Methamphetamine Abuse: A Perfect Storm of Complications

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Previously restricted primarily to Hawaii and California, methamphetamine abuse has reached epidemic proportions throughout the United States during the past decade, specifically in rural and semirural areas. Particular characteristics of methamphetamine production and use create conditions for a "perfect storm" of medical and social complications. Unlike imported recreational drugs such as heroin and cocaine, methamphetamine can be manufactured locally from commonly available household ingredients according to simple recipes readily available on the Internet. Methamphetamine users and producers are frequently one and the same, resulting in both physical and environmental consequences. Users experience emergent, acute, subacute, and chronic injuries to neurologic, cardiac, pulmonary, dental, and other systems. Producers can sustain life-threatening injuries in the frequent fires and explosions that result when volatile chemicals are combined. Partners and children of producers, as well as unsuspecting first responders to a crisis, are exposed to toxic byproducts of methamphetamine manufacture that contaminate the places that serve simultaneously as "lab" and home. From the vantage point of a local emergency department, this article reviews the range of medical and social consequences that radiate from a single hypothetical methamphetamine-associated incident.

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ED = emergency department; EMS = emergency medical services; STD = sexually transmitted disease; HIV = human immunodeficiency virus

Methamphetamine production and abuse have increased dramatically during the past decade in the United States.[1,2] US admissions, primarily for treatment of methamphetamine/amphetamine abuse and dependence, increased more than 500% from 1992 to 2002, from 10 to 52 per 100,000 people aged 12 years or older.[3] Of these admissions in 2002, more than 90% were methamphetamine related.

In 2002, 13 states had admission rates greater than 100 per 100,000 members of the general population; all but 1 of those states (Arkansas) was west of the Mississippi River. Oregon, Hawaii, and California reported rates greater than 200 per 100,000 people (Table 1). The criminal justice system referred more than half of these admissions.

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A question-and-answer section appears at the end of this article.

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Methamphetamine, a stimulant, was synthesized first in Japan in 1893.[4] German, English, American, and Japanese military personnel, as well as civilian Japanese factory workers, used the drug during World War II for its energy-promoting and performance-enhancing properties.[5] After World War II, the Japanese military dumped large supplies of methamphetamine on the civilian market, precipitating Japan's "first epidemic" of methamphetamine abuse.[6]

Methamphetamine is a highly addictive street drug with a variety of forms and street names (Table 2). The drug gives users a "rush" that includes feelings of enhanced well-being, heightened libido, increased energy, and appetite suppression.[7] Psychological effects observed with methamphetamine use include euphoria, paranoia, agitation, mood disturbances, violent behavior, anxiety, depression, and psychosis. Cheaper than cocaine, its stimulant effects are also longer lasting.[8] As the mood- and energy-enhancing effects of binging methamphetamine begin to wear off, users begin "tweaking,"[5] a term describing a dangerous combination of restless anxiety, irritability, fatigue, and dysphoria. Further use of methamphetamine temporarily improves the symptoms and further reinforces the addiction. Eventually, after days of sleeplessness, users "crash" into a nonrestful sleep.

From Hawaii and California, critical geographic stepping stones between Japan and the rest of the United States, methamphetamine use radiated eastward via its original primary mainland users, truckers and biker gangs.[1] Although "super labs" in California and northern Mexico still make most methamphetamine used in the United States, readily available ingredients and ease of production have encouraged the exponential growth[9] of makeshift labs operated by "do-it-yourselfers" throughout the country, particularly in rural areas (Figure 1). Despite methamphetamine's illegality, "recipes" for making the drug are found easily on the Internet and passed from user to user.

Using methods reminiscent of a college chemistry class, methamphetamine "cookers" brew methamphetamine from ingredients readily available in farm implement, hardware, and convenience stores.[10] The most common recipes include steps that extract ephedrine from over-the-counter pseudoephedrine-containing cold preparations, create hydroiodic acid from water and iodine, and mix both products with red phosphorus. The resulting series of chemical reactions replace a hydroxyl group on the ephedrine with a

TABLE 1. **Methamphetamine / Amphetamine Admission Rates***

	1992	2002		1992	2002
United States	10.4	52.1			
Northeast			Midwest		
Connecticut	1.0	3.8	Illinois	2.0	13.4
Maine	1.5	3.5	Indiana	1.6	22.8
Massachusetts	1.1	1.3	Iowa	9.2	*198.1*
New Hampshire	0.3	7.0	Kansas	9.8	*61.3*
New Jersey	2.6	1.9	Michigan	2.1	5.1
New York	1.8	3.4	Minnesota	4.6	*77.6*
Pennsylvania	2.5	2.3	Missouri	5.2	*86.2*
Rhode Island	2.1	2.4	Nebraska	6.8	*102.2*
Vermont	4.7	4.3	North Dakota	2.3	*65.4*
South			Ohio	5.3	1.9
Alabama	1.3	35.9	South Dakota	4.0	*68.9*
Arkansas	7.2	*124.9*	Wisconsin	0.4	3.5
Delaware	2.1	1.8	West		
District of Columbia	†	3.6	Alaska	4.5	15.0
Florida	1.5	5.3	Arizona	†	27.7
Georgia	1.9	22.2	California	*48.6*	*200.1*
Kentucky	†	13.3	Colorado	*14.0*	*67.7*
Louisiana	3.9	18.4	Hawaii	*32.8*	*217.2*
Maryland	1.5	2.3	Idaho	9.7	*116.2*
Mississippi	†	7.5	Montana	*33.5*	*118.6*
North Carolina	1.1	3.2	Nevada	*34.6*	*156.8*
Oklahoma	*15.5*	*118.8*	New Mexico	4.9	4.5
South Carolina	1.3	6.7	Oregon	*72.4*	*323.6*
Tennessee	0.1	9.3	Utah	10.0	*115.2*
Texas	7.2	13.0	Washington	*11.4*	*150.4*
Virginia	0.9	3.2	Wyoming	*15.2*	*166.9*
West Virginia	1.4	0.5			

*Per 100,000, aged ≥12 years, for 1992 and 2002. Italics indicate rates above the national rate for that year.
†Incomplete data.

hydrogen atom to yield methamphetamine. If red phosphorus is unavailable and hypophosphoric acid must be used as a phosphorus source instead, the process is especially dangerous because of the production of highly toxic phosphine gas. A farm country variation of the phosphorus-hydroiodic acid step uses lithium found in batteries and anhydrous ammonia from fertilizer tanks.

TABLE 2. **Methamphetamine Forms, Time to Effect, and Street Names**

	Intravenous	Smoked	Snorted	Ingested
Time to effect	15-30 s	Immediate	3-5 min	15-20 min
Peak concentration (h)	2-4	2-4	2-4	2-4
Elimination half-life (h)	10-12	10-12	10-12	10-12
Street terms for methamphetamine				
Blue meth	Granulated orange		Speed	
Chalk	Hillbilly crack		Spoosh	
Chicken feed	Hot ice		Stove top	
Cinnamon	Ice		Super ice	
Crank	Kaksonjae		Tick tick	
Crink	L.A. glass		Trash	
Crystal	Lemon drop		Wash	
Crystal meth	Meth		Working man's cocaine	
Desocsins	OZs		Yaba	
Geep	Peanut butter		Yellow barn	
Glass	Sketch		Yellow powder	

All the basic elements of a "meth lab" can fit into a suitcase, closet, or car trunk. Although methamphetamine is produced in cities, the isolation of rural settings decreases the likelihood that the potent chemical smells from cooking "meth" (ammonia, ether, or acetone) will be noticed by neighbors or law enforcement.

Each pound of methamphetamine produced yields an estimated 6 pounds of toxic waste,[11] including acid, lye, and phosphorus dumped into ditches, rivers, yards, and drains, and a fine particulate methamphetamine residue settles on exposed surfaces in household interiors.[12] Such flammable ingredients as acetone, red phosphorus, ethyl alcohol, and lithium metal, combined with the poor judgment of methamphetamine-intoxicated "cookers," result in fires and explosions. Accidents in home labs are one of the most common reasons that labs are discovered by law enforcement officials.

MEDICAL AND SOCIAL CONSEQUENCES

Between 1999 and 2002, emergency department (ED) visits resulting from medical and psychiatric complications of

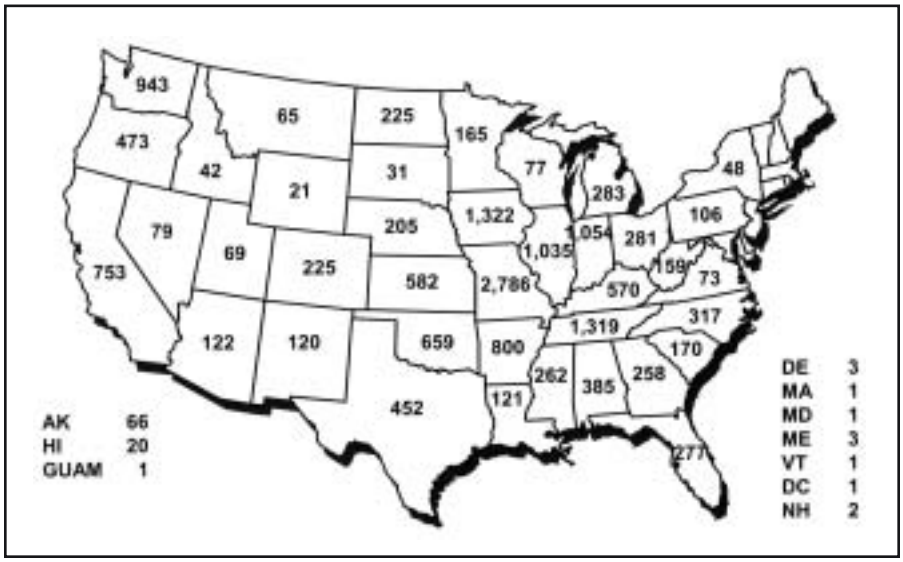

FIGURE 1. Number of US methamphetamine lab incidents in 2004 from the National Clandestine Laboratory Database. Total number was 17,033.

methamphetamine abuse increased nearly 75%.[13] The Drug Abuse and Warning Network database recorded 17,696 ED visits nationwide in 2002, up from 10,447 in 1999.[13] Exponential increases in admissions for primary methamphetamine inpatient treatment[3] and the medical complications associated with methamphetamine abuse directly affect the operations of medical and surgical units throughout the medical center.

To describe the extent and effect of methamphetamine abuse on the network of individuals around a user as well as the user himself or herself, we illustrate a series of ED encounters that flow from a hypothetical methamphetamine-fueled accident. We outline the types of presenting symptoms, physical findings, and medical and psychosocial concerns that result from methamphetamine abuse. Users face certain physical consequences particular to methamphetamine that require immediate medical attention. However, methamphetamine use has longer lasting consequences for users, their families, and their communities that also must be addressed in the initial ED evaluation.

Incident

After a neighbor calls 911 to report hearing an explosion and seeing a neighbor's house engulfed in flames, police and other emergency medical services (EMS) personnel respond to the scene of the house fire. Police had already been investigating the tenants for possible involvement in methamphetamine manufacture. Without protective gear available, a police officer races into the burning structure and rescues an occupant from certain immolation.

Emergent Presentation

A 25-year-old man is pulled from the fire and has multiple penetrating wounds and second- and third-degree burns on 50% of his body surface. He is dyspneic and in shock.

A worst case contemporary ED scenario involves EMS personnel transporting a methamphetamine-intoxicated patient with burns, wounds, and cardiorespiratory compromise. "Meth cookers" sustain burns from chemicals used in production, including acids and anhydrous ammonia, and/or from the explosions that result when volatile chemicals are combined. If the patient is able to give a medical history, it may not match the physical findings because the patient may try to disguise the illegal nature of the injurious activities.[14]

Patients with methamphetamine-related burns require more aggressive fluid resuscitation[15,16] and airway management and have a higher mortality rate[16] than matched-age controls not exposed to methamphetamine. In a sample of 668 patients admitted to a burn center over a 2-year period,[16] 15 patients were methamphetamine users, 11 of whom required tracheal intubation as a result of inhalation injury or combativeness. Among the methamphetamine users, 6 had burns on more than 40% of their body areas and died, compared with 60% who survived in a comparable age group at the burn center. Compared with controls, patients who were methamphetamine users also required more invasive cardiac monitoring, pressor support, and procedures.

Exposure to phosphine, a by-product of methamphetamine cooking, can damage multiple organ systems.[17-19] An agricultural pesticide, phosphine gas is colorless and has a fishy or garlicky odor. Although its exact mechanism of

injury is uncertain, it is known to inhibit cytochrome C oxidase, with subsequent generation of damaging oxygen free radicals.[19] Phosphine exposure can cause ocular and respiratory irritation, shortness of breath, headache, nausea, fatigue, and stomach pain. Its most devastating effects are pulmonary and cardiac damage, including acute, potentially fatal respiratory and hemodynamic failure.

Severe methamphetamine abuse may complicate the management of shock. Methamphetamine-induced sympathetic vasoconstriction exacerbates the acidosis typically expected from comparable trauma.[20,21] Thus, the additive effects of methamphetamine on already-present metabolic abnormalities should be considered in the emergency treatment of patients in shock, among whom methamphetamine use may be a factor. Either vasoconstriction-induced acute renal failure or methamphetamine-induced rhabdomyolysis[22] can present alone or in conjunction with any cardiorespiratory or vascular condition.

Cardiovascular problems can be acute or chronic. As with cocaine users, new-onset chest pain secondary to coronary vasoconstriction may herald myocardial infarctions or potentially lethal arrhythmias.[23] Emergent vascular presentations can include aortic dissections, ruptured berry aneurysms,[24] or spontaneous intracerebral[25] and retinal[26] hemorrhages. Acute pulmonary edema may occur[27] and complicate management. Long-term methamphetamine abuse with its associated catecholamine-related toxicity may cause dilated cardiomyopathy.[28]

If antisocial behavior or the psychosis or agitation stemming from intoxication interferes with initial ED stabilization, in patients who are not critically ill, aggressive intervention with benzodiazepines may be required. The use of antipsychotics according to standard psychiatric protocols may be needed to sedate or immobilize the motorically labile patient.

Acute Presentation

The girlfriend of the burned patient, a disheveled and emaciated 23-year-old woman, appears with her 6-year-old son. She tells the triage nurse that she was not at the house during the explosion but had earlier taken her son to a nearby pharmacy to pick up some pseudoephedrine "for his cold." She admits to having smoked "crystal" intermittently during the past week and says she has slept little during that time.

Extremely agitated about whether her boyfriend will die or go to jail, the woman threatens staff loudly about his care and says she has no reason to live and wants to die. She demands to be seen by a physician immediately. Pressured in speech and hyperkinetic, she describes recent physical altercations with her boyfriend and his sister. Recently discharged from a psychiatric inpatient unit after a suicide attempt, she states that she is again suicidal. She feels restless and believes she is infested by "bugs." She did not follow through with previously recommended sexually transmitted disease (STD) testing from her earlier hospitalization.

Agitation and psychosis from methamphetamine use may be difficult to distinguish from primary mania or schizophrenia. A primary psychotic disorder can be comorbid with methamphetamine abuse, which may itself be one among many drugs that methamphetamine users abuse.[15,29] The agitation directly relates to the severity of intoxication.[30] Although serum and urine toxicology screens are of little use in initial treatment in the ED, obtaining these screens early is critical for later treatment.

Patients commonly deny the role of illegal drug use in their behavior. However, an ED drug screen with positive results for methamphetamine can be critical for psychiatrists who later try to differentiate primary psychotic illness from psychosis resulting from mania/schizophrenia or methamphetamine abuse. Positive screening results serve as objective data to confront denial and deceit in hospital-based addiction interventions. Positive test results also assist in planning for further treatment by medical and surgical services.

However, because of the short half-life of methamphetamine and relative unreliability of detection, negative test results do not rule out methamphetamine intoxication or abuse. Collateral medical history from family and friends regarding a history of possible methamphetamine use and the patient's presentation and response over time may be enough to definitively establish diagnosis.

Patients suspected of methamphetamine intoxication should be placed in a calm and quiet environment, and benzodiazepines and/or antipsychotics should be administered to control agitated behavior. Violence-prevention protocols in the ED should include security searches of intoxicated patients and their belongings for weapons and a high level of vigilance for potential violent behavior directed against staff. Zweben et al,[31] in a sample of 1016 previous methamphetamine users, found that 40% of men and 46% of women had difficulty controlling their violent behavior when taking methamphetamine. The 239 subjects in the sample who used intravenous methamphetamine collectively had lifetime totals of 146 assault charges and 72 weapons violations.

Sympathetic stimulation from recent methamphetamine use results in appetite loss, tachycardia, mydriasis, coronary and peripheral vasospasm, headache, hyperreflexia, agitation, irritability, hypertension, hyperthermia, tachypnea, hypervigilance, and paranoia (Figure 2). Although patients such as the young woman described here do not come to the ED strictly for medical reasons, detecting the

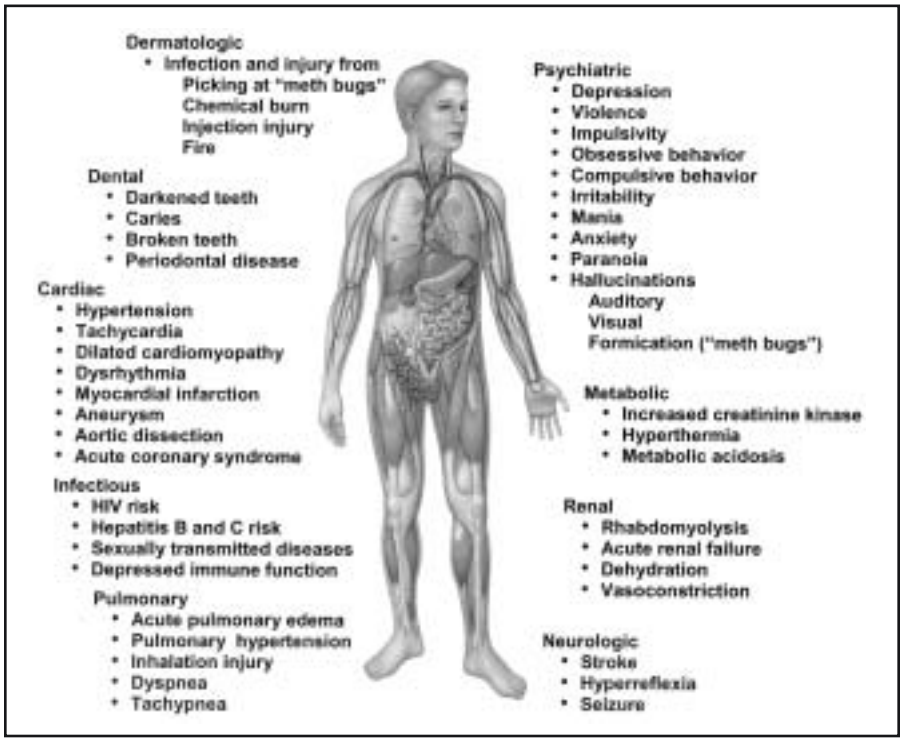

FIGURE 2. Systemic effects of methamphetamine. HIV = human immunodeficiency virus.

emerging cardiovascular and respiratory complications described earlier should be attempted at the physical examination. Long-term users typically appear cachectic and older than their chronological age. Oral examination may reveal "meth mouth," damaged and discolored teeth resulting from dry mouth, heavy sugar intake, and tooth-grinding associated with sympathetic nervous system overstimulation combined with poor dental hygiene.[32-34] Skin lesions may include excoriations and ulcers from the users compulsive picking at "meth bugs," the result of methamphetamine-induced delusional parasitosis,[35] needle marks from injections, or chemical burns sustained while "cooking" methamphetamine. Cellulitis from poor wound care may require treatment.

Methamphetamine both increases libido and reduces inhibition, a synergy that increases the risk of STD for users and their partners. This fueling of risky sexual behaviors has had particular ramifications for homosexual and bisexual men.[36] Men who are human immunodeficiency virus (HIV)-positive and engage in methamphetamine-driven homosexual activity report high rates of unprotected anal sex and low rates of condom use.[37] They are more likely to have multiple sex partners, participate in sexual marathons, and engage in anonymous sex. Increased seroconversion rates in certain subpopulations reflect the relaxation of HIV transmission–prevention practices encouraged since the emergence of the HIV epidemic in the 1980s. Public health efforts to prevent HIV must contend with methamphetamine's capacities to instill a sense of relief from the negative affects associated with being HIV-positive and to enhance sexual pleasure.

Men having sex with men are not alone in being endangered by methamphetamine use. In a sample of 98 heterosexual women, methamphetamine use was associated with a positive subjective experience of sex.[38] Heterosexual male and female users also are more likely to engage in risky sexual behaviors that include multiple sexual partners, anonymous partners, or unprotected sex.[38,39] Thus, the non–methamphetamine-abusing sexual partners of both male and female users have an elevated risk of STD themselves. Clinicians should have a low threshold for ordering STD screening for methamphetamine abusers and their partners.

Pediatric Presentation

The on-call social worker has been summoned to evaluate the 6-year-old son. She learns that the boy not only has had irregular school attendance but also has been experiencing academic difficulties and behavioral outbursts.

During the past 5 years, according to the US Drug Enforcement Administration, more than 15,000 children were affected at sites where methamphetamine was being

made.[40] Unlike adults who can choose to walk away from methamphetamine labs, children are captives of their caregivers and homes. Infants and toddlers naturally crawl on the floors and put things into their mouths. Analogous to those exposed to second-hand cigarette smoke, children living in methamphetamine-tainted environments are at high risk of passively absorbing, ingesting, or inhaling methamphetamine dust or toxic gases.[12] Easy access to ingredients such as acids and red phosphorus used in methamphetamine production and equipment for "shooting up" such as syringes and needles places children at further risk.

Some states are beginning to address pediatric issues stemming from methamphetamine-contaminated physical and social environments. California, Idaho, and Washington have policies ordaining intervention with methamphetamine-exposed children by teams consisting of medical personnel, law enforcement, child protective services, and local prosecutors. These policies require comprehensive physical examination of all affected children. The increased number of children taken from parental custody has caused difficulties in finding crisis foster care placement in heavily affected states.[41] The recent media focus on the effects of methamphetamine on families and children may have led to changes in many local hospital and community regulations. We recommend consultation with hospital social workers or child protective services to ensure that appropriate community contacts are made and that policies are followed for physical and psychological examinations. The decision to admit a child to the hospital or to place a child in foster care is made in consultation with child protective services, the evaluating physician, the admitting physician, and the extended family and depends on local laws.

On arrival at the ED, a child found at a methamphetamine lab will require decontamination, including removal of methamphetamine-impregnated clothing and careful washing of skin and hair, if not already performed. Anecdotally, adult methamphetamine users may drug children with antihistamines or benzodiazepines to keep them asleep and "safe" while they crash after their high.[42] Full toxicology screens for methamphetamine and other suspected drug exposures should be ordered to aid in understanding physiologic and behavioral symptoms and in planning treatment. A child living with methamphetamine users is at increased risk of physical, emotional, and sexual abuse.[41,43] Child protective services should thus be involved to develop a systematic plan to address these potential sources of pediatric comorbidity along with the child's basic needs.

Children in methamphetamine labs frequently live in squalor and neglect. The associated lack of stimulation, poor nutrition, and medical problems resulting from prenatal and postnatal exposure frequently leads to developmental delay, particularly in speech and language skills.[43] Children may not meet developmental milestones and may lack basic socialization skills.

Long-term physiologic effects of methamphetamine exposure, interacting with the toxic psychosocial environments within which these children grow up, can produce cognitive and behavioral symptoms such as those described in the 6-year-old boy in our case. Of 18 children in a study by Kolecki,[44] 9 were agitated, and 6 were irritable or inconsolable. Objective findings in children with prenatal methamphetamine exposure include smaller subcortical volumes with associated neurocognitive deficits.[45]

In laboratory animals, the heart was a particular target for arrested development with changes in messenger RNA expression.[46] All 18 pediatric patients, inadvertently poisoned with methamphetamine in the study by Kolecki,[44] had tachycardia. The same sympathetic hyperstimulation associated with methamphetamine abuse in adults can occur in children and may be even more pronounced.

First Responder

The police officer without personal protective equipment who rescued the young man from the burning house comes to the ED with progressive shortness of breath.

First responders—police and fire rescue teams rushing to disaster scenes—often are injured by toxic exposures at clandestine methamphetamine labs.[47] In 2003, 255 police officers reported sustaining injures while responding to incidents in methamphetamine labs, up from 129 in 2002.[1] Respiratory injuries have been reported most commonly.[47] The phosphine gas that injures the methamphetamine user causes similar pulmonary and cardiac injuries in first responders. Police, firefighters, and other EMS personnel may experience respiratory distress, headache, dizziness, fatigue, or nausea associated with breathing fumes without respiratory protection in a methamphetamine lab. First responders inadvertently may contaminate skin or clothing or sustain injuries by contact with "cooking" ingredients or by-products. They risk injury from both explosions and violent users. Use of protective gear is essential. Supportive management of respiratory injury is recommended.

Subacute and Chronic Symptoms

The girlfriend's 26-year-old sister arrives in the ED as part of the child protective services evaluation. She stopped using methamphetamine 3 months ago and is currently in an outpatient substance abuse treatment program. After an interview with child protective services, she asks to be examined for "problems with depression."

It is the rule rather than the exception that psychiatric disorders accompany methamphetamine abuse. Preexisting psychiatric symptoms, including poor impulse control and

a history of childhood trauma, may predispose to methamphetamine use.[39,48,49] A neurotoxin, methamphetamine induces psychiatric symptoms on its own. It can damage dopaminergic neurons in the striatum and serotonergic neurons in the hippocampus, striatum, and frontal lobes.[50] Damage to the former is associated with Parkinson disease and to the latter with depression, anxiety, and impulsive behavior. Ongoing methamphetamine abuse atop a preexisting psychiatric disorder alters the natural history of the disorder and increases treatment resistance.

Methamphetamine users in treatment are more likely than cocaine users to have psychiatric diagnoses and take psychotropic agents.[51] In a sample of 1073 methamphetamine-abusing patients from California treatment programs,[49] divided approximately evenly between the sexes, 39% of women and 30% of men reported severe depression. Anxiety was even more common, with 43% of women and 37% of men experiencing severe anxiety; 36% of men and 27% of women described problems with concentration and memory. In their sample of 1016 previous methamphetamine users, Zweben et al[31] emphasized a high level of distress manifested in a broad constellation of overlapping symptomatology, including elevated rates of attempted suicide, depression, anxiety, violent behavior, paranoid ideation, and frank psychosis. Residual psychotic symptoms, difficult to distinguish from chronic schizophrenia, can linger for years after methamphetamine abuse ceases and reappear with stressors.[52]

SUMMARY

Like the "great imitators" tuberculosis and syphilis, the multitude of clinical presentations associated with methamphetamine mimic many other illnesses (Figure 2). It is vital for clinicians of all specialties to become aware of medical and social considerations in treating patients affected by methamphetamine abuse. The severe and wide-ranging effects of methamphetamine have whipped up a "perfect storm" in rural Middle America, with direct damage to users, their children, and first responders and collateral damage to the legal, social, and health care systems. Efforts to turn the tide have begun in legislative bodies, law enforcement agencies, and drug abuse prevention efforts, but the methamphetamine-driven storm surge is nowhere near to being stemmed.

REFERENCES

1. US Dept of Justice. *National Drug Threat Assessment 2005*. Johnstown, Pa: National Drug Intelligence Center; February 2005. Available at: www.usdoj.gov/ndic/pubs11/12620/. Accessibility verified November 17, 2005.

2. Substance Abuse and Mental Health Services Administration, Office of Applied Studies. *Drug Abuse Warning Network, 2003: Interim National Estimates of Drug-Related Emergency Department Visits*. DAWN Series D-26, DHHS Publication No. (SMA) 04-3972. Rockville, Md; 2004.

3. Substance Abuse and Mental Health Services Administration, Office of Applied Studies. *The DASIS Report: Primary Methamphetamine/Amphetamine Treatment Admissions: 1992-2002*. September 17, 2004. Available at: http://oas.samhsa.gov/2k4/methTX/methTX.pdf. Accessibility verified November 17, 2005.

4. Suwaki H, Fukui S, Konuma K. Methamphetamine abuse in Japan: its 45 year history and the current situations. In: Klee H, ed. *Amphetamine Misuse: International Perspectives on Current Trends*. Amsterdam, Netherlands: Harwood Academic Publishers; 1997: .

5. Logan BK. Methamphetamine-effects on human performance and behavior. *Forens Sci Rev*. 2002;14:133-151.

6. Matsumoto T, Kamijo A, Miyakawa T, et al. Methamphetamine in Japan: the consequences of methamphetamine abuse as a function of route of administration. *Addiction*. 2002;97:809-817.

7. National Institute on Drug Abuse. *Research Report Series: Methamphetamine Abuse and Addiction*. Bethesda, Md: National Institutes of Health; January 2002. NIH Publication No. 02-4210.

8. Anglin MD, Burke C, Perrochet B, Stamper E, Dawud-Noursi D. History of the methamphetamine problem. *J Psychoactive Drugs*. 2000;32:137-141.

9. US Drug Enforcement Administration. Maps of methamphetamine lab seizures: 1999-2004. Available at: www.usdoj.gov/dea/concern/map_lab_seizures.html. Accessibility verified November 17, 2005.

10. New Mexico Sentencing Commission. *Research Overview: Methamphetamine Production, Precursor Chemicals, and Child Endangerment*. January 2004. Available at: www.nmsc.state.nm.us/download/MethLabReport2004.pdf. Accessibility verified November 17, 2005.

11. Holton WC. Unlawful lab leftovers. *Environ Health Perspect*. 2001;109: A576.

12. Martyny JW, Arbuckle SL, McCammon CS Jr, Esswein EJ, Erb N. Chemical exposures associated with clandestine methamphetamine laboratories. Available at: www.njc.org/pdf/chemical_exposures.pdf. Accessibility verified November 22, 2005.

13. Substance Abuse and Mental Health Services Administration, Office of Applied Studies. *Emergency Department Trends From Drug Abuse Warning Network, Final Estimates 1995-2002*, DAWN series: D-24, DHHS Publication No. (SMA) 03-3780. Rockville, Md; 2003.

14. Danks RR, Wibbenmeyer LA, Faucher LD, et al. Methamphetamine-associated burn injuries: a retrospective analysis. *J Burn Care Rehabil*. 2004; 25:425-429.

15. Santos AP, Wilson AK, Hornung CA, Polk HC Jr, Rodriguez JL, Franklin GA. Methamphetamine laboratory explosions: a new and emerging burn injury. *J Burn Care Rehabil*. 2005;26:228-232.

16. Warner P, Connolly JP, Gibran NS, Heimbach DM, Engrav LH. The methamphetamine burn patient. *J Burn Care Rehabil*. 2003;24:275-278.

17. Burgess JL. Phosphine exposure from a methamphetamine laboratory investigation. *J Toxicol Clin Toxocol*. 2001;39:165-168.

18. Willers-Russo LJ. Three fatalities involving phosphine gas, produced as a result of methamphetamine manufacturing. *J Forensic Sci*. 1999;44:647-652.

19. Sudakin DL. Occupational exposure to aluminium phosphide and phosphine gas? a suspected case report and review of the literature. *Hum Exp Toxicol*. 2005;24:27-33.

20. Burchell SA, Ho HC, Yu M, Margulies DR. Effects of methamphetamine on trauma patients: a cause of severe metabolic acidosis? *Crit Care Med*. 2000;28:2112-2115.

21. Horiguchi T, Hori S, Shinozawa Y, et al. A case of traumatic shock complicated by methamphetamine intoxication. *Intensive Care Med*. 1999;25: 758-760.

22. Richards JR, Johnson EB, Stark RW, Derlet RW. Methamphetamine abuse and rhabdomyolysis in the ED: a 5-year study. *Am J Emerg Med*. 1999; 17:681-685.

23. Turnipseed SD, Richards JR, Kirk JD, Diercks DB, Amsterdam EA. Frequency of acute coronary syndrome in patients presenting to the emergency department with chest pain after methamphetamine use. *J Emerg Med*. 2003; 24:369-373.

24. Davis GG, Swalwell CI. Acute aortic dissections and ruptured berry aneurysms associated with methamphetamine abuse. *J Forensic Sci*. 1994;39: 1481-1485.

25. McGee SM, McGee DN, McGee MB. Spontaneous intracerebral hemorrhage related to methamphetamine abuse: autopsy findings and clinical correlation. *Am J Forensic Med Pathol*. 2004;25:334-337.

26. Wallace RT, Brown GC, Benson W, Sivalingham A. Sudden retinal manifestations of intranasal cocaine and methamphetamine abuse. *Am J Ophthalmol*. 1992;114:158-160.

27. Nestor TA, Tamamoto WI, Kam TH, Schultz T. Acute pulmonary oedema caused by crystalline methamphetamine [letter]. *Lancet*. 1989;25:1277-1278.
28. Wijetunga M, Seto T, Lindsay J, Schatz I. Crystal methamphetamine-associated cardiomyopathy: tip of the iceberg? *J Toxicol Clin Toxicol*. 2003;41:981-986.
29. Drug Abuse Warning Network. *The DAWN Report*: *Amphetamine and Methamphetamine Emergency Department Visits, 1995-2002*. July 2004. Available at http://dawninfo.samhsa.gov/old_dawn/pubs_94_02/shortreports/files/DAWN_tdr_amphetamine.pdf. Accessibility verified November 23, 2005.
30. Batki SL, Harris DS. Quantitative drug levels in stimulant psychosis: relationship to symptom severity, catecholamines and hyperkinesia. *Am J Addict*. 2004;13:461-470.
31. Zweben JE, Cohen JB, Christian D, et al, Methamphetamine Treatment Project. Psychiatric symptoms in methamphetamine users. *Am J Addict*. 2004; 13:181-190.
32. Richards JR, Brofeldt BT. Patterns of tooth wear associated with methamphetamine use. *J Periodontol*. 2000;71:1371-1374.
33. Venker D. Crystal methamphetamine and the dental patient. *Iowa Dent J*. 1999;85:34.
34. Shaner JW. Caries associated with methamphetamine abuse. *J Mich Dent Assoc*. 2002;84:42-47.
35. Ellinwood EH Jr. Amphetamine psychosis, I: description of the individuals and the process. *J Nerv Mental Dis*. 1967;144:273-283.
36. Halkitis PN, Parsons JT, Stirratt MJ. A double epidemic: crystal methamphetamine drug use in relation to HIV transmission among gay men. *J Homosex*. 2001;41:17-35.
37. Semple SJ, Patterson TL, Grants I. Motivations associated with methamphetamine use among HIV+ men who have sex with men. *J Subst Abuse Treat*. 2002;22:149-156.
38. Semple SJ, Grant I, Patterson TL. Female methamphetamine users: social characteristics and sexual risk behavior. *Women Health*. 2004;40:35-50.
39. Semple SJ, Patterson TL, Grant I. The context of sexual risk behavior among heterosexual methamphetamine users. *Addict Behav*. 2004;29:807-810.
40. Avergun JL. Defending America's most vulnerable: safe access to drug treatment and Child Protection Act of 2005—H.R. 1528. Testimony before the House Judiciary Committee Subcommittee on Crime, Terrorism and Homeland Security. April 12, 2005. Available at: www.usdoj.gov/dea/pubs/cngrtest/ct041205p.html Accessibility verified November 23, 2005.
41. Swetlow K. Children in clandestine methamphetamine labs: helping meth's youngest victims *OVC Bulletin*. June 2003. Available at: www.ojp.usdoj.gov/ovc/publications/bulletins/children/197590.pdf. Accessibility verified November 23, 2005.
42. Mecham N, Melini J. Unintentional victims: development of a protocol for the care of children exposed to chemicals at methamphetamine laboratories. *Pediatr Emerg Care*. 2002;18:327-332.
43. Hohman M, Oliver R, Wright W. Methamphetamine abuse and manufacture: the child welfare response. *Soc Work*. 2004;49:373-381.
44. Kolecki P. Inadvertent methamphetamine poisoning in pediatric patients. *Pediatr Emerg Care*. 1998;14:385-387.
45. Chang L, Smith LM, LoPresti C, et al. Smaller subcortical volumes and cognitive deficits in children with prenatal methamphetamine exposure. *Psychiatry Res*. 2004;132:95-106.
46. Inoue H, Nakatome M, Terada M, et al. Maternal methamphetamine administration during pregnancy influences on fetal rat heart development [published correction appears in *Life Sci*. 2004;74:3053]. *Life Sci*. 2004;74: 1529-1540.
47. Centers for Disease Control and Prevention. Public health consequences among first responders to emergency events associated with illicit methamphetamine laboratories—selected states, 1996-1999. *MMWR Morb Mortal Wkly Rep*. 2000;49:1021-1024.
48. Dube SR, Felitti VJ, Dong M, Chapman DP, Giles WH, Anda RF. Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: the adverse childhood experiences study. *Pediatrics*. 2003;111:564-572.
49. Hser YI, Evans E, Huang YC. Treatment outcomes among women and men methamphetamine abusers in California. *J Subst Abuse Treat*. 2005;28: 77-85.
50. Hanson GR, Rau KS, Fleckenstein AE. The methamphetamine experience: a NIDA partnership. *Neuropharmacology*. 2004;47(suppl 1):92-100.
51. Copeland AL, Sorensen JL. Differences between methamphetamine users and cocaine users in treatment. *Drug Alcohol Depend*. 2001;62:91-95.
52. Yui K, Ikemoto S, Ishiguro T, Goto K. Studies of amphetamine or methamphetamine psychosis in Japan: relation of methamphetamine psychosis to schizophrenia. *Ann N Y Acad Sci*. 2000;914:1-12.

Questions About Methamphetamine Abuse

1. Selective damage in which <u>one</u> of the following is associated with methamphetamine psychosis?
   a. Locus coeruleus
   b. Pons
   c. Mammillary bodies
   d. Striatum
   e. Cerebellum

2. Which <u>one</u> of the following is a reported motivation for HIV-positive men who abuse methamphetamine?
   a. Self-medication for the negative affects associated with HIV positivity
   b. Enhanced immune response
   c. Pain control
   d. Suicidal ideation
   e. Denial

3. Which <u>one</u> of the following gases is a harmful by-product of the illicit manufacture of methamphetamine?
   a. Phosgene
   b. Phosphine
   c. Carbon monoxide
   d. Carbon dioxide
   e. Methane

4. Which <u>one</u> of the following is <u>accurate</u> regarding the percentage of women methamphetamine users who reported problems with controlling violent behavior in a sample studied by Zweben et al?[31]
   a. 17%
   b. 26%
   c. 33%
   d. 46%
   e. 58%

5. Which <u>one</u> of the following states had the <u>highest</u> admission rates per 100,000 for methamphetamine/amphetamine substance abuse treatment in 1992 and 2002?
   a. Massachusetts
   b. Oregon
   c. Hawaii
   d. Missouri
   e. California

Correct answers:
1. *d*, 2. *a*, 3. *b*, 4. *d*, 5. *b*