

**HEADS UP
REAL NEWS
ABOUT DRUGS
AND YOUR BODY**

Inhalants: A Looming Threat for All Teens



—A message from Dr. Nora D. Volkow,
Director of NIDA

Dear Teacher:

I have an important warning to share with you. Some of the most dangerous substances abused by your students may be found in the home—and even in schools. As a group, these toxic substances are referred to as inhalants. They are breathable chemical vapors that produce mind-altering effects. Abusers breathe in toxic fumes to achieve a high. Substances that are abused as inhalants include computer cleaner, nail polish remover, glue, and a host of other products that may seem

abusing inhalants once or twice was risky.

Monitoring the Future and other studies indicate that inhalant abuse is particularly prevalent among young teens. Some may abuse inhalants as a substitute for alcohol because they can be obtained easily.

This article, the second installment in this year's edition of *Heads Up: Real News About Drugs and Your Body*, will alert your students to the real dangers of inhalant abuse and explain to them why the smart choice is never to try inhalants—not even once.

In addition to sharing this article with your classes, there is one other step you can take to keep your students safe from inhalants. Encourage school officials and parents to store household products carefully; they should be keenly aware of the temptations that these dangerous substances pose to young people (as well as the danger of accidental inhalation by very young children).

Thank you for devoting a portion of your valuable classroom time to sharing this key message about inhalants with your students. As ever, we deeply appreciate your willingness to play a vital role in NIDA's mission: helping young people everywhere understand the risks of drugs and the damage they can cause.

Sincerely,

Nora D. Volkow, M.D.
Director of NIDA

In This Installment

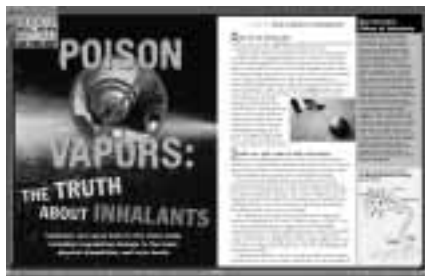
- How all inhalants are poisonous chemical vapors.
- How inhalants can cause a condition called **sudden sniffing death**.
- How inhalants can cause damage to the whole body—including death.
- Why teens need to learn the facts.

Coming Up in the Next Installment

- Dangers of Prescription Drug Abuse

Assessment Quiz

Use the Activity 1 Reproducible within as an Assessment Quiz to determine your students' core base of knowledge and to test what they've learned about inhalants.



harmless because their intoxicating effects are so totally unconnected to their intended uses.

Inhalants are anything *but* harmless. They are dangerous poisons that can kill in an instant. And I am troubled to report that the use of inhalants is on the upswing among young people—bucking the overall trend of decreasing drug abuse among teens. NIDA's most recent Monitoring the Future study, an annual survey of youth drug abuse, found a significant increase in the number of 8th-graders saying they had tried inhalants at least once. Not only that: more than 66 percent of students in this age group didn't think that

For printable past and current articles in the **HEADS UP** series, as well as activities and teaching support, go to www.drugabuse.gov/parent-teacher.html or www.scholastic.com/HEADSUP.

Lesson Plans for Student Activities

PREPARATION: Before beginning the lessons, make these photocopies: Two copies for each student of Activity 1 Reproducible for a pre-reading and post-reading quiz, and one copy for each student of Activity 2 Reproducible.

Lesson 1 Heads Up: What Do You Know About Inhalants and Their Dangers?

OBJECTIVE

To give students science-based facts about inhalants; to educate students about the ways in which inhalants can damage the brain and body, sometimes causing death; to help students understand that trying inhalants even once can be dangerous or even deadly; and to assess students' knowledge of the topics before and after reading the article "Poison Vapors: The Truth About Inhalants."

NATIONAL SCIENCE EDUCATION STANDARDS

Life Science; Science in Personal and Social Perspective

LESSON STRATEGY

Introducing the Topic

- Before the lesson begins, hold a class discussion based on these questions: *What are inhalants? How can they damage the body and brain? Surveys show that some teens think inhalants are less dangerous than they*

really are. Why might that be?

- Tell students that they are going to find out how much they know about inhalants and what the latest research is teaching us about them. Distribute copies of Activity 1 Reproducible. Tell students to write their names on the paper and label it No. 1. Then have them answer the questions. Collect and grade the papers.

READING, DISCUSSION, AND ASSESSMENT

- Have students read the article "Poison Vapors: The Truth About Inhalants." Next, hold a discussion based on these questions: *What are the key dangers of inhalant abuse? Why do you think many young teens don't understand the risks of inhalants? Does the fact that many inhalants have innocent purposes, such as cleaning, make them seem less dangerous?*
- Next, tell students it's time to find out how much they've increased

their knowledge. Give them a second copy of Activity 1 Reproducible. Tell them to write their names on the paper and label it No. 2. When students have finished, collect the papers, score them, and compare the results. Share the results with students before and after the lesson.

WRAP-UP

- Conclude the lesson by asking students what they think might be the most effective way to inform young people about the dangers of inhalants. Ask them if they think products that are abused as inhalants should carry warning labels, or if it should be against the law to sell products like computer cleaner to young people. Brainstorm ways that your class could spread the word about the risks of abusing inhalants.

ANSWERS TO QUIZ QUESTIONS:

1. b; 2. b; 3. b; 4. d; 5. d; 6. d; 7. a; 8. c; 9. a; 10. c.

Lesson 2 Heads Up: Learning How Inhalants Become Drugs of Addiction

OBJECTIVE

Students use scientific data to draw conclusions about the effects of toluene (a toxic component of many inhalants) on brain chemistry, behavior, and motor activity; students learn that the chemicals in inhalant vapors can lead to addiction.

NATIONAL SCIENCE EDUCATION STANDARDS

Science as Inquiry; Science in Personal and Social Perspective

LESSON STRATEGY

Introducing the Topic

- Begin by sharing with students the definition below of **drug addiction**, taken from the article "Drug Addiction Is a Disease: Why the Teen Brain Is Vulnerable," www.scholastic.com/headsup. (You may want to provide this entire article to students as back-up.)

Drug addiction: A chronic relapsing disease that is characterized by compulsive drug-seeking and abuse and long-lasting chemical changes in the brain.

Based on what they've already learned about inhalants from the article, ask students the following: *Why do you think inhalants can be classified as a drug of addiction?*

- Next, explain that students are going to read about an experiment in which researchers tested rats to find out how their brains and bodies respond to an inhalant component called toluene. (The experiment is described in Activity 2 Reproducible.) If the brain and body respond in the same way that they do to many other drugs of abuse, this will show that toluene may cause addictive behavior in a similar way. The brain chemical tested in the experiment was dopamine because of its key involvement in feelings of pleasure and motivation, as well as in motor coordination. *Ask students why and how they think drugs are able to change the way people behave. How do inhalants affect abusers' behavior?*

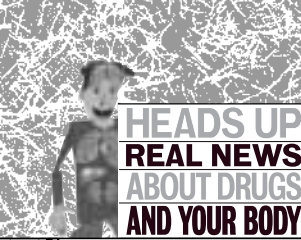
READING, DISCUSSION, AND WRAP-UP

- Hand out Activity 2 Reproducible. Have students read the sheet and answer the questions at the end.

- Wrap up the lesson by discussing the following questions: *How does the flood of dopamine in the brain that toluene apparently causes seem to affect the behavior of individual people who abuse inhalants? Based on this experiment, what might happen to toluene abusers' behavior if you gave them a drug that blocked dopamine from getting to the NAc? What would you need to know before you could recommend such treatment?*

ANSWERS TO REPRODUCIBLE 2:

1. Question part one: Dopamine acts on the brain to allow people to feel pleasure and motivation, and helps control motor coordination. **Question part two:** Taking drugs that make the brain produce unnaturally high levels of dopamine can throw off the brain's own ability to produce it. Abusers may then become addicted and unable to experience pleasure without the drug. **2.** Scientists knew amphetamine caused roaming by flooding the NAc with dopamine. They knew that scopolamine caused similar behavior through a different mechanism. They wanted to compare toluene—which they knew caused roaming—to see which category it fell into. **3. Question part one:** That inhalants may change abusers' brains so that the only way to feel pleasure is to continue inhaling. **Question part two:** Scientists can figure out ways to restore brain chemistry to normal.



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Heads Up: Inhalants—A Quiz

Test your knowledge of inhalants. Choose the correct answer to each question.

1. **Most inhalants are actually intended to be**
 - a. prescription drugs.
 - b. household and office products.
 - c. painkillers.
 - d. cold medicine.
2. **How do inhalants wind up in abusers' bloodstreams?**
 - a. Abusers inject them.
 - b. Abusers breathe them in.
 - c. Abusers take them in pill form.
 - d. All of the above.
3. **Some inhalants are safer than others.**
 - a. true
 - b. false
4. **Which of the following organs or body systems can be seriously damaged by inhalant abuse?**
 - a. the nervous system (brain, spinal cord, and nerves)
 - b. the heart
 - c. the liver
 - d. all of the above
5. **The inhalant nitrous oxide can rob the body of _____, causing death.**
 - a. blood
 - b. essential vitamins
 - c. dopamine
 - d. oxygen
6. **Which of the following is not a risk of inhalant abuse?**
 - a. hearing loss
 - b. blackouts
 - c. sudden sniffing death
 - d. none of the above
7. **Toluene, a chemical found in many inhalants, can cause muscle spasms, tremors, and hearing loss. It does so by breaking down**
 - a. a nerve coating called myelin.
 - b. a section of the inner ear called the cochlea.
 - c. the brain's balance center.
 - d. nerve cells in the nose.
8. **Benzene, a toxic component of gasoline fumes, can cause aplastic anemia, an often fatal disease of the**
 - a. liver.
 - b. lungs.
 - c. blood.
 - d. brain.
9. **When toxins from inhalants stay in the body for a long time, they are stored in**
 - a. fatty tissue.
 - b. muscle tissue.
 - c. the inner ear.
 - d. the stomach.
10. **A recent survey found that more than _____ of 8th-graders didn't realize that regular use of inhalants is harmful.**
 - a. 2 percent
 - b. 8 percent
 - c. 38 percent
 - d. 66 percent



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Heads Up: Learning How Inhalants Become Drugs of Addiction

Among the known risks of inhalants are severe brain damage, physical disabilities, and even death. In addition to these risks, new scientific evidence points to how inhalants also act upon the brain like other drugs of addiction.

Recently, two NIDA-sponsored researchers at the University of Arizona in Tucson studied how rats are affected by toluene—a chemical found in many inhalants, including gasoline, spray paint, and glue. If the scientists could show that toluene’s effects on the brain are similar to those of other drugs of addiction, it would help them figure out how to battle inhalant abuse. Read about the experiment, then answer the questions below.

The Experiment: A Change in Dopamine Levels Is Behind a Toluene-Induced Behavior Change

BACKGROUND

Researchers Art Riegel and Edward French knew that when toluene was given to rats, it caused increased motor activity, known as “roaming.” The researchers wanted to see whether this behavioral change in the rats’ motor activity resulted from heightened dopamine activity in their brains’ pleasure center.

It was known that some drugs that cause roaming *and* feelings of extreme pleasure—including the drug amphetamine—do so by increasing dopamine in a region of the brain called the nucleus accumbens

(NAc for short). The NAc is sometimes called the brain’s pleasure center, and dopamine is sometimes called the pleasure chemical.

Dopamine is a naturally occurring brain chemical that is important for pleasure, motivation, and motor activity. When people take drugs that cause the brain to produce unnaturally large quantities of dopamine, it can throw off the brain’s own ability to produce this chemical. Drug abusers become unable to feel pleasure without taking drugs. This is the start of the disease known as addiction.

DESCRIPTION

To test whether the increased roaming in rats that were given toluene is related to dopamine activity, the researchers compared toluene’s effects on two groups of rats. One group was made up of ordinary lab rats. The other group had a procedure done so that dopamine was blocked from reaching the NAc region

of their brains. If the dopamine-blocked rats showed roaming activities, scientists would know it couldn’t be caused by dopamine in the NAc.

Next, scientists injected the two groups with three drugs: toluene, amphetamine (which acts through dopamine in the NAc), and scopolamine (which induces roaming, but *not* through dopamine).

RESULTS

- As the scientists expected, the **normal rats** showed increased roaming when given **toluene**, **amphetamine**, or **scopolamine**.
- The **dopamine-blocked rats** reacted differently. Their roaming response to **toluene** was 55 percent less than in normal rats given toluene. Their roaming response to **amphetamine** was 67 percent less than in normal rats given amphetamine. Their

roaming response to **scopolamine** was the same as in the normal rats.

- “The findings put inhalants squarely in the same category as other drugs of abuse, suggesting that a similar mechanism of action is involved,” explained Dr. Riegel. “There is a strong likelihood that they are highly addictive substances and that some of the same strategies that work for other addictions may effectively combat inhalant abuse as well.”

YOU’RE THE SCIENTIST

Now imagine that you’re a scientist trying to understand and interpret this experiment. Answer the following questions.

1. What does dopamine do in our brains in its natural state? How can the dopamine system be damaged by drugs of abuse?
2. Can you think of a reason why the researchers injected the rats not only with toluene, but with amphetamine and scopolamine, too?

3. What do you think the results say about why people might repeatedly abuse inhalants even when they know they are dangerous? How can scientists use this information to help inhalant abusers?



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POISON



VAPORS:

THE TRUTH ABOUT INHALANTS

**Inhalants can cause harm to the whole body,
including long-lasting damage to the brain,
physical disabilities, and even death.**

Photo credits: spray from aerosol can © Hardy/zeta/CORBIS; household products inset © Custom Medical Stock Photo; ball and chain © Paul Hardy/CORBIS.

One Harmful Effect of Inhalants

WHAT IS AN INHALANT?

Inhalants are toxic—that is, **poisonous**—chemical vapors that can be misused to produce mind-altering effects, often with disastrous results.

These harmful vapors can be found in a variety of common household and office products, including nail polish remover, gasoline, aerosol sprays, correction fluid, whipped cream canisters, computer spray cleaners, paint thinners, and markers. Even when used for their intended purposes, such as cleaning or painting, these products are so toxic that they are recommended for use only in well-ventilated areas. That's to prevent people from accidentally breathing in the poison. When they are intentionally inhaled in order to experience a "high," they are known as **inhalants**, and can cause serious harm to the whole body. Abuse of certain inhalants may result in irreversible effects, including hearing loss, limb spasms, bone marrow damage, and damage to the central nervous system and brain. Serious but reversible effects may include liver and kidney damage and depletion of oxygen in the blood. An adequate blood oxygen level is critical to the function of every organ and tissue in our bodies.



HEADS UP: ONE TIME IS ONE TOO MANY

Inhalants are incredibly effective poisons. They enter the bloodstream quickly and are then distributed throughout the brain and body. They have direct effects on both the central nervous system (brain and spinal cord) and the peripheral nervous system (nerves throughout the body).

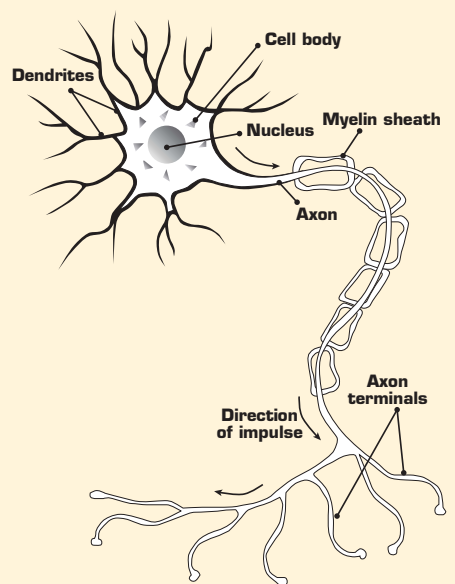
How severely can inhalants harm you? According to Dr. David Shurtleff, who heads the Division of Basic Neurosciences and Behavior Research at the National Institute on Drug Abuse (NIDA), they can affect your ability to think, talk, remember, hear, and even walk. They may be addictive, and they can wreak havoc on a healthy body from head to toe, causing hearing loss, vision loss, convulsions, and damage to the lungs, liver, kidneys, heart, bone marrow, and muscles.

Most frightening is that just one time can be one too many with inhalants. As explained by Dr. Nora D. Volkow, director of NIDA, "Even in an otherwise healthy person, a single session of abusing highly concentrated amounts of certain inhalants can lower oxygen levels enough to cause asphyxiation, or disrupt heart rhythms and cause death from cardiac arrest." There's a chilling name for this: *sudden sniffing death*. There are people—including teens and pre-teens—who have used inhalants and paid the ultimate price.

Consider Kyle Williams, a 14-year-old who kissed his mom goodnight and headed to his room one evening in March 2005. The next morning his

Inhalants destroy nerve fibers throughout an inhalant abuser's brain, which can lead to muscle spasms and difficulty with basic activities like walking and talking. How do inhalants destroy nerve fibers? Primarily by causing the myelin around them to deteriorate. Myelin is typically found in a thick layer around the axons, the long parts of nerve fibers through which impulses flow. If you picture nerve cells as your body's electrical wiring, then think of myelin as the rubber insulation that protects an electrical cord. When myelin breaks down, nerves become much less capable of transmitting messages. What happens? Imagine attaching heavy weights to your ankles just before leaving the starting blocks in a fifty-yard dash. When there's a normal heavy layer of myelin around the axon, nerve impulses travel as fast as 120 meters per second. Without myelin, these impulses slow to a crawl of only about 2 meters per second. Do the math—that's a deceleration of over 95 percent! In short, a losing pace.

Inhalant Abuse Breaks Down the Myelin Sheath Surrounding Nerve Fibers



INHALANTS: POISON VAPORS



HEADS UP REAL NEWS ABOUT DRUGS AND YOUR BODY

mother went in to wake Kyle up. Instead, she found him dead in bed, with a straw from the can of computer cleaner he had inhaled still in his mouth. One of Kyle's friends had shown him how to get high this way about a month before. Some might think such cans contain nothing but compressed air. They couldn't be more mistaken.

HOW INHALANTS DO THEIR DAMAGE

Inhalant vapors often contain more than one chemical, increasing the risk of serious harm. Some chemicals leave the body quickly, but others are absorbed by fatty tissues in the nervous system, including the brain. They can stay there for a long time.

One of these fatty tissues is myelin—a protective cover that surrounds many of the body's nerve cells (neurons). Nerve cells in your brain and spinal cord send and receive messages that control just about everything you think and do. Deterioration of myelin can lead to muscle spasms, tremors, or even difficulty with basic actions such as walking, bending, and talking.

Toluene, one of the most common chemicals in inhalants, is found in glue, spray paint, paint thinner, and a number of other products known as solvents.

Toluene can damage myelin—and also the liver, the kidneys, and the ability to hear.

Other inhalants such as benzene (found in gasoline) can compromise the body's ability to produce blood

Heads Up: Inhalants Are Poisons That Affect the Whole Body

Check out this diagram to learn about the damage the chemicals in inhalants can do.

Blackouts

Inhalants can cause rapid changes in blood pressure, which can lead to blackouts and fainting.

Hearing Loss

Inhalants can cause hearing loss, perhaps by damaging the hairs of the inner ear or by harming the protective coating (myelin) on the nerves that carry sound impulses to the brain.

Damage to Central Nervous System

Fumes from inhalants can change brain chemistry and permanently damage the central nervous system (brain and spinal cord).

Liver and Kidney Damage

Inhalants can cause serious harm to these organs, which have many vital functions, including filtering harmful substances out of the body.

Bone Marrow Damage

Inhalants can damage bone marrow, where blood cells are made, increasing the risk of leukemia and aplastic anemia (potentially fatal illnesses).

Limb Spasms

Inhalants break down the myelin needed for nerves to transmit messages, resulting in muscle spasms and tremors in arms and legs.

Inhalant	Sources	Harmful Effects
Toluene	<ul style="list-style-type: none"> Spray paint Glue Dewaxer Fingernail polish 	<ul style="list-style-type: none"> Hearing loss Damage to central nervous system Liver and kidney damage
Trichloroethylene	<ul style="list-style-type: none"> Cleaning fluid Correction fluid 	<ul style="list-style-type: none"> Hearing loss Liver and kidney damage Vision damage
Hexane	<ul style="list-style-type: none"> Glue Gasoline 	<ul style="list-style-type: none"> Limb spasms Blackouts
Nitrous Oxide	<ul style="list-style-type: none"> Whipped cream dispensers Gas cylinders 	<ul style="list-style-type: none"> Limb spasms Blackouts
Benzene	<ul style="list-style-type: none"> Gasoline 	<ul style="list-style-type: none"> Bone marrow damage Immune system damage

cells, which can lead to a life-threatening disease called aplastic anemia. Various chemicals in other inhalants can also cause hepatitis, liver failure, weight loss, muscle weakness, disorientation, inability to concentrate, loss of coordination, irritability, and depression. In short, *inhalants can seriously mess you up.*

H EADS UP: THERE ARE NO SAFE INHALANTS

Some teens who understand the dangers of inhaling glue or computer cleaner may believe that inhaling nitrous oxide is safe—maybe because medical professionals sometimes administer it. **They are wrong.** Nitrous oxide, also known as laughing gas, is an odorless gas used by dentists as a painkiller, but when abused, it can be as dangerous as any other inhalant. It can damage your peripheral nerves, causing numbness, tingling, and even paralysis. It also causes blackouts.

When you breathe in pure

nitrous oxide, it binds with the oxygen in your blood. This means your body's tissues can't get the oxygen they need. Dentists never give pure nitrous oxide to patients. They always mix it with oxygen. People who sell balloons or little canisters filled with nitrous oxide on the street or at concerts don't know how to do this—and even if they did, they wouldn't bother. If you inhale nitrous oxide outside of a dentist's office, you'll likely be flooding your body with sulphuric acid, ammonia, and nitric oxide—all toxic substances.

H EADS UP: YOUNGER TEENS ARE MOST AT RISK

It is vitally important that you tell your friends what you've learned about the risks of inhalants. While recent studies show that overall drug abuse is down among teens, the abuse of inhalants has increased, especially among younger teens. According to the most recent Monitoring the Future

survey, a study of youth drug trends sponsored by NIDA, twice as many 8th-graders as 12th-graders are using inhalants. In 2004, more than 17 percent of this age group reported having used inhalants at least once in their lives—a statistically significant increase compared with the previous year.

A key problem revealed by the Monitoring the Future survey is that more than **38 percent of 8th-graders didn't realize that regular use of inhalants is harmful.** More than 66 percent of this age group didn't think that using inhalants once or twice was risky. This lack of awareness can set the stage for disastrous health consequences. The more kids know about the harmful effects of inhalants, the more likely they'll be able to make the smart choice and avoid inhalants altogether.

For help with a drug problem or to locate treatment centers, go to www.findtreatment.samhsa.gov or call the national hotline at 1-800-662-HELP.

Cutting Edge: Drug-Abuse Statistics

To find out the data about dangers for teens regarding inhalants and other drugs of addiction, check out these Web sites for the latest statistics:

www.drugabuse.gov Scientific information from NIDA about all drugs of abuse and advice on how to quit.

<http://monitoringthefuture.org> Here you'll find data from the latest Monitoring the Future survey. Funded by NIDA, this survey of youth drug-use trends has been conducted annually by the University of Michigan's Institute for Social Research for more than 25 years.

www.nida.nih.gov/about/organization/CEWG/CEWGH.html Established by NIDA in 1976, the Community Epidemiology Work Group (CEWG) provides ongoing community-level surveillance of drug abuse through analysis of quantitative and qualitative research data.

www.drugabusestatistics.samhsa.gov Enter this site to access findings from the National Survey on Drug Use and Health, which investigates national drug-use trends among the general population age 12 and older.

www.cdc.gov/healthyyouth/yrbs/index.htm This will take you to the Youth Risk Behavior survey, which collects data from students in grades 9–12 nationwide. It includes questions on a variety of health-related risk behaviors, from drug use to seat-belt use.

