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Occupational Health Hazards to First Responders from Clandestine Methamphetamine Labs

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Methamphetamine is synthesized in clandestine drug labs from common household products and over-the-counter medications. Production methods involve numerous chemical reactions that can cause fire, explosion, and release of toxic gases and waste, thereby making these labs potential hazardous waste sites. First responders (fire fighters, police officers, and Emergency Medical Services personnel) are at risk for numerous health problems when they come in contact with clandestine methamphetamine labs during the course of their jobs, including eye and respiratory irritation, lung damage, burns, and violence perpetrated by methamphetamine producers and users. The objectives of this article are to review current literature on clandestine methamphetamine labs, describe methamphetamine production processes, describe the risks to first responders from the occupational health hazards generated by these labs, and, finally, discuss prevention strategies.

Keywords Methamphetamine, Meth, Methamphetamine Production, Clandestine Drug Lab, Clan Lab, Illicit Drug Lab, Occupational Health Hazard, Methamphetamine Exposure

Among the many drugs of abuse, methamphetamine presents a particularly wide array of hazards which are increasingly apparent across the United States. Methamphetamine is a "man-made, addictive stimulant-hallucinogenic compound, which associates the properties of cocaine with those of LSD" (National Drug Intelligence Center: NDIC, 2001, p. 2). Street names or alternative names for methamphetamine are speed, ice, meth, crystal, crank, and Tina. Available in powder and crystal forms, methamphetamine can be ingested, injected, inhaled, snorted, or inserted as a rectal suppository (Holton, 2001; Specter, 2005).

The prevalence of methamphetamine use has been monitored in three national surveys. In the 2004 National Survey on Drug Use and Health, 11.7 million Americans ages 12 and older (4.9% of the population) reported using methamphetamine in their lifetime (Substance Abuse and Mental Health Services Administration: SAMHSA, 2004). In the 2004 Monitoring the Future study, 6.2% of high school seniors reported using methamphetamine sometime in their lifetime (Johnston, O'Malley, Bachman, & Schulenberg, 2004) while in the 2003 Youth Risk Behavior Surveillance System, 7.6% of the high school students reported use in their lifetime (Centers for Disease Control and Prevention: CDC, 2003). All three of these national surveys rely on self-reports. Another mechanism for monitoring trends in methamphetamine use is the recording of drug mentions in Emergency Department (ED) visits. The number of ED mentions for methamphetamine has fluctuated between 1994 and 2002 but the overall trend demonstrates an increase from 1999 (10,447 mentions) to 2002 (17,696 mentions) (SAMHSA, 2003). Using treatment episode data (TEDS), treatment admissions with primary methamphetamine use problems increased from 21,000 in 1993 to 117,000 in 2003 (SAMHSA, 2005).

Methamphetamine is highly addictive with numerous adverse health effects. This drug of abuse releases a large amount of dopamine, which then "stimulates the brain and enhances mood and body movement" (NDIC, 2001, p. 2). Over time, chronic abusers show reduced dopamine D_2 receptor availability in the brain (Volkow et al., 2001b), as well as altered metabolism in both "dopamine- and nondopamine-innervated brain regions" (Volkow et al., 2001a, p. 383). Chronic abusers "often display paranoia, memory loss, aggression, mood disturbances, and a tendency toward violence" (NDIC, 2001, p. 4). Sekine et al. (2001) found that prolonged methamphetamine use leads to "greater reduction in dopamine transporter density, which in turn is associated with higher occurrence of residual psychiatric symptoms" and "that lasting reduction of brain dopamine transporter density could occur after habitual methamphetamine use" (p. 1212). Abusers of this drug also may experience cardiac arrhythmia, ventricular fibrillation, and weight loss, and are at increased risk of blood clots, stroke, and hypertension (NDIC, 2001). Burns may result when chemical reactions in the lab cause

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fire and/or explosion. A 2005 case-control study of users burned at methamphetamine lab explosions found they had significantly greater intubation rates, tracheostomy rates, inhalation injuries, hospital charges, and longer duration of ventilator use (Santos et al., 2005).

Although these adverse effects are considerable, the hazards of methamphetamine extend far beyond the users themselves to other individuals exposed to the drug and its precursors in clandestine labs. In particular, the risk to first responders from an occupational exposure perspective has public health implications. The objectives of this article are to review current literature on clandestine methamphetamine labs, describe methamphetamine production processes, describe the risk to first responders from the occupational health exposures generated by these labs, and, finally, discuss prevention strategies. Findings were obtained by searches of PubMed, CINAHL, LexisNexis, Google, and key informant interviews with Hazardous Materials fire fighters and clandestine methamphetamine lab investigators.

METHAMPHETAMINE PRODUCTION

Methamphetamine is synthesized in clandestine drug labs and, due to the illicit nature of its production, the exact number and locations of clandestine labs are unknown. U.S. Drug Enforcement Agency (DEA) agents identified and seized 15,994 clandestine methamphetamine labs in 2004 (DEA, 2005). These labs are located and seized in every state (DEA, 2005), and individual states have seen yearly increases exceeding 200% (Holton, 2001). Raids on clandestine methamphetamine labs have increased dramatically in western and Midwestern states, but are also on the rise in previously unaffected areas, such as New England (Holton, 2001). The scope of methamphetamine use and production has expanded across the U.S. and a 2005 survey by the National Association of Counties found that 58% of counties report methamphetamine is their largest drug problem.

The methods of producing methamphetamine expose large populations to health and safety hazards. Methamphetamine is synthesized from multiple chemicals available in over-the-counter medications and household products (Table 1). Precursor compounds include pseudoephedrine (available in over-the-counter cold medications), red phosphorous (contained in matchbox striker plates), ammonia (found in fertilizer), sulfuric acid, alcohols, sodium hydroxide (from lye and drain cleaner), solvents (such as camp fuel), ether (in auto starting fluid), and hydrochloric acid (Holton, 2001; Palmer, n.d.; Vanek, 2002). The ingredients may vary according to which production method is followed (NDIC, 2001). The commonly used lithium/ammonia ("Nazi" or "Birch") and red phosphorus ("Red-P") methods require pseudoephedrine, but the Phenyl-2-Propanone ("P-2-P") method does not and may become more common as federal regulations are already restricting pseudoephedrine sales.

Production commonly occurs in clandestine methamphetamine labs, which require minimal equipment. These labs have been found in houses, apartments, hotel rooms, storage units, trailers, car trunks, suitcases, and parks (Burgess et al., 2002; Dark side, 2005; NDIC, 2001; C. Ramirez, personal communication, July 19, 2005). These small, "stovetop laboratories" produce small quantities of methamphetamine for personal use. However, when the constituent chemicals are heated during production, they present significant risk of environmental contamination, explosion, and fire (Palmer, n.d.). It is estimated that for every pound of methamphetamine produced, six pounds of waste are created (Holton, 2001). The uncontrolled manufacture of methamphetamine in clandestine labs may lead to the production of "toxic by-products such as lead oxide, aluminum hydroxide, mercury vapor, iodine, phosphine, and yellow phosphorus. These chemicals become a hazard to everyone who comes in contact with them, and they can be released into the air, septic systems, streams, soil, or when they permeate furniture, carpets, or air vents" (Holton, 2001). During active production of methamphetamine, clandestine labs may pollute the environment in any or all of these manners and every lab becomes a hazardous waste site. In several experiments where methamphetamine was produced under controlled circumstances, Martyny et al. found that during production methamphetamine is widely dispersed as an aerosol and contaminates both horizontal and vertical surfaces (2004a). The Red-P method releases dangerously high levels of phosphine, iodine, and hydrogen chloride (Martyny et al., 2004a). The lithium/ammonia method releases dangerously high levels of anhydrous ammonia (Martyny et al., 2004b). The labs that are discovered must be decontaminated by removing all absorbent surfaces (e.g. carpet, furniture) and all remaining surfaces must be treated, a process that may cost up to $10,000 and is the responsibility of the property owner, regardless of who used the property to make methamphetamine (*All Things Considered*, 2004).

TABLE 1
Common methamphetamine ingredients and their sources

Ingredient	Source
Anhydrous ammonia	Fertilizer
Ether	Automotive starting fluid
Hydrochloric acid	Industrial muriatic acid
Iodine	Over-the-counter tincture of iodine
Lithium	Batteries
Methanol	Gas-line antifreeze
Petroleum distillate	Camp fuel; mineral spirits
Pseudoephedrine	Over-the-counter cold medications
Red phosphorous	Matchbox striker plates
Sodium chloride	Table salt
Sodium hydroxide	Drain cleaner

OCCUPATIONAL HEALTH HAZARDS TO FIRST RESPONDERS

Any individual exposed to the ingredients and/or by-products of methamphetamine production is at risk for adverse

TABLE 2
Adverse health effects of methamphetamine lab exposure

Adverse Health Effect
Abdominal pain
Chemical burns
Collapse
Mucous membrane irritation
Respiratory effects
Breathlessness
Bronchitis
Chronic bronchitis
Cough
Emphysema
Pneumonia
Wheezing
Skin irritation

(Burgess, Barnhart, & Checkoway, 1996; Burgess et al., 2002)

health effects, including lung damage, breathing difficulties, abdominal pain, mucous membrane and skin irritation, chemical burns, pain, and collapse (Table 2) (Burgess, Barnhart & Checkoway 1996). At-risk individuals include methamphetamine producers ("cooks"), other residents in household labs, and first responders. First responders (fire fighters, police officers, and Emergency Medical Services [EMS] personnel such as paramedics and Emergency Medical Technicians [EMTs]) may be exposed directly at the scene, such as during a police raid of the lab or when fire fighters respond to explosions and fires and decontaminate the scene, or indirectly when treating contaminated and injured individuals within the lab. First responders also are at risk of violent crime due to booby traps and weapons; methamphetamine users may become psychotic and violent, and most guard their labs with guns (S. Hergenreter, personal communication, July 7, 2005).

First responders are more likely to come in contact with high levels of the toxic ingredients and by-products of methamphetamine production than are members of the general public. Data collected from the Hazardous Substances Emergency Events Surveillance (HSEES) system, a program of the Agency for Toxic Substances and Disease Registry (ATSDR), indicate that police and fire fighters are "likely to be the first to arrive on the scene of a hazardous substances emergency event before the full scope of the incident and all related dangers are identified and realized. Because most injuries of emergency personnel occur in the first few minutes of response, this group of responders is most likely to be injured (Zeitz et. al., 2000). These police officers and fire fighters are often unaware that they are entering a methamphetamine lab, and only discover this fact when lab equipment is identified and they have been exposed to toxins. Police officers "stumble across a majority of the labs on routine calls, such as domestic disputes and traffic stops" (Crissey, 2004, p. 2). Fire fighters often discover methamphetamine labs when responding to 911 dispatches; approximately 20–30% of methamphetamine labs are discovered because of fires or explosions (CDC, 2000). Fire fighters also discover methamphetamine labs when they are called in by neighbors to investigate strange odors. Less common are planned raids conducted by specially trained Hazardous Materials (HazMat) fire fighters and law enforcement clandestine drug lab investigators (Burgess et al., 2002).

Healthcare providers also may be exposed to toxic chemicals from clandestine methamphetamine labs. EMTs and paramedics may find themselves at sites of methamphetamine production when called to assist victims of explosions and fires, or during a response to a routine call (Vanek, 2002). Hospital workers in emergency departments can be exposed secondarily if victims are not properly decontaminated before transport for treatment. Nurses and other ED staff are likely to come into close contact with victims, but may be unaware of the contamination and be unprotected from exposure. The uniforms worn by EMS and hospital personnel "provide little or no chemical/respiratory protection" (CDC, 2000, p. 3).

Anecdotal reports and limited surveillance indicate that many first responders experience health problems after exposure to clandestine methamphetamine labs (Burgess, Barnhart, & Checkoway, 1996; Burgess et al., 2002; CDC, 2000; Peterson, n.d.; Schulz, 2004; Zeitz et al., 2000). In 2003, a volunteer fire fighter's lung capacity decreased 85% after an explosion at a methamphetamine lab (U.S. Fire Administration, 2004). Between 1998 and 1999, 155 people were injured in the 112 methamphetamine events reported to HSEES; 10.1% were fire fighters; the remainders were police officers, EMTs, and hospital employees (CDC, 2000). Of the injured first responders, 54.1% experienced respiratory irritation, and 10.8% experienced eye irritation (CDC, 2000). Between 2000 and 2004, 31% of the 1,791 methamphetamine responses tracked by HSEES resulted in injuries (CDC, 2005). Police officers were the most frequently injured group, accounting for 558 (31%) of the 947 total injury victims. Summary statistics, which include first responders, methamphetamine users, and the general public, found that "a total of 274 (29%) victims were treated at hospitals but not admitted, 68 (7%) were treated at hospitals and admitted, and 62 (7%) were treated at the scene; nine (1%) died" (CDC, 2005). In addition, 698 (60%) of the 1,154 persons who required decontamination were first responders (CDC, 2005).

PREVENTION STRATEGIES

The incidence of these health hazards can be reduced through use of certain personal protective equipment (PPE). Regular (non-HazMat) fire fighter turn-out gear (helmet, facepiece, coat, pants, boots, gloves, hood, positive-pressure self-contained breathing apparatus [SCBA]) does not protect responders from all of the toxic chemicals found in clandestine methamphetamine labs (Zeitz et al., 2000). Although this non-HazMat gear provides protection from heat and moisture, chemical vapors and liquids can penetrate this type of PPE (Zeitz et al., 2000). Additionally, if the SCBA—a mask-like respirator that provides pure air from enclosed tanks carried on the back—is not worn, fire fighter turn-out gear offers little more protection than a regular work uniform (Zeitz et al., 2000). Police officers generally do not wear PPE appropriate for chemical exposure, and may enter a lab with no more protection than their uniform. Of those injured police officers included in the HSEES report, 78.9% had not worn any PPE at the time of injury (CDC, 2000).

Even on a planned raid, HazMat fire fighters and law enforcement clandestine drug lab investigators cannot fully predict the chemical hazards of exposure, particularly since the ingredients and production methods employed are varied (Burgess, Barnhart, & Checkoway, 1996). Investigators of the crime may spend up to ten hours in a laboratory while they apprehend individuals, collect evidence, and decontaminate the scene (Burgess, Barnhart, & Checkoway, 1996). Although these special responders generally have the appropriate chemical-resistant clothing and respirators, they may not use such PPE on arrival at the scene, "because of their need for speed and surprise, and the possibility of hostile actions from laboratory occupants" (Burgess et al., 2002, p. 2).

In a 2002 study of experienced law enforcement clandestine drug laboratory investigators in California, Burgess et al. documented long-term respiratory effects from exposure to methamphetamine production sites. Lab investigators in this study reported increases of up to 15% of new incidences of wheezing, breathlessness, persistent cough, bronchitis, chest colds, pneumonia, chronic bronchitis, and emphysema since the initiation of clandestine laboratory investigation work (Burgess et al., 2002) (Table 2). Burgess et al. documented an average annual decline in forced expiratory volume (FEV_1) of 70.5 mL/year for seven years among responders, with a median decline of 46.2 mL/year. This level of decline is slightly greater than that of active smokers, but only 28% of the participants had ever smoked. The study also demonstrated a statistically significant association between annual decline in FEV_1 and the amount of time an investigator spent in a lab wearing appropriate PPE. The protective effect of PPE was found to exist regardless of personal susceptibility factors such as smoking history or asthma. Thus, first responders who are exposed to methamphetamine labs may experience chronic respiratory effects, but these exposures are preventable with use of appropriate PPE. These findings corroborate an earlier report that incidence of methamphetamine-related illnesses in clandestine drug laboratory investigators could be reduced through appropriate respiratory and dermal PPE (Burgess, Barnhart, & Checkoway, 1996). The selection of appropriate PPE depends on the extent of exposure and the requirements of the job, but in general Environmental Protection Agency-rated Level B protective clothing with SCBA can protect first responders from almost all chemical exposures (N. Vent, personal communication, June 27, 2005).

CONCLUSION

Clandestine methamphetamine labs are an occupational health hazard to first responders. Research demonstrates that clandestine methamphetamine labs are contaminated with dangerously high levels of toxic chemicals. Additionally, first responders are at risk of violence from methamphetamine producers and users. The existing literature on methamphetamine labs is limited, primarily due to the brief history of this newly recognized hazard. However, as future experience with this man-made occupational and environmental hazard grows, more research is expected to examine the associated health effects. Further research is warranted to determine the prevalence and effectiveness of hazardous chemical exposure prevention programs among first responders.

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