**The dangerous rise of electronic cigarettes**

**Smoking is making an addictive comeback among young people and adults through e-cigarettes**

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Electronic cigarettes are billed as a healthier alternative to traditional tobacco cigarettes. However, e-cigarettes still expose users to nicotine, the addictive drug found in tobacco. That has health experts worried that teens’ increased use of e-cigarettes will lead to increased tobacco use, too — and reverse the steep decline in teen-smoking rates.

It’s been a full half-century since the Surgeon General of the United States declared that cigarette smoking causes lung cancer and chronic bronchitis. Yet that knowledge hasn’t stopped people from smoking. Especially teens. In fact, nine out of every 10 smokers start by age 18.

In the United States alone, every day more than 3,200 people under age 18 smoke their first cigarette. And each day, an additional 2,100 teens and young adults transition to smoking daily.

The 1964 Surgeon General’s report had drawn on more than 7,000 scientific studies. Since then, research has only expanded the range of serious illnesses linked to smoking. These include other cancers, heart disease and diabetes. The evidence has triggered many anti-smoking campaigns. These have saved the lives of an estimated 8 million Americans who either stopped smoking or never took up smoking, according to a recent Yale School of Public Health study.

Still, smoking remains a major problem — and the leading cause of preventable death. Every year, 480,000 Americans die prematurely from tobacco-related disease, according to the Office of the Surgeon General. Since its first report, smoking has killed more than 20 million Americans.

Which ad is selling a tobacco product and which is selling e-cigarettes? It’s hard to tell just by a quick look at the promotional materials. But the woman on the left is vaping and the Virginia Slims ad is trying to sell women on conventional cigarettes.

A harmful and addictive drug, called nicotine, hooks these smokers. That natural tobacco ingredient makes it extremely difficult for smokers to quit. Now, a new threat is putting young people at risk of nicotine addiction: electronic cigarettes, also known as e-cigarettes.

These battery-powered devices superficially resemble traditional cigarettes. But they do not burn tobacco. Instead, e-cigarettes heat a mix of chemicals to create an aerosol (tiny airborne particles), which the user inhales. E-cigarette companies call this aerosol vapor. As a result, many people now refer to puffing on e-cigarettes as *vaping*.

Makers of e-cigarettes describe their products as a healthier alternative to tobacco. Yet most e-cigarettes still deliver a range of chemicals, including nicotine. In fact, health experts worry these devices will ultimately expand the use of tobacco, including regular cigarettes. How? By hooking kids on nicotine as they again make smoking fashionable.

**How e-cigarettes target teens**

Almost no one starts smoking after age 25, research shows. So it is no surprise that some makers of e-cigarettes appear to target teens. They offer products in candy and fruit flavors that appeal to kids. With names like lovely bubbly, snicker doodle, cherry crush and piña colada, “Those flavors tell kids that ‘this product is for you,’” says Rachel Grana. She’s a behavioral scientist at the University of California, San Francisco (UCSF). There, her work focuses on how cigarettes are advertised and how this affects smoking habits among the young.

Manufacturers also promote e-cigarettes as safe, modern and even glamorous. Yet Grana and other experts say that e-cigarettes are not nearly as harmless as some might want us to believe. Right now, e-cigarette companies can largely say what they want. That’s because there aren’t laws — yet — to restrict how they advertise e-cigarettes or who they sell them to.

That is in sharp contrast with traditional cigarettes, which do face heavy regulation. For example, cigarette makers have not been able to legally advertise their products on U.S. radio or TV stations since 1972, nor on billboards since 1998. A 2009 ban outlawed the sale of flavored cigarettes, arguing that these were targeting teens. And in 2010, federal law made it illegal to sell cigarettes to anyone under 18.

The goal has been to discourage teens from experimenting with a dangerously addictive product.

[**What are e-cigarettes?**](https://student.societyforscience.org/article/explainer-what-are-e-cigarettes)

Currently, those laws don’t apply to e-cigarettes. Last December, however, the U.S. Food and Drug Administration announced [plans](http://www.reginfo.gov/public/do/eAgendaViewRule?pubId=201310&RIN=0910-AG38) to extend current cigarette regulations to e-cigarettes. If successful, FDA officials say this “would reduce initiation and increase cessation [of vaping] (particularly among youth).” Most people expect e-cigarette companies will fight this. And their opposition could delay for years any extension of the law to e-cigarettes.

For now, advertisements attempt to sell people on the idea that e-cigarettes are “cool.” Such ads sometimes show attractive people smoking e-cigarettes in fancy cars. Alongside those images run messages such as: “smoke in style,” or “e-cigarettes: the smart alternative to cigarettes.” Hollywood actors have been spotted vaping during awards shows watched by millions of people. And such celebrity endorsements can be more effective than a paid ad in influencing young people. Indeed, such trends threaten to reverse the last few decades of progress in steering young people away from smoking, says Stanton Glantz. He directs the Center for Tobacco Control Research and Education at UCSF.

“We now have for the first time since 1972 nicotine addiction advertising back on television,” he notes. A major concern is that e-cigarettes will make smoking seem more “normal” or socially acceptable again, Glantz worries. “A lot of people see these e-cigarette ads and think they’re cigarette ads. That to me is very, very bad. The net effect e-cigarettes seem to be having is to make the tobacco epidemic worse.”



At first glance, electronic cigarettes, or e-cigarettes, look a lot like regular cigarettes. But e-cigarettes run on batteries. And unlike traditional cigarettes, e-cigarettes don’t burn tobacco or produce smoke. However, they can expose users to nicotine, the addictive drug also found in tobacco.

U.S. National Library of Medicine

**Unsupported claims**

Vaping has become popular in the United States only in the last four or five years. As a result, scientists have not had time to study its long-term health effects. That hasn’t stopped companies that sell e-cigarettes from making product claims that science cannot support. For instance, manufacturers assert that e-cigarettes are less harmful than regular cigarettes. And e-cigarette vapors do contain far fewer toxic compounds than the smoke from burning tobacco. In fact, companies often market e-cigarettes as a way for people to quit smoking traditional cigarettes.

This logic would make sense if vaping really did cause smokers to give up tobacco products. But that is not happening. Instead, studies show that smokers appear to be using both traditional *and* e-cigarettes (called "dual use"). In fact, about three in every four pre-teens and teens who vape also smoke tobacco cigarettes. Also worrisome, many young people seem to be experimenting with e-cigarettes, even before trying tobacco products. That raises the likelihood that vaping will serve as a bridge to smoking real cigarettes.

Earlier this year, Glantz and Lauren Dutra of UCSF reported data from a national survey on youth smoking habits. These new data show that just between 2011 and 2013, the share of students in grades 6 through 12 who reported trying e-cigarettes doubled — to 6.8 percent (from 3.3 percent). The number of students in that age group who reported vaping within the previous 30 days also nearly doubled, to 2.1 percent. In 2011, the share of teens that smoked was lower than at any time since 1975. But the uptick in vaping threatens to undo that progress, Glantz and Dutra charge.

[**What is a hookah?**](https://student.societyforscience.org/article/explainer-what-hookah)

The pair published their findings on March 6 in *JAMA Pediatrics*, a journal of the American Medical Association.

“What it looks like,” says Glantz, “is that e-cigarettes are not only *not* helping people quit,” but also they’re preventing people from quitting. He and his colleagues, including Grana, have studied e-cigarette and smoking trends in youth in the United States and in South Korea. They are finding that once kids try e-cigarettes, they are more likely to also smoke traditional cigarettes. Indeed, Glantz points out, “The kids who were e-cigarette users were actually heavier smokers.”

**Harmful all the same**

Even if vaping is less toxic than smoking tobacco cigarettes, it doesn’t mean vaping is safe. Sure, people who use e-cigarettes inhale fewer toxic chemicals than do cigarette smokers. But e-cigarette vapors can be bad. Because e-cigarettes are so new, experts still don’t know how bad. Consider, however, one example of a common ingredient in e-cigarettes: propylene glycol.

**E-cigarettes are advertised as an alternative to tobacco products. But many studies are finding that people frequently vape and smoke. This is described as “dual use.”**

This odorless liquid tastes slightly sweet. Propylene glycol is often used as a preservative in food. But eating small amounts of it is very different from constantly inhaling its vapors into the lungs. “What I do know is that the human lung is not meant to clear propylene glycol-laced vapor out of its system every day,” says Thomas Eissenberg. He is an expert on tobacco products who works at Virginia Commonwealth University in Richmond. “It would surprise me to find that it’s completely harmless to do that.”

Maciej Goniewicz is an expert on toxic chemicals and cancer at the Roswell Park Cancer Institute in Buffalo, N.Y. He and his students use a smoking robot to identify the chemicals in e-cigarette vapors. They also study the smoke from tobacco products. Tobacco smoke produces a mixture of more than 7,000 chemicals. Of them, at least 69 are “carcinogenic.” That means they cause cancer. Goniewicz and his team have studied and detected only a handful of these harmful chemicals in the vapors from e-cigarettes.

That may sound like good news. However, that handful includes compounds called nitrosamines. These potent cancer-causing chemicals are thought to be the main culprits that lead to lung cancer in tobacco smokers. Worse, some other chemicals that the Roswell Park team found in e-cigarette vapors also are carcinogenic. These include formaldehyde (a toxic substance often used as a disinfectant because it kills bacteria) and acrolein (a compound sometimes used as a weed killer).

And don’t forget the nicotine. Because no one regulates e-cigarettes, there is no telling how much nicotine vaping delivers. In one recent study, Goniewicz and his team discovered that nicotine levels reported on the labels of one in every four types of e-cigarettes was off by more than 20 percent. The researchers also found nicotine in some refill solutions even when the labels had claimed these products were “nicotine-free.”

Experts know that nicotine is the drug in tobacco that causes addiction. But nicotine also is directly harmful, particularly to young people. The human brain continues to develop until we reach our mid-20s. During this time, the brain is very sensitive to the influence of outside chemicals. Nicotine, for example, can actually change the physical structure of the brain. It also can change how it functions.

The brain and spinal cord are made up of millions of nerve-cell connections that work together. You might think of it as a far more complicated version of the wiring laid down on a computer’s circuit board. Electrical signals, called impulses, travel between nerve cells and other cells in the body. Chemicals, such as acetylcholine (Ah SEE til KO leen), transmit these signals. Those chemical signals tell the brain things like, “Look this way,” or “Make this muscle twitch.”

The U.S. government banned sales of flavored cigarettes that appeared to be designed to appeal to kids. But what about e-cigarettes? The solutions purchased to supply their “vapors” come in kid-friendly flavors, including bubble gum, Dr. Pepper soda, gummy bears, chocolate, pizza with bacon and SweeTarts (shown here).

From the collection of Stanford Research Into the Impact of Tobacco Advertising [(tobacco.stanford.edu)](http://tobacco.stanford.edu/tobacco_main/index.php)

Normally, when a signal reaches its target, called a receptor, it releases a molecule of acetylcholine. But the brain can mistake nicotine for acetylcholine. Both molecules share a very similar shape. Indeed, nicotine can activate nerves. It creates the “buzz” that people associate with smoking.

But then the brain gets even more confused.

Normally, acetylcholine lets go of its receptor once it has delivered its assigned signal. Nicotine doesn’t. It stays locked onto a receptor much longer. And that action blocks the flow of newly arriving messages.

This creates a kind of traffic jam. When the correct signals can’t reach their intended targets, some messages will get lost. The brain tries to compensate by making more receptors that can accept acetylcholine. But this further confuses the brain — because now there are too many receptor sites when the nicotine is taken away. So the nerves become too activated.

One result: “You get hyped because you are experiencing nicotine withdrawal,” explains Glantz. Smoking will "relax" smokers, because it starts blocking some of the signal again. He likes to use the metaphor of listening to music. Think of nicotine as putting a pillow over the speakers. To make the music loud enough, you turn up the volume. Later, when the pillow — the nicotine — is taken away, the music is way too loud. Puffing a cigarette or vaping puts the pillow back. Now everything seems normal again.

What’s worse, these physical changes to the developing brain leave lasting impacts. “There’s lots of evidence that kids who start smoking younger have a harder time quitting and smoke for more years before they quit,” says Glantz. If nicotine also causes that, then vaping risks triggering the same problem.

Another worrisome problem with vaping: Others can be exposed to that nicotine just by being in the same room. This is called secondhand exposure (and is an even bigger problem with tobacco smoke). In a 2013 study, Goniewicz and his team found that vaping exposed nearby non-users to nicotine vapors.

Researchers at the Karolinska Institute in Stockholm, Sweden, point to yet another nicotine threat. In the February 15 *Toxicology and Applied Pharmacology*, they report animal data suggesting that nicotine in tobacco smoke may be a prime contributor to the asthma seen in many smokers. Nicotine makes it hard for airways of the lung to relax appropriately. If confirmed in follow-up studies, that could highlight another risk from vaping.

As research continues to probe how e-cigarette vapors interact with the body, be wary of safety claims being made by promoters of these products. No matter what the message, even if it’s an image of a movie star vaping, don’t buy it.

“For kids, there is no reason to try this product,” says Goniewicz. “I would definitely discourage non-smokers — especially kids, but all non-smokers — from experimenting with these products.”

**Power Words**

**acetylcholine** A chemical signal that relays messages between nerve cells and other cells in the body.

**acrolein** A liquid that’s clear or yellowy and has an odor that can create a choking sensation. In high concentrations it’s a known poison. Manufacturers add it to plastics, medicines, pesticides, resins and more.

**aerosol** Particles of a solid or liquid that are small enough to remain airborne for minutes to weeks.

**addiction** The uncontrolled use of a habit-forming drug.

**Centers for Disease Control and Prevention,** or **CDC** An agency of the U.S. Department of Health and Human Services, CDC is charged with protecting public health and safety by working to control and prevent disease, injury and disabilities. It does this by investigating disease outbreaks, tracking exposures by Americans to infections and toxic chemicals, and regularly surveying diet and other habits among a representative cross-section of all Americans.

**e-cigarette** (short for **electronic cigarette**) Battery-powered devices that disperse nicotine and other chemicals as tiny airborne particles that users can inhale.

**carcinogen** A substance, compound, or element that causes cancer.

**formaldehyde** A widely used and toxic chemical that manufacturers add to plastics, resins, some fertilizers, dyes, medicines and embalming fluids. It’s even in the treatments used to keep fabrics from wrinkling.

**neuron, or nerve cell** Any of the impulse-conducting cells that make up the brain, spinal column and nervous system.

**nicotine** A chemical compound present in tobacco. It creates the ‘buzz’ effect associated with smoking. It is one of the main ingredients in many e-cigarettes.

**nitrosamine** A family of compounds, some of which are potent carcinogens (at least in animals), that form when nitrogen oxides or nitrites interact with amine. They develop in many foods, some alcoholic beverages, cosmetics, pesticides and industrial processes.

**pulmonary disease** A disease of the lungs that makes it difficult to breathe.

**receptor** A molecule on the surface of a cell that receives incoming signals from outside the cell.

**Surgeon General** A doctor who serves astheleading spokesperson on public health from within the U.S. government. This person also serves as the primary deputy on medical matters to the Assistant Secretary for Health (within the Department of Health and Human Services).

**tobacco** A plant cultivated for its leaves. Dried tobacco leaves are burned in cigars, cigarettes, and pipes. Tobacco leaves are also sometimes chewed. The main constituent of tobacco leaves is nicotine.

**vaping** Slang term for the inhalation of vapors from e-cigarettes.

**withdrawal** (in medicine) An almost disease-like syndrome that can develop after animals (including people) attempt to stop using a drug (including alcohol) to which they have become addicted. Shaking, sweating, trouble sleeping, anxiety, diarrhea, vomiting, abdominal cramping, muscle aches and flu-like symptoms can occur and last for days.

