



HEALTH EFFECTS OF E-CIGARETTES

Issue brief #2 in a series of three on e-cigarettes

Are E-Cigarettes a Safe Alternative?

Many recent reports have shown that the use of electronic cigarettes, commonly known as e-cigarettes, has risen sharply among both adults and youth in the United States. The long-term health effects of e-cigarette use are not known, and regulation at the local, state and federal levels is lagging. This brief is the second in a series of three discussing the public health issues related to e-cigarettes in Kansas: (1) *E-Cigarettes and Their Use in the U.S. and Kansas*; (2) *Health Effects of E-Cigarettes*; and, (3) *E-Cigarette Policy, Regulation and Marketing*.

E-cigarettes are being marketed as a “safer” alternative to smoking and even as smoking cessation devices; with some manufacturers going so far as to label their products “e-health cigarettes.” Since e-cigarettes have existed for less than 15 years, there is limited research regarding the safety or long-term health effects of their use, but some research is beginning to emerge. This brief summarizes

the results of this research regarding the health effects of the chemical components of e-cigarettes and also examines whether e-cigarettes may actually help with smoking cessation efforts.

Components of E-Liquid

E-cigarettes burn what is commonly referred to as e-liquid, e-juice or liquid nicotine (though not all e-liquid contains nicotine). The main chemicals usually found in the e-liquid are nicotine, propylene glycol and other flavoring components. Each has its own unique health effects.

Nicotine

Nicotine is a chemical found in tobacco plants and is classified as a stimulant. Once it enters the bloodstream, nicotine promotes the release of adrenaline, which can lead to wakefulness, alertness and increased blood pressure.

Nicotine is not classified as cancer-causing, or carcinogenic, though emerging research

What is Nicotine?

- A chemical found in the tobacco plant
- A stimulant that can increase alertness and energy
- Not currently classified as cancer-causing
- Highly addictive
- Harmful to brain development

- The negative health effects of nicotine are well-documented, especially for children. Nicotine is generally harmful for the human brain, particularly during developing years. Nicotine poisoning also poses risk and can be deadly.
- Many studies indicate that e-cigarette vapor is less harmful than conventional cigarette smoke.
- Some components of e-liquid, particularly propylene glycol and flavor additives, may pose significant risk to users, and the long-term effects of e-cigarette use are not yet known.
- Public health experts continue to debate whether e-cigarettes help with smoking cessation, reduce harm for smokers who are not ready to quit, or lead teens to begin using other forms of nicotine.



E-liquid is often sold in small, **brightly colored bottles containing sweet-smelling liquids** that may be attractive to small children.

suggests that it may play a role in tumor progression. However, nicotine is well-established as the highly addictive component of tobacco products.

Generally, studies have concluded that e-cigarettes deliver nicotine less effectively than traditional cigarettes, though recent evidence suggests that newer products on the market have increased nicotine delivery, especially for experienced smokers.

High Risks for Fetal and Child Development

Exposure to nicotine can be toxic to fetal cells, affects lung development and capacity, and is linked to Sudden Infant Death Syndrome (SIDS). Pregnant women and infants may be at particular risk of harm as a result of the use of products containing nicotine.

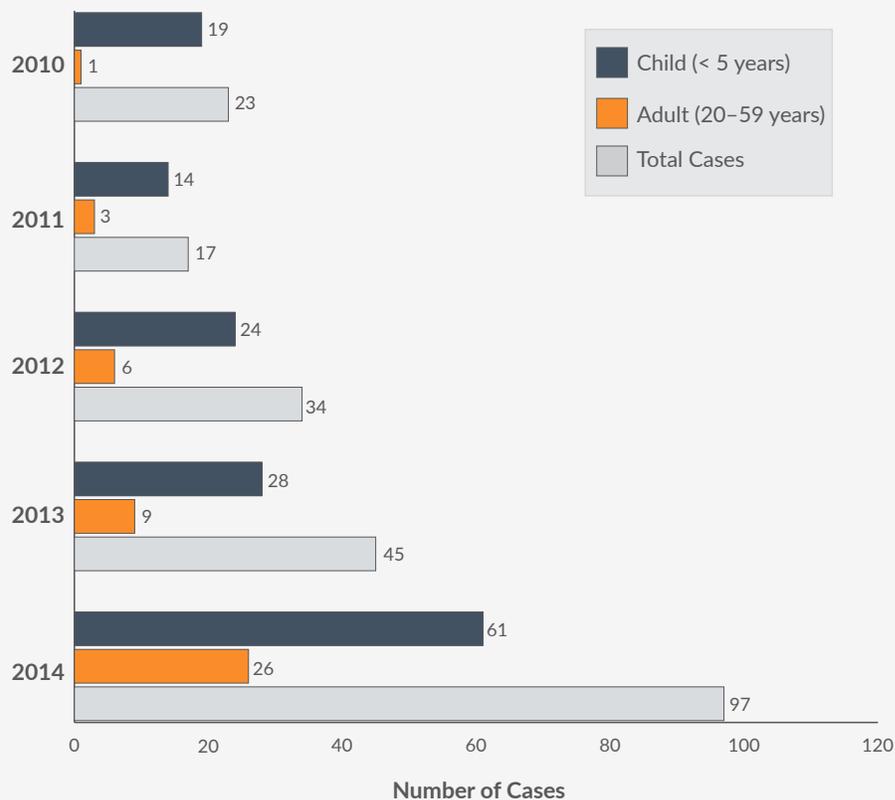
In children, nicotine also harms brain development. Once nicotine enters the body, it is distributed through the bloodstream and reaches the brain within 10-20 seconds after inhalation. The prefrontal cortex, which is associated with personality development and decision-making, is still in the process of developing during adolescence. Therefore, the adolescent brain is particularly sensitive to the effects of nicotine, and studies indicate adolescents who are exposed to nicotine are at increased risk of suffering from attention deficits and cognitive impairment later in life.

Nicotine Poisoning

E-liquid also comes with the risk of nicotine poisoning or overdose, and there are currently no federal or Kansas state regulations requiring that liquid nicotine containers be childproof.

Nicotine is highly dangerous to children with as little as 2.23 mg, or less than one drop, able to cause toxicity for a child weighing 50 lbs. Because an e-cigarette refill can contain several milligrams of nicotine—one study found that e-cigarette refills sold in the U.S. contained anywhere from 0.0 to 36.6 mg of nicotine—even small spills can be cause for concern.

Figure 1. Calls to Kansas Poison Control Centers Related to E-Cigarettes Increased Four-fold
Exposures to E-Cigarette Devices and Liquid Nicotine in Kansas by Year, 2010–2014



Source: KHI analysis of data from The University of Kansas Hospital Poison Center, 2015.

Data from the University of Kansas Poison Control Center show that as the e-cigarette market has grown, poison control calls related to liquid nicotine have similarly jumped, reaching 97 in 2014 up from 23 in 2010 (Figure 1, page 2). This trend is also reflected in national data, with the American Association of Poison Control Centers reporting 3,783 exposure calls in 2014, up from 271 cases reported in 2011.

Propylene Glycol

The main component of e-liquid is usually propylene glycol and/or glycerin, which together can comprise up to 90 percent of e-liquid. Propylene glycol is “generally recognized as safe” according to the CDC, but information regarding the health effects of inhaling propylene glycol are limited.

The breakdown of propylene glycol after it is heated can produce formaldehyde, a carcinogen also found in traditional cigarettes. One study found that when using an identical e-cigarette at a “high” voltage (5.0 V) rather than “low” voltage (3.3 V), formaldehyde was released at detectable levels.

Flavor Additives and Other Compounds

Though flavoring of traditional cigarettes is generally banned in the U.S, e-cigarettes are available in a number of flavors, such as cotton candy, vanilla, traditional tobacco or whiskey. Recent evidence suggests that the chemicals used to create these flavors may be cause for concern, especially with regard to inhalation.

One study found that e-cigarette flavoring made up between 1 and 4 percent of e-liquid (by weight) and included vanillin, menthol and benzaldehyde, the last of which is known to irritate the lungs. These ingredients were typically not placed on the labels, according to the study. An analysis of e-liquid similarly found a number of harmful chemicals, including formaldehyde and acetone, at significant levels across dozens of samples from popular brands.

Some researchers have raised concern that most of these chemicals have not been assessed for safety by inhalation and note that further analysis is needed to help draw broader conclusions. In addition, e-cigarette users have been reported to mix multiple e-liquids to create their own unique flavors, further complicating safety assessments.

E-Cigarette Vapor

A primary difference between e-cigarettes and traditional cigarettes is that e-cigarettes are non-combustible, and thus create an aerosol (vapor) rather than smoke. Thus, some researchers have suggested that this difference alone makes e-cigarettes less harmful both to the user and people nearby through secondhand exposure.

Evidence suggests that secondhand e-cigarette vapor complies with regulatory standards for clean air. In addition, the existing literature has thus far shown that vapor is safer for exposure than traditional cigarette smoke.

Analysis of the aerosol generated by e-cigarettes—across several studies—shows low concentrations of the most potentially harmful chemicals and concluded that secondhand exposure posed little risk to human health for both adults and children. Though limited evidence exists to determine the amount of nicotine generated by secondhand vapor—especially long-term—some reports show that the air concentration of nicotine generated secondhand is about one-tenth of that generated by traditional cigarettes, but is significant compared to clean air.

Risk to E-Cigarette User

One study showed that after adjusting for puff volume, dilution and quantity, e-cigarette vapor causes less stress to human lung cells than traditional

*The breakdown of propylene glycol (main component of e-liquid) after it is heated can produce **formaldehyde**, a carcinogen also found in traditional cigarettes.*



cigarettes, but is more harmful than clean air. Some compounds generated during vaporization, such as formaldehyde and acetaldehyde, may have adverse health effects, especially as the voltage of the e-cigarette device increases. Some studies suggest that vapor inhalation may pose minimal risk. Literature concerning metals (copper, lead and nickel) emitted from e-cigarettes, found that levels in e-cigarette vapor were within U.S. safety standards.

Public Health Concerns

The public health debate over e-cigarettes generally weighs three main factors: whether the devices reduce harm for smokers; aid in smoking cessation, and/or introduce a new generation of teenagers and young adults to nicotine addiction.

Harm Reduction

Proponents of e-cigarettes generally focus on the harm-reduction theory, which states that e-cigarettes are less harmful than traditional cigarettes as a method of delivering nicotine. E-cigarettes generally contain significantly fewer chemicals than traditional tobacco products. Studies thus far have consistently shown that the resulting vapor contains fewer particles and lower concentrations of potentially harmful chemicals by as much as 90 percent. In a recent, comprehensive report issued by the United Kingdom, the government's chief medical officer expressed caution regarding the lack of evidence on the long-term use of e-cigarettes, but noted that the available evidence shows that e-cigarettes "carry just a fraction of the harm." However, with the large number of flavor-generating additives in e-cigarettes, wide variation in e-liquid composition, and, in particular, lack of long-term research, questions remain as to whether e-cigarettes are truly a less harmful method of nicotine delivery.

Smoking Cessation

Despite widespread anecdotal evidence and marketing strategies, scientific evidence suggesting that

e-cigarettes aid in smoking cessation is lacking, and what information exists is inconclusive. A scientific review of population-based and clinical studies suggests that e-cigarettes do not help smokers transition off cigarettes, and a recent study on whether e-cigarettes help smokers quit was inconclusive. Some research suggests that smokers may instead supplement their tobacco use with e-cigarettes, rather than quitting smoking. On the other hand, the same United Kingdom study cited previously, concluded that the products have the potential to serve as an aid in quitting when supported by a smoking cessation service such as behavioral support.

Initiation

It is well-established that virtually all smokers begin smoking by age 26, with 90 percent starting in their teen years, and most continuing into adulthood. Thus, much of the public health concern—compounded by data showing increased use of e-cigarettes—has revolved around e-cigarettes introducing youth to nicotine.

Evidence suggests that teen e-cigarette use is associated with higher intention to smoke, and one recent study concluded that teens who try e-cigarettes are subsequently more likely to try other tobacco products such as traditional cigarettes, hookah (inhalation of flavored tobacco through the use of a water basin), or cigars. It will be important to monitor whether additional studies confirm these preliminary results.

Conclusion

Though research on e-cigarettes is rapidly expanding, the relative newness of the product means that long-term studies on the health effects of e-cigarette use are not yet available. It will be critical for policymakers, public health officials and health policy advocates to remain up-to-date as additional studies emerge detailing how these products can affect health.

*Stay tuned for the third and final installment on e-cigarettes: **E-Cigarette Policy, Regulation and Marketing**. To view the entire series, please visit our website at khi.org.*

ABOUT THE ISSUE BRIEF

This brief is based on work done by Andrea Hinton and Linda Sheppard, J.D. This publication is available online at khi.org/policy/article/E-cigSeries2.

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