

# E-Cigarettes: Facts for the Osteopathic Family Physician

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Electronic cigarettes are becoming increasingly popular in the United States, but misperceptions among consumers are common. There is a sense that they are safer than traditional cigarettes, however, there is limited research on long-term effects regarding the safety of these devices. They have not been proven to be efficacious for use in smoking cessation. The toxic effects may be increased in those using cartridges with flavoring compounds in the solution. The younger demographic is more likely to utilize e-cigarettes, especially flavored versions, than traditional cigarettes. Manufacturers are aware of this and produce flavoring additives such as bubble gum and cotton candy to sell more of these products. Parents may be unaware that their children use e-cigarettes as a delivery mechanism for cannabis. Osteopathic physicians should be aware of the health risk of e-cigarettes to their patients, and counsel appropriately.

## INTRODUCTION

Electronic cigarettes are nicotine-delivering devices that create a vapor from a solution to make an inhalable aerosol. The device consists of an electrical unit which heats (activated by inhalation) a cartridge (which is either inserted or attached to the device) to create the vapor. Some cartridges are removable and contain a variety of chemical solutions. Multiple device designs are available to increase their market appeal. Some larger devices can control the amount of vapor that is produced while some resemble a traditional cigarette or cigar. The consumer may continue to use these devices until either the battery or cartridge has run out, with the added benefit that some are rechargeable or have refillable cartridges. Electronic cigarettes are also known as e-cigarettes, e-cigs, e-cigars, personal inhalers, e-hookahs, vape pens, and vaporizers. Colloquially, the act of inhaling the vapor from the e-cigarette is known as "vaping" and stores selling these products are often referred to as "vape shops." Current loose regulations have permitted manufacturers of these products to target younger patients, as well as individuals trying to discontinue traditional cigarette or cigar use.

## FIGURE 1:

From Grana R, Benowitz N, Glantz SA: Background paper on e-cigarettes (electronic nicotine delivery systems): prepared for the 7th meeting of the WHO Study Group on Tobacco Product Regulation. San Francisco, 2013, UCSF.

Product	Description	Some Brands
Disposable e-cigarette 	Cigarette-shaped device consisting of a battery and a cartridge containing an atomizer to heat a solution (with or without nicotine). Not rechargeable or refillable and is intended to be discarded after product stops producing vapor.	NJoy, Blu, Green Smoke
Rechargeable e-cigarette 	Cigarette-shaped device consisting of a battery that connects to an atomizer used to heat a solution typically containing nicotine. Often contains an element that regulates puff duration and/or how many puffs may be taken consecutively.	V2 Cigs, Halo G6, Mark Ten
Pen-style, medium-sized rechargeable e-cigarette 	Larger than a cigarette, often with a higher capacity battery, may contain a prefilled cartridge or a refillable cartridge (often called a clearomizer). These devices often come with a manual switch allowing the smoker to regulate length and frequency of puffs.	eGo, Kanger EVOD, Halo Triton
Tank-style, large-sized rechargeable e-cigarette 	Much larger than a cigarette with a higher-capacity battery and typically contains a large, refillable cartridge. Often contains manual switches and a battery casing for customizing battery capacity. Can be easily modified.	Kanger Aerotank, Innokin iClear, Aspire Nautilus

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One component of the e-cigarette is the cartridge (atomizer), which can be prefilled and disposable, or multiple use, and refillable. The contents of the cartridges vary greatly and often contain a chemical solution composed of nicotine, propylene glycol, and other compounds. Cartridge labeling is not currently required, so chemical content may vary from product to product, with the user unable to determine what is being inhaled.

Nicotine is an addictive agent that leads to the pathogenicity of some diseases and is extremely harmful to fetal brain development. During pregnancy, nicotine can cross the placenta and can negatively affect the growing fetus. Nicotine may inhibit brain development, and directly causes problems with learning, attentiveness, and being more prone to addiction. While most adults know that nicotine is present in traditional cigarettes, this may be less apparent to those who use e-cigarettes, especially younger users. The Food and Drug Administration has mandated that beginning in 2018, and e-cigarettes will be required to have a package label stating that they contain nicotine.

Although every company makes a different solution of chemicals for their cartridges, propylene glycol is used in almost all e-cigarette cartridges. This chemical is vaporized by the device and provides the aerosol. Propylene glycol is commonly used in food additives, intravenous diluents, and smoke generators utilized in theaters and nightclubs. Acute exposure to vaporized propylene glycol can cause acute upper airway and eye irritation. This may be problematic in asthmatics or patients with other respiratory issues.<sup>1</sup> There is no research on human subjects regarding the effects of long-term exposure to the propylene glycol alone, or in combination with nicotine and other additives being vaporized and inhaled. However, studies have proven there is oxidative stress and inflammatory effects on lung cell tissue samples of mice.<sup>2</sup>

## ADDITIVES

Other common additives utilized as part of the production of e-cigarettes are chemicals that produce different flavors. One study demonstrated that the addition of flavor compounds to e-cigarettes could alter the rate of nicotine absorption, possibly due to the differences in pH between flavored and non-flavored e-liquids. It showed an increased rate of nicotine absorption with the use of strawberry flavored e-liquid when compared to the non-flavored e-liquid. The study also demonstrated that users of the strawberry flavored e-liquid incurred a greater total systemic exposure to nicotine resulting from a combination of the faster nicotine absorption rate and an increased frequency of use by those who found the flavored vapor enjoyable.<sup>3</sup>

In addition to their ability to alter nicotine absorption and intake, the chemicals that make up the flavored compounds in e-cigarettes must also be considered. E-cigarette products often market their flavoring ingredients as safe; however, the safety levels recognized by the Flavor Extracts Manufacturers Association pertain to ingestion of these chemical compounds, and high doses of the same flavoring ingredients may not be safe for inhalation. The types of chemicals and their concentrations vary widely among the different brands and flavors of e-cigarettes, and most e-cigarette products do not list the chemical ingredients of their

flavoring compounds. A 2016 study out of Portland, Oregon analyzed the chemical content of 30 different flavored e-cigarette fluids, and found that a significant number of flavor compounds contained aldehydes (i.e. vanillin, benzaldehyde), which are known to cause inflammation of the mucosa of the respiratory tract and can be harmful with prolonged use or to those who have respiratory problems.<sup>4</sup> Some of the chemicals used to produce different flavors were found to be present at concerning levels; the authors reported that e-cigarette users might be exposed to as much as two times the daily-recommended workplace exposure limits by inhalation of chemicals such as vanillin and benzaldehyde.<sup>4</sup>

## OTHER USES

There are commercially available cartridges and refills containing cannabis oil for those who use marijuana, both recreationally and medicinally. Alternatively, cannabis may be incorporated into the cartridge by grinding the dried bud/leaf of the plant or utilizing wax infused THC oil. As with other cartridges, the consumer may not be aware of all of the additives and chemicals that are present in combination with the cannabis oil. Any pesticides or herbicides used in the harvest of the marijuana plant generally will be present in the oil and inhaled along with the vaporized oil. Sometimes, parents and others are unaware that people using e-cigarettes are vaporizing cannabis oil, as the odor is far less noticeable than traditionally smoked marijuana cigarettes, and it dissipates quickly. Users may utilize cannabis oil in public venues, such as concerts, with less concern of being caught. Flavored cannabis oil is available, making it more attractive to younger consumers, and also increasing the quantity used. A survey conducted in Connecticut asked 3847 high school students about cannabis use and electronic cigarettes. The results showed that 5.4% of the total sample had used e-cigarettes to vaporize cannabis (compared to 0.2% of adults reported in a previous study), revealing that high school students are 27 times more likely to use electronic devices to vaporize cannabis than adults.<sup>5</sup> Of note, among the 1075 students who reported using e-cigarettes, 18% had tried using them to vaporize cannabis, indicating that high school students who are already using e-cigarettes may be at an increased risk for using electronic devices to vaporize cannabis.<sup>5</sup>

These devices are ubiquitous, are sold online, and in local gas stations, specialty smoking stores, retail stores such as Wal-Mart and other chain drug stores. Current laws state they may only be purchased by consumers 18 years and older. Prices for the devices vary greatly based on the design and range from \$10 to \$300 for higher-end products.

## SMOKING CESSATION

Some people use electronic cigarettes in an attempt to quit smoking traditional cigarettes. One of the selling points that some manufacturers make is that their product can limit the amount of nicotine one receives during inhalation. However, one study measured saliva cotinine (a metabolite of nicotine) levels of electronic cigarette vs. traditional cigarette users. It was found that users of electronic cigarettes had the same amount of cotinine in their saliva as those who smoked regular cigarettes.<sup>6</sup> At the time of writing this article, the FDA has not approved for utilizing electronic cigarettes as smoking cessation aids. There is limited research comparing the efficacy of e-cigarettes for smoking cessation to other means, such as transdermal patches or nicotine gum.<sup>7</sup> As electronic cigarettes are a relatively newer product, research is lacking in many aspects of their safety and use.

## YOUTH APPEAL

Electronic cigarettes are now the most popular nicotine product used by children in middle and high school. A report of the US Surgeon general cited the fact that more than 25% of children in middle school and high school had tried e-cigarettes, and that this use is positively correlated with the use of other tobacco products. One study of middle and high school students asked why they first tried electronic cigarettes, and one factor cited was that electronic cigarettes were less expensive than regular cigarettes. Children also liked the fact that they can be used anywhere and some saw them as a tool to quit smoking traditional cigarettes.<sup>8</sup>

A study done in Oregon surveyed students between eighth grade and ninth grade. The results showed almost 30% of these eighth graders had tried electronic cigarettes and 16.8% had used in the past 30 days. This study demonstrates the prevalence of electronic cigarette use, with an additional finding that those who smoked electronic cigarettes were more likely to use other drugs such as marijuana.<sup>9</sup>

## NON-PRIMARY CHEMICAL EXPOSURE

Not enough research has been done to define the long-term effects to patients who are around others who use electronic cigarettes. The secondhand aerosol contains nicotine and other toxins known to cause cancer. In 2013 a study found that not only was there nicotine being exhaled, but also volatile organic compounds and ultrafine particles. The levels of these compounds (excluding nicotine) were not concerning in this study. However, the secondhand nicotine exposure is, on average, ten times less than from combustible tobacco products. Although the amount of nicotine emitted is less than from classic cigarettes, non-smokers and vulnerable populations such as children, pregnant women, and those with cardiovascular problems may still be at risk of involuntary exposure to nicotine. This may be directly from the vapor or it can be from exposure to nicotine that has adhered to different indoor surfaces. Nicotine is hard to remove from surfaces and may be transmitted by touching these nicotine coated surfaces. Currently, however, there are no studies on the effects of such exposure among these populations, and further research is needed to determine if exposure to the low levels of nicotine emitted from e-cigarettes can be deemed as harmful to these individuals.<sup>10</sup>

## SUMMARY

There is limited research on long-term effects regarding the safety of electronic cigarette use. These products may be perceived as being safer by patients and their families. However, until further research is done, patients should be counseled to avoid using both traditional and electronic cigarettes. (Figure 2) The aerosol that the devices create is not harmless. With the lack of labeling and control of these devices users should be aware that they are inhaling chemicals that can cause adverse effects to their health. The toxic effects are especially prominent for those using cartridges with flavoring compounds in the solution. Parents should be warned that their children may be using these as a delivery mechanism for cannabis. Pregnant women should not use these devices because of the toxic effects on the fetus and postnatal development. These devices put others at risk by the generation of second and third-hand nicotine exposure. Physicians should ask about the use of electronic cigarettes as part of their well patient visits, as many children have tried these products, and may be unaware of the potential health hazards.

FIGURE 2:

Physician counseling patient to avoid using both traditional and electronic cigarettes



**AUTHOR DISCLOSURES**

No relevant financial affiliations.

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