CASE REPORT

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Haemodialysis as an Imperative Treating Modality in Severe Glyphosate-Surfactant Poisoning

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Abstract

Glyphosate-surfactant herbicide is one of the commonly used herbicides in agriculture[1]. There is no known antidote for its toxicity. The patient was a 23-year-old male who presented with history of ingestion of approximately 100 ml of glyphosate-surfactant herbicide. He complained of 4 - 5 episodes of vomiting at the time of presentation. The patient subsequently developed severe toxicity in the form of decreased urine output, hyperkalaemia, metabolic acidosis and respiratory distress. He was managed with aggressive supportive treatment and haemodialysis and recovered completely. This article emphasizes the importance of haemodialysis in severe glyphosate-surfactant herbicide poisoning.

Introduction

Glyphosate-surfactant herbicide toxicity is determined by the combined effect of glyphosate and surfactant. Gastrointestinal symptoms are the most common manifestations after oral ingestion. Severe toxicity is marked by development of acute kidney injury, oliguria, metabolic acidosis, pulmonary oedema and cardiovascular effects in the form of arrythmias and hypotension. It has been seen that the triad of pulmonary oedema, hyperkalaemia and metabolic acidosis is associated with a grave prognosis and mortality of around 30% in patients of glyphosate-surfactant herbicide poisoning.

Case presentation

The patient was a 23-year-old male who came to the emergency department with a history of ingestion of approximately 100 ml of glyphosate-surfactant herbicide and had 4 - 5 episodes of vomiting associated with burning pain in epigastrium. At the time of admission, examination of respiratory, cardiovascular, neurological and abdominal systems was unremarkable. Next day, the patient developed decreased urine output and shortness of breath, associated with orthopnoea. His respiratory rate was 40/min and Spo_2 was 82%, on room air and 95%, on 5 liters of O_2 given through a Venturi mask. His pulse rate was 156/minute and blood pressure were 114/70 mmHg. On auscultation, chest revealed fine crepitations in bilateral bases.

Investigations

At the time of admission, ECG showed sinus tachycardia and chest X-ray PA view was normal (Fig. 1). Blood urea was 14 mg/dl, serum creatinine 0.7 mg/dl, serum Na^+ 148 mEq/l and serum K^+ was 4.1 mEq/l. Arterial blood gas analysis was normal. Next day, when the patient's condition deteriorated; ECG was done which showed sinus tachycardia with changes of hyperkalaemia. Chest X-ray showed fluffy opacities in bilateral lung fields (Fig. 2). Blood urea was 109 mg/dl, serum creatinine 5.6 mg/dl, and serum potassium was 5.7 mEq/l. Arterial blood gas analysis revealed metabolic acidosis with hypoxia having pH 7.19, paO_2 78.9 mmHg, $paCo_2$ - 23.4 mmHg and bicarbonate - 13 mEq/l.

Treatment

Patient was put on mechanical ventilation for respiratory distress. Treatment for hyperkalaemia and metabolic

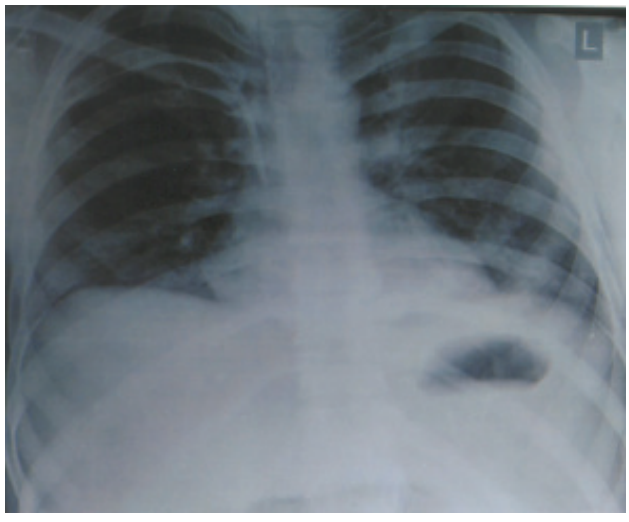

Fig. 1: *Chest X-ray PA view on admission (normal).*

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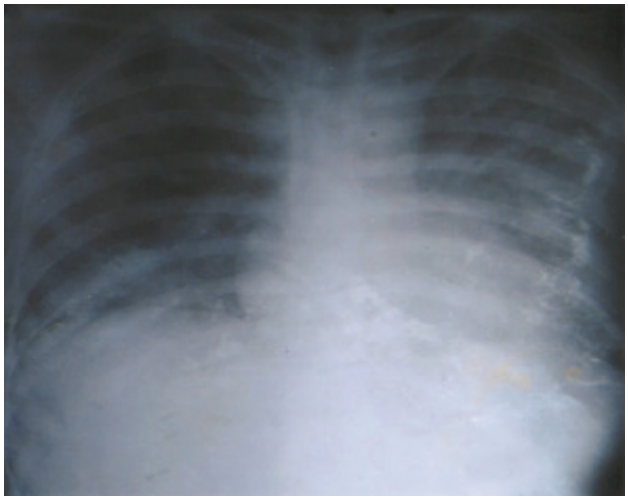

Fig. 2: *Chest X-ray PA view on day 2 showing fluffy opacities in bilateral lung fields suggestive of pulmonary oedema due to toxicity of glyphosate-surfactant poisoning.*

acidosis was given. Intravenous Nitro-glycerine infusion was started for pulmonary oedema. Patient was started on haemodialysis and underwent seven sessions.

Outcome and follow-up

A gradual improvement was seen in the condition of the patient over 14 days. Patient was gradually weaned from the ventilator on 4th day. Patient was discharged in a stable condition. At one-month follow-up his blood urea and serum creatinine were 24 mg/dl and 0.9 mg/dl and is currently not on any treatment with normal renal parameters.

Discussion

Glyphosate-surfactant is a non-selective herbicide used for weed control. Despite its widespread use, no data is available regarding the prevalence of its toxicity worldwide. Due to introduction of genetically engineered glyphosate tolerant crops, an exponential rise in glyphosate use has been seen[2]. The herbicide contains 41% isopropylamine salt of glyphosate which is active ingredient,15% ethoxylated tallowamine surfactant (POEA), water and related organic acids of glyphosate and excess isopropylamine. It acts via disrupting the shikimic acid pathway which is present in plants that results in a deficiency of 5-enolpyruvylshikimate-3-phosphate production and leads to reduction of protein synthesis and plant growth and ultimately death in 4 - 20 days[3]. Glyphosate itself does not cause severe toxicity in humans as shikimic acid pathway is absent. Toxicity is due to the uncoupling of oxidative phosphorylation and POEA mediated inhibition of glutathione conjugation[4]. This is the reason why clinical manifestations of toxicity are determined by combined effects of glyphosate and surfactant. The toxicity of the surfactant, polyoxyethyleneamine (POEA) is greater than the toxicity of glyphosate alone. After oral ingestion of glyphosate 30 - 36% is absorbed and peak concentrations are achieved in tissues within 6 hours. It undergoes little metabolism and is excreted mostly unchanged in the faeces and secondarily in the urine. The effects usually manifest within 24 hours from ingestion. Oral ingestion results in nausea, vomiting and diarrhoea. Eye and skin irritation have occasionally been reported from dermal exposure. Inhalation of spray mist may cause oral/nasal discomfort, tingling and throat irritation. Severe toxicity is marked by development of acute kidney injury, oliguria, metabolic acidosis, pulmonary oedema and cardiovascular effects in form of arrythmias and hypotension. Predictors associated with poor outcomes and mortality in patients of glyphosate-surfactant herbicide poisoning are pulmonary oedema, abnormal chest X-ray, respiratory distress necessitating intubation, shock (systolic blood pressure less than 90 mmHg), altered consciousness, renal failure necessitating haemodialysis, large amount of ingestion (> 200 ml), and hyperkalaemia[5,6]. Severity of toxicity is dependent on the amount of ingested glyphosate-surfactant herbicide. It is seen that ingestion of more than 85 ml of concentrated preparation is associated with severe toxic manifestations in adults[7]. Many studies show that mortality of this poison is very high in the setting of severe toxicity despite aggressive supportive management[8,9]. However, recent studies highlight a possibility of survival if early initiation of haemodialysis is done along with other aggressive supportive measures[10,11,12]. Haemodialysis if initiated early may lead to clearance of toxins; however, this fact is unsubstantiated according to data available. The main role of haemodialysis in the setting of severe toxicity is mainly symptomatic management till toxin is cleared from circulation. Our patient had ingested 100 ml of glyphosate-surfactant herbicide which led to severe toxicity in the form of pulmonary oedema, acute kidney injury, hyperkalaemia and metabolic acidosis after 12 hours. Patient improved dramatically after initiation of haemodialysis which shows the vital role of haemodialysis in patients with severe toxicity.

Learning points

1. Enquire about the amount that patient had ingested as severity of toxicity and prognosis correlates with amount of toxin.
2. The triad of pulmonary oedema, hyperkalaemia and metabolic acidosis in patients of glyphosate-surfactant poisoning is associated with a grave prognosis.
3. Early institution of renal replacement therapy must be

considered for oliguria, metabolic acidosis or hyperkalaemia, developing in a patient of glyphosate-surfactant poisoning.

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