

### Science of Addiction

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When scientists first started to study drug abuse, people addicted to drugs were thought to be morally flawed and lacking in willpower. This view has shaped society's response to drug abuse, treating it as a moral failing rather than a health problem, resulting in punitive rather than preventative and therapeutic actions. Due to groundbreaking scientific discoveries, we now recognize drug addiction as a brain disease that can be successfully prevented and treated.

## What is Drug Addiction?

Drug addiction is a chronic, relapsing brain disease characterized by compulsive drug seeking and use despite often devastating consequences. It results from a complex interplay of biological vulnerability, environmental exposure, and developmental factors (e.g., stage of brain maturity).

As with many other diseases, vulnerability to addiction stems partly from a person's genetic makeup. Scientists estimate that genetic factors account for 40–60 % of an individual's vulnerability to addiction, with environmental and developmental variables influencing whether and how particular genes are expressed. Additional factors, such as conditions at home, at school, or in the neighborhood, can heighten addiction vulnerability. Research also shows that early drug use increases the likelihood of addiction and that people with psychiatric disorders have a higher risk of drug abuse and addiction than the general population.

Research has improved our understanding of the biological mechanisms underlying drug abuse and addiction. All drugs of abuse directly or indirectly target the brain's reward system by flooding the circuit with dopamine—the neurotransmitter that regulates feelings of pleasure, as well as movement, emotion, cognition, and motivation. Overstimulation of this system produces the euphoric effects sought by people who abuse drugs and teaches them to repeat the behavior. Our brains are wired to repeat activities that bring us pleasure or reward (e.g., eating or having sex) as a way of ensuring our survival. Because taking drugs of abuse stimulates the same circuit, our brains urge repetition of the behavior, and thus people "learn" to abuse drugs without thinking about it. These intense impulses can overcome a person's willful intent not to take drugs, despite catastrophic consequences—which is really the essence of drug addiction.

Therefore, even though the initial decision to take drugs is mostly voluntary, once drugs take over, they cause brain changes that acutely impair a person's ability to exert self-control. Brain imaging studies of drug-addicted individuals have revealed physical changes in brain areas critical to judgment, decision-making, learning, memory, and behavior control, which may help explain the compulsive and destructive behaviors associated with drug addiction.

#### **Preventing Drug Abuse**

The National Survey on Drug Use and Health (NSDUH) estimated that 22.6 million persons (9.2 % of the U.S. population aged 12 or older) were classified with substance abuse or dependence in 2006 (based on criteria specified in the *Diagnostic and Statistical Manual of Mental Disorders*, 4<sup>th</sup> edition). Of these:

• 3.2 million abused or were dependent on both alcohol and illicit drugs;

- 3.8 million abused or were dependent on illicit drugs but not alcohol; and
- 15.6 million abused or were dependent on alcohol but not illicit drugs.

Data on teen drug use reflect both encouraging and troubling trends. Although statistics show a 23 % decline from 2001–2006 in past-month use of any illicit drug by students in 8<sup>th</sup>, 10<sup>th</sup>, and 12<sup>th</sup> grades, abuse of marijuana continues to be a problem with approximately 12 % of 8<sup>th</sup> graders, 25 % of 10<sup>th</sup> graders, and 32 % of 12<sup>th</sup> graders reporting use in the past year. Prescription painkillers also continue to be abused at unacceptably high levels, with 1 in 10 high school seniors reporting abuse in the past year. In addition, while past-year abuse of OxyContin was down among 12<sup>th</sup> graders, the rate nearly doubled among 8<sup>th</sup> graders between 2002 and 2006—going from 1.3 % to 2.6 %. Prescription drugs are easily accessible and are often obtained from a friend or relative for free. Moreover, there is a common misperception that, because they are prescribed by a doctor, prescription medications are safe, even when used in ways not intended.

Because early use of drugs increases a person's chance of more serious abuse and addiction, prevention is crucial. NIDA studies have shown that prevention programs backed by science (rationally designed and rigorously tested) can be effective in youth. Such programs work to boost protective factors, reduce risk factors for drug use, and help shape youths' perceptions about drug abuse risk.

#### **Medical Consequences of Addiction**

Illicit drug abuse causes 17,000 deaths annually in the United States and more than \$180 billion in annual economic costs. Abuse of nicotine, alcohol, and/or prescription drugs causes additional morbidity and mortality. Although some medical consequences of drug abuse and addiction are temporary and can be essentially reversed with treatment, others may be more persistent, diminishing the quality of individuals' health long after drug use has stopped. Whether short-lived or chronic, the many potential health effects from drug abuse and addiction underscore the fact that drug abuse does not exist in medical isolation—it causes a broad array of medical consequences throughout the body (http://www.nida.nih.gov/consequences/). A few examples follow:

- Cardiovascular effects. Researchers have found a connection between the abuse of most drugs
  and adverse cardiovascular effects, ranging from abnormal heart rate to heart attacks. Injection
  drug use can also lead to cardiovascular problems such as collapsed veins and bacterial
  infections of the blood vessels and heart valves. Use of marijuana, cocaine, methamphetamine,
  and inhalants can result in cardiovascular effects.
- Neurological effects. All drugs of abuse act in the brain to produce euphoric effects; however, some drugs also cause severe negative consequences in the brain such as seizures, stroke, and widespread brain damage that can impact all aspects of daily life. Drug use can also cause brain changes that lead to problems with memory, attention, and decision-making. Examples of drugs with neurological effects include cocaine, methamphetamine, inhalants, and ecstasy.
- HIV, hepatitis, and other infectious diseases. Drug abuse increases the spread of infectious diseases. Injection of heroin, cocaine, and methamphetamine causes more than a third of new AIDS cases and is a major contributor to the spread of hepatitis C. In addition, all drugs of abuse interfere with judgment and increase the likelihood of risky behaviors, which also contribute to the spread of HIV/AIDS and other sexually transmitted diseases.
- Other health effects. In addition to the effects various drugs of abuse may have on specific
  organs of the body, many drugs produce global body changes such as dramatic changes in
  appetite and increases in body temperature, which may impact a variety of health conditions.
  Withdrawal from drug use also may lead to numerous adverse health effects, including
  restlessness, mood swings, fatigue, muscle and bone pain, insomnia, cold flashes, diarrhea, and
  vomiting.

In addition to harmful effects for the addicted individual, drug abuse can result in serious health consequences for others. For example, while the full extent of the effects of prenatal drug exposure on a child is not known, studies show that various drugs of abuse may result in premature birth, miscarriage, low birth weight, and a variety of behavioral and cognitive problems in infants and children. Secondhand exposure to tobacco smoke is another example. According to the 2006 Surgeon General's Report, *The Health Consequences of Involuntary Exposure to Tobacco Smoke*, exposure to environmental tobacco smoke increases the risk of heart disease and lung cancer in persons who have never smoked by 25–30% and 20–30%, respectively. Exposure to tobacco smoke in the home increases severity of childhood asthma and has been associated with sudden infant death syndrome.

# **Treatment and Recovery**

Discoveries about the science of addiction have lead to advances in drug abuse treatments that enable people to counteract addiction's powerful effects on the brain and behavior and regain control of their lives. Despite the availability of many forms of effective treatment for addiction, the problem of relapse remains the major challenge to achieving sustained recovery. However, relapse rates for addiction are similar to those for other well characterized chronic medical illnesses such as diabetes, hypertension, and asthma, which also have both physiological and behavioral components. Treatment of chronic diseases involves changing deeply embedded behaviors, and relapse does not mean treatment failure. For the addicted patient, lapses back to drug abuse indicate that treatment needs to be reinstated or adjusted, or that alternate treatment is needed. For most individuals, combining medications with behavioral therapies is the most successful approach.

Different types of medications may be useful at different stages of treatment—during withdrawal to ease symptoms; during treatment to help people stay engaged; and following treatment to prevent relapse. Medications currently available include those used to treat:

- **Tobacco addiction.** Nicotine replacement therapies (patch, inhaler, gum), bupropion, varenicline.
- Opioid addiction. Methadone, buprenorphine.
- Alcohol and drug addiction. Naltrexone (helps prevent relapse to alcohol and heroin abuse), disulfiram (helps prevent relapse to alcohol abuse and is currently being tested for treating cocaine abuse), acamprosate (helps prevent relapse to alcohol abuse).

Behavioral treatments help people modify attitudes and behaviors related to drug abuse and increase their ability to handle stressful situations and environmental cues that may trigger intense craving for drugs and prompt relapse. For example,

- **Cognitive behavior therapy** helps people recognize, avoid, and cope with situations in which they are most likely to abuse drugs.
- **Motivational incentives treatment** uses positive reinforcements (i.e., rewards or privileges) to help people remain drug free.
- Motivational interviewing is conducted at treatment entry to stoke an individual's desire to fully
  participate in treatment and change his or her behaviors.
- **Group therapy** helps people face their drug abuse realistically, acknowledge the harm it can cause, and increase motivation to not use drugs.

Behavioral therapies can also enhance the effectiveness of medications and help people remain in treatment.

The process of recovery from drug abuse or addiction can be long and complex. When people enter treatment, addiction has often taken over their lives. The compulsion to find and use drugs may have disrupted their families, their professional lives, and their standing in the community. It also may have

made them vulnerable to other serious illnesses. Because the effects of drug abuse are far reaching, treatment must address the needs of the whole person to have the best chance for success. The most effective programs incorporate a variety of rehabilitation services to address a person's medical, psychological, social, vocational, and legal needs to enhance their recovery process.

At NIDA, we believe that a fuller understanding of the science of addiction will encourage adoption of research-based policies and programs to reduce drug addiction and will increase support for scientific research to improve the health of our citizens. Please visit our recently created Web site to access a wealth of resources designed to help physicians recognize, diagnose, and treat drug abuse and addiction: <a href="http://www.nida.nih.gov/medstaff.html">http://www.nida.nih.gov/medstaff.html</a>. Together, we can continue to leverage the power of science against this devastating disease that causes so much suffering for individuals, communities, and society at large.