 34 years
- **Sex:** Male
- **Weight:** Approximately 65 kg
- **Height:** 170 cm
- **Occupation:** Farmer
- **Residence:** Rural area
- **Marital Status:** Married
- **Socioeconomic Status:** Lower-middle class
- **Mode of Arrival:** Brought by family members via private vehicle
- **Time Since Ingestion:** Approximately 1 hour prior to presentation.

Presenting Complaint

When the patient arrived at the hospital, he had the following problems:

- Shortness of breath and fast breathing
- His lips, tongue, and fingertips looked bluish (a sign of low oxygen in the blood)
- He was very drowsy and confused, not fully aware of what was happening
- Oxygen levels were very low, even though he was given oxygen through a mask
- He had one episode of vomiting shortly after swallowing the poison

He did not have any fits (seizures), no chest pain, and no frothing at the mouth.

History of Present Illness

Family members said the patient was found unresponsive at home after having ingested almost 50 mL Indoxacarb 14.5% SC insecticide supposedly to commit suicide after some sort of disturbances in family. The act was witnessed. No history of either alcohol or other substances co-ingested has been reported.

Past Medical History

- No history of diabetes, hypertension, or any chronic illness
- No known allergies
- No previous history of psychiatric illness or suicide attempts

Family History

- No family history of hereditary methemoglobinemia or hemoglobinopathies.

Personal History

- Smoking: No
- Alcohol: Occasional use reported
- Diet: Mixed
- Sleep/Appetite: Normal until event
- Stressors: Reported ongoing financial stress related to crop loss

Clinical Examination

Upon presentation to the Emergency Department, the patient was examined thoroughly. The following findings were noted:

General Appearance

- Patient was drowsy and disoriented, responding to verbal stimuli.
- Marked central and peripheral cyanosis observed, especially around the lips, tongue, and nail beds.
- Skin was cold and clammy.
- No visible signs of trauma or insecticide spillage.

Vital Signs

- Temperature: 98.7°F (37.0°C)
- Heart Rate: 108 beats per minute, regular rhythm
- Respiratory Rate: 28 breaths per minute, shallow breathing
- Blood Pressure: 100/60 mmHg
- SpO_2: 84% on room air, unchanged even with high-flow oxygen (non-rebreather mask)

Airway and Breathing

- Airway patent.
- No stridor or upper airway obstruction noted.
- Auscultation revealed bilaterally equal air entry with no added sounds.
- Breath sounds clear, no crackles or wheeze.
- No frothing or oral secretions present.

Cardiovascular System

- Tachycardia noted.
- Heart sounds S1 and S2 normal, no murmurs.
- Peripheral pulses present but weak.
- Capillary refill time: >3 seconds (delayed).

Neurological Examination
- GCS: 12/15 (E3V4M5)
- Pupils: 3 mm, equal and reactive to light
- No focal neurological deficit identified.
- No signs of seizure activity or rigidity.

Abdominal Examination
- Soft, non-distended.
- No organomegaly or tenderness.
- Bowel sounds audible.

Skin and Mucous Membranes
- Notable dusky discoloration of lips, tongue, and fingertips.
- Blood drawn appeared chocolate-brown in color.
- No rashes or signs of allergic reaction.

Musculoskeletal and Extremities
- No edema or deformity.
- Muscle tone normal.

Laboratory Investigations

Test	Result	Normal Reference Range	Remarks
Arterial Blood Gas (ABG)			
– pH	7.31	7.35 – 7.45	Mild acidosis
– $PaCO_2$	32 mmHg	35 – 45 mmHg	Respiratory compensation
– HCO_3^-	19 mmol/L	22 – 26 mmol/L	Metabolic acidosis
– PaO_2	112 mmHg	80 – 100 mmHg	Normal oxygen tension
– SpO_2	84% (on O_2)	>95%	Low saturation despite oxygen
Complete Blood Count (CBC)			
– Hemoglobin (Hb)	12.8 g/dL	13 – 17 g/dL (M)	Within normal limits
– White Blood Cell Count (WBC)	13,000 /mm³	4,000 – 11,000 /mm³	Mild leukocytosis
– Platelet Count	210,000 /mm³	150,000 – 450,000 /mm³	Normal
Renal Function Tests			
– Serum Creatinine	0.9 mg/dL	0.6 – 1.2 mg/dL	Normal
– Blood Urea	28 mg/dL	10 – 40 mg/dL	Normal
Liver Function Tests			
– AST (SGOT)	32 U/L	5 – 40 U/L	Normal
– ALT (SGPT)	28 U/L	7 – 56 U/L	Normal
– Total Bilirubin	0.8 mg/dL	0.3 – 1.2 mg/dL	Normal
Electrolytes			
– Sodium (Na^+)	136 mmol/L	135 – 145 mmol/L	Normal
– Potassium (K^+)	4.1 mmol/L	3.5 – 5.1 mmol/L	Normal
Methemoglobin Level	*Not Available*	<1.5%	Test not accessible at the time
Peripheral Smear	Normocytic, normochromic	–	No hemolysis or morphological changes

Diagnosis

Acute indoxacarb poisoning had been diagnosed in this patient, which presented a severe form of methemoglobinemia, characterized by unresponsive central cyanosis to oxygen, chocolate-brown blood, and a significant oxygen saturation gap despite normal levels of PaO_2. Clinical deterioration in the form of metabolic acidosis and eventual cardiac arrest sealed the diagnosis of life-threatening toxicity. Measurement of methemoglobin levels was not possible; however, clinical features firmly pointed toward fatal methemoglobinemia due to indoxacarb ingestion.

Treatment

The patient was immediately resuscitated and supported upon admission to the emergency department. The course of treatment consisted of the following:

1. Initial Stabilization
- The airway was kept patent; oxygen was applied with a non-rebreather mask at 15 L/min.
- High-flow oxygen was applied in spite of low SpO_2 (84%); this suggested methemoglobinemia.
- IV access was established; normal saline was infused rapidly to support the blood pressure.

2. Decontamination
- About an hour after ingestion, gastric lavage was done on account of recent exposure and consciousness.
- Activated charcoal (1 g/kg) was given to prevent any further absorption of indoxacarb into the systemic circulation.

3. Suspected Methemoglobinemia Management

- Given the classical presentation (cyanosis unresponsive to oxygen, chocolate-colored blood), empirical treatment with methemoglobinemia was given:
  - Methylene blue at the dose of 1-2 mg/kg IV infusion over five minutes; however, It was not available in the emergency setup immediately.
  - As an adjunct alternative antioxidant therapy reducing levels of methemoglobin, 1 g ascorbic acid (vitamin C) was given IV.

4. Monitoring and Supportive Care

- Continuous cardiac monitoring, with frequent checks for SpO_2, BP, and ABG.
- Mechanical ventilation was planned but suspended when the patient rapidly worsened.
- Severe metabolic acidosis was corrected by intravenous sodium bicarbonate as ABG pH 7.31, HCO_3^- 19 mmol/L.
- Electrolyte levels and renal function were monitored closely.

5. Emergency Response to Cardiac Arrest

- The patient developed bradycardia followed by pulseless electrical activity (PEA).
- Advanced Cardiovascular Life Support (ACLS) protocol was initiated:
  - Immediate CPR
  - Epinephrine 1 mg IV every 3–5 minutes
  - Intubation for airway protection and ventilation
  - Defibrillation not indicated due to non-shockable rhythm
- Following 30 minutes of resuscitative efforts, return of spontaneous circulation (ROSC) was not achieved, and the patient was declared dead.

DISCUSSION

Indoxacarb belongs to the oxadiazine class of insecticides. It poisons insect sodium channels, resulting in paralysis and ultimately death. It is said to be relatively safer compared to other insecticides; yet even acute exposure to it could be dangerous or fatal. Indoxacarb rarely causes methemoglobinemia in humans, characterized by oxidation of iron in hemoglobin into a ferric form with diminished ability to deliver oxygen and subsequently tissue hypoxia. The present case report represents a rare but serious form of presentation.[11]

Patients diagnosed with methemoglobinemia exhibit cyanosis that is resistant to oxygen therapy, chocolate-brown-colored blood with signs of altered levels of emotional perception, tachypnea, and progressive respiratory and neurological deterioration. The clinical findings in this case, where Pa O 2 was highly elevated in the arterial blood gas analysis, seem to suggest functional hypoxia due to increased levels of methemoglobin. While specific tests to ascertain methemoglobin levels were not being performed, the clinical features were more than indicative in this case. The SpO 2 gap—low levels of saturation with normal arterial levels refractory to alternative therapy—provides an important clue for the diagnosis.[12]

Treatment consists of the administration of methylene blue, a reducing agent that helps restore methemoglobin to hemoglobin in an NADPH-dependent manner; however, methyline blue was not immediately available in this circumstance, pointing to an important lack in emergency preparedness for toxicological emergencies in resource-poor settings. Ascorbic acid, a slower and less effective reduce, was administered instead. In addition, supportive care with oxygen, intravenous fluids, bicarbonate for acidosis, and activated charcoal to decrease the absorption of the poison were instituted without delay. Unfortunately, the quick clinical demise resulted in bradycardia and pulseless electrical activity leading to cardiac arrest and death despite attempts at resuscitation.[13,14]

Recognizing pesticide-induced methemoglobinemia early and aggressively treating it will always be important, as this case illustrates. It also raises the need for timely availability of lifesaving antidotes, like methylene blue, in every emergency department. Public awareness regarding safe handling and storage of agricultural chemicals is dovetailed in preventing such poisonings. Added to that, this case highlights a lacuna in the routine diagnostic capabilities of many centers where methemoglobin levels cannot be reliably measured in a short turnaround time and underscores the role of clinical judgment in emergency toxicology.[15]

CONCLUSION

We describe a rare but fatal complication of indoxacarb poisoning, which involves severe methemoglobinemia and hypoxia-induced cardiac arrest. Despite the fact that supportive measures were started rapidly and clinicians had a high suspicion of poisoning, the absence of availability of methylene blue worsened the outcome. The case also highlights the requirement of improved clinical awareness of methemoglobinemia among patients presenting with cyanosis unresponsive to oxygen, as well as the need for readily available antidotes. Rapid identification, effective treatment, and increased preparedness for the emergencies would help decrease the mortality rates involved with such toxic exposures.

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