

Vaping and oral health: It's worse than you think

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Drs. Scott Froum and Alisa Neymark examine the effects of e-cigarette ingredients and their notable deterioration on oral health, as well as offer insight into how explosions while vaping and burn injuries from e-cigarettes can lead to disfigurement of oral soft tissue.

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Figure 2: Effects of e-cigarette usage

The use of electronic cigarettes (e-cigarettes) represents a significant and increasing proportion of tobacco consumption, posing a tremendous threat to oral health. This article will look at the following aspects of e-cigarettes:

- Overview of e-cigarette usage
- Statistics on the current prevalence of e-cigarettes
- Three chemicals contained in e-cigarettes and their effects on oral health

When compared to traditional tobacco use, an argument that e-cigarette use may be as dangerous to oral health—if not more dangerous—can be made.

Overview

Using e-cigarettes, referred to as vaping, works by heating a liquid to generate an aerosol that the user inhales. The liquid in the e-cigarette, called e-liquid, is usually made up of propylene glycol, glycerin, flavorings, water, and nicotine, although some users will substitute THC for nicotine. In practice, e-cigarette users tend to reach lower blood nicotine concentrations than tobacco smokers, although it is difficult to make a direct comparison because nicotine concentrations in e-cigarettes vary widely.

Reasons individuals vape include the following:

- Smoking cessation
- The thought that vaping is less harmful than cigarettes

- Circumvention of smoke-free areas
- Recreational enjoyment (1)

Prevalence

Researchers and antitobacco advocates are especially concerned that irresponsible marketing has made e-cigarettes appeal to the segment of the young population that had no history of tobacco usage and never intended to start smoking. Because of the known dangerous effects of traditional tobacco methods, use among middle and high school students has been steadily decreasing since 2014. However, since the introduction of the e-cigarette, that number is now increasing, and it is estimated that one in five high school students may now be using tobacco products. (2) E-cigarette use from 2017 to 2018 increased 78% among high school students and 48% among middle school students. (3)

Propylene glycol

The first danger of e-cigarettes is associated with the carrier product known as propylene glycol (PG). PG is primarily used in the production of polymers and in food processing. It can be found in various edible items, such as liquid sweeteners, ice cream, and whipped dairy products. It can also act as a carrier for various inhalant pharmaceutical products, including nicotine. PG is a viscous, colorless liquid that possesses a faintly sweet taste and is one of the major ingredients of the e-liquid used in e-cigarettes. When used orally, the breakdown products of PG include acetic acid, lactic acid, and propionaldehyde, which are all toxic to enamel and soft tissue. (4) In addition, PG is a hygroscopic product, which means water molecules in saliva and oral tissue will bond to the PG molecules, leading to tissue desiccation. (5) The result of this is xerostomia, or "dry mouth," which has been shown to lead to an increase in cavities, gum disease, and other oral health issues.

Vegetable glycerin and flavorings

The second danger of e-cigarettes is due to other major component of e-liquid: glycerin and flavorings. Vegetable glycerin (VG) is a colorless, odorless, viscous, and sweet-tasting liquid. It has a myriad of applications, including medical, pharmaceutical, and personal care. In the food industry, it serves as a humectant, solvent, and sweetener. It is 60% as sweet as sucrose and is not metabolized by cariogenic bacteria, and is therefore thought not to cause cavities. However, studies have shown that the combination of VG with flavorings produces a fourfold increase in microbial adhesion to enamel and a twofold increase in biofilm formation. (6) In addition, a 27% decrease in enamel hardness was demonstrated when flavorings were added to e-liquid as compared to unflavored controls. The viscosity of the e-liquid also allowed *Streptococcus mutans* to adhere to pits and fissures. In other words, e-liquid allows more cavity-causing bacteria to stick to a softer tooth and can lead to rampant decay.

Nicotine

Another danger associated with e-cigarettes has to do with nicotine. Although the percentage of nicotine is much lower (0.3%–1.8%) than traditional tobacco products, one electronic cartridge (200–400 puffs) can equal the smoking of two to three packs of regular cigarettes. The dangerous effects of nicotine on gum tissue are well known. The literature suggests that nicotine affects gingival blood flow as it is a vasoconstrictor. It also affects cytokine production, neutrophil function, and other immune cell function. (7) In addition, nicotine decreases connective tissue turnover. All of this results a much higher chance of developing gum disease and tooth loss.

Lithium batteries

Recently, a 24-year-old man from Texas was killed when his vape pen exploded, and part of the device wound up severing his jugular vein. (8) Although these types of sensationalized deaths are rare with e-cigarettes and vaping pens (only two reported to date), the explosions of these pens are not. The problem lies within the vape pen and the lithium batteries overheating and exploding. These explosions are usually attributed to improper charging of the device or have been linked to a type of device called a mechanical mod that has no internal safety and can overheat and explode.

One report found that 195 of these adverse events occurred between the years of 2009 and 2016. (9) However, Dennis Thombs, dean of the School of Public Health at UNT Health Science Center, published a study that concluded the number of vape explosions in the US were most likely underestimated. Thombs estimated that there were 2,035 e-cigarette explosions and burn injuries in the US between 2015 and 2017—more than 40 times the initial estimate by the US government. (8) These injuries are serious and often lead to disfigurement of oral soft tissue (figure 1).

Figure 1: Oral soft-tissue injuries due to e-cigarette explosion (photo courtesy of Nicole Angemi)



Bottom line

The bottom line is vaping can be just as dangerous, if not more dangerous, when compared with smoking. The problem is that vaping is thought to be a safer alternative to traditional tobacco products, and companies are adding flavoring products to attract younger generations. According to a 2013–2014 survey, 81% of current youth e-cigarette users cited the availability of appealing flavors as the primary reason for use. (10)

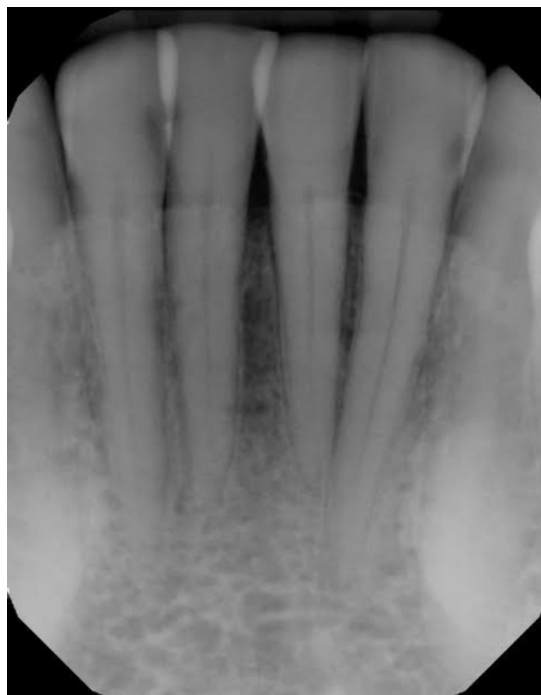
For example, one patient of a general dental practice had a caries-free history for 35 years. He ceased smoking traditional cigarettes and decided to vape as he thought this was a healthier alternative. Within a year, cervical enamel demineralization and

interproximal lesions were present on the mandibular anterior sextant, consistent with the primary point of contact of the e-liquid aerosol (figure 2).

In another example, a young patient had been using e-cigarettes for five years. He started vaping as a method to quit smoking traditional tobacco products thinking vaping was a healthy alternative. Because of its ease of use, he smoked a cartridge of one of the more popular vaping products a day. Admittedly, he also drank energy drinks (high sugar content), stating that his mouth was often dry after vaping. This combination led to rampant decay with smooth-surface lesions and future tooth loss (figure 3).

Many advocates of vaping claim that e-cigarette use and vaping poses 5% the health risks of traditional tobacco smoking and claim its use to be helpful in getting people to quit. (11) This particular use does have merit and has helped many individuals quit smoking. Unfortunately, these studies have only analyzed e-cigarette use in former smokers using vaping as a way to stop smoking. The studies have not looked at the health effects of nonsmokers who start vaping because of the perceived innocuous health effects and because it "tastes yummy." In addition, these studies have not looked at vaping in middle school and high school individuals, the group where e-cigarette use is increasing the most in percentage of use. Because of this, a tidal wave of oral health problems is heading our way.

Figure 3: Effects of e-cigarettes



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Additional clinical tips from Dr. Scott Froum

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Also by Dr. Neymark: [An alternative to surgical crown lengthening: Margin elevation using a two-matrix system](#)



How vaping may ruin your teeth

 [cnet.com/news/how-vaping-may-ruin-your-teeth](https://www.cnet.com/news/how-vaping-may-ruin-your-teeth)

Danielle Kosecki

July 9,
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Nearly one in 20 us adults now uses e-cigarettes, and more than half are under 35 years old, studies show.

Thorn Yang/Pexels

Two stories stuck out to him. The first involves a young man who had quit smoking traditional tobacco products by **switching to e-cigarettes, which he had been using for five years.**

Believing vaping to be healthier, this patient smoked a cartridge a day, often chasing it with a sugar-laden energy drink to quench the resulting dry mouth. The combination left him with **extensive tooth decay, enamel wear and, eventually, tooth loss.**

Then there was the older gentleman who had also switched from traditional cigarettes to e-cigarettes. **This patient had been cavity-free for 35 years, but within a year of taking up vaping, the enamel on his teeth started to erode and soften, increasing his risk of cavities.**

It was this latter case that led Froum, who is also a clinical associate professor in the department of periodontics at SUNY Stony Brook School of Dental Medicine, to dig into the research on vaping's effect on oral health.

Watch this: Get your vitamins by vaping

▶ 4:37

He posted his findings in [Perio-Implant Advisory](#), of which he is the editorial director (Warning: there are graphic images) and the response was huge. The article was picked up by other industry magazines, leading to an outpouring of emails from other dentists.

"We began seeing [the tooth decay], but didn't realize what it was from," Froum says. "We had been noticing it in teens that weren't at risk and then attributing it to other things like Monster Energy-type drinks. We never realized that vaping could also be a cause."

What the research says about how vaping harms your teeth

Anecdotal stories don't definitively prove vaping makes your teeth rot, but they shouldn't be dismissed outright either. Most experts agree that although e-cigarettes generally contain fewer toxins than tobacco cigarettes, that doesn't mean they're harmless. And

after reviewing the evidence on how propylene glycol, vegetable glycerin, and nicotine -- the three most common ingredients in e-cigarettes -- can affect oral health, Froum thinks there's cause for concern.

Propylene glycol, a liquid alcohol that's often used in food processing because of its ability to mix well with flavoring ingredients, can lead to dry mouth, which (when chronic) can cause cavities and gum disease. PG also breaks down into acetic acid, lactic acid and propionaldehyde -- all of which are known to deteriorate tooth enamel and soft tissues.

Research also shows that when teeth are exposed to vaping aerosol that contains a mix of vegetable glycerin and flavorings, they carry four times more bacteria than teeth that haven't been exposed.

Although both propylene glycol and vegetable glycerin are recognized as safe for ingestion by the FDA, less is known about their health effects (or those of their byproducts, which include potential carcinogens, like formaldehyde, and heavy metals like lead, nickel and mercury) when they're inhaled.

"These breakdown products haven't been tested," Froum says. "Because vaping was deemed to be innocuous and a better choice than smoking, nobody studied it... they kind of let the lesser evil go by unchecked and not researched."

Experts also don't know how the distribution of these chemicals changes when they're turned into a vapor, says periodontist Richard Kao, D.D.S., Ph.D., president of the American Academy of Periodontology and clinical professor in the department of orofacial sciences at the University of California San Francisco.

There's some evidence they may be able to travel farther into the body's tissues and cells, just as diacetyl -- a buttery-flavored chemical in foods -- did when popcorn factory workers inhaled it, causing a type of lung disease known as bronchiolitis obliterans, or "popcorn lung."

The potential effect of nicotine on gums, on the other hand, is well-known thanks to cigarette research. Although e-cigarettes generally contain less nicotine than tobacco cigarettes, there's substantial evidence it can have the same effect: decreased blood flow and cellular turnover, which can increase your risk of gum disease and tooth loss.

And what the research doesn't say

Given the explosion of e-cigarette use, especially among kids -- it increased 78% among high school students and 49% among middle school students between 2017 and 2018, according to the CDC -- the FDA asked the National Academies of Sciences, Engineering and Medicine (NASEM) to report on the potential public health consequences.

Unfortunately, when it came to oral health, NASEM researchers were unable to find any epidemiological studies examining the link between e-cigarette use and periodontal disease. And the clinical and in vitro studies that did exist only provided "limited

evidence" that e-cigarette aerosol can cause cell damage in oral tissue.

The problem with trying to evaluate the public health risk of vaping at this time is that e-cigarettes are still relatively new. They were first imported into the US in 2006 but didn't really gain traction into 2015 when Juul launched a discreet, USB-size device. The studies that do exist are small and often done on tissue samples in a lab or only include people who have switched from traditional cigarettes to e-cigarettes -- not first-time users who only use e-cigarettes.



Juul devices can be easily concealed, one reason experts believe use has skyrocketed among middle and high school students.

truthinitiative.org

"We know cigarettes can cause cardiovascular disease, lung disease and cancer and that they dramatically increase your chances of getting gum disease by 400%," Kao says. "But it took something like 20 to 30 years of research to get those kinds of facts." Vaping is a new problem that's largely associated with young adults, who don't show up in dental offices as often, so it's hard to say how bad the problem really is."

Froum, too, acknowledges these limitations, but based on the available evidence and what he's seeing in his office, says he believes "a tidal wave of oral health problems is heading our way."

How to take control of your oral health

If you're fond of your smile and want to keep it intact, the best thing you can do is [kick vaping to the curb](#), Kao says. But, Froum warns, "if you're going to vape, then your oral hygiene has to be impeccable."

Here are a few ways to minimize your risk of developing dental issues:

- **Brush with fluoride toothpaste.** Aim for at least twice a day, plus at least 20 minutes after vaping. When you drink something acidic, it weakens the enamel of your teeth, and brushing too soon after can remove some of that enamel. There's no research to suggest vaping would cause the same problem, but if you want to be extra cautious, Froum says, "Wait 20 minutes before you brush your teeth."
- **Clean between your teeth.** Regular brushing can help keep your mouth clean between vaping. And along your gum line. Using dental floss is best, especially if you're young, but older vapers who have more space between their teeth and gums may also get good results from oral irrigators. Andrew Hoyle/CNET
- **Avoid dry mouth.** Carry around a bottle of water or a moisturizing mouth spray containing xylitol, which can help stimulate saliva production. "And certainly avoid sugary drinks when you're vaping," says Froum.
- **See the dentist more often.** Instead of a yearly appointment, go in "every six to four months to check for cavities and things of that nature," Froum advises.

Oral health issues to watch for

Whether you currently vape or have recently quit, it's important to continue monitoring your oral health between dental visits. "Vaping may not stain your teeth like smoking cigarettes does," Kao says, "but the nicotine and some of the chemicals are still harmful carcinogens that can cause problems."

Here are a few symptoms to look out for:

- **Red, puffy, bleeding gums.** "These can all be signs of periodontal disease going unchecked," Kao says.
- **Receding gums.** "When you lose a lot of gum tissue, you essentially lose the protective seal for keeping the bacteria out of your body," Kao says. This can cause faster gum recession and more bone loss.
- **White spots on your teeth.** "These are decalcifications that show the beginning of enamel softening," Froum says.
- **Red or white patches on your gums or the inside of your cheek.** "These lesions could be something as simple as scarring," Kao says. "But sometimes they start transforming into precancerous cells and sometimes they do become cancer cells. And the thing you should know about oral cancer is that by the time we catch it,

there's not a high success rate to treat it. So any oral cancer is a bad cancer."

- **Oral thrush.** White patches on your tongue or mouth or redness inside your mouth can also be a sign of thrush, an outbreak of a type of fungus, or yeast, known as Candida. "We know that Candida is a normal part of the flora," Kao says. "But when a person's immune system is compromised, there's an overgrowth."

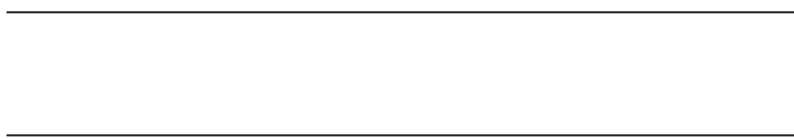
Teeth: You've got a lot to lose.

Nhia Moua/Unsplash

These problems can take longer to develop in teens and young adults with no prior history of tobacco use, but that doesn't mean you or your loved one should wait to see a professional. "Damages can go unseen, unmonitored, and could potentially get to be quite extreme before they're aware of what's going on," Kao warns.

Your dentist should be your first stop. "But if the problem advances, most dentists are very good about sending you to a periodontist," Kao says. Just know that smokers, even those who go in for cleanings every six months, tend to respond worse to treatment and maintenance management. Their gum tissue just isn't as resilient -- and the same may be true for vapers, says Kao.

It's just too soon to tell.



Get your vitamins by vaping Autoplay 00:00 04:37

'Fine, I'll just vape without the nicotine.' Not so fast! E-cig flavorings may cause damage all by themselves

DIQ dentistryiq.com/dental-assisting/patient-relations/article/16363601/fine-ill-just-vape-without-the-nicotine-not-so-fast-ecig-flavorings-may-cause-damage-all-by-themselves

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Early last year, we got our first confirmation that vaping—once touted as a “Get Out of Jail Free” card for smokers—isn’t all that it’s cracked up to be.

That confirmation came in the form of a [600+ page report](#) that comprehensively analyzed 800 peer-reviewed studies. It concluded that the available evidence supports far more caution should be exercised with regard to vaping than we previously thought, especially when it comes to young people vaping.

I’ve written about the importance of [dentists, hygienists, and assistants taking vaping seriously](#), especially in young patients. As health-care professionals with a special interest in the oral-systemic connection, dental professionals have a unique opportunity to stress to patients that *we don’t know everything* about how these substances can harm bodies in the long run.

However, we are rapidly learning more about the “juice” that runs the vaping industry. As new studies are released, there are rising concerns about ingredients that have *absolutely nothing to do with nicotine*.

Studies are showing the effects of vaping

According to an article published in the American Heart Association’s journal called “Arteriosclerosis, thrombosis and vascular biology,” flavor additives commonly used in electronic cigarettes may impair blood vessel function.

In another article titled “E-cigarette flavorings may damage blood vessel function,” by Jessica L. Fetterman, PhD, assistant professor of medicine at Boston University School of Medicine, nine chemical flavorings widely used in e-cigarettes—menthol (mint), acetylpyridine (burnt flavor), vanillin (vanilla), cinnamaldehyde (cinnamon), eugenol (clove), diacetyl (butter), dimethylpyrazine (strawberry), isoamyl acetate (banana), and eucalyptol (spicy cooling)—were tested for their short-term effects on endothelial cells, the cells that line the blood vessels and the inside of the heart.

RELATED ARTICLE: [Vaping and oral health: It's worse than you think](#)

In the in vitro (laboratory) studies, researchers found all nine flavors can damage delicate blood vessel endothelial cells at the highest levels tested, and all of the flavorings impaired nitric oxide production in endothelial cells. Several of the flavorings—menthol, clove, vanillin, cinnamon, and burnt flavoring—resulted in higher levels of an inflammatory marker called interleukin-6 (IL-6) at all concentrations tested, which suggests the endothelium is particularly sensitive to these flavors.

In addition, these flavorings were responsible for lower levels of nitric oxide, which inhibits inflammation and clotting and promotes vasodilation in response to greater blood flow. There’s also every reason to believe that flavors that were not tested may have similar properties and effects on the body, however, that’s for other researchers to test and measure in another study.

Dr. Fetterman did not leave a great deal of wiggle room when it came to interpreting the effects of the flavorings on cells in the lab setting. “Increased inflammation and a loss of nitric oxide are some of the first changes to occur leading up to cardiovascular disease and events like heart attacks and stroke, so they are considered early predictors of heart disease.”

The findings of this study will need to be replicated in vivo—in laboratory animals—but in the meantime, this research led to the American Heart Association reemphasizing its 2014 caution against vaping.

Meanwhile, a similarly designed study at the University of Rochester Medical Center reported an additional avenue for future research regarding the effects of vaping flavoring agents on overall health, this time focusing on the immune system rather than cardiovascular risks.

The article, “Inflammatory and oxidative responses induced by exposure to commonly used e-cigarette flavoring chemicals and flavored e-liquids without nicotine” was published in the open-source, non-peer-reviewed journal, *Frontiers in Physiology*.

In the study, researchers concluded that their data suggests that the flavoring compounds used in e-liquids appear to elevate biomarkers of damage in immune cells called monocytes, leading to potential pulmonary toxicity and tissue damage in e-cigarette users. While it turns out that some flavors were more damaging than others, the most interesting aspect of this study was that the cells showed the greatest amount of damage when flavors were combined.

The pace of investigation to regulate products to protect public health seems to proceed at a snail's pace. It may very well take data collected from a full generation of vapers to build a bulletproof case that vaping e-liquids causes health problems beyond a reasonable doubt.

Dental professionals can make a difference sharing this knowledge

Fortunately, that is not the standard that dental professionals need to abide by. We can offer our professional opinions, advice, and all the evidence we can muster in the few minutes we have with each patient. It's not only our professional right, it's our duty as health advocates to share what we know with our patients and to warn them about health consequences they may not be aware of.

Don't be afraid to ask patients whether they vape, and to point them to emerging research about the potential long-term health consequences of vaping.

With over 30 years of experience as a pharmacist, dental educator, and author, Tom Viola, RPh, CCP, has earned a reputation as an international authority on dental pharmacology. He says that knowledge of pharmacology has never been more essential to patient care. Tom is well known for his contributions to many dental journals in the areas of pharmacology, pain management, and local anesthesia. He's served as a contributor, chapter author, and peer reviewer for several dental pharmacology textbooks and national board exam review books. For more information, visit TomViola.com or contact him at Tom@TomViola.com.



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