

# Treatment of Gastrointestinal Corrosive Burns Caused by Highly Lethal Glyphosate Solution Poisoning

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## ABSTRACT

Glyphosate was developed by Monsanto in the United States in the 1970s and has now become the world's best-selling pesticide. It is used in more than 100 countries and regions. Glyphosate is generally considered to be less toxic or even safe for mammals, including humans, and most patients with glyphosate poisoning have a better prognosis. However, this article reports a case of a 36-year woman who suffered severe gastrointestinal damage after oral administration of 50 ml of glyphosate. After the active rescue, scar contractures occurred in both the oesophagus and trachea. The patient recovered clinically after undergoing reconstructive surgery.

**Key Words:** *Glyphosate poisoning, Chemical burns, Oesophageal reconstruction, Tracheal reconstruction.*

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## INTRODUCTION

Glyphosate is currently the most widely sold herbicide in the world. It is widely used in agriculture and animal husbandry due to its high efficiency and broad-spectrum. Although some studies have shown that chronic accumulation of glyphosate has certain toxic effects, but the current mainstream opinion still believes that glyphosate is safe and less toxic.<sup>1,2</sup> However, many cases of glyphosate poisoning have been reported where glyphosate has caused severe damage to humans.<sup>3-5</sup> We think this is due to the different ingredients of glyphosate preparations taken orally. Herein, we report a 36-year woman who ingested about 50 ml of glyphosate aqueous solution. After gastric lavage at a local hospital, she was transferred to this hospital. During hospitalisation, the patient suffered a severe gastrointestinal corrosive injury, accompanied by scar contractures of the trachea and the oesophagus. After early rescue and multiple surgical treatments in the later period, she was cured

## CASE REPORT

A 36-year female, 164 cm tall and 52 kg in weight, ingested 50 ml of glyphosate solution. She described that it was difficult to swallow, and then vomited, and had a cough. Three hours after gastric lavage at a local hospital, she was transferred to this hospital. Her vital signs were stable.

The patient had severe erosions of the oral mucosa, and laryngeal oedema. The abdomen was flat and supple, and there was slight tenderness below the xiphoid process. The patient complained of difficulty in breathing. After testing, the pH value of glyphosate solution was <1. We assumed that this bottle of the glyphosate contained high concentrations of sulfuric acid, which caused severe acid corrosion. The patient was given oxygen and a nasogastric tube was inserted. We used methylprednisolone intravenously, 80 mg once daily, and changed to oral prednisone 3 days later, and gradually reducing the dose over one week, continuous intravenous esomeprazole and somatostatin. The patient vomited dark red blood and developed melena in the early morning of the next day. We used hemocoagulase and started with parenteral nutrition for the next 3 days. The patient continued to have melena. Five days after treatment, the patient's condition gradually stabilised, and no melena was noted. Her voice was still hoarse, but she could drink water and take a small amount of liquid food. We removed the stomach tube. Chest CT showed multiple lung lesions and subcutaneous emphysema of the chest and back, possibly due to tracheo-oesophageal fistula (Figure 1).

We discontinued steroids and somatostatin. Only intravenous pantoprazole and nutritional support were continued. The patient's condition gradually improved, the ulcers were healed, but eating was difficult, and only a small amount of milk could be taken orally. Due to oesophageal scarring, the oesophagus was severely narrowed and gastroscopy was inaccessible. The patient's weight dropped to 40 Kg due to difficulty in eating. We performed a gastrostomy operation for enteral nutrition support and discharged her to return to the hospital for oesophageal reconstruction after six months. The patient returned to the hospital in due time. She complained of dyspnea for nearly six months and had been unable to eat orally. The

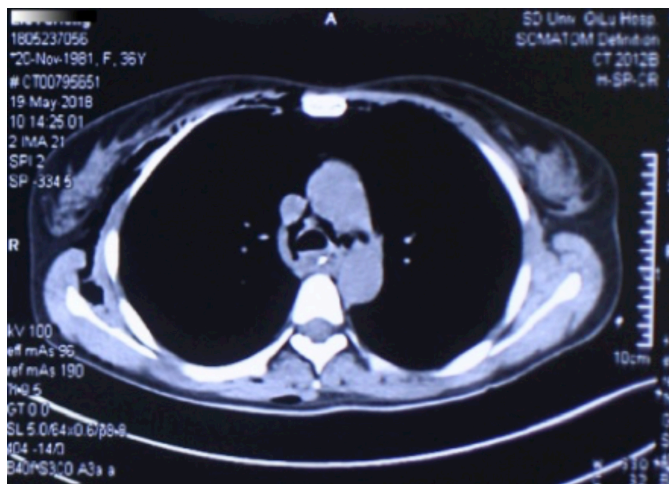
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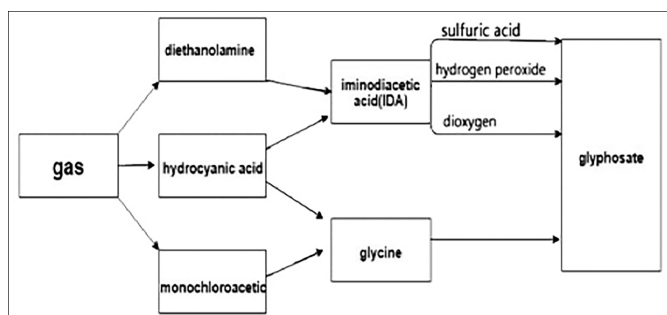
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gastroscope was entered from the gastric fistula and could not enter oesophagus due to gastric cardia stricture. A guidewire and X-ray were used to determine the location of oesophageal stricture. The diseased oesophagus and diseased trachea were removed, the oesophagus and the trachea were reconstructed, and a tracheotomy was performed. One week after discharge, the metal cannula at the tracheotomy was pulled out, and the incision healed by itself after about 2 weeks. Follow-up was conducted 1 year after surgery, and the patient had no problem with food ingestion and experienced no discomfort.



**Figure 1:** CT reveals multiple lung lesions and subcutaneous emphysema of chest and back, possibly due to tracheo-oesophageal fistula.



**Figure 2:** Glyphosate preparation routes in China.

## DISCUSSION

Extensive experimental data from the two major organisations of pesticide residue safety audits, U.S. Environmental Protection Agency (EPA)<sup>6</sup> and Codex Alimentarius, show that glyphosate is the safest and least toxic of the existing herbicides. But in some previous reports, we found that some glyphosate pesticides are significantly more toxic, and we also noted in clinical work that the prognosis of patients with glyphosate pesticide poisoning varies widely.<sup>3-5</sup> Patients with a more severe condition have some common characteristics, such as ingestion of an aqueous solution of glyphosate and very low pH of the formulation. These reports mostly come from developing countries, and glyphosate preparations that cause patient poisoning are not produced by regular companies such as Monsanto. We suggest that the ingredients that cause severe poisoning are the strong acids used in such mixture preparation. There are two main routes for glyphosate production in

China (Figure 2), namely IDA route with iminodiacetic acid (IDA) as the starting material and glycine route using glycine as raw material.

The IDA route is the formation of N-(phosphonomethyl) iminodiacetic acid (PMIDA) through the Mannich condensation reaction of paraformaldehyde and phosphorous acid. Then, oxidative decarboxylation of PMIDA produces glyphosate. In this process, concentrated sulfuric acid, hydrogen peroxide or dioxygen is often used as the oxidant.<sup>7</sup> The method for preparing glyphosate by oxidizing PMIDA with concentrated sulfuric acid does not use solvents and catalysts, the reaction process is simple, and the product cost is low. This method can only be used for the production of glyphosate aqueous solution. The quality of the products is not good and pollution is serious. Regular manufacturers no longer apply this solution. If this method is used, the pH should be adjusted by using ammonia gas. The national standard of the People's Republic of China requires that the glyphosate aqueous solution has a pH value of 4.0-8.5.<sup>8</sup> Obviously, glyphosate-aqueous solutions with a pH value <1 do not meet Chinese national standards. These glyphosate aqueous solutions contain concentrated sulfuric acid, which can cause severe chemical burns. Therefore, patients with poisoning will have severe digestive tract burns, severe acidosis, and even oesophageal fistula in the early stage.

Thus, patients with glyphosate poisoning, especially those who have taken glyphosate-aqueous solutions must be taken seriously. When the pH of the solution is <1, one should strongly suspect that the pesticide contains strong acids. Once confirmed as a strong acid, emergency treatment should be provided immediately. Gastric lavage is not recommended. Steroids should be used early to inhibit scar formation. Early use of proton pump inhibitors is required to inhibit gastric acid. When severe gastrointestinal bleeding occurs, timely application of hemostatic drugs is required. For patients with mild scar stenosis or short lesions, oesophageal dilatation can be used.<sup>9</sup> This method is convenient and simple. When oesophageal dilatation could not be performed, esophagectomy is needed. The surgery should be performed after the scar is stabilised, usually six months after the corrosion injury has occurred.<sup>10</sup> While waiting for the operation, if the patient could not eat due to severe oesophageal stricture, gastrostomy can be performed for nutritional support.<sup>11</sup>

This case emphasises that great attention should be paid to this kind of poisoning incident caused by glyphosate solution containing strong acid. The treatment protocol is not the same as the common glyphosate poisoning, and the toxicity of this kind of pesticide is far greater than ordinary glyphosate.

## PATIENT'S CONSENT:

Consent for publication was obtained from the patient.

## COMPETING INTEREST:

The authors declared no competing interest.

## AUTHORS' CONTRIBUTION:

YMT, JH, SC: Collected data and drafted the manuscript.

XDJ, KBT: Edited and critically reviewed the manuscript.  
All the authors have approved the final version of the manuscript to be published.

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