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CASE REPORT

Phosphine Exposure from a Methamphetamine Laboratory Investigation

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ABSTRACT

***Background**: Law enforcement personnel may be exposed to a variety of hazardous materials during investigation of clandestine methamphetamine laboratories.* ***Case Report**: A 28-year-old forensic specialist investigating a methamphetamine lab was exposed to phosphine without respiratory protection at approximately 2.7 ppm for 20–30 minutes. Shortly following exposure she developed dizziness, cough, headache, and diarrhea, although initial medical evaluation within 1–2 hours was unremarkable. Pulmonary examination at 4 and 7 days postexposure revealed bilateral rhonchi. The cough was worse with exertion, and persisted despite* β*-agonist and steroid inhaler treatment.* ***Conclusions**: This is apparently the first published case of symptomatic occupational phosphine exposure in a law enforcement officer during investigation of a methamphetamine laboratory. If phosphine exposure is suspected, the possibility of delayed pulmonary toxicity should be recognized.*

INTRODUCTION

Illicit production of methamphetamine is an increasing problem in the US. Although national statistics are not available, the number of laboratories reported by a number of states has drastically increased in recent years (1). These drug laboratories may be found in a variety of structures including residential homes, apartments, hotel rooms, storage units, and automobiles. Law enforcement personnel are required to investigate clandestine drug laboratories in order to arrest suspects, collect evidence, and begin the disposal process for hazardous materials. Such assignments may involve exposure to acid gases, solvents, caustics, and other toxicants. A previous study

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found that investigators frequently reported headache and symptoms or irritation consistent with solvent and irritant chemical exposure (2).

Phosphine gas (PH_3) may be produced during methamphetamine production. Phosphine has been reported as a possible cause of death in individuals synthesizing methamphetamine, also known as ''cooks'' (3). Significant exposure to phosphine may result in delayed pulmonary toxicity, although the risk of permanent injury has not been defined. The purpose of this case report is to describe such an exposure, and alert clinical care providers to this hazard.

Case Report

A 28-year-old, previously healthy, nonsmoking forensic specialist with a clandestine drug laboratory team was investigating a red phosphorus-hydriodic acid methamphetamine lab in an automobile repair shop. Four warm 22-liter reaction flasks half full of red liquid were found, vented into separate 5-gallon buckets of ice (Fig. 1). Phosphine was initially detected during entry, and the building was ventilated until the levels decreased to below detectable limits. During subsequent lab processing without respiratory protection, the patient noted a fishy garlic odor and left the exposure area. Phosphine concentration in her work area was subsequently measured at 2.7 ppm. Estimated duration of exposure was 20–30 minutes.

Shortly following exposure she developed dizziness, dry cough, headache, and diarrhea. She was evaluated in an emergency department within 90 minutes of the exposure and initial physical examination, chest X-ray, and laboratory tests including electrolytes, BUN, creatinine, transaminases, carboxyhemoglobin, methemoglobin, and blood cyanide were normal. She was released within 2 hours after arrival. The patient had no prior history of illnesses from methamphetamine lab investigation. One other laboratory investigator was present in the same area as the first investigator. This second individual reportedly developed similar symptoms and was also evaluated and released from the emergency department. No follow-up information is available for this person. Phosphine concentrations in her work area were estimated as much lower than those in the work area of the first investigator.

For the first investigator, pulmonary examination at 4 days postexposure revealed bilateral rhonchi, although spirometry was normal (height 64 inches, FVC 3.58 L, 101% of predicted; FEV_1 3.01 L, 99% of predicted). An

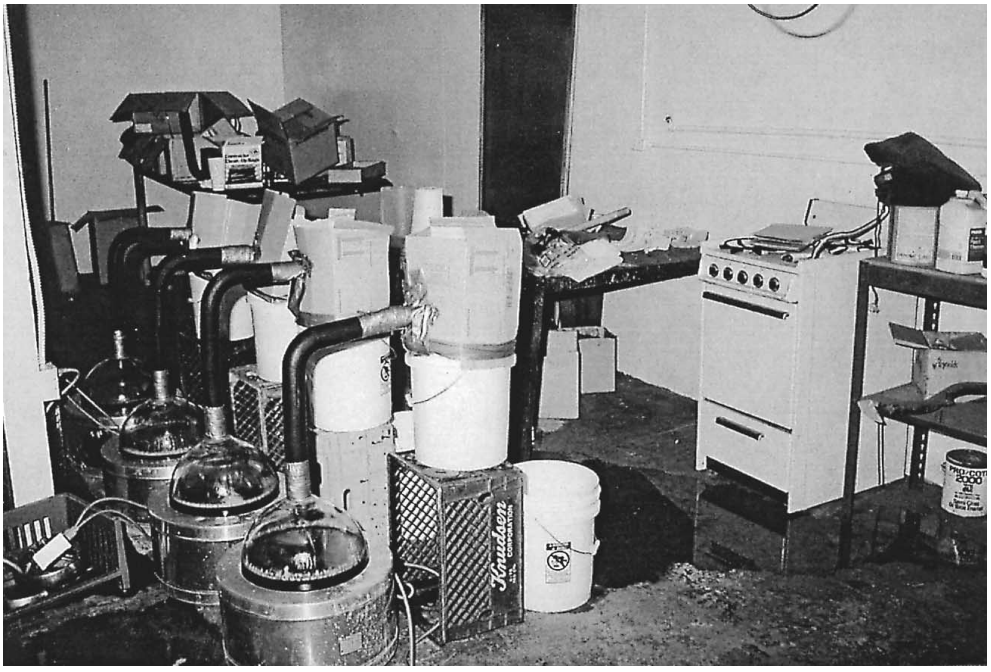

Figure 1. Four 22-liter flasks containing red-phosphorus, hydriodic acid, and pseudoephedrine vented into 5-gallon buckets filled with ice. (Photo by Kelli Brown, Orange County Sheriff's Department.)

evaluation by another physician 7 days after exposure also noted bilateral rhonchi on lung auscultation, with no significant change in spirometry. The patient's lungs were clear to auscultation on examination 12 days after exposure. Based on persistent cough and dyspnea with exertion, stress echocardiogram 3 months following exposure and high resolution CT scan of the chest 4 months following exposure were completed and were essentially normal. Angiotensin converting enzyme and rheumatoid factor levels were normal and ANA and anti ds-DNA titers were negative. Methacholine challenge test 4 months following exposure demonstrated a 10% drop in FEV_1 after methacholine 25 mg/mL, a response within the normal range.

The nonproductive cough persisted despite β-agonist inhaler treatment and was worse with exertion. Symptoms improved on inhaled steroids, but were still present at a reduced level with exertion 9 months following initial exposure.

DISCUSSION

Adverse health effects in law enforcement personnel investigating clandestine labs have been reported, even in individuals wearing respiratory protection (2). The most common symptoms included headache and respiratory, mucous membrane, and skin irritation. Responding to labs actively manufacturing drugs was also found to be a risk factor for acute symptoms. The most common inhalation exposures were considered to be from acid gases and solvents.

The methods used to manufacture methamphetamine vary from lab to lab. One of the most common methods uses red phosphorus, hydriodic acid, and ephedrine or pseudoephedrine reacted together to form methamphetamine. Although red phosphorus is generally considered to have low toxicity, with sufficient heating it can be converted to pyrophoric yellow phosphorus and can also burn producing phosphorus pentoxide. Heating of red phosphorus in the presence of acids may produce phosphine gas. Additional chemicals that may be present and released in methamphetamine manufacture include a large number of solvents, hydrochloric acid, ammonia, metallic sodium, lithium or potassium, and sodium hydroxide.

Within law enforcement there are anecdotal reports of occupational phosphine exposure. Three deaths reported in methamphetamine cooks were considered secondary to phosphine exposure, although actual exposure concentrations could not be documented (3). In other occupational settings, phosphine is commonly used as a fumigant, produced from the reaction of water with either aluminum or zinc phosphide. At sufficient concentration and duration of exposure, the effects may be lethal (4). The American Conference of Governmental Hygienists has established a threshold limit value-time weighted average concentration of 0.3 ppm and a short-term (15 minute) exposure limit of 1 ppm for phosphine (5). Due to its relatively low water solubility, phosphine has minimal warning properties. Phosphine (or commonly encountered impurities found with phosphine) has a ''fishy'' or ''garlic'' smell, with an odor threshold of 1.5–3.0 ppm (6). Individuals may therefore be exposed for relatively prolonged periods without recognizing the hazard. Although gastrointestinal symptoms such as nausea and vomiting may occur rapidly following exposure at higher concentrations, such symptoms are not universal (7,8).

Pulmonary toxicity commonly manifests several hours following exposure, but may be delayed for 18 hours or more (8,9). Respiratory symptoms may persist for weeks (10), or as in the present case, for months, but no study has critically addressed the risk of chronic effects. Following suspected exposure to chemicals during a lab investigation, law enforcement personnel may seek evaluation in a medical facility. If phosphine exposure is suspected, the patient needs to be advised that delayed pulmonary symptoms may occur and an adequate mechanism must be in place to reevaluate the patient if that occurs.

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