6.0 CHEMICAL AND PHYSICAL PROPERTIES▲

Molecular Weight: 44.1

Boiling Point: -44° F

Solubility in Water: 0.01%

Flash Point: NA (Gas)

Ionization Potential: 11.07 eV

Relative Gas Density: 1.55

Flammability Class: Flammable Gas

Vapor Pressure: (70° F) 8.4 atm

Freezing Point: -306° F

Upper Explosive Limit in air (% by volume): 9.5%

Lower Explosive Limit in air (% by volume): 2.1%

7.0 INCOMPATIBILITIES AND REACTIVITIES▲

Strong oxidizers

8.0 MEASUREMENT METHOD (SEE TABLE 1)▲

Combustible gas meter; none; none; II(two are used in series) [#S87]

9.0 PERSONAL PROTECTION AND SANITATION (SEE TABLE 3)▲

Skin: Wear appropriate personal protective clothing to prevent the skin from becoming frozen from contact with the liquid or from contact with vessels containing the liquid.

Eyes: Wear appropriate eye protection to prevent eye contact with the liquid that could result in burns or tissue damage from frostbite.

Wash Skin: No recommendation is made specifying the need for washing the substance from the skin (either immediately or at the end of the work shift).

Remove: Work clothing that becomes wet should be immediately removed due to its flammability hazard (i.e., for liquids with a flash point <100° F).

Change: No recommendation is made specifying the need for the worker to change clothing after the workshift.

Provide: Quick drench facilities and/or eyewash fountains should be provided within the immediate work area for emergency use where there is any possibility of exposure to liquids that are extremely cold or rapidly evaporating.

10.0 RECOMMENDATIONS FOR RESPIRATOR SELECTION (SEE TABLE 4)▲

NIOSH/OSHA

2100 ppm: Any supplied-air respirator.(Assigned Protection Factor = 10)/Any self-contained breathing apparatus with a full facepiece.(Assigned Protection Factor = 50)

Emergency or planned entry into unknown concentrations or IDLH conditions: Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode(Assigned Protection Factor = 10000)/Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive-pressure mode.(Assigned Protection Factor = 10000)

Escape: Any appropriate escape-type, self-contained breathing apparatus.

11.0 HEALTH HAZARDS▲

Exposure Routes: Inhalation, Skin and/or eye contact, (liquid)

Exposure Symptoms (See Table 5): Dizziness, Confusion, excitation, Asphyxia; liquid: frostbite

Eye (See Table 6): If eye tissue is frozen, seek medical attention immediately; if tissue is not frozen, immediately and thoroughly flush the eyes with large amounts of water for at least 15 minutes, occasionally lifting the lower and upper eyelids. If irritation, pain, swelling, lacrimation, or photophobia persist, get medical attention as soon as possible.

Skin (See Table 6): If frostbite has occurred, seek medical attention immediately; do NOT rub the affected areas or flush them with water. In order to prevent further tissue damage, do NOT attempt to remove frozen clothing from frostbitten areas. If frostbite has NOT occurred, immediately and thoroughly wash contaminated skin with soap and water.

Breath (See Table 6): If a person breathes large amounts of this chemical, move the exposed person to fresh air at once. If breathing has stopped, perform mouth-to-mouth resuscitation. Keep the affected person warm and at rest. Get medical attention as soon as possible.

Target Organs (See Table 5): Central nervous system

NATIONAL INSTITUTE ON DRUG ABUSE

Research Report SERIES

INHALANT Abuse

from the director

Although many parents are appropriately concerned about illicit drugs such as marijuana, cocaine, and LSD, they often ignore the dangers posed to their children from common household products that contain volatile solvents or aerosols. Products such as glues, nail polish remover, lighter fluid, spray paints, deodorant and hair sprays, whipped cream canisters, and cleaning fluids are widely available. Many young people inhale the vapors from these sources in search of quick intoxication without being aware of the serious health consequences that can result.

National surveys indicate that more than 22.9 million Americans have abused inhalants at least once in their lives. NIDA's Monitoring the Future study reveals that approximately 17.3 percent of eighth-graders have abused inhalants. Parents and children need to know that experimentation with these substances should not be taken lightly. Even a single session of repeated inhalant abuse can disrupt heart rhythms and cause death from cardiac arrest or lower oxygen levels enough to cause asphyxiation. Regular abuse of these substances can result in serious harm to vital organs including the brain, heart, kidneys, and liver.

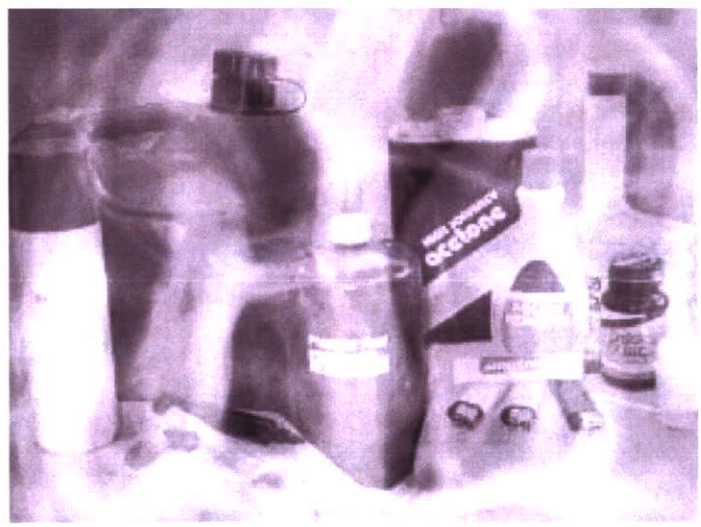
Through scientific research, we have learned much about the nature and extent of inhalant abuse, its pharmacology, and its consequences. This research has brought the picture of inhalant abuse in our Nation into focus and pointed to the dangers and the warning signs for parents, educators, and clinicians. We hope this compilation of the latest scientific information will help alert readers to inhalant abuse and its harmful effects and aid efforts to deal with this problem effectively.

Nora D. Volkow, M.D.
Director
National Institute on Drug Abuse

What are inhalants?

Inhalants are volatile substances that produce chemical vapors that can be inhaled to induce a psychoactive, or mind-altering, effect. Although other abused substances can be inhaled, the term "inhalants" is used to describe a variety of substances whose main common characteristic is that they are rarely, if ever, taken by any route other than inhalation. This definition encompasses a broad range of chemicals found in hundreds of different products that may have different pharmacological effects. As a result, precise categorization of inhalants is difficult. One classification system lists four general categories of inhalants—volatile solvents, aerosols, gases, and nitrites—based on the form in which they are often found in household, industrial, and medical products.

Volatile solvents are liquids that vaporize at room temperatures. They are found in a multitude of inexpensive, easily available products used for common household and industrial purposes. These include paint thinners and removers, dry-cleaning fluids, degreasers, gasoline, glues, correction fluids, and felt-tip marker fluids.



U.S. Department of Health and Human Services • National Institutes of Health

Aerosols are sprays that contain propellants and solvents. They include spray paints, deodorant and hair sprays, vegetable oil sprays for cooking, and fabric protector sprays.

Gases include medical anesthetics as well as gases used in household or commercial products. Medical anesthetic gases include ether, chloroform, halothane, and nitrous oxide, commonly called "laughing gas." Nitrous oxide is the most abused of these gases and can be found in whipped cream dispensers and products that boost octane levels in racing cars. Household or commercial products containing gases include butane lighters, propane tanks, whipped cream dispensers, and refrigerants.

Nitrites often are considered a special class of inhalants. Unlike most other inhalants, which act directly on the central nervous system (CNS), nitrites act primarily to dilate blood vessels and relax the muscles. While other inhalants are used to alter mood, nitrites are used primarily as sexual enhancers. Nitrites include cyclohexyl nitrite, isoamyl (amyl) nitrite, and isobutyl (butyl) nitrite, and are commonly known as "poppers" or "snappers." Amyl nitrite is used in certain diagnostic procedures and was prescribed in the past to treat some patients for heart pain. Nitrites are now prohibited by the Consumer Product Safety Commission, but can still be found, sold in small bottles, often labeled as "video head cleaner," "room odorizer," "leather cleaner," or "liquid aroma."

What are the patterns of inhalant abuse?

Inhalants—particularly volatile solvents, gases, and aerosols—are often among the first drugs that young children use. One national survey indicates that about 3.0 percent of U.S. children have tried inhalants by the time they reach fourth grade. Inhalant abuse can become chronic and extend into adulthood.

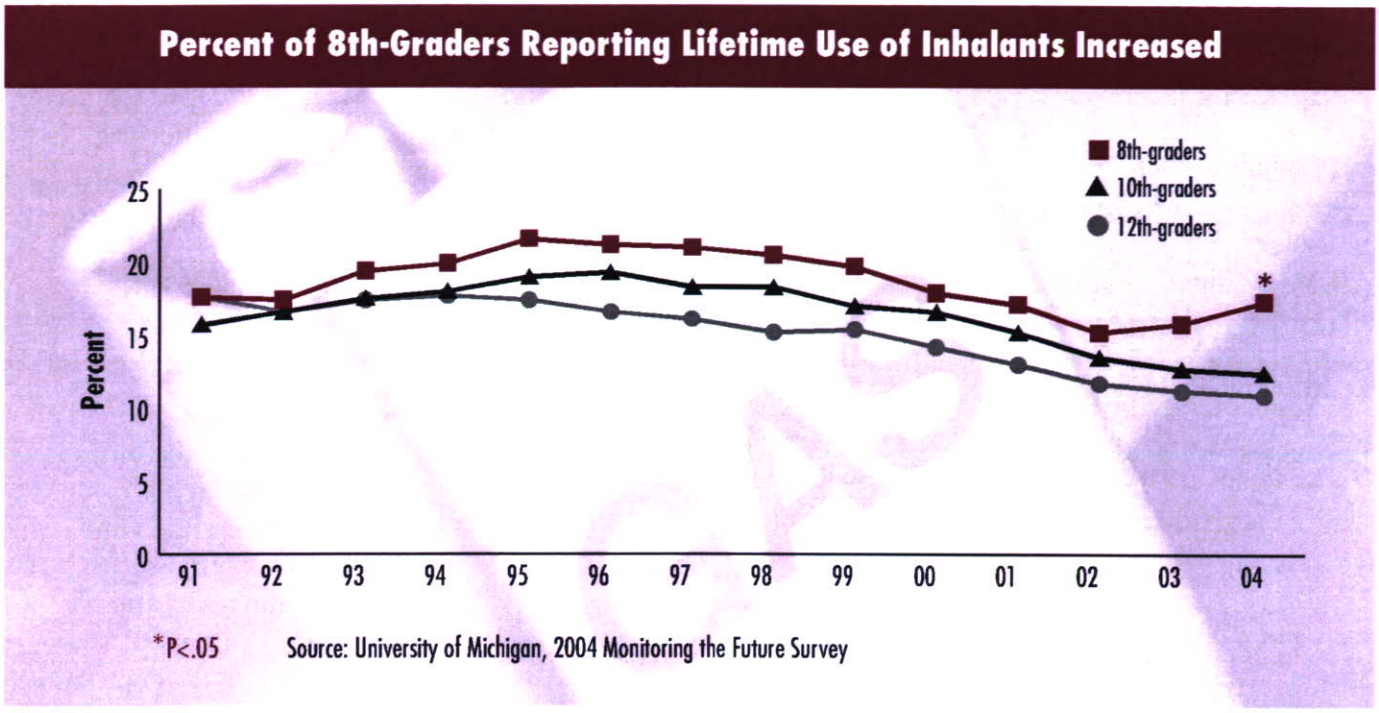
Generally, inhalant abusers will abuse any available substance. However, effects produced by individual inhalants vary, and some individuals will go out of their way to obtain their favorite inhalant. For example, in certain parts of the country, "Texas shoe-shine," a shoe-shining spray containing the chemical toluene, is a local favorite. Silver and gold spray paints, which contain more toluene than other spray colors, also are popular inhalants.

Data from national and State surveys suggest inhalant abuse reaches its peak at some point during the seventh through ninth grades. In the Monitoring the Future (MTF) study, an annual NIDA-supported survey of the Nation's secondary school students, 8th-graders also regularly report the highest rate of current, past year, and lifetime inhalant abuse; 10th- and 12th-graders report less abuse.

Gender differences in inhalant abuse have been identified at different points in childhood. The 2004 MTF indicates that 10.5 percent of 8th grade females reported

Students who have ever used inhalants versus other commonly abused drugs, percent

Source: Monitoring the Future Survey, 2004



using inhalants in the past year, compared with 8.8 percent of 8th grade males. Among 12th-graders, 3.4 percent of females and 4.8 percent of males reported using inhalants in the past year. The National Survey on Drug Use and Health (NSDUH), an annual survey of drug use among the Nation's noninstitutionalized civilians, reports that similar percentages of 12- to 17-year-old boys and girls abused inhalants in 2003. However, the percentage of 18- to 25-year-old males who abused inhalants within the past month was more than twice that of females in that age group, suggesting that sustained abuse of inhalants is more common among males.

People who abuse inhalants are found in both urban and rural settings. Research on factors contributing to inhalant abuse suggests that adverse socioeconomic conditions, a history of childhood abuse, poor grades, and dropping out of school all are associated with inhalant abuse.

What is the scope of inhalant abuse?

Inhalant abuse was up significantly for the second year in a row among 8th-graders, according to the latest MTF data, while use among 10th- and 12th-graders continued to decline.

- The rate of high school seniors who abused inhalants in the past year was 4.2 percent in 2004, down from the peak of 8.0 percent in 1995.
- Annual abuse of inhalants among 10th-graders was 5.9 percent in 2004, also down from a high in 1995 (9.6 percent).
- Among 8th-graders, 2004 abuse figures, at 9.6 percent, were down overall from the 1995 peak of 12.8 percent, but were up from the 2002 rate of 7.7 percent.

According to the 2003 NSDUH, lifetime, past year, and past month inhalant use among persons aged 12 to 17 were 10.7 percent, 4.5 percent, and 1.3 percent, respectively. The number of new inhalant users increased from 627,000 new users in 1994 to 1 million in 2002. Inhalant initiates were predominantly under age 18 (78 percent in 2002).

How can inhalant abuse be recognized?

Early identification and intervention are the best ways to stop inhalant abuse before it causes serious health consequences. Parents, educators, family physicians, and other health care practitioners should be alert to the following signs of a serious inhalant abuse problem:

- Chemical odors on breath or clothing
- Paint or other stains on face, hands, or clothes
- Hidden empty spray paint or solvent containers and chemical-soaked rags or clothing
- Drunk or disoriented appearance
- Slurred speech
- Nausea or loss of appetite
- Inattentiveness, lack of coordination, irritability, and depression

MTF's lifetime prevalence figures indicate that the percentages of students who have tried inhalants continue to decrease steadily for 10th- and 12th-graders. In 2004, 12.4 percent of 10th-graders and 11.9 percent of 12th-graders said they have abused inhalants at least once in their lives. Although lifetime prevalence peaked for 8th-graders in 1995 (21.6 percent), rates of inhalant use among this group are still high. In fact, 8th-graders reported a significant increase in lifetime use from 15.8 percent in 2003 to 17.3 percent in 2004. For 10th-graders, the peak was 19.3 percent in 1996. For seniors, rates were highest in 1994 at 17.7 percent. These data raise a question: How can fewer 12th-graders than 8th-graders consistently report they have ever abused inhalants? Possibly, many 12th-graders fail to recall their much earlier use of inhalants or, more troubling, many 8th-grade inhalant abusers may have dropped out of school by the 12th grade and are no longer included in the survey population.

How are inhalants used?

Inhalants can be breathed in through the nose or the mouth in a variety of ways, such as:

- "Sniffing" or "snorting" fumes from containers;
- Spraying aerosols directly into the nose or mouth;
- "Bagging"—sniffing or inhaling fumes from substances sprayed or deposited inside a plastic or paper bag;
- "Huffing" from an inhalant-soaked rag stuffed in the mouth; and
- Inhaling from balloons filled with nitrous oxide.

Inhaled chemicals are rapidly absorbed through the lungs into the bloodstream and quickly distributed to the brain and other organs. Within seconds of inhalation, the user experiences intoxication along with other effects similar to those produced by alcohol. Alcohol-like effects may include slurred speech, an inability to coordinate movements, euphoria, and dizziness. In addition, users may experience lightheadedness, hallucinations, and delusions.

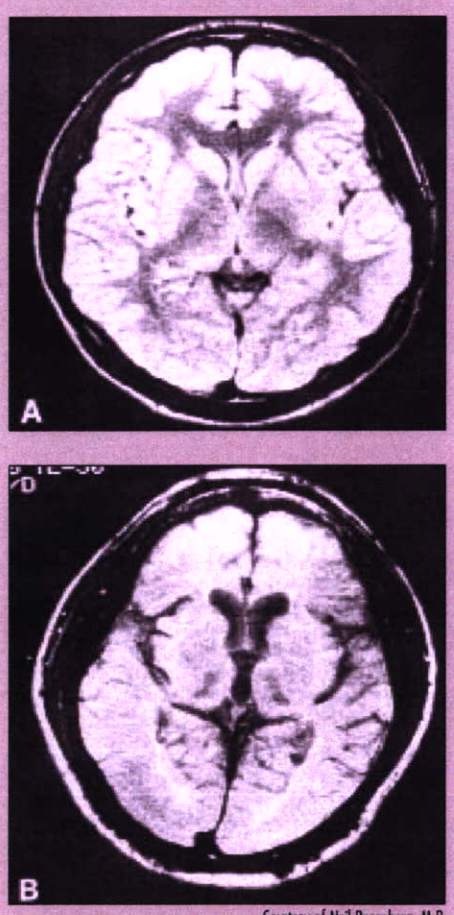
Because intoxication lasts only a few minutes, abusers frequently seek to prolong the high by continuing to inhale repeatedly over the course of several hours, a very dangerous practice. With successive inhalations, abusers can suffer loss of consciousness and death. At the least, they will feel less inhibited and less in control. After heavy use of inhalants, abusers may feel drowsy for several hours and experience a lingering headache.

How do inhalants produce their effects?

Many brain systems may be involved in the anesthetic, intoxicating, and reinforcing effects of different inhalants. Nearly all abused inhalants (other than nitrites) produce a pleasurable effect by depressing the CNS. Evidence from animal studies suggests that a number of commonly abused volatile solvents and anesthetic gases have neurobehavioral effects and mechanisms of action similar to those produced by CNS depressants, which include alcohol and medications such as sedatives and anesthetics.

A recent study indicates that toluene, a solvent found in many commonly abused inhalants, including model airplane glue, paint sprays, and paint and nail polish removers, activates the brain's dopamine system. The dopamine system has been shown to play a role in the rewarding effects of many drugs of abuse. Nitrites, in contrast, dilate and relax blood vessels rather than acting as anesthetic agents.

Brain damage in a toluene abuser



Courtesy of Neil Rosenberg, M.D.

Brain images show marked atrophy (shrinkage) of brain tissue in a toluene abuser (B) compared to a nonabusing individual (A). Note the smaller size and the larger empty (dark) space within the toluene abuser's brain. (The white outer circle in each image is the skull.)

What are the short- and long-term effects of inhalant use?

Although the chemical substances found in inhalants may produce various pharmacological effects, most inhalants produce a rapid high that resembles alcohol intoxication with initial excitation, then drowsiness, disinhibition, lightheadedness, and agitation. If sufficient amounts are inhaled, nearly all solvents and gases produce anesthesia, a loss of sensation, and even unconsciousness.

The chemicals found in solvents, aerosol sprays, and gases can produce a variety of additional effects during or shortly after use. These effects are related to inhalant intoxication and may include belligerence, apathy, impaired judgment, and impaired functioning in work or social situations. Dizziness, drowsiness, slurred speech, lethargy, depressed reflexes, general muscle weakness, and stupor are other possible effects. For example, research shows that toluene can produce headache, euphoria, giddy feelings, and inability to coordinate movements. Exposure to high doses can cause confusion and delirium. Nausea and vomiting are other common side effects.

Inhaled nitrites dilate blood vessels, increase heart rate, and produce a sensation of heat and excitement that can last for several minutes. Other effects can include flush, dizziness, and headache. Unlike other inhalants, which are abused mainly for their intoxicating effects, nitrites are abused primarily because they are believed to enhance sexual pleasure and performance.

A strong need to continue using inhalants has been reported among many individuals, particularly those who abuse inhalants for prolonged periods over many days. Compulsive use and a mild withdrawal syndrome can occur with long-term

inhalant abuse. Additional symptoms exhibited by long-term inhalant abusers include weight loss, muscle weakness, disorientation, inattentiveness, lack of coordination, irritability, and depression.

What are the medical consequences of inhalant abuse?

Inhalant abusers risk an array of devastating medical consequences. Prolonged sniffing of the highly concentrated chemicals in solvents or aerosol sprays can induce irregular and rapid heart rhythms and lead to heart failure and death within minutes of a session of prolonged sniffing. This syndrome, known as "sudden sniffing death," can result from a single session of inhalant use by an otherwise healthy young person. Sudden sniffing death is particularly associated with the abuse of butane, propane, and chemicals in aerosols. Inhalant abuse also can cause death by:

- Asphyxiation—from repeated inhalations, which lead to high concentrations of inhaled fumes displacing the available oxygen in the lungs;
- Suffocation—from blocking air from entering the lungs when inhaling fumes from a plastic bag placed over the head;
- Convulsions or seizures—caused by abnormal electrical discharges in the brain;
- Coma—the brain shuts down all but the most vital functions;
- Choking—from inhalation of vomit after inhalant use; or
- Fatal injury—from accidents, including motor vehicle fatalities, suffered while intoxicated.

Animal and human research shows that most inhalants are extremely toxic. Perhaps the most significant toxic effect of chronic exposure to inhalants is widespread and long-lasting damage to the brain and other parts of the nervous system. For example, both animal research and human pathological studies indicate that chronic abuse of volatile solvents such as toluene damages the protective sheath around certain nerve fibers in the brain and peripheral nervous system. This extensive destruction of nerve fibers is clinically similar to that seen with neurological diseases such as multiple sclerosis.

The neurotoxic effects of prolonged inhalant abuse include neurological syndromes that reflect damage to parts of the brain involved in controlling cognition, movement, vision, and hearing. Cognitive abnormalities can range from mild impairment to severe dementia. Other effects can include difficulty coordinating movement, limb spasms, and loss of feeling, hearing, and vision.

Inhalants also are highly toxic to other organs. Chronic exposure can produce significant damage to the heart, lungs, liver, and kidneys. Although some inhalant-induced damage to the nervous and other organ systems

Nerve fiber deterioration in an inhalant abuser

Reproduced with permission from the *Journal of Neuropathology & Experimental Neurology*.

Dark-stained patches show areas where nerve fibers have lost their protective sheath in a specimen of brain tissue removed from a deceased inhalant abuser.

Hazards of chemicals found in commonly abused inhalants

amyl nitrite, butyl nitrite
("poppers," "video head cleaner")
sudden sniffing death syndrome, suppressed immunologic function, injury to red blood cells (interfering with oxygen supply to vital tissues)

benzene *(found in gasoline)*
bone marrow injury, impaired immunologic function, increased risk of leukemia, reproductive system toxicity

butane, propane
(found in lighter fluid, hair and paint sprays)
sudden sniffing death syndrome via cardiac effects, serious burn injuries (because of flammability)

freon *(used as a refrigerant and aerosol propellant)*
sudden sniffing death syndrome, respiratory obstruction and death (from sudden cooling/cold injury to airways), liver damage

methylene chloride
(found in paint thinners and removers, degreasers)
reduction of oxygen-carrying capacity of blood, changes to the heart muscle and heartbeat

nitrous oxide *("laughing gas")*, **hexane**
death from lack of oxygen to the brain, altered perception and motor coordination, loss of sensation, limb spasms, blackouts caused by blood pressure changes, depression of heart muscle functioning

toluene
(found in gasoline, paint thinners and removers, correction fluid)
brain damage (loss of brain tissue mass, impaired cognition, gait disturbance, loss of coordination, loss of equilibrium, limb spasms, hearing and vision loss), liver and kidney damage

trichlorethylene *(found in spot removers, degreasers)*
sudden sniffing death syndrome, cirrhosis of the liver, reproductive complications, hearing and vision damage

may be at least partially reversible when inhalant abuse is stopped, many syndromes caused by repeated or prolonged abuse are irreversible.

Abuse of inhalants during pregnancy also may place infants and children at increased risk of developmental harm. Animal studies designed to simulate human patterns of inhalant abuse suggest that prenatal exposure to toluene or trichlorethylene (TCE) can result in reduced birth weights, occasional skeletal abnormalities, and delayed neurobehavioral development. A number of case reports note abnormalities in newborns of mothers who chronically abuse solvents, and there is evidence of subsequent developmental impairment in some of these children. However, no well-controlled, prospective study of the effects of prenatal exposure to inhalants in humans has been conducted, and it is not possible to link prenatal exposure to a specific chemical to a specific birth defect or developmental problem.

What are the special risks for nitrite abusers?

Nitrites are abused mainly by older adolescents and adults. Typically, individuals who abuse nitrites are seeking to enhance sexual function and pleasure. Research shows that abuse of these drugs in this context is associated with unsafe sexual practices that greatly increase the risk of contracting and spreading such infectious diseases as HIV/AIDS and hepatitis.

Animal research raises the possibility that there may be a link between abuse of nitrite inhalants and the development and progression of infectious diseases and tumors. The research indicates that inhaling nitrites depletes many cells in the immune system and impairs immune system mechanisms that fight infectious diseases. A recent study found that even a relatively small number of exposures to butyl nitrite can produce dramatic increases in tumor incidence and growth rates in animals.

Where can I get further scientific information about inhalant abuse?

To learn more about inhalants and other drugs of abuse, contact the National Clearinghouse for Alcohol and Drug Information (NCADI) at 1-800-729-6686. Information

specialists are available to help you locate information and resources.

Fact sheets, including *InfoFacts*, on the health effects of inhalants, other drugs of abuse, and other drug abuse topics are available on the NIDA Web site (www.drugabuse.gov), and can be ordered free of charge in English and Spanish from the National Clearinghouse for Alcohol and Drug Information (NCADI) at www.health.org.

Access information on the Internet

- **What's new on the NIDA Web site**
- **Information on drugs of abuse**
- **Publications and communications (including *NIDA NOTES*)**
- **Calendar of events**
- **Links to NIDA organizational units**
- **Funding information (including program announcements and deadlines)**
- **International activities**
- **Links to related Web sites (access to Web sites of many other organizations in the field)**

NIDA Web Sites
www.drugabuse.gov
www.inhalants.drugabuse.gov
www.steroidabuse.org
www.clubdrugs.org

NCADI
Web Site: www.health.org
Phone No.: 1-800-729-6686

Glossary

Anesthetic: An agent that causes insensitivity to pain.

Central nervous system: The brain and spinal cord.

Dementia: A condition of deteriorated mental function.

Dopamine: A neurotransmitter present in regions of the brain that regulate movement, emotion, motivation, and feeling of pleasure.

Epidemiology: The sum of the factors controlling the presence or absence of a disease or condition.

Toxic: Causing temporary or permanent effects that are detrimental to the functioning of a body organ or group of organs.

Withdrawal: A variety of symptoms that occur after use of an addictive drug is reduced or stopped.

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National Institute on Drug Abuse

RESEARCH

MONOGRAPH SERIES

Inhalant Abuse: A Volatile Research Agenda

129

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Inhalant Abuse: A Volatile Research Agenda

Editors:

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Public Health Service
National Institutes of Health

National Institute on Drug Abuse
5600 Fishers Lane
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Contents

Contents (Continued)

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Sudden Sniffing Death Following Inhalation of Butane and Propane: Changing Trends

Earl Siegel
Suman Wason

Volatile substance abuse has been noted as a serious problem in Britain since the 1970s (Editorial, *Lancet* 1988). In the United Kingdom two deaths from solvent abuse were reported in 1971 and almost 1,000 deaths since then (Ramsey et al. 1989; Johns 1991). One fifth of these deaths were apparently first-time users (Johns 1991). Among products abused by the British teenager, in order of decreasing frequency, are toluene-containing glues, chlorinated hydrocarbons (cleaning fluids, paints, varnishes, lacquers, dyes), acetone (nail polish remover, polystyrene cements), and gasoline, butane, and propane (lighter fuels and bottled gases) (Editorial, *Lancet* 1988). The largest number of deaths resulted from exposure to butane and propane (gas fuels or propellants) (Johns 1991). In a survey from the United Kingdom, deaths due to abuse of volatile substances occurred primarily in male teenagers (95 percent) of all social classes. Twenty-five percent were due to butane or propane. The causes of death were direct toxic effects (51 percent), asphyxia (21 percent), aspiration of gastric contents (18 percent) and trauma (11 percent) (Anderson et al. 1985).

The profile of American teenagers who abuse volatile substances fits a slightly different pattern (see chapters by Beauvais, Smart, and Fredlund in this volume). A recent U.S. survey indicated almost one in five eighth-graders have

experimented with inhalant abuse (Johnston et al. 1992). By contrast with the United Kingdom, experience with propane and butane inhalation appears to be more limited in the United States. There are only limited reports of deaths in the United States due to inhalation abuse. However, reports of the American Association of Poison Control Centers annual data, which reflects the experience of approximately 70 poison control centers across the United States from 1987 to 1990, are an indicator and are summarized in table 1 (Litovitz et al, 1988, 1989, 1990, 1991). Details were provided for only four cases (table 2). They were all young adults aged 14 to 20 years. We believe that this and other published data underrepresent the true numbers of fatalities related to propane and butane abuse for the following reasons: (a) the circumstances surrounding death may be misrepresented to coroners, (b) volatiles are not easily or routinely screened for in cases of sudden sniffing death, and (c) there, is no formalized registry of this form of drug abuse.

Death resulting from deliberately inhaled aerosol propellants for the purpose of getting high was first reported in 1970. The cause of death was attributed to cardiac dysrhythmia induced by the fluoroalkane propellants, trichlorofluoromethane (Freon 11) and dichlorodifluoromethane (Freon 12) (Bass 1970). Because evidence indicated that continued discharge of these fluoropropellants would lead to a decrease in atmospheric ozone concentrations, and result in climatic changes and skin cancer, the Food and Drug Administration called for a ban of chlorofluorocarbons in aerosol products in 1978 (Molina and Rowland 1974). Most manufacturers replaced the Freon propellants with isobutane, n-butane, isopropane, and isopentane. In 1986, we reported the first human case of ventricular tachycardia after the accidental inhalation of n-butane and isobutane, suggesting that these replacement propellants, too, had potential for inducing fatal dysrhythmia in humans and animals (Wason et al. 1986; Final report of the safety assessment, 1982).

Teenagers have continued to seek products other than fluorocarbons, for their "highs." Inhalation of gasoline, previously a well-known problem among American Indians and lower socioeconomic teenagers, has become more prevalent among all teenagers (Edminster and Bayer 1985). Also, the use of

Table 1. American Association of Poison Control Center inhalant abuse related deaths

Year	No. of inhalant abuse related deaths	No. caused by butane/propane
1987	10	1
1988	12	7
1989	25	9
1990	20	10

Table 2. Details of sudden sniffing deaths due to propane and butane

Age	Sex	Product	Symptoms/Signs	Post mortem drug
17	M	Nail-enamel dryer	Collapse	Propane/ isobutane
16	M	Air freshener	Coma Ventricular fibrillation	Not reported
16	M	Butane lighter fluid	Collapse	Butane
16	M	Butane lighter fluid	Collapse/electro-mechanical dissociation	Butane

typewriter correction fluids frequently occurs and has resulted in sudden sniffing deaths among teenagers following deliberate inhalation (King et al. 1985); this fluid contains trichloroethane and trichloroethylene.

Although not a comprehensive sample, table 3 identifies several cases brought to the authors' attention from the Tristate area surrounding Cincinnati, in the latter part of 1991. These and those in table 2 compile only a portion of the total deaths in the United States due to these replacement hydrocarbon propellants.

Two recent fatalities attributed to propane and butane abuse serve to emphasize the potential for sudden death. The ready availability of these products makes it imperative that health care providers and youth counselors across the United States are aware of this problem (Siegel and Wason, 1990).

> March 1990: An 11-year-old boy collapsed in a movie theater bathroom. A butane cigarette lighter fuel container and a plastic bag were found next to him. He also had several bottles of typewriter correction fluid in his pocket. Cardiopulmonary resuscitation was instituted; efforts proved unsuccessful and he was pronounced dead shortly thereafter. Post mortem examination showed no evidence of organic disease or anatomic cause of death. Toxicologic analysis confirmed the presence of butane in the patient's blood and lung tissue. Trichloroethane and trichloroethylene were not detected in the patient's blood or tissues.
>
> April 1990: a 15-year-old boy was found unconscious in a backyard. Three companions related that the four teenagers had taken a 20-gallon propane tank from the family gas grill, placed some of the gas in a plastic bag and were inhaling it in order to get high. They also engaged in "torch breathing" whereby they purposefully exhaled the propane gas and ignited it. The subject collapsed soon after inhaling the gas; fumes, ignited by a match, resulted in a flash fire. The patient did not sustain any burns. He could not be resuscitated and died en route to the hospital. Post mortem examination in this case, too, failed to reveal an organic cause of death. Propane was detected in the blood and lung tissues.

Table 3. Other selected Midwestern cases

Date	Age	Sex	Origin	Comments
7/91	16	M	Kokomo, IN	Inhaling lighter fuel while driving with friends, held his head out of the window gasping for air and then crashed. Autopsy showed no anatomic or traumatic cause of death
8/91	16	M	West Michigan	Died after inhaling butane lighter fluid
10/91	16	M	Dayton, OH	1 of 4 boys inhaling butane lighter fuel died
10/91	15	M	Noblesville, IN	Died after inhaling aersolized* shoe protectant
11/91	14	M	Madisonville, KY	Died from inhaling aerosolized* solvent
11/91	29	M	Portsmouth, OH	Died after sniffing aerosolized* paint
12/91	17	M	West Michigan	1 of 3 boys inhaling butane lighter fuel died

*Aerosol blends usually contain isobutane, n-butane, and propane.

Also, in January 1991 four teenagers huffing butane in a parked car in Jefferson County, Kentucky, sustained facial and upper body burns from an explosion ignited by a spark from the car lighter.

In addition, in October 1991 a 6-year-old boy imitating his older brother huffing aerosolized room deodorizer was hospitalized.