



# Mass Occupational Phosphine Poisoning of a Dry-Cargo Ship Crew: A Case Report

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## Abstract

Fumigation of grain cargoes in the ship holds with phosphorus hydrogen-based substances has been widely introduced into the daily practice of the fleet. We present a case of mass occupational phosphine poisoning in the crew of the cargo ship. On October 18, 2018, the "Nazmeh" cargo ship transporting grain from Kazakhstan to Azerbaijan by the Caspian Sea has sent a SOS signal. The Azerbaijani patrol ship was found with 12 seafarers on board with signs of poisoning and evacuated them onshore. Upon admission to the hospital the patients were diagnosed with "phosphine poisoning" based on clinical symptoms and positive chemical-toxicology test. Because phosphine has no antidote, supportive care and symptomatic therapy was administered. In 36 hours, all patients were discharged without complications. Three seafarers died on board before the patrol ship arrived. The autopsy showed that death occurred due to profound shock, acute myocarditis, pulmonary edema and multi-organ failure. The cause of this mass poisoning in seafarers was the failure in the ship safety requirements, decrepitude of the vehicle and the lack of tightness of the holds. The incident showed the necessity for strengthening of control over the observance of safety rules during transportation of fumigated goods.

**Keywords:** Phosphine; Poisoning; Ship crew; Azerbaijan

## Introduction

Fumigation of grain cargoes in ship holds with phosphorous hydrogen-based substances is a widely used practice in the shipping industry (1). Generally, phosphides of aluminum or magnesium are used. When these fumigants come in contact with moisture in air or grains, they emit phosphorous hydrogen (phosphine) gas which kills agricultural pests. However, phosphine gas is also toxic to humans and affects the heart, lungs, gastrointestinal tract, and kidneys (2).

The literature describes several cases of phosphine poisoning in ship crews (3;4), but such incidents continue to occur.

We present a case of mass occupational acute phosphine poisoning in the crew of an Iranian cargo ship sailing on the Caspian Sea.

## Case report

On October 18, 2018 at 11:00 PM, the Iranian dry cargo vessel *Nazmeh* (IMO 8876522) which was carrying 1500 tons of 3rd grade grain from Aktau, Kazakhstan to Baku, Azerbaijan, being sent out a distress signal due to mass poisoning on board.



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The SOS signal was received by the State Maritime Agency and was immediately forwarded to the Coast Guard of the State Border Service of Azerbaijan. Despite bad weather conditions, an Azerbaijan Coast Guard team was immediately sent to assist the *Nazmebr* crew and moored to the ship at 12:30 AM on October 19, 2018.

The Coast Guardsmen found on board the crew of 12 men. Three of the *Nazmebr* crew members died before the arrival of the Coast Guard vessel. Another 4 men were found unconscious. After providing first aid to crew members, four of them who were seriously poisoned and unconscious were evacuated to the Azerbaijani port of Dubandi on the Absheron Peninsula and then transferred by ambulance to the Center of Clinical Toxicology (CCT). The remaining five crew members, after receiving medical care onboard, refused to evacuate to shore. However, at approximately 4:00 AM on October 19, the captain of the *Nazmebr* contacted the Coast Guard again requesting medical assistance for 4 more crew members whose condition had deteriorated. The Coast Guard immediately dispatched another ship, provided first aid to the remaining five *Nazmebr* crew members, and evacuated four of them to shore and to the CCT. The captain of the ship, a citizen of Ukraine who had only minor signs of poisoning, refused medical evacuation to shore and remained with the ship.

In all, four victims were admitted to the CCT after 3.5 hours, and four more after 8 hours from the moment of toxic exposure. All hospitalized patients were male; the average age was  $33.11 \pm 2.98$  years.

Upon admission to the CCT, the patients' main symptoms of acute poisoning were: headache, dizziness, tinnitus, nausea, vomiting, abdominal pain, lethargy, drowsiness, and stupor. Several patients exhibited respiratory symptoms such as coughing, choking, and tightness in the chest.

According to the Coast Guard investigation into the incident, fumigation of grain was carried out using aluminum phosphide (*Quickphos*) tablets at a dose of 560g/kg. The amount of aluminum phosphide used during fumigation was 9 grams

per ton of grain, which was an appropriate dosage per industry standards.

The patients were diagnosed with acute inhalation phosphine poisoning and put in the Intensive Care Unit. Diagnosis was based on history, clinical suspicion, symptoms and positive chemical-toxicology test to phosphine.

Laboratory test results showed leukocytopenia ( $2.86 \pm 0.62 \cdot 10^3/\mu\text{L}$ ) and thrombocytopenia ( $118.78 \pm 90.96 \cdot 10^3/\mu\text{L}$ ) in all patients. Arterial blood gas analysis revealed metabolic acidosis. In two patient ECG showed a right bundle branch block, which spontaneously resolved within several hours.

As no known phosphine effective antidote exists, the patients were treated with supportive care and symptomatic therapy. Sodium bicarbonate, crystalloid solution infusion and n-acetyl cysteine were administered to all patients. Symptomatic therapies including nootropics, metabolic agents, antiemetics, diuretics, corticosteroids and 100% humidified oxygen were also administered as needed.

After initial stabilization, all patients were additionally examined by a cardiologist, neurologist, infectious disease specialist, and internal medicine specialist. No persistent organ damage was detected in any of the patients. In 36 hours all patients were discharged without any complications.

As mentioned above, three *Nazmebr* ship crew members died on board before the arrival of the Coast Guard ship. Autopsy showed that the cause of death in all 3 cases was profound shock, pulmonary edema, acute myocarditis and multi-organ failure.

## Discussion

Phosphine (hydrogen phosphorus) is a colorless odorless gas, though often a scent similar to that of rotting fish or garlic is added to technical preparations. The maximum permissible concentration (MPC) of phosphine adopted in Azerbaijan for the air of the working area is  $0.1 \text{ mg}/\text{m}^3$ ,

the smell of scented phosphine can be detected at concentrations of 0.03 mg/m<sup>3</sup>.

We found several case reports of phosphine poisoning in members of crews working on grain cargo ships as follows.

In March 2015 on the Russian bulk grain carrier *Ulus Sky*, a 26-year-old first mate died, and another five crew members were evacuated by helicopter to the Russian coast due to severe phosphine poisoning. Four more crew members with signs of poisoning were brought ashore by a rescue ship. The *Ulus Sky* bulk carrier transported 2704 tons of grain across the Caspian Sea from the port of Astrakhan (Russia) to the port of Amirbad (Iran) (5).

In March 2008, off the coast of Crimea, the crew of the Belizean dry cargo ship *Roksolana-1* was poisoned with phosphine. Soon after the fumigation of the cargo (more than one and a half thousand tons of wheat bran), the health condition of the sailors sharply deteriorated. The captain of the ship died, seven other crew members with symptoms of poisoning were taken to the hospital. The vessel was not designed for the transport of such cargo, so toxic gas penetrated into the ship's living quarters. Investigation determined that phosphine concentration in the cargo hold exceeded the safe level by 200 times (6).

In February 2008, on board a Romanian bulk carrier with a cargo of peas sailing from Rouen, France to Cairo, Egypt, a 56-year-old seafarer with intense abdominal and chest pains associated with dizziness, was rescued by helicopter 80 miles away from the coast. Despite being admitted rapidly to the hospital he eventually died of pulmonary edema, severe metabolic acidosis and acute multi-organ failure caused by acute phosphine poisoning. The following day, eleven other crew members were evacuated for observation. Three of them showed clinical abnormalities. The investigation team found out that aluminum phosphide pellets had been put in the ship's hold for pest control before the vessel's departure. Seafarers were poisoned by phosphine gas spreading through cabins above the hold. It was found that the compartments and ducts were not airtight (4).

Built in 1988, the *Nazmehr* is a 2,700-ton freighter. Her last registered PSC inspection was conducted in the port of Astrakhan, Russia, in 2015, and officials noted 45 shortcomings (7). Reported issues included problems with fire equipment, life rafts, water tightness and main engines, as well as other areas.

The cause of this mass occupational poisoning of crew members of the *Nazmehr* apparently was the lack of tightness of the holds and a failure to comply with international safety standards related to fumigation with phosphine.

It is necessary to evaluate the suitability of the vessel for fumigating cargo prior to loading. Such an assessment should take into account the age and condition of the vessel, and also any changes in design that increase the risk of crew poisoning from uncontained fumigants.

Crew members whose duties include loading and unloading fumigated goods must be aware of the potential risks of poisoning and must use necessary precautions. The vessels must have the necessary equipment for gas monitoring of phosphine, in accordance with IMO recommendations for the safe use of pesticides at sea.

## Conclusion

The cause of this mass occupational poisoning in seafarers was the failure in the ship safety requirements, decrepitude of the vehicle and the lack of tightness of the holds. The incident showed the necessity for a serious strengthening of control over the observance of safety rules during transportation of fumigated goods by the Caspian Sea.

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## Conflict of interest

The authors declare that there is no conflict of interests.

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