SMOKING AND VAPING ADDICTION

DEADLY VAPING ADDITIVES

CBD, THC, and Contaminants

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The Predatory Drug

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KEY ICONS TO LOOK FOR:

Words to Understand: These words with their easy-to-understand definitions will increase the reader's understanding of the text while building vocabulary skills.

Sidebars: This boxed material within the main text allows readers to build knowledge, gain insights, explore possibilities, and broaden their perspectives by weaving together additional information to provide realistic and holistic perspectives.

Educational videos: Readers can view videos by scanning our QR codes, providing them with additional educational content to supplement the text. Examples include news coverage, moments in history, speeches, iconic sports moments, and much more!

Text-Dependent Questions: These questions send the reader back to the text for more careful attention to the evidence presented there.

Research Projects: Readers are pointed toward areas of further inquiry connected to each chapter. Suggestions are provided for projects that encourage deeper research and analysis.

Series Glossary of Key Terms: This back-of-the-book glossary contains terminology used throughout this series. Words found here increase the reader's ability to read and comprehend higher-level books and articles in this field.

Since 2014, American teenagers have been more likely to use electronic vapor devices than to smoke cigarettes. By 2018, more than 3.6 million Americans under the age of eighteen were vaping regularly.

WORDS TO UNDERSTAND

acetate: a salt formed by the combination of acetic acid with an alkaline base
additive: substance added to something in small quantities to improve or preserve it
cardiovascular: relating to the heart and blood vessels
cessation: the act of quitting something, such as smoking cigarettes
smoking gun: term for a piece of evidence that is nearly impossible to argue against

The Scope of this Epidemic

In recent years, e-cigarettes and electronic vapor devices—small tools that heat a nicotine-rich liquid so that it can be inhaled—have become extremely popular, particularly among young Americans. Manufacturers claimed that their products were a safe alternative to traditional nicotine products, such as cigarettes or chewing tobacco. Unfortunately, the popularity of these items grew faster than scientific tests could be performed on them to assess their safety. Yet, nicotine is still a highly addictive drug, and many young people have wound up addicted to e-cigarettes.

As electronic vapor devices grew in popularity, manufacturers introduced new products to appeal to a broader range of users. They included flavors, vitamins, and other **additives** to make their vape juices stand apart. These include compounds like cannabidiol (CBD) and tetrahydrocannabinol (THC), the active ingredients of the plant *Cannabis sativa* (better known as "marijuana"). Consumers bought these products hoping to achieve the calm promised by CBD or the high triggered by THC. Unfortunately, for many years the market for these products was barely regulated, and the health effects of such additives were uncertain.

Cannabidiol (CBD) and tetrahydrocannabinol (THC), two compounds that are derived from the plant Cannabis sativa*, are among the most popular additives to vape juices today.*

Even worse, manufacturers did not openly advertise the variety of toxic chemicals that are used in most vape juices, such as formaldehyde. As a preservative, formaldehyde may help keep the fluid from spoiling. However, it has been shown to cause cancer in humans.

Vaping is a widespread practice today—even people who don't vape have probably seen someone walking in public with an e-cigarette or vaporizer over the past few days. Thus, many people may think that the danger of e-cigarettes has been exaggerated. Unfortunately, this is not the case. If anything, the risks of vaping have been downplayed by manufacturers and users. A recent surge in emergency room visits due to vaping-related illnesses has shown that the danger is a real concern.

VAPING-RELATED ILLNESSES

Beginning in the fall of 2019, there was a surge in vaping-related lung illnesses throughout the United States. Some patients had to go to intensive care units to avoid severe long-term damage to their lungs and **cardiovascular** systems. Hospitalizations lasted from a few days to several weeks. Typical symptoms of these cases included shortness of breath, a sudden fever, heavy coughs, diarrhea, vomiting, headaches, dizziness, and chest pain. In the worst cases, victims developed serious heart or lung problems that resulted in coma or death. By February of 2020, more than 2,700 people had been hospitalized, and over sixty had died from vaping-related lung illnesses in the United States.

Just what is causing all of these cases across the nation? Initially, medical researchers focused their attention on vaping liquids that contained the chemical THC, the active chemical compound in

To learn how vaping deaths impact teens, scan here.

marijuana that causes the "high" feelings when smoked or otherwise ingested. A lot of the early cases involved THC-infused vape juices that people had purchased online, often illegally or from shady manufacturers. However, researchers at the Centers for Disease Control and Prevention (CDC) soon found that in some of the vaping-related lung illness cases, the victims had used vape juices that did not contain THC. As a result, they had to expand the scope of their search to find the real problem.

By the spring of 2020, state and federal health officials had investigated thousands of cases of vaping-related lung illnesses in the United States, including dozens that ended in the vaper's death. Nearly half of the cases involved e-cigarette users under the age of twenty-five.

TEEN ATHLETES ARE BEING HURT BY VAPING

According to a recent report by NBC News, a growing number of teen athletes are turning to vaping. Some consider vaping a way to get a burst of energy before a game, to focus their mind during practice, or to stay in shape and lose weight. (Many people mistakenly believe that nicotine products can provide all of these effects. However, scientists have found that these beneficial effects are mostly illusory and are outweighed by the health risks of the drug.) Unfortunately, these young athletes are finding that their competitiveness decreases as their lung capacity shrinks. In fact, some have experienced permanent lung damage that makes it more difficult for them to compete at a high level.

After extensive study, the CDC came to believe that one possible culprit is a compound called vitamin E **acetate**. This chemical compound was found in the lungs of many people who suffered from vaping-related lung illnesses. Vitamin E acetate is a chemical that is commonly used in many types of products, including vitamin supplements and skin creams. It is included in vape juices to help dilute the liquid. It is often found in products containing THC, although it can be found in other types of vaping fluids as well.

In a November 2019 call with reporters, CDC deputy director Anne Schuchat called the compound a "potential toxin of concern." She explained that vitamin E acetate usually does not cause harm when taken as part of a vitamin supplement or when applied to the skin in a cream. However, previous scientific research had found that inhaling vitamin E acetate may interfere with normal lung function. "Until

the relationship between vitamin E acetate and lung health is better characterized, it's important that vitamin E acetate not be added to e-cigarette or vaping products," Schuchat said. "Caution should be used before substituting other cutting agents or additives for vitamin E acetate."

Vitamin E acetate, also known as alpha-tocopheryl acetate, is a chemical that is often found in skin care products and dietary supplements. It is not known to cause harm when eaten or applied to the skin. However, it has been linked to lung diseases when inhaled.

The CDC looked into other potential causes of the vaping-related lung illnesses, including various plant and mineral oils used in vape juices. However, researchers did not find these oils in the lungs of anyone affected by this disease, so some researchers concluded that Vitamin E acetate was the cause of vaping-related lung illnesses. However, Schuchat cautioned against this belief, noting that there could be other dangerous substances in the vape juices that haven't yet been identified. To date, the CDC and the Food and Drug Administration (FDA) are not convinced that Vitamin E acetate is the only chemical that is causing health problems.

OTHER TOXIC CHEMICALS

Just because many users have experienced reactions due to vitamin E acetate, that doesn't mean that other chemicals don't contribute to health problems. Vaporizing fluid contains many dangerous chemicals that should never be ingested in large amounts. For example, the Minnesota Department of Health, in a lengthy report on this epidemic, stated:

> Many of the patients report having vaped illegal THC (a component of cannabis)…. While investigators remain focused on these illegal products as a primary concern, health officials cannot guarantee the safety of any vaping products. People vaping nicotine to help quit smoking should consider alternative options to support their quit efforts.

Since September of 2019, the Centers for Disease Control and Prevention has investigated thousands of cases, which have occurred in thirty-one different states and the District of Columbia. Samples of lung tissue and fluid have come directly from hospitals and state clinics where patients with vaping-related lung illnesses have been treated. Around half of the cases involved THC, and half of those cases involved vitamin E acetate. That seems like a **smoking gun** until the

Dr. Anne Schuchat, the principal deputy director of the Centers for Disease Control and Prevention (CDC), has warned the public about the health dangers of vaping.

statistics are examined more carefully. Vitamin E acetate is found in just 25 percent of all vaping-related lung illnesses. That is a higher percentage than other chemicals, but that fact indicates that vitamin E acetate is not the only cause of the problem, creating a confusing and scattershot situation. As a result, even those who do not use THC products or who avoid vitamin E acetate may not be safe. Just about any vape juice additive could be an issue.

While vitamin E acetate may be the most likely trigger for health problems, THC and other chemicals may also contribute. And the widespread nature of vaping means that cases like these are only likely to worsen, even as manufacturers remove vitamin E acetate. As a result, a statement from the CDC said:

> CDC and FDA recommend that people not use THC-containing e-cigarette, or vaping, products, particularly from informal sources like friends, family, or in-person or online dealers. Vitamin E acetate should not be added to any e-cigarette, or vaping, products. Additionally, people should not add any other substances not intended by the manufacturer to products, including products purchased through retail establishments.

This statement highlights the potential dangers common in all types of vaping activities. The CDC also said that people who are using e-cigarettes to help with smoking **cessation** should not turn back to cigarettes. Instead, they should reach out to medical professionals to find safe and healthy ways to quit smoking that don't cause serious health issues. These professionals may find that various types of patches, gums, or even nasal sprays may be beneficial for those who are trying to quit smoking or using vaporizing equipment.

As Americans have become more aware of the lung illnesses caused by vaping, the number of new cases has begun to decline. This may be because the media and public health experts have spread the

news about this problem. As public awareness increases, more people may avoid using e-cigarettes or vaporizers in the future. However, the popularity of these devices has not shown signs of decreasing. The marketing group Euromonitor believes that by the year 2021, more than 55 million adults around the world will use electronic vapor devices. In the United States, the CDC estimates that over 3.6 million Americans under the age of eighteen are regularly using e-cigarettes.

President Donald J. Trump, joined by First Lady Melania Trump, Acting FDA Commissioner Norman Sharpless (left), and Secretary of Health and Human Services Alex Azar (right), announced in September 2019 that the Food and Drug Administration was working on a plan to remove flavored e-cigarette products from sale. The FDA ban of many flavored products went into effect in January 2020.

TEXT DEPENDENT QUESTIONS

1. What is the primary cause of vaping-related problems?
2. What are some products that vitamin E acetate is used in?
3. What is THC?

RESEARCH PROJECT

Reach out to medical professionals in your state to find vaping-related statistics. Talk to them about the nature of the problem and what they are doing to stop it. Try to visit somebody who may have experienced these adverse reactions, and talk to them about what they felt like at the time. Find out whether they are still vaping or whether they have turned to other nicotine products. Ask them whether this change, if any, has been a good one or whether they want to quit using nicotine completely.

For years electronic vapor devices were promoted as a healthier nicotine-based alternative to cigarettes. However, recent scientific research has shown that the use of these devices is also associated with many health risks.

WORDS TO UNDERSTAND

advocate: someone who promotes or strongly supports a product or cause

cure-all: a drug that has many positive benefits and is believed to be useful for treating many medical conditions

decriminalize: to make something legal that was once illegal

metabolism: the body's natural process for breaking down food, water, and other ingested substances

psychoactive: referring to a compound that affects the mind or changes the way that it works

CBD Is Not Harmless

Ask people who use CBD oil about its benefits, and they'll claim that it reduces pain, decreases anxiety and depression, and helps them deal with stress and other issues. Some studies do seem to verify some of these statements. That said, CBD is far from being a completely safe compound. Further studies are finding that it has many potential side effects and risks that must be fully understood.

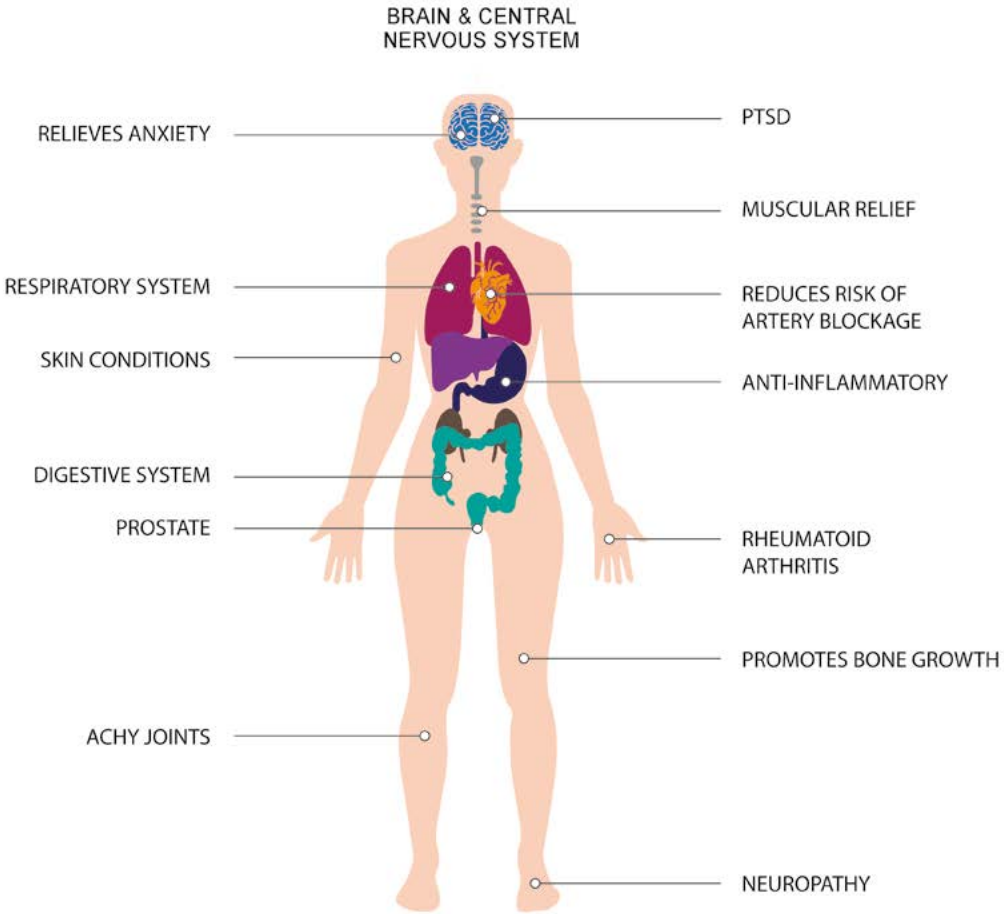
In particular, people who buy CBD oil to use in their e-cigarettes or electronic vapor devices need to understand how inhaling CBD oil vapor is even less safe than taking the compound in other ways. Vaping products with CBD oil can permanently affect a person's health.

WHAT IS CBD OIL?

Cannabidiol, also known as CBD oil, is one of the two main active ingredients in marijuana (the other being THC). Medical CBD products, as well as those sold in stores, are not derived from marijuana, however. Instead, they come from hemp, a strain of the cannabis plant that is related to marijuana but does not contain its active **psychoactive** compound THC. Because CBD does not produce a high, it is not considered a mind-altering substance. Multiple studies have shown that it does not cause a physical addiction either.

CBD PRODUCTS
ENDOCANNABINOID SYSTEM

CB1 RECEPTORS CB2 RECEPTORS



CBD oil might be useful in treating a wide variety of health issues. Advocates for this substance believe it relieves pain and anxiety, and claim that it could have other beneficial uses as well. However, the only medical use currently approved by the FDA is as a treatment for certain types of epilepsy.

Although some states allow the use of marijuana for medical or recreational use, the possession, sale, and use of marijuana is still a crime under federal law. At one time, CBD was illegal across the nation, but in recent years the substance has been **decriminalized** in many states. Hemp products were once illegal as well, but because they contain no THC, manufacturers have been permitted to distill CBD from hemp plants to avoid complications with the law.

That said, the federal government still classifies CBD oil the same way that it does marijuana, meaning that federal law enforcement agents could technically arrest somebody who manufactures or uses CBD oil, regardless of state laws. This type of arrest is scarce because of the widespread state-wide legality of CBD and its high level of manufacture and use. The federal government simply doesn't have the time or resources and would prefer not to cause conflict with states over what is considered a fairly minor issue.

In 2015, the FDA also decreased the regulatory requirements for those who wanted to use CBD oil for research trials. As a result, many people can find this product online and buy it without a medical license. In states where CBD is 100 percent legal, it is commonly available in gas stations, movie rental shops, and many supermarkets. This strange flux of legality has created some confusion, and many aren't sure when or whether CBD oil will be made legal nationally.

BENEFITS AND RISKS OF CBD

Currently, government agencies like the FDA and CDC only recognize a few of the touted health benefits of CBD oil. These are important to understand, because they are the central reason for the push for legalization. For example, some studies have found that CBD can help manage the symptoms of various types of epilepsy, such as Dravet syndrome and Lennox-Gastaut syndrome. These symptoms don't respond to anti-seizure medications but do react to CBD oil. The FDA has approved two medications that include CBD for this purpose.

Because CBD is primarily sold as a supplement, not a medication, it is not regulated by government agencies such as the Food and Drug Administration.

Other studies have found that CBD oil may help with various types of problems such as anxiety. For example, an article written by Dr. Peter Grinspoon said:

> A study from the *European Journal of Pain* showed, using an animal model, CBD applied on the skin could help lower pain and inflammation due to arthritis. Another study demonstrated the mechanism by which CBD inhibits inflammatory and neuropathic pain, two of the most difficult types of chronic pain to treat. More study in humans is needed in this area to substantiate the claims of CBD proponents about pain control.

Most CBD oil sold in the United States is extracted from the industrial hemp plant, a variety of Cannabis sativa that does not produce the same "high" effect as marijuana.

Nora D. Volkow, the director of the National Institute on Drug Abuse, told Congress in 2015 that the substance might be an effective pain reliever. “In addition to epilepsy, the therapeutic potential of CBD is currently being explored for a number of indications, including anxiety disorders, substance use disorders, schizophrenia, cancer, pain, inflammatory diseases, and others,” Volkow said.

Although research on the benefits of cannabidiol is incomplete, that has not stopped the substance from becoming a popular supplement. Because it is not regulated by the FDA, however, there is no oversight of the ways it is produced or the amount of CBD that is in each supplement product. Some manufacturers have made wild claims that CBD can cure cancer and other diseases, or provide other health benefits. As a result of such promotion, many people have come to view CBD as a **cure-all** that can manage just about any problem. Unfortunately, most of these claims are wildly inaccurate and based on limited results in only a handful of studies. Even worse, many producers claim that CBD has no adverse side effects, which is untrue. And finally, consumers are left to read labels to find out how much to take, when to take it, and how much of the active ingredient is in the product. Some products sold as hemp oil actually have very little CBD content.

Though CBD oil may have some positives, the negatives are much more potent than you might expect. For example, in November of 2019, the FDA released a lengthy statement on the dangers of CBD, which included this telling quote:

> The FDA is concerned that people may mistakenly believe that trying CBD “can’t hurt.” The agency wants to be clear that we have seen only limited data about CBD’s safety, and these data point to real risks that need to be considered. As part of the drug review and approval process for the prescription drug containing CBD, it was determined that the risks are

outweighed by the benefits of the approved drug for the particular population for which it was intended.

Some proponents of CBD believe that this statement is meant to suppress a potentially helpful substance because the FDA doesn't want to create a case for the federal legalization of marijuana. However, the FDA also has evidence, based on multiple studies, showing that CBD may not be as beneficial as some people believe. No drug is free of side effects, and these must be considered before they are taken. For example, the FDA found that a pure form of CBD could have the potential to cause various types of liver injury. The reasons for this damage were unknown but apparent in those who used CBD oil for extended periods. The agency found that this risk was higher in those who did not take CBD oil as prescribed by a doctor. For example, the effect was more likely to occur in people who took

TEENS AND CBD OIL DO NOT MIX

Although CBD oil is marketed toward adults, many teens get a hold of CBD oil either from their parents or in vaping compounds. And while this substance isn't hazardous, it has been found to produce side effects such as nausea, vomiting, lowered immune system function, and a lack of focus in some teens. Further studies must be undertaken on CBD oil and its use with teens to ensure that it is safe. Until then, parents should try to keep their teens away from products containing CBD as much as possible.

Side effects of CBD include nausea, fatigue, and irritability, and the compound can also interfere with the way other prescription medications work in the body.

unregulated over-the-counter CBD supplements and products than in those who were prescribed anti-seizure medications by a doctor. The FDA also found that the anti-seizure medication Epidolex may cause complications with some types of drugs. Unfortunately, CBD may increase or decrease the effects of some substances and worsen their adverse effects in many ways. The specific elements weren't mentioned in their report but were noted to be similar to those experienced when taking herbs and other dietary supplements.

And though the tests have not been fully confirmed, there have been signs that male reproductive health could be affected by CBD oil. Typically, these studies have been focused on rats and have found that CBD could decrease the size of the testicles, the quality of sperm growth, and circulating testosterone. The same risk could exist in humans, although this has not yet been confirmed.

Other potential problems noted in some tests included issues with **metabolism**, a high degree of drowsiness, problems with alertness, changes in mood, stomach troubles, diarrhea, decreased appetite, problems with brain operation, and much more. The FDA has been mainly concerned with how much cumulative exposure to these products could trigger adverse reactions in humans.

Remember: these side effects are noticed when people use CBD oil without vaping. When pairing CBD oil with this method, though, people may end up with even more extreme problems. As a result, it is critical to understand how vaping with CBD oil can be a problem.

WHY VAPING CBD IS A BAD IDEA

All of the problems mentioned in the previous section could be concerns when a person vapes using products that contain CBD oil. Many sources have examined the nature of vaping CBD oil to gauge its danger. The results have not been positive, much to the chagrin of CBD advocates.

For example, an article on Marijuana Break, a cannabis-advocacy website, examined the dangers of vaping CBD oil. Throughout the report, various health problems related to CBD vaping are highlighted. For example, the article discusses cuticle wax:

> One of the lesser talked about aspects of CBD vaping safety is the potential respiratory hazard of cuticle wax. Cuticle waxes are basically the oily, fatty outer layer of lipids that cover the surface of most flowering cannabis plants, including hemp … it's believed that the oily, waxy bits may collect together and eventually settle in the lungs, which may produce serious long-term health concerns.

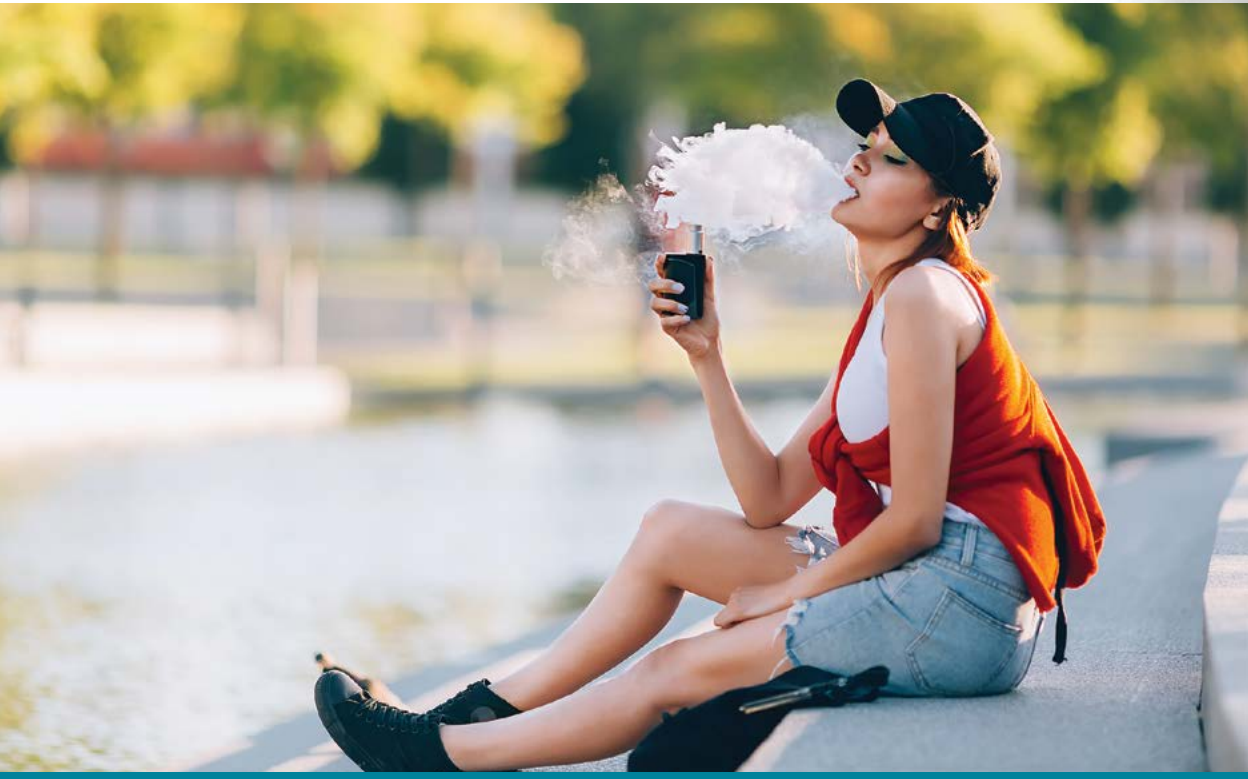
These concerns were particularly noted in a 2017 statement to *Rolling Stone* magazine by Steep Hill Labs, which indicated that vaping CBD oil was very likely to cause granules of this wax to build up in the

Scan here to learn more about the danger of vaping CBD products.

lungs. The exact effects are unknown but could be as minor as a slight cough to as severe as lung damage and even the potential risks for scar tissue or even cancer.

Other concerns raised by Marijuana Break include the thinning agents used in vaporizing fluids. These agents are necessary to make the CBD oil easier to vaporize and inhale. However, they are potentially dangerous and could become an issue when inhaled.

Some who vape CBD oil have noted asthmatic complications, allergic reactions to the fluid and its many chemicals, and other respiratory concerns. All of these problems have emerged over the



More scientific testing and research is needed to determine the health benefits and risks of CBD, and establish whether the compound is a safe ingredient in vape juices.

last few years and have many people wondering about vaping safety. Those who enjoy vaping CBD oil may wonder whether there is any safe way to enjoy their favorite additive.

CAN VAPING CBD BE SAFE?

Currently, there is no unequivocal evidence that vaping CBD oil is unsafe. The risks mentioned above are issues that have been observed but have not been proven through rigorous scientific studies to be long-term health issues. But does that mean that vaping CBD oil can be done safely? Probably not, most scientists and public health experts agree.

However, people who are willing to vape using products that contain CBD oil, despite the warnings, can take a few steps that might help them avoid permanent injury. First, they should examine each container of vaporizing fluid to determine the level of CBD that is included. To minimize the danger, the CBD level should be about 70 percent of the total fluid content. The actual level can vary drastically from product to product, so care is needed in selecting a vape juice.

Consumers should also read through the ingredients and look for listed chemicals that might be concerning. Stay away from CBD vape juices that include chemicals like formaldehyde. Unfortunately, there are very few vaping fluids that don't contain such chemicals.

Finally, vaping as little as possible will minimize the side effects. The effects of CBD oil can last for hours, so those who are using it for the supposed health benefits should not need to vape very often. The healthiest thing is not to vape at all, but for those who feel they absolutely must vape with CBD oil, trying to limit themselves to no more than once or twice a day could help them to avoid complications.

TEXT DEPENDENT QUESTIONS

1. What are the benefits of CBD oil?
2. What are the potential negative side effects of CBD oil?
3. Why is vaping CBD oil more dangerous than taking it as a supplement or in a topical cream?

RESEARCH PROJECT

Find various CBD vaping products in your area, and research their ingredient lists. If your state does not sell CBD products, find some online. What do their lists include, and what do they leave out? For example, do you see any listing of formaldehyde or other dangerous thinning chemicals? Are any side effects listed, or do they try to claim that there are no health risks? Find which brands do a better job of highlighting these potential problems and which fail to offer much protection to the consumer.

A commercial marijuana growing operation. As of 2020, medical marijuana is legal in thirty-three states, and recreational use of the drug by residents over the age of twenty-one is permitted in eleven states.

WORDS TO UNDERSTAND

cannabinoids: active chemicals found in marijuana, which include THC and CBD
exacerbate: to make something worse
hippocampus: the part of the brain that processes memories

THC Poses a Real Health Danger

As a growing number of states have legalized marijuana for either medical or recreational use, manufacturers have infused vaping fluids with THC. It is no coincidence that a rise in the use of these fluids has corresponded with an increase in vaping-related deaths. Vitamin E acetate has been found more in THC vaping fluids than in any other types.

However, just because vitamin E acetate has been linked to many health problems, that doesn't mean THC or other additives are safe to use. The truth is that plenty of vaping-related injuries and deaths have not been related to vitamin E acetate. As a result, further studies need to be undertaken to check into how THC could be causing these deaths or injuries. It is critical to know how THC could further impact users in unexpected ways.

Even if THC isn't responsible for the injuries or deaths noted so far, this chemical is by no means 100 percent safe. Like any substance that alters the mind and the body, it has many dangers that make it problematic to take. In a more concentrated fluid form, such as with vaping liquids, it could be even more problematic and cause a number of dangers that may be hard to predict and treat.

Some people have suggested that THC-infused vape juices are a safer way to ingest the chemical than smoking marijuana, which can damage the lungs and cause respiratory problems such as chronic bronchitis. While marijuana smoke does contain toxic, cancer-causing chemicals, vaping THC products comes with its own health concerns.

WHAT IS THC?

The scientific name for THC is delta-9-tetrahydrocannabinol, and it is the main psychoactive chemical found in marijuana. Although marijuana contains over 500 different chemicals and 100 THC-related compounds, called **cannabinoids**, THC is responsible for the psychoactive effects that occur when a person smokes or eats marijuana. As a result, THC has been studied heavily over the years by medical scientists.

When a person uses a product with THC, the cannabinoids travel to the brain, where they activate special receptors. The receptors are concentrated in areas of the brain associated with thinking, memory, pleasure, coordination, and time perception. THC attaches to these receptors, which causes the brain to release other chemicals, such as dopamine, which affect many aspects of a person's brain function.

Another compound in marijuana, CBD, actually inhibits the effects of THC, making them less strong. This matters because when THC

Scan here to see how vaping marijuana compares to smoking.

Studies have found that THC can have a negative impact on the developing brain. The American College of Obstetricians and Gynecologists recommends that women should not use marijuana during pregnancy or while they are breastfeeding. The drug increases the risk of miscarriage during pregnancy, and inhibits the development of young children's brains.

is extracted from marijuana, CBD no longer has this moderating influence on the psychoactive effects.

When THC releases dopamine, the body gets a feeling of euphoria and pleasure. Unfortunately, this reaction can cause problems with the **hippocampus** and may trigger other issues. Ingesting small amounts of THC will cause symptoms such as elation, sedation, pain relief, and a slowing of cognitive processing. Higher levels of

the compound can cause anxiety, heart palpitations, hallucinations, delusions, and confusion. Some people become very paranoid when smoking marijuana. They may experience panic attacks that can be quite severe and may leave long-lasting psychological scars. Users should keep in mind that THC does have adverse effects, and it also has positive effects.

For example, studies have found that THC can help relieve anxiety in some people, minimize physical pain and suffering, and even help with inflammation. A few studies have also found that THC could be used to help some symptoms of cancer, though the results are mixed. Though some studies found pain and nausea relief from THC, others did not.

The same is true of THC's alleged ability to help increase appetite in those with cancer. Studies have found that, while some had higher appetites after using THC, many more did not. Despite taking THC, most cancer patients were not able to maintain their weight during their cancer treatments—a critical aspect of staying healthy when fighting this disease. Other medicines, such as megestrol, produced a much stronger effect in cancer patients.

The most positive effects of medical marijuana have been on pain management and anxiety. Regular users of medical cannabis have noted decreased symptoms of pain from many diseases and much lower levels of anxiety and discomfort. It is important to note that THC does not cure any of these problems, it simply mitigates the symptoms. As a result, the underlying concerns are still present.

THE DANGERS OF THC

So, if THC does have medical benefits—and has been used for medicinal purposes for 3,000 years, as some advocates claim—why does the federal government still ban its use? Well, the concept that THC is 100 percent safe is bogus and needs to be debunked. THC is a

California became the first state to allow cannabis treatment for certain conditions when voters approved the Compassionate Use Act in 1996. This marijuana dispensary is located in Venice Beach.

chemical that affects how the body and mind operate. Any drug of this type will produce adverse effects of some type in anyone who uses them.

For example, short-term THC use can cause a decrease in motor skills that may cause accidents on the road or in other situations. It may also cause extreme drowsiness and confusion, which may lead to further complications in a person's life, such as forgetting to pick up their child at school or not remembering to go to work at a certain time.

The long-term effects of marijuana use are often downplayed by heavy users and the groups that advocate for medical marijuana. Studies have found that heavy use of marijuana over an extended period can cause memory problems, difficulties with solving problems, a decrease in intelligence quotient (IQ), and even a relapse

THC COULD AFFECT HEART HEALTH

Although THC has been heavily tested over the years, few truly understand the potential heart-health dangers this chemical may cause. A study at Harvard University found that people who smoke marijuana are more likely to develop chest pain when stressed than those who don't. That's because marijuana use can raise the heart rate, dilate blood vessels, and make the heart pump harder. This type of damage could lead to various emergencies, such as heart attacks and even strokes.

Boxes of THC-infused vaping fluid for sale in Illinois, which legalized marijuana for recreational use in 2020. While public health experts caution that THC could have a dangerous effect when vaped, many agree that products sold by state-licensed dispensaries are less likely to contain other harmful additives than "black-market" juices created by unlicensed foreign companies.

in some schizophrenia symptoms. Some believe it could even cause breathing troubles or infertility.

These problems typically worsen if a person starts taking THC at a younger age. For example, a study at Duke University found that heavy marijuana smokers who start using the drugs as teenagers could lose eight IQ points by the time they are in their early thirties. Although some cognitive and mental decline is common as a person ages, that kind of steep fall is not usually noted in such a short period or at such a young age without underlying factors. However, adults who start smoking marijuana later in life might experience such a decline.

The troubling thing about these changes is that they could become more notable or worse in future smokers. That's because marijuana now contains more THC than it did in the past, due to careful cultivation of potent strains and improved growing methods. And the concentrated THC found in vaping fluids may only **exacerbate** these problems and cause more complications in users.

WHY VAPING THC IS MORE DANGEROUS

The increases in vaping-related lung diseases and deaths have caused many people to urge caution when it comes to vaping products that include THC. The concentrated nature of THC vaping fluids removes the other chemicals in marijuana that balance its reactions. Remember how CBD helps to decrease the psychoactive effects of THC? Its absence in vaping fluids means that THC can create more potent results in users.

Therefore, users won't have to take nearly as much of a hit off their vaporizer as they would when taking marijuana to achieve a potent effect. Unfortunately, many users might not realize this fact and might try to take huge hits like they did in the past. The result could be a very potent high that lasts for much longer and makes it more difficult for them to drive or do anything at all.

A marijuana dispensary worker trims small leaves off the THC-containing marijuana buds.

Even worse, there's a chance that they could overdose on THC when using a vaporizer. Though there aren't many reported incidents of this happening, the nature of vaping could make it more likely. As users can adjust their doses, they may take hits that are far too large and could put them in the hospital or cause other long-term health problems.

So, although vitamin E acetate may be getting most of the blame, many scientists feel that THC also helps to cause health problems. "THC use has been associated with a wide range of health effects, particularly with prolonged frequent use," notes the CDC. "The best way to avoid potentially harmful effects is to not use THC-containing e-cigarette, or vaping, products." Clearly, this additive is one that should be avoided, especially by young people.

SHOULD THC VAPING BE BANNED?

A growing movement has arisen to ban THC-infused vaping fluids in states where medical or recreational marijuana is legal. Currently, marijuana and all other THC products are illegal in the eyes of the federal government, but it has chosen not to enforce its laws in states that choose to allow marijuana for medical or recreational use. So, these products remain available and very marketable. However, the federal government could pursue cases against manufacturers and users if it wanted to ban such products.

As federal pressure rises, states could implement stricter regulations. However, many states lack the resources necessary to properly control the manufacture and sale of such products. Turning to the federal government for help isn't an option. Because such products are illegal under federal law, the FDA and other government agencies do not regulate THC-infused vaping products.

As a result, this situation could remain frustratingly hard to solve, especially as more and more states make THC products legal to use.

And if states start banning THC vaping liquids, people who want these products will simply look for fly-by-night black-market vape fluids. After all, marijuana has been illegal for nearly a century, yet it has remained one of the most commonly abused drugs. The biggest concern is that manufacturers of illegal THC vaping fluids would take even less precaution in the additives and chemicals that they use than do the companies and marijuana dispensaries that make legal THC-infused vaping fluids. All of these factors make figuring out the next move here quite tough, and many experts aren't certain that a ban on THC vaping fluids would help.

TEXT DEPENDENT QUESTIONS

1. What are some of the heath concerns related to THC?
2. How does THC affect memory?
3. What are some reasons that banning THC-infused vaping fluids might not be a good idea?

RESEARCH PROJECT

Find contact information for legal THC vaping fluid manufacturers, and call them up to ask about their ingredients. Let them know that you are doing a research project and want to know exactly which chemicals are used. What kind of answer do they give you when you ask? Are they open about their chemicals, or are they secretive? Some may hide the amount that they use or try to keep the processes that they use a secret. Why do you think they behave in these ways? Right a brief report detailing your findings.

So-called "heavy metals," such as aluminum, chromium, copper, lead, magnesium, nickel, silicon, and tin, are produced in e-cigarette vapor. These metals can be toxic and produce serious health effects.

WORDS TO UNDERSTAND

carcinogen: a substance that may increase a person's risk for cancer
cognitive: referring to processes connected with the mind and thinking
concentration: the amount of an element or item that appears within another substance
regulatory agencies: governmental divisions that establish rules and guidelines for specific industries

Heavy Metals Are Common in Vaping Fluids

Manufacturers of vaping fluids and devices happily promote additives like CBD and THC, because of the perception that many people have about the benefits of those substances. However, many other chemicals are in vape juices or produced through the process of vaping, which manufacturing companies would prefer consumers not know about. That's because the process of creating this vapor may produce a larger amount of dangerous and noxious chemicals than was previously understood. As a result, users may be adding a dangerous amount of heavy metals to their bodies when they vape.

These metals vary in their **concentrations** and their dangers, depending on the type of vaporizer used. While some are common minerals needed for a healthy diet, others are much more dangerous, and inhaling them certainly does no favors for a person's health. Even heavy metals that a person needs to eat at small levels may be dangerous when inhaled in a vaporizer.

As a result, it is critical to understand the natures of these liquids and how they can affect a person's health in adverse ways. More research is currently being done on these fluids, as well, which should help to illuminate any other problems that they may develop.

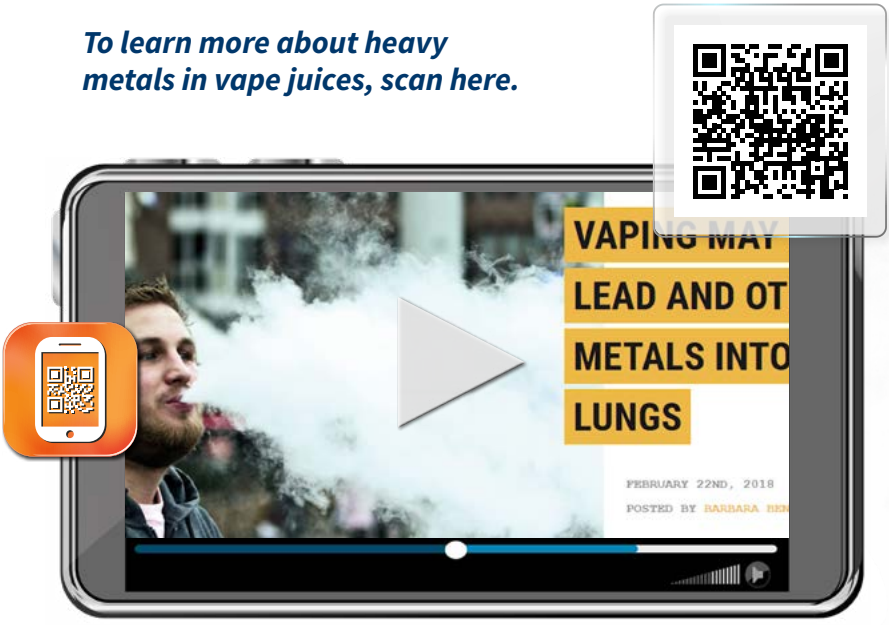
TYPES OF HEAVY METALS FOUND IN VAPING FLUIDS

Vaping fluids are not as simple as they may seem. The manufacturers of e-cigarettes and vaping fluids purposefully try to make their products seem more healthy and less harmful in an attempt to distract or misinform the public. Unfortunately, their deceptive advertising practices seem to be working, as few people truly understand the effects that can occur when a person uses vaping fluids for too long.

In 2018 and 2019, Prue Talbot, a professor at UC-Riverside, researched the side effects of electronic vapor devices along with

A young man refills the tank of his electronic vapor device.

To learn more about heavy metals in vape juices, scan here.



colleagues Monique Williams and Jun Li. They found that one result of heating the vape juice in e-cigarettes was that small amounts of heavy metals were included in the vapor, which the users took into their lungs. The harmful substances were produced when the metal parts of the vaporizer were heated, and included aluminum, calcium, chromium, copper, iron, magnesium, nickel, silicon, tin, and zinc.

These byproduct "heavy metals" were found in multiple brands and types of e-cigarettes but were more common in high-powered ones. As Talbot explained to *Forbes* magazine:

> When batteries with more power are used in these tank-style e-cigarettes, their atomizing units can heat to temperatures greater than 300° Celsius (572° Fahrenheit), which could produce harmful byproducts. The presence of heavy metals, including some known **carcinogens**, in e-cigarette aerosols is concerning because with prolonged exposure they could cause adverse health effects.

By themselves, these metals are not necessarily unhealthy. In fact, small amounts of magnesium, iron, calcium, and zinc are all necessary for a healthy diet. However, these metals are not meant to be inhaled into the lungs and could, in high concentrations, cause serious health issues.

Typically, the more voltage used in a vaporizer, the higher the concentration of heavy metals a vaper was likely to take in. Someone who uses a larger, modified electronic vaping device is more likely to experience problematic side effects than a person who uses a low-powered e-cigarette. However, anyone who uses an e-cigarette or vaporizer is likely to experience some contamination of their lungs from these metals.

Therefore, it is critical to fully understand the dangers of each of these elements and how they can affect a person's health. While some aren't that problematic, others can be very dangerous even in small doses. The following sections will examine the most dangerous of these substances to ensure that they are avoided as much as possible by those who may want to start vaping soon.

The 2019 study by Williams, Li, and Talbot, titled "Effects of Model, Method of Collection, and Topography on Chemical Elements and Metals in the Aerosol of Tank-Style Electronic Cigarettes," examined many elements of this problem. The researchers concluded that higher-powered vaporizers were more dangerous for a variety of reasons, stating:

> Tank-style EC have evolved to provide larger puffs, store larger amounts of refill fluid, and allow for more customizability by the consumer. These changes enable operation of products at higher voltage/power, which correlates with increased concentrations of several elements/metals (including lead, nickel, iron, copper) in their aerosols.

Their collection methods quickly found a broad array of different concentrations of elements, each of which they believed would help

regulatory agencies make better-informed decisions on vaping. For example, they found that the location of the electronic vapor device's tank—such as whether it is on the bottom or the top—could affect the distribution of these heavy metals through a person's lungs and throughout their body.

HEALTH EFFECTS OF HEAVY METALS

The possible impact of these metals is often quite serious. For example, high concentrations of chromium and nickel have been found in many vaping fluids. All have been found to cause cancer

When vape juice is exposed to heated metal parts in the atomizer of an electronic vapor device, it can produce toxic metallic byproducts that are drawn into the user's lungs.

in humans. Chromium is also linked to gastrointestinal disorders, breathing problems, and lung cancer when inhaled. Nickel is also linked to a variety of breathing problems and lung diseases.

One of the most toxic heavy metals is lead, which since ancient times has been known to cause **cognitive** damage in humans that could last for the rest of a person's life. The body absorbs higher levels of lead through inhalation, which can cause abdominal pain, memory loss, and feelings of weakness and tiredness. Over time, lead inhalation is also associated with an increased risk of stroke, heart disease, and other illnesses.

Pod vapes contain two elements: a pod filled with vape juice (right) that snaps into a small battery unit (left). The heating elements in these pod vapes are typically not as powerful as in other e-cigarettes, so the risk of heavy metals entering the vapor from contact with the heating coil is reduced. On the other hand, studies indicate that these cheaply made vapes may have more contaminants already mixed into the vaping fluid, including heavy metals like arsenic, copper, iron, and lead.

Studies have found that people who inhale aluminum can have lung problems, such as coughing or damage that appears in X-rays. Inhaling aluminum may also affect the nervous system. The mineral has been linked to kidney damage and an increased risk of Alzheimer's disease in humans.

Silicon is another substance that has been found in vaping fluids. It is not normally toxic to humans, but it can cause irritation and lung damage when inhaled.

Copper, iron, magnesium, and zinc are metals that are naturally ingested as part of the human diet. However, these metals were not meant to be inhaled, and their effect on breathing is still being studied. In higher-than-normal amounts, copper can cause a person to feel sick or experience diarrhea, vomiting, or stomach cramps. Very high levels can cause liver and kidney damage, and even death. There have not been studies on whether copper causes cancer. High levels of iron, magnesium, and zinc can cause lethargy, liver damage, and joint pain and may contribute to heart attacks and strokes.

At high levels, tin can cause skin and eye irritation, respiratory irritation, digestive problems, and neurological issues in humans. Sometimes, the neurological problems have lasted for years after the poisoning occurred. Tin may also affect the human immune system.

LEAKS MAKE THE PROBLEM WORSE

One of the scariest parts about these heavy metals is that they appear in vape juices at much higher concentrations than they would in foods or other types of products. That's because vaping fluid itself is highly concentrated. The heavy metals are present in the vapor due to the process of heating the vaping fluid. The many chemicals in the fluid, along with the metal parts of the electronic vapor device, react to heat differently and release the dangerous heavy metals.

A series of studies since 2016 have found that poor design of e-cigarettes may be making the situation even worse. Following a

LEAD POISONING

Lead is a metal that is naturally found in the Earth's crust. It is strong, can be melted down and worked easily, and has many useful properties. Ancient people used lead for everything from plumbing pipes to makeup. In the twentieth century, it was added to paint to make it last longer, and to gasoline to help engines run better. Unfortunately, lead is highly toxic to humans and can cause serious damage to the brain and body. The effects of lead exposure are especially strong in the developing brains of children. In high enough doses, it can be deadly. Over time, the government and public health organizations have taken steps to mitigate exposure to lead. Lead paint was removed from the market in 1978, and leaded gasoline was banned in 1996. So, while the once-common problem of lead poisoning has been significantly reduced, recent studies indicate that vaping could result in a whole new generation of lead-damaged young people.

2016 report that found high levels of nickel and chromium in those who used e-cigarettes, scientists at the Johns Hopkins Bloomberg School of Public Health examined various types of e-cigarettes used by fifty-six people who vaped daily, to discover what kind of toxic chemicals they were ingesting. Their study found that heating the vape fluid was a major source of contamination, as the heat from metal coils helps to turn the heavy metals that they contain into a liquid or gas form. This cross-contamination is more common in high-powered vaporizing pens and in cheaply made e-cigarettes.

About half of the e-cigarette tests produced aerosol vapor that had lead levels exceeding the safe limits set by the U.S. Environmental

Protection Agency (EPA), said the study's lead author, Ana Maria Rule. The average levels of nickel, chromium, and manganese were also above the safe levels. "These were medial levels only. The actual levels of these metals varied greatly from sample to sample, and often were much higher than safe limits," Rule said. "It's important for the FDA, the e-cigarette companies and vapers themselves to know that these heating coils, as currently made, seem to be leaking toxic metals—which then get into the aerosols that vapers inhale."

Lead is a useful but dangerous heavy metal. People exposed to levels of lead can develop a blood disorder called anemia, which causes tiredness and weakness. Higher levels of lead exposure can lead to permanent kidney damage, brain damage, and even death.

Some scientists have taken this new information to argue that vaping—once promoted as a safe alternative to cigarettes—might actually be more dangerous over the long term than smoking, due to these heavy metals. Others disagree, believing the problem could be fixed by improving the design of e-cigarettes. But in any case, it is clear that vaping is not the safe process that many people assumed.

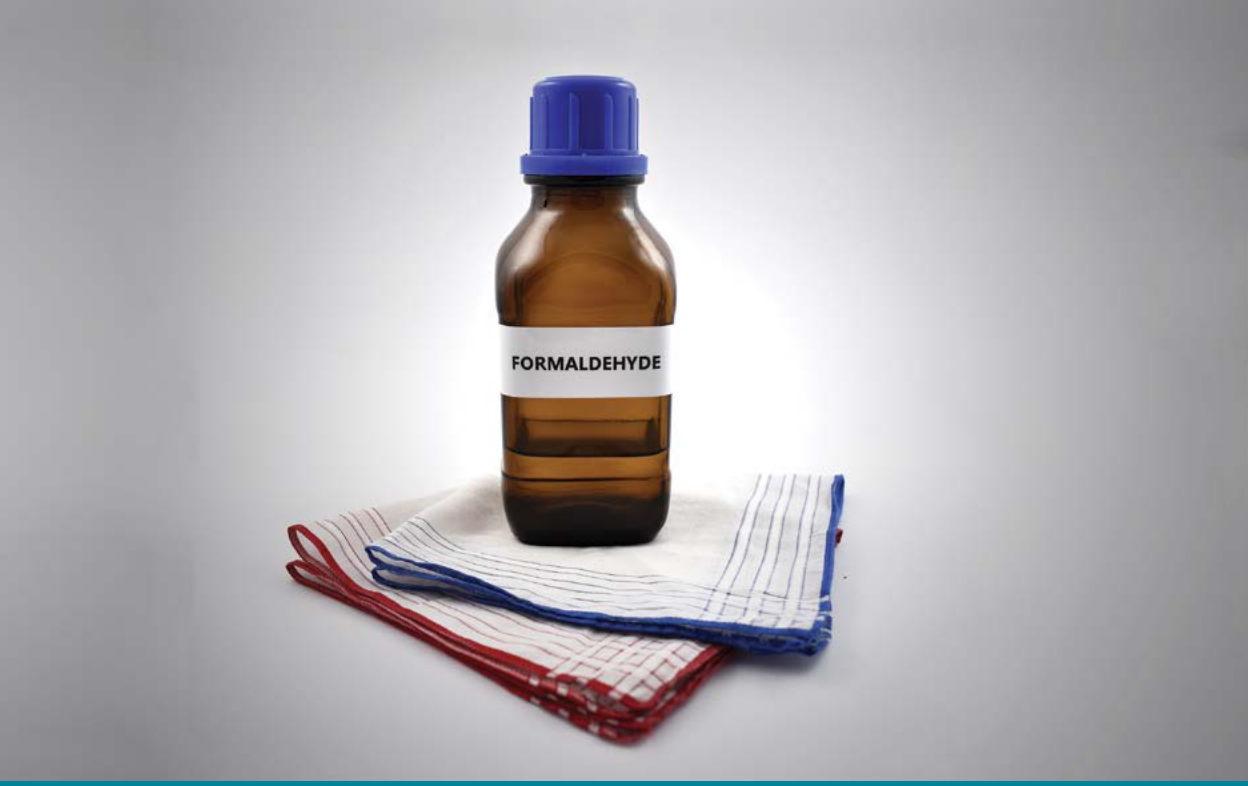
People who like to expel large clouds of vapor may be setting themselves up for lifetime problems by setting their heating coils at a powerful level. This makes them more likely to be exposed to higher levels of arsenic, cadmium, chromium, and nickel—all of which are considered carcinogens by the International Agency for Research on Cancer.

TEXT DEPENDENT QUESTIONS

1. What are the most common heavy metals found in vaporizing pens?
2. What are the effects of lead poisoning?
3. What are some heavy metals that are found naturally in a healthy diet?

RESEARCH PROJECT

Examine the recent lead contamination in the water of Flint, Michigan. See how the state reacted, the ways the residents were impacted, and any damage that may have occurred to others. The outrage level was rather high during this incident—does this kind of sentiment appear common in the vaping industry? Why do you think it does or doesn't? Develop a hypothesis about why one incident causes such a reaction, while the other may or may not trigger a similar reaction. What does that say about the vaping industry and those who either support it or oppose it?



Formaldehyde is one of many toxic chemicals produced when an e-cigarette heats nicotine vape juice. Since the 1980s, the US Environmental Protection Agency has classified formaldehyde as a probable human carcinogen.

WORDS TO UNDERSTAND

infinitesimal: referring to a minimal measurement of something, usually not viewable by the naked eye

OSHA: an acronym for the Occupational Safety and Health Administration, a federal government agency that establishes safety rules for workplaces

phenomenon: a fact or situation that is observed to exist, especially one whose cause or explanation is in question

theoretical: referring to an estimate of what a scientific study may reveal, based on past evidence and research

Formaldehyde and Other Dangerous Chemicals

Some chemicals just have a strange-sounding name or a bad reputation in the general community. Formaldehyde is one of those chemicals. Used for decades as a preservative, formaldehyde is often depicted in the media as an example of a dangerous chemical. In 2011, after years of scientific study, the federal government officially confirmed that formaldehyde causes cancer in humans.

Yet, this chemical is still found in many different items, including vaccines and many types of food. That's because formaldehyde can be ingested in **infinitesimal** amounts, so small you'd never know it was there. But cigarette smokers are exposed to dangerously high levels of formaldehyde, which is much more potent when inhaled. Scientists consider it to be one of the primary triggers for lung cancer in tobacco smokers.

When the first e-cigarettes were introduced in 2011, the companies that promoted vaping tried to tout their products as being safe from formaldehyde and other dangerous chemicals that were created when tobacco was burned. It turns out that these claims were very wrong—surprise, surprise. Vaping not only produces high levels of formaldehyde, it actually creates more of this toxic chemical than

cigarette smoking does. Yet, millions of vapers believe that their devices are safe. Therefore, it is essential to examine the dangers of formaldehyde and how it could impact those who think that vaping is a harmless habit.

Formaldehyde can be listed on a product label by other names, such as formalin, formic aldehyde, methanediol, methanal, methyl aldehyde, methylene glycol, and methylene oxide.

WHAT IS FORMALDEHYDE?

Formaldehyde is a colorless but very strong-smelling gas that is used in a variety of different products. The range of items that use formaldehyde is surprisingly broad, including pressed-wood products like fiberboard and plywood, glues and other types of strong adhesives, coatings for paper products, many types of insulation, and permanent press fabrics. Other products that use formaldehyde include various cleaning agents, cosmetics, fertilizers, carpets, medicines, paints, varnishes, antiseptics, and many types of preserved foods. The levels used in these products are minimized as much as possible to decrease the health risks. As a result, there is probably a little formaldehyde in most people's homes.

When exposed to air, formaldehyde typically breaks down within a few hours, which makes it a challenging gas to work with. For commercial use, formaldehyde is often processed into a liquid known as "formalin." Formalin is easier to work with than formaldehyde during the manufacturing process, contains more overall consistency, and doesn't break down as quickly. People who are concerned about formaldehyde exposure should look for formalin on their ingredients lists. In some foods, formalin is labeled as "other preservatives."

There are plenty of other sources of formaldehyde in the world, both natural and unnatural. Humans, animals, and plants all produce tiny amounts of this gas every day through breathing and in their waste. According to the U.S. Consumer Product Safety Commission (CPSC), formaldehyde is normally present at low levels (less than 0.03 parts per million) in both indoor and outdoor air. Manufactured materials containing formaldehyde can release it as a gas into the air. Manufacturing processes and power plants also produce large amounts of formaldehyde, as do automobile exhaust and tobacco smoke. Formaldehyde often ends up in rainwater due to these chemical releases and can be quite destructive to the environment

before it evaporates and dissipates. Older homes may also have high levels of formaldehyde in the air, due to the use of UFFI foam insulation. This insulation is not used much anymore, but homes built or insulated during the 1970s probably contain these products.

The potential dangers of formaldehyde are not a problem for most people. The quick-dissolving nature of this chemical makes it hard for a non-smoker person to accumulate it within the body in high enough

Because formaldehyde is so toxic, it kills bacteria that would otherwise destroy tissue cells as part of the decomposition process. This makes it useful as an embalming fluid, as well as for preserving human or animal tissue samples for later examination.

levels to trigger any problems. That said, smokers and people who vape may end up inhaling dangerous amounts of formaldehyde. As a result, it is critical to examine this concerning **phenomenon**.

THE DANGERS OF FORMALDEHYDE

The trace amounts of formaldehyde that are ingested are normally broken down in the cells and metabolism of the body and quickly disappear. However, sustained exposure via smoking or vaping raises a person's exposure to this chemical. "Formaldehyde is a highly reactive molecule that can be directly irritating to tissues with which it comes into contact," notes the federal government's Agency for Toxic Substances and Disease. "Human and animal studies indicate that formaldehyde, at certain exposure levels, can be irritating to

FORMALDEHYDE AND VACCINATION FEARS

Well-meaning, but misguided, parents who oppose vaccination have pointed to the adverse potential of chemicals like formalin and formaldehyde. They believe that these chemicals could be causing autism and even death in children. However, unlike with cigarette smoking and vaping, the levels of formaldehyde used are very small and disappear almost immediately after a vaccine is administered. Tiny amounts of formaldehyde are used to kill the virus that is used to make the vaccine, so that it can't produce disease in the body. The amount of formaldehyde used in vaccines is lower than the level of this chemical that naturally occurs in the human body, meaning it is safe.

Houses built during the 1970s are likely to have high levels of interior formaldehyde, due to the foam insulation and other materials used in construction at the time.

the upper respiratory tract and eyes with inhalation exposure, to the skin with dermal exposure, and to the gastrointestinal tract with oral exposure." The agency notes that cancer often occurs where the formaldehyde enters the body, so in smokers and vapers that would be the upper respiratory tract and lungs.

Smokers are familiar with irritation in their throats or respiratory tracts. Although other chemicals contribute to this problem, formaldehyde is one of the most agitating. When it gets into the eyes, it can also irritate them—the familiar "smoker's squint" against the smoke from a cigarette shows just how agitating smoke can be to the eyes. Red and dry eyes may ultimately result from this exposure.

The longer and more heavily a person smokes, the more severe these problems are likely to become. For example, some may develop asthma or asthma-like symptoms due to formaldehyde exposure in cigarette smoke. As this chemical breaks down so quickly, the development of these symptoms usually requires more sustained and frequent exposure, such as a pack-a-day smoking habit.

More severe problems have been noted in animal studies, and include impaired learning and changes in behavior. Formaldehyde causes brain damage in those who smoke. Again, this damage is more severe based on how much a person smokes and how heavily. But some damage is likely to occur in all regular smokers.

Perhaps worst of all, many types of cancers have been noted in conjunction with exposure to formaldehyde. Studies have shown that rats develop stomach cancer if they over-eat formaldehyde—way beyond what a person would ever eat in their lives. But other studies show that people who are exposed to formaldehyde in a workplace environment—or through cigarette smoke—have more cases of nose and throat cancer than is typical for the general public. And rats that are exposed to formaldehyde in their air may also develop some types of nose cancer.

Increased levels of formaldehyde are produced when electronic vapor devices are operated at higher heat settings.

All of these dangers may be concerning even to readers who do not smoke. They can take heart in the knowledge that they are very likely not exposed to dangerously high levels of formaldehyde. However, vapers who think that they are also safe are very mistaken. Sadly, there is a very good chance that they not only are exposed to similar levels of formaldehyde as smokers but also could experience even more risks.

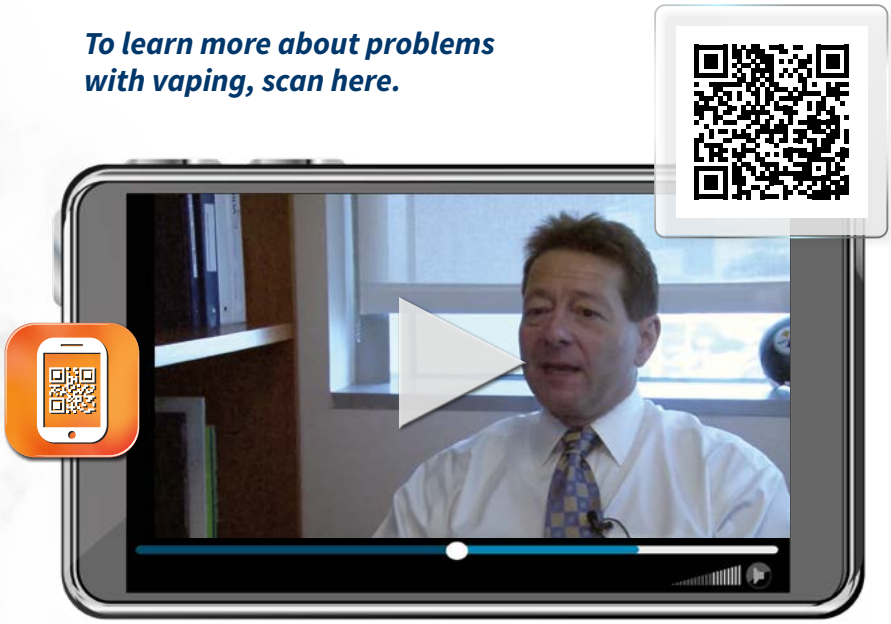
FORMALDEHYDE AND VAPING: THE DANGER IS HIGHER

As with other types of additives and chemicals in vaping, the exposure to formaldehyde may be higher due to the concentrated nature of vaping fluids. This goes against the perception of many people who use e-cigarettes, who believe that vaping is safer than smoking. However, studies on this concept have found quite the opposite to be true. For example, a 2018 study published in the journal *Toxics* concluded that e-cigarettes exposed vapers to higher levels of formaldehyde and other hazardous chemicals than cigarettes did. The study's authors noted:

> We found that the average concentration of aldehydes in the breath after vaping sessions was about ten and a half times higher than before vaping. Beyond that, we saw that the concentration of chemicals like formaldehyde in the breath after vaping was hundreds of times lower than what is found in the direct e-cigarette vapors, which suggests that a significant amount is being retained in the user's respiratory tract.

Despite this finding, the biggest question that many vapers may have regarding formaldehyde is whether or not it's tolerable at any level. The answer here is somewhat complicated. While it is true that exposure to formaldehyde won't cause an immediate adverse reaction, it is still a carcinogen and still may cause problems. That

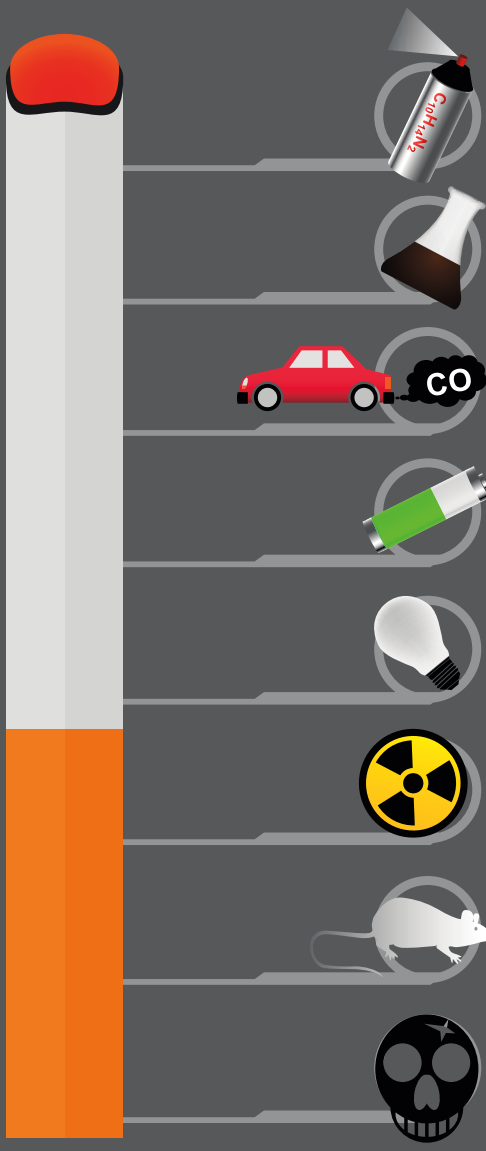
To learn more about problems with vaping, scan here.



said, **OSHA** has created a tolerance level that it believes is safe for people. Currently, it has set a limit of 0.75 parts formaldehyde per million parts air over an eight-hour time limit. Most people will never be exposed to that level of formaldehyde in an average day unless they work in a dangerous environment, smoke cigarettes, or vape.

Studies have found that smoking increases a person's risk of cancer by as much as fifteen times if they smoke one pack per day, just due to the formaldehyde alone. The risk of cancer from vaping has not yet been determined, because e-cigarettes have not been available for long enough to conduct proper research studies of the long-term effects. However, some experts believe that people who vape could be exposed to even more cancer-causing formaldehyde than people who smoke cigarettes. Even worse, it appears that the formaldehyde released by vaping ends up penetrating more deeply into a person's

What does a cigarette give you?



NICOTINE
- Increase blood pressure and heart rate
- Coronary artery constriction

TAR
- Lung cancer

CARBON MONOXIDE
- Dizziness
- Headache

CADMIUM
- Cardiovascular disease
- Obstructive pulmonary disease.

MERCURY
- Deteriorates nervous system
- Corrodes skin and mucous membranes

POLONIUM-210
- Affect liver function.
- Cancer.

ARSENIC
- Scaling skin, pigment changes
- Nerve damage
- Lung, bladder, kidney, and liver cancers

FORMALDEHYDE
- Primary skin irritation, allergic dermatitis
- Cancer

Formaldehyde is one of many toxic by-products of cigarette smoke.

respiratory tract than cigarette smoke, which could make the risk of cancer even greater. Until long-term studies are conducted, the risks are **theoretical** for now. However, this theory is based on robust science and studies. It is not merely a "guess"—as many erroneously think a theory represents—but a grounded estimation that is based in a lot of research and care. No medical scientist makes a theory without having an excellent idea of whether or not it is accurate. Though sometimes a theory may prove to be wrong, they are more often right than not.

As a result, vape users have a hard decision to make. Do they risk formaldehyde exposure and hope that they don't get cancer, or put their pens down and try to quit using? This choice is tough, because nicotine is so often incredibly addictive and hard to manage. Before choosing, however, users should understand a few more dangerous chemicals that vaping may introduce to their bodies.

TEXT DEPENDENT QUESTIONS

1. How is formaldehyde produced in the body?
2. Why is formaldehyde in so many products?
3. Which cancer has formaldehyde been linked to?

RESEARCH PROJECT

Talk to a medical official about the different ways that they use formaldehyde in their facility. Ask them about any protective measures that they take to limit their exposure. What do they think about the use of formaldehyde in vaping pens? Have they treated anyone who has been exposed to excessive levels of this chemical? Lastly, have them show you some liquid formaldehyde. Does that look like something that you would want in your body?

A selection of flavored vaping supplies on display in the window of a vaping store in New York City. In January 2020, the Food and Drug Administration announced a ban on most flavored vape products as part of an effort to reduce e-cigarette use among teenagers.

WORDS TO UNDERSTAND

antioxidants: substances that prevent oxygen damage to the body or other elements

benign: harmless and non-threatening

diagnostic: concerned with the diagnosis of illness or other problems

toxicity: the potential danger of a substance to cause poisoning or other unhealthy reactions

Propylene Glycol Can Be Destructive

At first glance, some additives to vaping fluids may seem relatively safe. For example, propylene glycol—a type of food alcohol—is used in a broad array of consumer products and has been classed as generally safe to use. There have been very few cases in which people eating foods or taking medications that contain propylene glycol have experienced adverse reactions.

However, a growing number of people are concerned about the use of propylene glycol in vaping fluids. While it is by no means the most dangerous chemical or additive, it has come under fire in recent years due to a myriad of different symptoms and problems that it has triggered in vaporizer users. Therefore, it is essential to examine the full range of this problematic chemical and how it could affect those who vape.

WHAT IS GLYCOL?

Before moving on, it is essential to define the type of glycol being discussed here. The kind used in vaping fluids is known as propylene glycol, not ethylene glycol. These two substances are often confused, because their names are similar. However, ethylene glycol $(CH_2OH)_2$

is, by far, the more dangerous of the two compounds. No foods or any other products designed for human consumption use this chemical, because it is highly toxic. It is used in the production of polyester cloth as well as in antifreeze fluids used in cars and trucks.

By comparison, propylene glycol ($CH_3CH(OH)CH_2OH$) is much safer. It is a colorless, odorless, and slightly syrupy fluid that is non-toxic when ingested, and it has been approved by the Food and Drug Administration as a food additive as well as an ingredient in cosmetics and other products. "Propylene glycol is commonly used as an additive

Nicotine use is the leading cause of preventable death in the United States. According to the Centers for Disease Control and Prevention, almost 500,000 Americans die prematurely each year due to diseases caused by tobacco use or exposure to secondhand smoke.

to aid in the processing of foods and improve their texture, flavor, appearance and shelf life," notes the website Healthline. "It is also used in injectable medications, like lorazepam, and in some creams and ointments that are applied to the skin, such as corticosteroids.… Due to its chemical properties, it is also found in a wide variety of hygiene and cosmetic products. Additionally, it is used in industrial products like paint, antifreeze, artificial smoke and e-cigarettes."

Propylene glycol is added to many types of processed foods, including dried soups and grated cheese, to prevent clumps. It also can be used to extend the shelf life of various types of foods and protect them against oxygenation through **antioxidants**. And glycol can help to dissolve food additives and different kinds of nutrients to make them easier for the body to absorb. These same traits make it a popular choice for keeping cosmetics fresh, helping to absorb

THE SAFETY OF PROPYLENE GLYCOL

Some people grew outraged when they learned that propylene glycol was a food additive, because they confused it with ethylene glycol. The connection to antifreeze, which is highly toxic, was too much for these folks to ignore. However, chemists quickly came to its defense in this public outcry. In fact, some scientists have pointed out the safe nature of propylene glycol, even in the face of the anti-vaping outrage that occurred in late 2019, due to the rise of vaping-related lung diseases. Similarly, the Food and Drug Administration continues to consider propylene glycol to be a safe additive when it is used appropriately—although it's important to point out that the FDA does not consider inhalation through vaping to be a proper way to ingest it.

oxygen in antifreeze, or producing artificial fog. Those who are looking for propylene glycol on food or product labels may find it labeled as 1,2-propanediol, 1,2-dihydroxy propane, Methyl ethyl glycol, and Trimethyl glycol.

Propylene glycol is not considered a toxic chemical, because most people are not exposed to it at very high levels. Like any chemical, it can cause negative health effects if too much is consumed. **Toxicity** may occur if a person consumes more than 15 milligrams per body pound per day. However, the safe nature of propylene glycol does not take into account the effects of inhaling the compound. It is essential for those who vape to understand what this compound does within their body, particularly when it is introduced through inhalation.

Vaping juice includes a variety of chemicals and artificial flavorings. Some of these many be safe to eat, but cause problems when inhaled. For example, diacetyl, a buttery flavor that was once added to microwave popcorn, has been linked to obstructive lung disease when inhaled.

THE DANGERS OF PROPYLENE GLYCOL

Although propylene glycol is defined by the FDA as "relatively safe," it may cause some health problems when consumed in massive levels. For example, studies have found that the buildup of lactic acid produced by overeating propylene glycol could cause acidosis and kidney failure. This problem could also occur if a person inhales propylene glycol, as it may build up in the blood and cause even more complications.

When toxicity does occur with propylene glycol, a person is likely to notice a series of nervous-system issues. These include slower breathing rates, a lower heart rate, and a potential loss of consciousness. These are the most common apparent symptoms of glycol toxicity. Unfortunately, more lingering and highly sustained exposure to this substance could lead to even more troubles.

For example, slow but persistent kidney damage could spread to cause other types of organ failure. Typically, people with liver and kidney disease should not consume propylene glycol for any reason. Due to the weakening of these organs through illness, they are more likely to experience damage. And a person's toxic doses may be smaller, which may trigger more problems more quickly.

In most cases, the symptoms of this problem occur because a person takes too much medicine with propylene glycol. Sometimes, this happens when the person receives a medication with propylene glycol and takes too much without letting their doctor know. With other types, doctors may give too much medicine in error. That's because there is no current maximum dose limit for the use of propylene glycol in drugs. As a result, the level may be much higher than the doctor intends.

Beyond this concern, propylene glycol has posed a danger to infants and pregnant women, because they have a lower level of a specific enzyme in their bodies. As a result, their exposure limits are much smaller than other people's, which may cause an overdose.

This issue may be of particular note for women who vape while pregnant because they think it is healthier than smoking.

Other dangers noted with massive exposure to propylene glycol include heart damage, neurological problems, and skin issues. Heart problems included decreased blood pressure and heart rates that could trigger cardiac arrest. Neurological damage included repetitive convulsions in those with epilepsy, and the potential for neurological problems in children. And skin concerns included persistent rashes in those who are sensitive or allergic to propylene glycol (about 0.8 to 3.5 percent of the population).

POPCORN LUNG

In 2004, a large number of workers at a microwave popcorn factory were found to have developed a lung condition called "bronchiolitis obliterans." People with this condition have damage to the smallest airways in the lungs, which causes them to cough and feel short of breath. Scientists found that the workers had developed the condition from breathing large quantities of diacetyl, a chemical that was used to add the buttery flavor to the microwave popcorn. Most companies soon stopped using the chemical in food products. In 2015, a study of fifty-one flavored vape juices found that most of them contained diacetyl, and the researchers raised concerns that vapers could be risking bronchiolitis obliterans, which has been nicknamed "popcorn lung." Vaping advocates claim that the amount of diacetyl that is needed to cause popcorn lung is much higher than the amount in vape juices. However, in 2019, a Canadian teenager developed the condition by vaping, which led doctors to conclude that the risk is real.

All of these problems are bad enough on their own but most occur due to massive medical exposure. That said, a person can still experience adverse reactions when inhaling propylene glycol. The most common way that they would get propylene glycol in their lungs is through e-cigarettes and vaping. For example, one study of vaping found that propylene glycol exposure resulted in lung damage. "The team of researchers, in the pilot clinical trial have found that those who smoked e-cigarettes twice a day for just a month had higher levels of chemicals such as propylene glycol in their blood," wrote Dr. Ananya Mandal. "This was associated with inflammatory changes in their lungs. The count of the inflammatory cells in their lungs rises over time, speculate the researchers."

This inflammation risk is something that shouldn't be ignored when considering the dangers of propylene glycol. Though this chemical may not seem as dangerous as others mentioned so far, it is still not healthy. For example, inflammation of the lungs may cause damage that leads to more persistent issues, including the danger of various types of lung diseases and even lung cancer in some people.

Therefore, it is essential to minimize exposure to this chemical whenever possible. However, those who vape expose themselves to higher levels than average, as mentioned in the study above. Under these circumstances, understanding the full range of **diagnostic** issues caused by vaping and propylene glycol is critical. Doing so could help to prevent lung damage and other major problems.

When a person vapes, they can often change the intensity of their puff to create more potent effects. This step naturally increases the amount of propylene glycol that they consume, which could trigger a myriad of health problems. For example, it is much easier to overdose on propylene glycol in this way. Beyond that, some studies have also found that vaping could produce propylene glycol in high enough levels to cause cancer. For example, a 2016 study published in the journal *Pediatrics* found that propylene glycol and vegetable glycerin

Scan here to learn how to talk with parents about vaping.

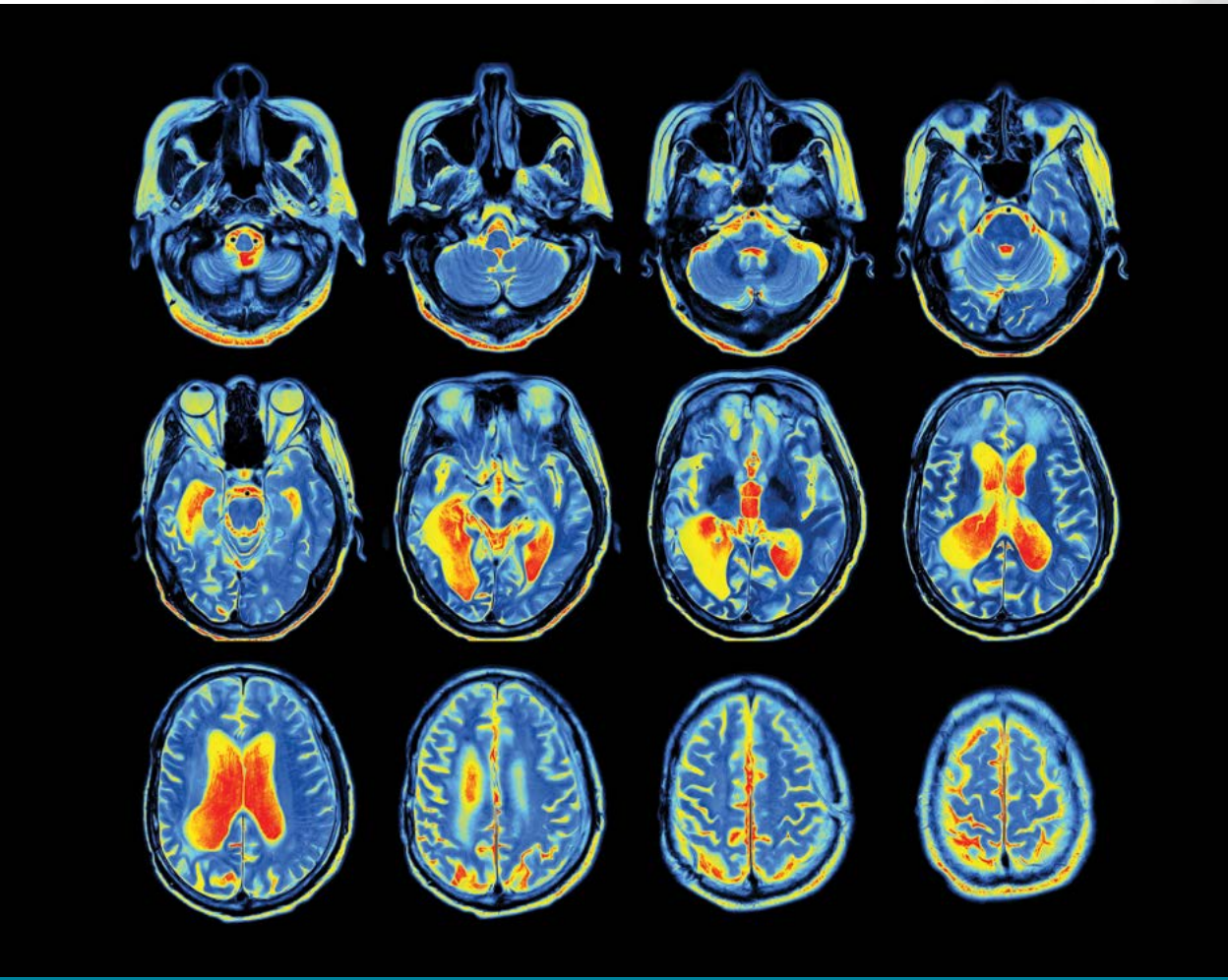
can form carcinogenic compounds when they are heated. The study tested teenagers who were vaping, and found the cancer-causing compounds in their bodies. Thus, even substances that are safe to eat in food can become carcinogenic due to the unique dynamics of vaping.

More recently, a study in October of 2019, conducted by researchers at New York University and published in the journal *Proceedings of the National Academy of Sciences,* reported that e-cigarette vapor causes lung cancer in lab mice and could potentially cause bladder cancer as well. Although the long-term effects are still being studied, the report concluded that vaping probably causes some human cancers as well as other diseases.

THE PROBLEM OF OVERSIGHT

One of the major issues with vaping is that until recently, there has been little oversight of vape juices. Consequently, cheap vape pod

systems and vape juices manufactured overseas have been found to contain many hazardous chemicals and heavy metals. For example, some inexpensive vape pod systems have been found to contain the toxic industrial solvent ethylene glycol rather than propylene glycol. “Essentially, vape makers are required to inform the FDA of



Scientists have begun to examine the long-term health effects of electronic vapor devices. Initial studies, including one conducted in 2019 by the National Institute on Drug Abuse, have concluded that e-cigarette vapor containing nicotine produces changes in the human brain that are similar to the effect of cigarettes.

what is in their product, but there is no public disclosure," noted Sam MacArthur in a 2018 article on the safety of vaping. "Companies can tell customers as much or as little as they want. And there are a lot of valid concerns when consumers don't know what they're consuming."

That is beginning to change, however. In July of 2019, a federal judge ruled that manufacturers of e-cigarettes and vaping products would have to either apply to the Food and Drug Administration for a formal safety review by May of 2020, or withdraw them from the market. Companies that apply to the FDA can keep selling their products for up to a year while the FDA reviews the applications.

The federal government has taken other steps to reduce vaping and use of nicotine products among young people. In December of 2019, President Donald Trump signed a new law raising the legal age at which people could purchase tobacco products, including e-cigarettes, from eighteen to twenty-one. The idea was that twenty-one-year-olds would be more mature and could make better, more informed decisions about vaping or tobacco use. Public health organizations and anti-tobacco groups praised the new law, which passed in Congress with bipartisan support.

In January of 2020, the FDA announced a nationwide ban on most flavored products used in e-cigarettes and closed-system vaping products. The FDA ban prohibited fruit, candy, mint, and dessert flavors—the most popular flavors used by teenagers—from being sold. It specifically targeted closed-system cartridge-based vape pens and e-cigarettes, because they are the most commonly used by high-school students.

These new laws and regulations indicate that Americans are beginning to understand the dangers of chemical additives in vape juices. As this book details, even relatively **benign** substances like propylene glycol can be transformed into toxic, cancer-causing chemicals when introduced to the body through vaping. Simply put, vaping is not a safe habit for anyone.

TEXT DEPENDENT QUESTIONS

1. What are some products that use propylene glycol?
2. How does vaping make the effect of propylene glycol worse?
3. What steps has the FDA taken to ensure the safety of vape juices?

RESEARCH PROJECT

Gather some processed food and household items, and check their ingredient lists. How many of them include propylene glycol? Then check the listings for various vaporizing fluids online. How many have propylene glycol, and at what doses? Compare those doses to those in the foods and other items in your home to get an idea of just how problematic this issue could be for those who vape.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SERIES GLOSSARY OF KEY TERMS

Addiction—a complex condition in which a person experiences an overpowering desire to use a substance, such as nicotine, despite its harmful consequences. Today, most scientists consider addiction to be a disease of the brain.

Carbon monoxide—a colorless, odorless highly poisonous gas found in tobacco smoke and in the lungs of people who have recently smoked, or (in smaller amounts) in people who have been exposed to tobacco smoke.

Carcinogen—a substance that damages the growth of cells, increasing the likelihood that cancer will develop.

E-cigarette—an electronic smoking device (including a vape or JUUL) that heats and vaporizes a liquid solution containing nicotine. The aerosol vapor is inhaled by the user when they draw on the device, as they would a regular tobacco cigarette, and the user exhales the aerosol into the environment.

Nicotine—an alkaloid derived from tobacco, responsible for the psychoactive and addictive effects of smoking.

Secondhand aerosol—emission from e-cigarettes and vaping devices that contains nicotine as well as low levels of cancer-causing toxins, which can be breathed by those around the device user.

Secondhand smoke—a mixture of smoke exhaled by smokers and smoke released from smoldering cigarettes, cigars, pipes, bidis, or other smoking materials. The smoke mixture contains gases and particulates, including nicotine, carcinogens, and toxins. Also known as “passive smoke” or “environmental tobacco smoke” (ETS).

Tobacco—the name for the dried leaves of the plant Nicotiana tabacum, which are rich in the alkaloid nicotine and can be smoked or chewed.

Tolerance—a condition that occurs when a user of an addictive substance no longer responds to the drug and requires higher dosages to achieve the same effect.

Withdrawal—a term for a group of unpleasant side effects that occur when a drug addict stops taking a particular substance such as nicotine. Symptoms of nicotine withdrawal can include fatigue, headache, irritability or depression, strong cravings to smoke, constipation, and anxiety.

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www.hopkinsmedicine.org/health/wellness-and-prevention/5-truths-you-need-to-know-about-vaping
An informative article from John Hopkins University explains how vaping affects people.

https://www.samhsa.gov/find-help/national-helpline
The Substance Abuse and Mental Health Services Administration (SAMHSA) provides resources for helping people suffering from nicotine addiction.

https://nicotine-anonymous.org/
Nicotine Anonymous is an organization formed to help people who are trying to quit using tobacco products. The organization's website includes information about local support groups.

https://www.drugabuse.gov/publications/research-reports/tobacco-nicotine-e-cigarettes/what-are-treatments-tobacco-dependence
The National Institute on Drug Abuse provides information on nicotine and other drugs, as well as resources for fighting drug addiction.

https://www.cdc.gov/tobacco/data_statistics/fact_sheets/cessation/quitting/index.htm
The Centers for Disease Control and Prevention (CDC) provides health-related information on its website, including tips to help people quit smoking and live without vaping or nicotine.

https://truthinitiative.org/our-top-issues/vaping-issue
The Truth Initiative is a non-profit organization dedicated to educating people about the dangers of vaping and nicotine use.

https://e-cigarettes.surgeongeneral.gov/
An advisory from the office of the U.S. Surgeon General explains the dangers of vaping, particularly when done by young people.

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Eric Benac is a full-time author who focuses heavily on online content, educational content, fictional writing, and music writing. He has written several books for Mason Crest as well as an examination of the life and music of Frank Zappa. Eric attended Northern Michigan University, where he earned both bachelor's and master's degrees in writing. He currently lives in Traverse City, Michigan, where he enjoys hiking, swimming, playing board games with friends, and making music as Gergy 12 in his spare time.

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