



Vapor Trail

E-Cigarettes, Questions of Health,
and Policy Considerations

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Cinnatoast Munch. Pebbles Donuts. Ultra Magnetic Fruit Loop. These might sound like the names of breakfast cereals targeting kids, but you won't find them in any grocery store.

Instead, they are flavors added to the liquid in e-cigarettes, the increasingly popular battery-operated cigarette substitutes that produce a vapor containing nicotine and other chemicals.

Annual sales of e-cigarettes and other vapor-producing devices—including the tiny JUUL e-cigarettes that have found an enthusiastic market among teens—are growing exponentially. Worldwide sales skyrocketed to \$2.7 billion in 2014 from \$20 million in 2008.¹ One estimate calls for e-cigarette sales alone, not including vaporizers, to top \$2 billion this year in the U.S.²

Today, roughly one of four Colorado high schoolers (26 percent) reports using an e-cigarette recently, three times higher than the 8.6 percent who reported recently smoking cigarettes.³

Colorado teens, in fact, lead the nation in the rate of recent e-cigarette use—defined as at least once during the previous 30 days. The Colorado rate is twice the national average.⁴

But research hasn't kept pace with this explosive growth, and little data exists about possible long-term health implications of using e-cigarettes.

A product that was launched a little more than a decade ago as a safer alternative to smoking tobacco is now fueling a great deal of debate.

Public health advocates worry that e-cigarettes are contributing to a new generation hooked on nicotine, a “gateway” to cigarette smoking that could reverse years of declining cigarette sales. Medical professionals fear that inhaling the flavored vapor in e-cigarettes will cause harmful health consequences down the road.

Others, particularly manufacturers and retailers, argue that e-cigarettes are less harmful than tobacco and that they help smokers cut back and ultimately kick the habit.

How the debate plays out will affect the breadth and timing of future regulations. Already, the federal Food



Refillable e-cigarette cartridges, or pods, contain flavored liquid that is heated up, producing a vapor to simulate the tobacco smoking experience.

and Drug Administration (FDA), states and localities are moving quickly to address e-cigarette policy through new laws and rules.

This paper provides a closer look at e-cigarette use, summarizes the known health effects and outcomes, and reviews policy options.

E-cigarettes, also known as electronic nicotine delivery systems (ENDS), simulate the experience of tobacco smoking. Many even look like a cigarette.

E-cigarettes come in disposable and rechargeable models. Vape and vaporizer devices have refillable cartridges called pods, which contain the liquid that is heated. These devices do not burn tobacco like traditional cigarettes do. Cartridges can last for a day or two weeks, depending on how often the user takes a puff.

The term e-cigarette is used in this paper. Some research and data may use the term e-vapor product. Other common terms: Vapes, vaporizers, vape pens, hookah pens, electronic cigarettes, and e-pipes.

E-Cigarettes: At a Glance

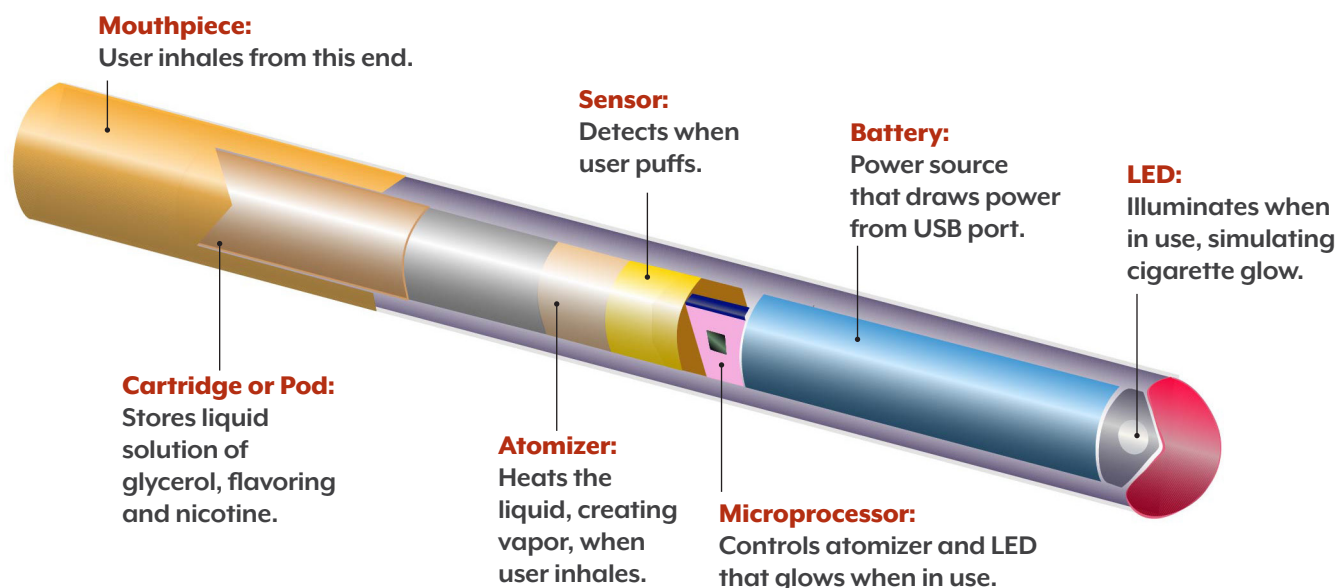
E-cigarettes, also known as electronic nicotine delivery systems (ENDS), simulate the experience of tobacco smoking. Many even look like a cigarette. But there are important differences.

Models: Some are disposable, others rechargeable.

Chemicals: Cigarette smoke contains as many as 7,000 chemicals, some carcinogenic. E-cigarette vapor has far fewer chemicals, but does contain potentially harmful metals like lead, volatile organic compounds and cancer-causing agents, according to the Centers for Disease Control and Prevention (CDC).

Cost: A pack of 20 cigarettes averages \$5.35, including taxes, in Colorado. That's about a dollar less than the national average. By comparison, a JUUL pod averages \$4.36, including taxes based on Colorado's tax structure. The pod can last from a day to two weeks, depending on how often the user takes a puff.

Figure 1. A Look Inside



The Rising Popularity of E-Cigarettes

It's illegal for anyone under 18 to buy e-cigarettes in the United States, but that hasn't stopped minors from inhaling, which in the case of e-cigarettes is called vaping. About 11.7 percent of U.S. teens vaped in 2017, up more than 10 percentage points from 1.5 percent in 2011, according to the CDC.⁵

Colorado high school students vape at more than double the national rate — 26.1 percent report using an e-cigarette in the past 30 days, according to the 2015 Healthy Kids Colorado Survey (HKCS). Three of four Colorado teens who smoke cigarettes also

report using e-cigarettes, the survey found.

Colorado adults are much less likely to use e-cigarettes than the state's teens. About five percent of adults say they've used e-cigarettes recently, according to the 2016 Behavioral Risk Factor Surveillance Survey (BRFSS). Of those, only about a third say they are daily or near-daily users.

There is evidence that some adult smokers may turn to e-cigarettes to help them quit. Sixty-eight percent of Colorado adults who smoke now or quit in the past year report using e-cigarettes as a tool to either cut back or quit smoking.⁶



Employees at Denver Vapor show off their vaping technique. Photo by Brian Clark, CHI

Looking Through the Haze: What Research Says about the Health Effects of E-cigarette Use

E-cigarettes present public health advocates with a dilemma: weighing e-cigarettes as a tool to cut back or quit smoking versus the potential health risks of inhaling vapor that includes nicotine and chemicals.

E-cigarettes have some benefit if a user substitutes them for regular cigarette smoking, according to the CDC. That's because they produce fewer harmful chemicals than cigarettes.

But more research is needed about how well e-cigarettes work to help quit smoking, the CDC adds. It has also warned that e-cigarettes aren't safe for youth, young adults, pregnant women, or adult non-

smokers.⁷ Though they produce fewer chemicals, they still expose the user to some chemicals and can lead to a nicotine addiction.

A National Academies of Sciences, Engineering and Medicine (NASEM) committee published a review of e-cigarette research in January 2018.⁸ On the negative side, the committee reported that e-cigarettes:

- Expose users to high levels of nicotine;
- Result in symptoms of dependence; and
- Increase the risk of adolescents smoking cigarettes in the future.

The committee found, however, that e-cigarettes have fewer harmful toxins and cancer-causing chemicals than cigarettes.

A Look at the Evidence

Here is a look at what is known about e-cigarettes, based on the NASEM report findings.

Question: What do we know about nicotine levels in e-cigarettes?

Answer: The levels of nicotine in e-cigarettes are similar to levels in cigarettes. However, this depends on the e-cigarette product, which have varying amounts of nicotine. JUUL Labs, which makes the JUUL e-cigarette that a growing number of teens are using in classrooms and elsewhere, reports that the amount of nicotine in one vapor pod, or cartridge, is equivalent to one pack of 20 cigarettes. But one vapor pod can last a day or two weeks depending on how often the user takes a puff.

Question: What do we know about the levels of toxins and carcinogens in e-cigarettes?

Answer: There is conclusive evidence that e-cigarettes emit many potentially toxic substances, including formaldehyde, lead and arsenic. The number of toxins, and the concentrations of toxins, depends on the type of product. Some of the contents in e-cigarette vapor are capable of causing DNA damage, but it is unknown if the exposure is high enough to contribute to cancer among users. Though many toxins are found in e-cigarettes, cigarettes release chemicals at a much higher rate and have nearly 70 carcinogens.⁹

Question: Do e-cigarettes cause changes to the cardiovascular or respiratory system?

Answer: There is evidence that a person's heart rate increases after e-cigarette use. There is not enough research to determine if use causes long-term changes in heart rate or risk of clinical cardiovascular outcomes, such as stroke or heart disease. There is no available evidence on whether e-cigarettes cause respiratory problems.

Question: What do we know about e-cigarette use and cancer?

Answer: Vapor products are relatively new, and few studies have examined their relationship with cancer. But there is substantial evidence that chemicals in e-cigarette vapor, such as formaldehyde, can cause DNA damage. This suggests long-term exposure to the e-cigarette vapor could increase the risk of cancer.

A Tale of Two Studies

Two reports. Two countries. Two different opinions.

The United Kingdom's public health agency and the National Academies of Sciences, Engineering and Medicine (NASEM) released reports within weeks of each other that reached different conclusions about the health outcomes of e-cigarette use.

The NASEM report concludes there is "substantial evidence" that e-cigarette use among adolescents increases the risk of smoking later on.

The U.K. report concludes evidence does not support the concern that adolescent e-cigarette use leads to cigarette use.

The NASEM report says there is "limited evidence" supporting the use of e-cigarettes as a stop smoking tool.

The U.K. report projects that e-cigarettes could contribute to at least 20,000 successful quit smoking results per year.

Many health officials in the U.S. are discouraging e-cigarette use, particularly among nonsmokers. Their U.K. counterparts are focusing on the potential benefits of e-cigarettes for current cigarette users, saying that e-cigarette use is 95 percent less harmful than smoking cigarettes.

The diverse approaches each country is taking, both in policy and communications, can provide researchers with an opportunity to compare e-cigarette regulation strategies and outcomes.

Question: Can pregnant women safely use e-cigarettes?

Answer: There is little research on whether e-cigarette use during pregnancy risks the health of the mother or fetus. However, research does show that using nicotine during pregnancy can lead to increased risk of miscarriage and low birthweight, suggesting that e-cigarettes pose a risk as well because they contain nicotine.

Question: Can a person reduce harm to their health by switching from cigarettes to e-cigarettes?

Answer: Yes. Completely switching from smoking to e-cigarette use reduces exposure to the toxins and cancer-causing agents in cigarettes, according to the research.

Question: Can e-cigarettes help a smoker to quit?

Answer: Evidence is mixed. The report says there is not enough research comparing e-cigarettes with FDA-approved smoking cessation aids to reach a conclusion. However, there is moderate evidence that more frequent e-cigarette use is associated with a reduction in smoking or quitting cigarettes. Moderate evidence means most studies support the conclusion, but there are limitations to the research.

Question: Does e-cigarette use lead to cigarette smoking among youth and young adults?

Answer: Research supports that e-cigarette use among youth and young adults increases their risk of smoking cigarettes.

Question: Does second-hand exposure to e-cigarette vapor pose a health risk to others?

Answer: There is moderate evidence that second-hand exposure to e-cigarette vapor is less harmful than second-hand exposure to cigarette smoke. There are limitations to the research, however.

Finally, the report identifies a need for further studies on using e-cigarettes to reduce cigarette use. Other studies highlight the necessity of rigorous and systematic evaluation, including randomized-controlled trials assessing the use of e-cigarettes specifically for cigarette smoking cessation. They also emphasize the need for clear definitions of usage levels and frequency.

The Policy Tightrope: Regulating E-Cigarettes

Most e-cigarette regulation efforts are coming directly from the tobacco regulation playbook.

The FDA, starting in 2016, began regulating



Photo by Brian Clark, CHI

Table 1. Federal Cigarette and E-cigarette Regulation

Federal Policy	Cigarettes	E-cigarettes
Age Restrictions to 18 years and older	Yes	Yes
Nicotine Addictiveness Label	Yes	Yes
Smoke-free Policies	Yes	No*
Flavor Restrictions	Yes	No*
Taxes	Yes	No*

* But some states and local governments have smoke-free policies in place.

e-cigarettes under the Family Smoking Prevention and Tobacco Control Act. The law prohibits the sale of e-cigarettes to minors, selling them in vending machines or distributing free samples.

Later this summer, in August, e-cigarettes must have a warning label saying that nicotine is addictive. And by the end of 2018, all manufacturers will need to submit an ingredient list to the FDA.

And on tap for 2019, e-cigarette manufacturers will have to report the quantities of FDA-designated harmful or potentially harmful components in their products to the FDA. The FDA is also looking at options for regulating the flavors added to the e-cigarette liquids.

Additionally, the FDA plans to require e-cigarette manufacturers to file so-called public health applications providing details about their products and the impact on public health. FDA Commissioner Scott Gottlieb pushed the deadline to 2022 from August 2018,



31% of students who have used e-cigarettes cite the flavors as their primary reason for vaping.

saying both the FDA and manufacturers need more time for research.

Several organizations, including the Campaign for Tobacco-Free Kids and the American Academy of Pediatrics, have sued the FDA, contending the delay will result in more consumers being exposed to harmful products.

While that issue plays out, the FDA has implemented enforcement actions, the first part of the Youth Tobacco Prevention Plan, to stop youth from using tobacco products, and in particular, e-cigarettes. These actions include an undercover blitz of retail establishments to crack down on illegal sales of e-cigarettes to minors.

They also requested information from JUUL about product marketing and whether it is targeting youth. JUUL vaporizers look like computer jump drives, which makes it easy for students to discreetly vape at school. JUUL products now account for 64 percent of the U.S. e-cigarette market, up from just 5 percent in 2016.¹⁰

State and local governments can also regulate e-cigarettes — to a point.

In Colorado, there is a statewide regulation establishing smoke-free locations where e-cigarettes can't be used, including schools, child care facilities and school buses. Twenty-one Colorado communities further prohibit e-cigarette use in locations such as restaurants and workplaces.¹¹

Some policy efforts in Colorado have failed, including bills to add warning labels to nicotine products and licensing retailers who sell nicotine products.

Colorado has relatively fewer policies than other states. Elsewhere, state and local regulators employ multiple strategies to regulate tobacco — some of which have been used to regulate e-cigarettes — such as taxing products and regulating flavors along with campaigns to reduce tobacco use or stop people from smoking altogether.

The Law of Supply and Demand

A potential strategy to discourage youth from using e-cigarettes is taxing them to increase the price. But some policymakers worry that higher prices might discourage cigarette smokers from switching to less harmful e-cigarettes or using them to kick the habit.

Research concludes that increasing the price of a pack of cigarettes by 20 percent would cut the number of cigarettes smoked by 10 percent and reduce the number of youth starting to smoke by eight percent.¹² This is known as an inverse relationship — as price goes up, consumption goes down.

The same goes for e-cigarettes. As the price increases, the number of days a teen uses them decreases, according to a recent study.¹³

Supporters of an e-cigarette tax suggest that increasing the price would accomplish two goals: discouraging youth from using e-cigarettes and stopping them from smoking cigarettes in the future.

Nine states currently tax the devices, ranging from five cents per milliliter of e-liquid in North Carolina and Louisiana to an excise tax of 95 percent of the wholesale price in Minnesota. That tax range adds between four cents and \$3.80 to the average \$4 cost of a JUUL pod.

Minnesota in 2012 became the first state to implement an e-cigarette tax. Even so, cigarette use increased by 50 percent among Minnesota's teens between 2014 and 2017.¹⁴ One explanation may be that consumers turned to online purchases.

There is an opportunity to evaluate whether taxes are an effective regulation tool when it comes to e-cigarettes.



Flavors such as Amazing Mango and Go Nanas fill the shelves at Denver Vapor. Photo by Brian Clark, CHI

Like a Good Book – Once You Start, It's Hard to Stop

Supporters of e-cigarettes think they can be effective in helping smokers to quit. But others look to the experience with cigarettes and don't think it's a good idea to wait to regulate a product that could lead to a new generation of nicotine dependence.

Currently, there are seven FDA-approved tools to help smokers stop as well as other strategies aimed at would-be quitters such as counseling and motivational interviewing.^{15,16} Advocates of e-cigarettes want the devices added to the FDA's list, which could mean that insurers would consider covering some of the costs of the devices when used to help kick the habit.

The 2018 NASEM report concludes that there is not enough sound evidence to say for sure that e-cigarettes are an effective cessation strategy. But in a press release the agency says, "Evidence suggests that while e-cigarettes are not without health risks, they are likely

to be far less harmful than conventional cigarettes."

More research is required on these relatively new products. To make informed policy, policymakers should look for research that answers these questions about the long-term outcomes of e-cigarettes:

- What policy strategies can be used to prevent a new generation from becoming addicted to nicotine?
- Are e-cigarettes an effective smoking cessation tool?
- Should they be promoted as a more effective than other cessation tools?

Joe Camel, Double Apple, and Marketing

E-cigarette manufacturers use chemicals to flavor the liquid that, when heated, produces vapor. This results in names like juicy nerds, peachy rings, and sour worms.

Despite the names, e-cigarette flavors appeal to all

ages. About one of three students who have used e-cigarettes (31 percent) cite the flavors as a reason for vaping, according to the 2016 National Youth Tobacco Survey.¹⁷ Roughly 84 percent of Colorado adults who use e-cigarettes report doing so because they enjoy the flavors.¹⁸

Because of the wide appeal, regulating flavoring could deter youth from vaping, but it also could discourage adult smokers from switching to e-cigarettes.

The federal Tobacco Control Act, which regulates the marketing of cigarettes, banned flavored cigarettes in 2009. However, these regulations do not extend to e-cigarettes.

The same law prohibits states from regulating the e-cigarette manufacturing process, so a state can't ban the production of flavored e-cigarettes. States can, however, regulate the sale and distribution of these products.

Providence, Rhode Island, among other local governments, restricts the sale of all flavored e-cigarettes except menthol, mint and wintergreen flavors. The tobacco industry sued the city, but the courts ruled that restricting the sale of flavored e-cigarettes did not violate federal law.

San Francisco voters in June banned the sale of

flavored tobacco products, including menthol cigarettes and flavored vaping liquids.

Besides flavoring, e-cigarette advertising and packaging are designed to appeal to teens. Recent research found that youth who were receptive to e-cigarette advertising were more likely to have ever used a vaping device and conventional cigarettes compared with youth who were not receptive to advertising.¹⁹

The link between advertising and use may provide more ammunition for advocates who want to ban e-cigarette ads — a strategy used to reduce cigarette consumption.

Conclusion

Weighing the pros and cons of vaping while trying to creatively regulate e-cigarettes will be a test for policymakers and the public health community as popularity of the products continues to grow.

All eyes will be looking for additional data and research to inform the debate. In Colorado, new findings will come from the 2017 Healthy Kids Colorado Survey, results of which are scheduled to be released this summer. The survey includes more detailed questions about e-cigarette use among Colorado youth.

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