

Clinical Note

Fumigant Intoxication during Transport of Grain by Railroad

We would like to report what appears to be a previously unreported source of worker exposure to fumigants. In May of 1989, three federal grain inspectors with the US Department of Agriculture in Portland, Oregon, were exposed to phosphine while inspecting wheat on an unplacarded railroad train. One worker, the "grain sampler," opened the top hatch on the first car in the shipment and immediately noted a gray deposit on the grain and a garlicky smell. The worker recognized this as the appearance and smell of aluminum phosphide. A second worker collected grain samples for grading by reaching into the hopper cars, while the first worker continued opening cars. Similar evidence of aluminum phosphide residue was noted in subsequent cars, though odors were not consistently perceptible. A third worker arrived to transport the samples to the lab. None of the workers were wearing any respiratory protection.

When the seventh car was opened, there was "an immediate overpowering blast of fumigant odor." There was no skin contact and the hatch was closed very quickly. Almost immediately, the three workers began to develop symptoms; within an hour they were seen at a local emergency room. All three complained of facial numbness and tingling, dizziness, nausea, and shortness of breath. Two of the three complained of headache and disorientation. One worker also complained of diaphoresis, despondency, and a "sense of doom." He reported being closest to the cars when they were opened. He had a history of asthma, a remote 10-pack year use of tobacco, and hypertension. His medications were theophylline 300 mg twice daily; an occasional beta agonist inhaler, chlorthalidone 50 mg daily, and clonidine .1 mg

twice daily. He had a similar exposure episode in 1979 to a carbon tetrachloride- and- bisulfide-based fumigant, for which he sought medical treatment.

The other two workers were current smokers and had negative medical histories. Ear, nose and throat, cardiac, pulmonary, gastrointestinal, and neurological exams were unremarkable acutely and on follow-up. All three had negative chest roentgenographs. Arterial blood gases showed no abnormalities. All three workers had urine and blood samples sent for phosphine detection to the Department of Agriculture laboratory. Test results were negative.

The grain in several of the railroad cars in question were sampled after at least 20 minutes of aeration. Car #2 had a phosphine level of 159 ppm, car #5 298 ppm, and car #7 2029 ppm. Aeration of the cars precluded measuring the amount of phosphine in the air pocket within the cars above the grain. Unfortunately, there is no reliable method for measuring levels of phosphine in blood and urine except for high-dose exposures to aluminum phosphide. [Personal communication, Daniel Shaheen, Vice President, Technical Section, Degesch America Incorporated (manufacturer of aluminum phosphide) Weyers Cave, VA].

Case 1 was symptomatic 4 days later and reported for consultation to the Occupational Medicine Clinic at Kaiser Permanente, Clackamas, Oregon. He complained of headache, nausea, shortness of breath, fatigue, and intermittent diaphoresis. The exam remained negative and the complete blood count was normal. Serum SGOT was 33, GGT was 47, BUN 15, and creatinine 1.2. Three weeks later the patient still complained of shortness of breath. The other symptoms had resolved. Pulmonary function testing for case 1 is presented in the Table.

TABLE 1
Pulmonary Function Testing in Case 1 Exposed to Phosphine

Date	FVC (liters)	% predicted	FEV1 (liters)	% predicted
9/83	3.87	84	2.84	80
6/89*	3.65	82	2.57	71
7/89†	3.85	84	2.90	80

* 3 weeks postexposure.

† 7 weeks postexposure.

From the Department of Occupational Medicine, Kaiser Permanente Sunnyside Medical Center, Mount Talbert, 10180 SE Sunnyside Road, Clackamas, OR 97015. Address correspondence to Dr Feldstein.

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Case 1 returned to work 12 days postexposure with use of a respirator with a filter effective for fumigants for use while inspecting railroad cars. By 6 weeks post-exposure he was asymptomatic.

Case 2 was asymptomatic after 4 days and did not seek follow-up care.

Case 3 followed-up at the Kaiser Permanente Occupational Medicine Clinic 3 months postexposure and complained of episodes of disorientation and daily occipital headaches. Neurological exam remained negative. The electroencephalogram was normal.

Phosphine is a highly toxic fumigant that is widely used against insects and rodents in stored grain.¹ Its use has increased dramatically after changes in regulation limiting the use of liquid fumigants.² Aluminum phosphide tablets are placed in the grain, resulting in the production of phosphine gas as moisture is absorbed and hydrolysis occurs.³ Health effects have been reported to occur at levels below the olfactory threshold of 1.5 to 3 ppm.⁴ At perceptible levels, olfactory fatigue may reduce the ability of workers to detect phosphine odor.⁵

These three workers probably received short exposures to air levels of phosphine that exceeded American Conference of Governmental and Industrial Fumigants short term exposure limit of 1 ppm⁶ and possibly the level considered to be "Immediately Dangerous to Life or Health" (National Institute of Occupational Safety and Health) of 200 ppm.⁶ The product label and federal law specifically require placarding of containers and railroad hopper cars when aluminum phosphide is used for grain fumigation.^{7,8}

Two of the persons involved in this incident reported experiencing symptoms in previous grain inspection exposure situations. In the Portland metropolitan area, 25 similar—through less severe—episodes of fumigant exposure have occurred during the last 18 months (personal communication, Walter Rust, Assistant District Manager, Federal Grain Inspection Service, US Department of Agriculture).

These workers' symptoms are similar to those described elsewhere after acute exposure to phosphine.^{3,9,10} Symptoms from acute exposure are generally transient and findings are negative on physical examination and laboratory tests.^{3,9} The one worker with preexisting asthma had a temporary exacerbation of his bronchospasm. Other reported exposures have been aboard ships^{10,11} and in grain elevators.^{3,9} Longer exposures have been reported to cause myocardial, liver, urinary tract, and neurological injury.¹⁰

There is little information on health effects associated with repeated low dose exposures. Exposure to low levels of phosphine has been identified as a potential safety hazard because it increases the risk of exposed

workers falling from the top of the rail cars.¹² Our experience suggests that unaerated railroad cars carrying fumigated grain may be an important source of fumigant exposure in addition to those sources already described in the literature. Up to 500 state and federal grain inspectors may be at risk.¹⁰ Their work practices and resultant exposures need to be better characterized to determine the best preventive interventions. Minimum prevention should include better work education about health risks, better enforcement of placarding fumigated shipments, and better use of respiratory protection by grain inspectors opening railway cars.¹³

Adrienne Feldstein, MD, MS
Department of Occupational Medicine
Kaiser Permanente Northwest
Michael Heumann, MPH
Margot Barnett, MS
Office of Epidemiology and Health Statistics
Oregon State Health Division

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