CLANDESTINE METHAMPHETAMINE LABS
RISKS FOR FIRST RESPONDERS

Phil Jiricko, University of Utah

philip.jiricko@hsc.utah.edu

ABSTRACT

Methamphetamine (Meth) is possibly the most abused drug on earth with an estimated 26 million addicts worldwide. Meth, unfortunately, can easily be created with common over the counter products and simple recipes accessible from the Internet. Combining its ease of manufacture with increasing demand has spawned a clandestine lab industry found in homes, trailers, and even cars across the United States. As first responders are called to investigate these clandestine labs there has been growing concern over toxic exposure resulting from the products of Meth "cooking." This presentation reviews the toxicology of Meth clandestine labs and suggests a Medical Surveillance program for first responders based on their likely exposure.

Overview of Methamphetamine

According to the U.N. World Drug Report, Methamphetamine (meth) is abused by an estimated 26 million addicts worldwide (WHO 2004). This number equals the number of cocaine and heroin users combined. In the US, hospital admissions for meth abuse have risen 5000% from 1992 to 2002 (Brecht, Greenwell et al. 2005).

Meth is considered a central nervous system (CNS) stimulant. The effect of meth on human physiology includes euphoria, appetite suppression, and heightened libido (Brecht, Greenwell et al. 2005). These three characteristics have given meth the nickname of "The Party Drug". The high from meth lasts about 6-8 hrs, which is several fold longer than cocaine (cocaine lasts 30 minutes).

What is a Clandestine Lab?

The word clandestine literally means secretive in nature. So clandestine meth labs are secret labs that produce methamphetamines. The reason there has been such a proliferation of these labs is because "the cook", or making meth, is easy to do. The recipe is readily available on the web. The ingredients available at any drug or farm implement store. In fact, the main ingredient in the meth cook is over the counter ephedrine which can be found in a variety of cough and cold formulations. The space required to cook the ingredients is negligible and can actually fit in the trunk of a car.

Why is Meth a Medical Surveillance Issue?

First as stated above, there has been a sharp increase in number of labs to meet the demand posed by consumers of this drug. In addition, the cook process creates a number of potential hazardous exposures. Unfortunately, sometimes a first response call may actually be an unknown meth lab. This puts first responders at risk (Santos, Wilson et al. 2005). Because the lab may be unknown at the time of the call, often first responders also underutilize Personal Protective Equipment (PPE). Thus, a combination of all these factors may contribute to this issue.

What is Medical Surveillance?

Medical surveillance is a screening tool to assist a health care provider in early diagnosis and treatment of the individual. Surveillance is used to detect and eliminate the underlying causes, such as hazards or exposures. In other words, "The ultimate goal of medical surveillance is primary prevention" (Sullivan 2001).

What are the Goals of this Review?

This review was completed in order to assess the exposure potential from clandestine labs. Then to correlate exposure with known toxicology to determine possible health effects for first responders. Finally, based on the previous information, create a medical surveillance program that would address these potential health hazards.

What are the potential exposures?

The best evidence to date comes from the National Jewish Medical and Research Center (Martyny 2004; John W. Martyny 2005; Martyny 2005; Martyny 2005). They performed several experiments but this review will cover only the information during the simulated "Cook" in a fume hood, an old house, and a condemned hotel. These researchers set up an active cook in the three different settings as noted above, and then measured the chemical milieu that was produced from the active cook. During this active cook 4 major gases were noted as well as other minor compounds discussed below. The major effluents were:

- Hydrogen Chloride Gas
- Iodine Gas
- Anhydrous Ammonia
- Phosphine

Each of these will be reviewed in more detail below. It should be noted that the ranges determined by these studies will vary greatly depending on the location of the cook, ventilation in the area, the size or volume of the cook, and the recipe utilized. Thus, while these data may not be generalized to all cooks, to date this information represents the best data we have on the topic. In real work situations, it is likely significant variation will be noted in many clandestine labs.

Hydrogen Chloride (ATSDR 2004)

In the studies the amount ranged from non-detected to 56.2 mg/m^3. The Occupational Health and Safety Association (OHSA) and the National Institute of Occupational Safety and Health (NIOSH) ceiling are 7.0 mg/m^3 and the immediate danger to life and health (IDLH) is 74.5 mg/m^3. So the level was at about the ceiling permitted by these regulatory organizations.

Hydrogen chloride can have several effects on the human body. Acidic necrosis of local tissue is the most prominent effect. Thus, one can suffer in the acute period from severe mucus membrane irritation and necrosis of the bronchial epithelium from inhalation. There are very few studies that give us chronic exposure data. There is also no evidence of carcinogenicity in the long term.

From a surveillance standpoint, there is no biologic marker available to test for bodily concentrations of this compound. However, because the route of exposure is primarily inhalation with necrotic tissue damages, the best way to survey this exposure is pulmonary evaluation. Thus, the suggested surveillance would be pulmonary function testing and a chest x-ray.

Anhydrous Ammonia (ATSDR 2004)

In the studies the amount ranged from 30 ppm to over 437 ppm. The OSHA Short Term Exposure Limit (STEL) is 35 ppm and the IDLH is 300 ppm.

Anhydrous ammonia is used in a variety of manufacturing needs (plastics, fertilizers). It releases thermal energy when dissolved in water, so acts in a similar way to hydrogen chloride and can damage exposed tissue through burning.

In the acute phase of inhalation exposure, one may demonstrate upper airway damage and irritation of mucus membranes, including eyes, nose, and skin. Chronically, animals exposed to ammonia demonstrate severe pulmonary dysfunction and asthma. Higher doses are lethal through hemorrhagic necrosis of liver. No cardiac, gastrointestinal, or renal effects have been demonstrated in the literature. No animal or human studies demonstrate elevated risk of cancer even with high doses.

Thus, the suggested surveillance for anhydrous ammonia because it demonstrates adverse effects of the pulmonary and hepatic system could be

- Chest x-ray
- Pulmonary function tests (PFT)
- Liver function tests (LFT)

Phosphine (ATSDR 2004)

In the studies the amount ranged from 0.17 to 4.84 mg/m^3. The OSHA permissible exposure limit (PEL) is 0.4 mg/m^3 and the ACGIH short term exposure limit (STEL) is 1.4 mg/m^3. Phosphine is primarily used as an insecticide. It interferes with enzymes and protein synthesis.

In the acute setting inhaled phosphine can alter cardiac transmembrane potentials, be cytotoxic to pulmonary cells, and cause centrilobular necrosis of the liver. No known teratogenic or carcinogenic effects from acute exposures are known. In the chronically exposed, research has demonstrated reactive airways dysfunction syndrome (RADS), liver damage, renal failure, and anemia in laboratory animals (ECAO 1989; NCEA 1999; Newton, Hilaski et al. 1999).

There have been a couple of case reports in the literature regarding exposure of humans to phosphine. For example, in 1999 Willers-Russo reported three officers died after being overwhelmed by phosphine gas during an active raid (Willers-Russo 1999; Burgess 2001).

From a surveillance standpoint there is no biologic marker available. However, given the physiological effects noted above, a prudent surveillance protocol may involve the following:

- Electrocardiogram (ECG)
- Pulmonary function testing (PFT)
- Chest X-ray
- Creatinine
- Liver function tests (LFT)
- Complete Blood Count (CBC)

Iodine (ATSDR 2004)

In the studies the amount ranged from 2.3 to 37 mg/m^3. The OHSA, NIOSH and ACGIH ceiling is 1.0 $mg/m^{3.}$ Industrial iodine is primarily used in manufacturing of organic materials, pharmaceuticals, and photography. Iodine is also a naturally occurring substance and is an essential micronutrient required for thyroid function.

In the acutely exposed, individuals may suffer thyroiditis (acute inflammation of the thyroid). In addition gaseous iodine is a strong irritant of mucus membranes including the eye, nose, and skin. Chronic exposure in lab animals demonstrate decreased PFT's and thyroid dysfunction. The IARC and ACGIH have not assigned carcinogencity for iodine.

From a surveillance perspective, there are biological makers for iodine. The most utilized and standard approach is a 24-hour urine sample. Tissue sampling is also available (e.g. thyroid biopsy). Based on the above information a prudent program for surveillance would be

- Chest X-Ray
- Pulmonary function testing (PFT)
- Thyroid Panel

Driving Factors for Exposure Risks

In addition to the toxins listed above there are other driving factors, which could have an effect on health outcomes. The historic toxicology mantra of the "dose makes the poison" is true in this case as well. Higher exposure will likely translate into higher probability of disease. Thus, if the first responder is wearing PPE or is involved in multiple lab exposures it could impact the dose dramatically. In addition, the activity state of the lab will have a large impact on potential health outcomes. If a first responder enters into a house with a lab that is no longer active, the toxicology profile of that exposure will certainly be different that the one presented above where gaseous material will be present. The type of cook in the lab will also alter the exposure as this will alter the ingredients and hence the toxicology profile.

Prior Human Health Studies

In addition to the laboratory studies noted above, there have been case studies reported in the literature on human exposure to a clandestine lab setting.

The CDC reported in MMW in 2000 following 112 events reported between 1996-1999 of clandestine lab exposure (CDC 2000). These exposures resulted in:

- 155 persons injured (more than one per event)
- 54% respiratory complaints
- 11% eye irritation
- 85% did NOT wear PPE

In 1996 Burgess et al. (Burgess, Barnhart et al. 1996) reported on a retrospective cohort study evaluating a total of 2,800 combined investigations. Responding to an active laboratory was associated with a 7 to 15-fold risk of becoming ill. Symptoms were headache and respiratory, mucous membrane, and skin irritation

Later in 2002 Burgess (Burgess, Kovalchick et al. 2002) reported another study looking at officers over an 8 yr period. He noted that the following pulmonary changes:

- 64 mls yr decrease in FEV1
    - Normal Aging – NIOSH 25 mls/yr in FEV1
    - Smokers – 55 mls/yr decrease per year in FEV1 (Jay D. Pearson 1998)
- No changes in AST, ALT, HgB, WBC

Other Potential Exposures in a Cook Area

There are numerous other possible exposures, albeit in lower doses, than just those reported above. Several other potential exposures have been reported and are listed in the table below. Note there is no published research indicating the level of each of the following chemicals that one could expect at an active lab.

- Acetone: fingernail polish remover
- Methanol: brake cleaner fluid
- Benzene: varnishes, lacquers
    - Known carcinogen
- Ether: Starter fluid
- Hydriodic acid: driveway cleaner
- Lithium metal: lithium batteries
    - Known to cause kidney toxicity (Hardman et al., 1996).
- Muriatic acid: swimming pool cleaner
- Sodium hydroxide: drain cleaners, lye

    - May cause nose and throat irritation, chest pains, shortness of breath, and ulceration of the nasal passages. (ATSDR, 2000).
- Sulfuric acid: battery acid
- Toluene: paint thinners
- n-hexane: Coleman Fuel
    - Known to cause peripheral neuropathy (HESIS, 2000; HSDB,2002A)
- Meth
    - Reported that several officers had meth residue on clothes when tested after a clandestine lab raid

Suggested Medical Surveillance Program

Based on the above exposure data, given toxicology of those specific exposures and case reports in the literature, the following could represent a practical and complete medical surveillance program for first responders who are exposed to known clandestine laboratories.

Baseline

- Chest X-Ray
- Pulmonary function testing (PFT)
- Thyroid Panel
- Electrocardiogram (ECG)
- Pulmonary function testing (PFT)
- Chest X-ray
- Creatinine
- Liver function tests (LFT)
- Complete Blood Count (CBC)

Annual

- Pulmonary function testing (PFT)
- Thyroid Panel
- Electrocardiogram (ECG)
- Pulmonary function testing (PFT)
- Chest X-ray
- Creatinine
- Liver function tests (LFT)
- Complete Blood Count (CBC)

Every 3-5 Years

- Chest X-Ray

SUMMARY

First responders are at risk when investigating active meth labs for potential health hazards. The risk to the responder is dependent on a variety of factors including the activity of the lab, number of exposures, use of PPE, and the total dose of exposure. While not all first responders will have adverse health effects from exposure to these labs, based on the toxicology of the chemicals used in “cooking” meth, it seems prudent to screen these workers for potential adverse health measures. In addition, the bulk of the evidence indicates that few if any exposures could cause a definitive risk of cancer.

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