

February 2016 Summary of Some Key Areas of Vapor Product Research

This document expands upon the Snohomish County Research Document from June 2015.

Introduction

Vapor products, also known as e-cigarettes, are electronic devices that heat a liquid into an aerosol for inhalation. The liquid, also known as “e-liquid” is usually a combination of various chemicals and nicotine. The process of puffing on an e-cigarette is called “vaping.”

As the vapor product market grows, the range of products offered has expanded. These products can be generally grouped into three categories:

- Small e-cigarettes similar in appearance to traditional cigarettes. Some are sealed and disposable, others are refillable.
- Medium-sized vaping pens with refillable tanks, also known as e-hookahs, hookah pens, or vape pens.
- Large vaping devices, known as mods or personal vaporizers.

Public health concerns with the use of vapor products include:

- Potential health effects from vaping or exposure to an aerosol containing unknown mixtures of potentially harmful chemicals, especially for vulnerable populations such as children, pregnant women, and individuals with compromised lungs.
- Rapidly increasing use of e-cigarettes and vapor devices by teens and young adults.
- Using the devices to inhale other substances, including marijuana and illegal drugs.
- High poisoning risk to children from exposure to concentrated liquid nicotine or other substances.
- Concern about the lack of regulation/standardization of the “e-liquid”, especially regarding ingredients, labeling, safety packaging and others.
- Explosion and burn risks

Research on vapor products is still in early stages. It took decades to discover the full health effects of tobacco use and secondhand smoke. Modern research continues to reveal new adverse health effects of tobacco use.

Current challenges in vapor product research include:

- Vapor products have been used for a relatively short period of time so it is difficult to draw scientifically based conclusions on long term health effects.
- E-cigarettes and vapor products are not a standardized product, and e-liquid ingredients are unregulated and not fully disclosed. This complicates analysis of the health effects of vapor products, and may mean that research results for one type of vapor product do not apply to other types or brands.
- Controlled clinical trials and population-level cohort studies are needed to assess the use of vapor products by current smokers and nonsmokers, and impacts on smoking reduction and nicotine addiction. Early studies have yielded mixed results about the utility of e-cigarettes in reducing harm.

This paper provides a summary of some key areas of research on vaping and vapor products.

Deciding Whether a Source of Claimed Research is Reliable

Many sources of scientific information are available. Knowing if the information can be trusted can be difficult. The following are some criteria to help you consider the reliability of a source.

- Was the research published in a credible, trusted, peer-reviewed scientific journal? Peer review is a critical step in quality control, enlisting multiple expert reviewers, to help readers know that what they are reading is reliable research, using valid scientific research and analysis methods.
- How does the new information fit with and build on the findings of other reputable research? A single study is never enough to make a case; new research requires other studies to support the results before a study's findings are considered applicable to a particular field of science and/or medicine.
- Does the source of funding have a potential conflict of interest? The funding source is usually included in the journal article. When reading an article from a funded research project, you must consider whether the funders of this research had anything to gain by the results.
- Where did the information come from? Who provided the information; is the source credible; who did the study; and is it consistent with other research? The most credible information comes from recognized scientific experts with no stake in the research results.
- Was the study population large enough to produce representative results? Scientific evidence from large studies is reliable, because the studies are rigorous and better reflect the experiences of the population that is being studied, including any individuals with their own stories. An important element of studying large populations is that individual experience is included in the reported data.
- What about personal stories? Personal stories, sometimes called "anecdotal evidence," refer to individual experiences. They may or may not be consistent with scientific research, but should not be confused with scientific research.
- When was the article published? Has the population or substance studied changed since the study? Is more recent information known about the substance/population?

--Adapted from CDC's "Deciding Whether a Source is Reliable"; Retrieved from http://www.cdc.gov/DES/consumers/research/understanding_deciding.html

Potentially Harmful Chemicals Identified in “E-Juice” and Vapor

The federal government does not currently regulate vapor products as it does combustible and smokeless tobacco products, therefore, manufacturers are not required to disclose the ingredients used in vapor products. Studies have found that the chemical composition of vapor products varies greatly from brand to brand, and within brands. Studies of e-liquid ingredients and emitted vapor have identified a range of potentially toxic chemicals, and other constituents that have not been assessed for safety. The wide array of food flavorings used in e-juices have not been tested for safety when inhaled, and the “Generally Recognized as Safe” (or GRAS) category for food flavorings and propylene glycol does not apply to inhalation.

1. E-cigarettes contain a nicotine solution that ranges in concentration between products but can contain as much nicotine as a full pack of cigarettes. A user might take 15-30 puffs on an e-cigarette to receive the same amount of nicotine released by a conventional cigarette. Analysis of different vapor products have found inconsistencies between the nicotine content claimed on product packaging and measured nicotine levels experienced by users.

Sources:

- i. Arnold, C. 2014. “Vaping and Health: What Do We Know about E-Cigarettes?” *Environmental Health Perspectives* Vol. 122 (9). DOI:10.1289/ehp. <http://ehp.niehs.nih.gov/122-a244/>
- ii. Grana, G., Benowitz, N., Glantz, S.A. 2014. “E-Cigarettes: A Scientific Review” *Circulation*. 129: 1972-1986. doi: 10.1161/CIRCULATIONAHA.114.007667. <http://circ.ahajournals.org/content/129/19/1972>
- iii. Westenberger B.J. 2009. “Evaluation of E-Cigarettes”. U.S. Department of Health and Human Services, Food and Drug Administration (FDA), Center for Drug Evaluation and Research, Division of Pharmaceutical Analysis. <http://www.fda.gov/downloads/drugs/scienceresearch/ucm173250.pdf>
- iv. Pagano *et al.* 2015. “Determination of Nicotine Content and Delivery in Disposable Electronic Cigarettes Available in the United States by Gas Chromatography-Mass Spectrometry” *Nicotine Tobacco Research*. doi: 10.1093/ntr/ntv120. <http://ntr.oxfordjournals.org/content/early/2015/06/18/ntr.ntv120.abstract>

2. In addition to nicotine (or other drugs), the aerosol produced by e-cigarettes and vapor products contains fine and ultrafine particles of solvents, flavorings, and chemical byproducts produced in the heating process. Chemical analysis of the vapor has identified cancer-causing and potentially toxic chemicals that are also found in higher levels in cigarette smoke.^{i, ii, iv, v, viii}

Chemicals found in e-cigarette vapor include:

- Propylene glycol and glycerin, used as solvents to create the vapor.^{ii,iv} These chemicals may cause respiratory irritation and have not been fully tested for other health effects when inhaled.^{ix}
- Carbonyl byproducts formed from heating propylene glycol and glycerin^{ii,iii} that have known health consequences^{ix} including:
 - Formaldehyde, a known carcinogen and respiratory irritant.
 - Acetaldehyde, a possible carcinogen.
 - Acrolein, an irritant that has not been sufficiently studied for health effects.
- Metal particles from the device casing or electronics including tin, nickel, aluminum and the highly toxic heavy metals lead, cadmium, and chromium.^{.vi, ix}
- A wide array of food flavoring chemicals that have not been evaluated or approved as safe for inhalation (see below).^{ii,iv}

- At least one brand of e-cigarettes includes several forms of the chemical pyrazine, a common additive to conventional cigarettes that enhances sensory appeal and that may enhance tobacco addiction.^{vii}
- Carcinogens called tobacco-specific nitrosamines have been measured in many e-cigarettes containing nicotine, which is extracted from tobacco.^{i, ii}

Sources:

- i. Westenberger B.J. 2009. "Evaluation of E-Cigarettes". U.S. Department of Health and Human Services, Food and Drug Administration, Center for Drug Evaluation and Research, Division of Pharmaceutical Analysis. <http://www.fda.gov/NewsEvents/PublicHealthFocus/ucm173146.htm>
- ii. Goniewicz, M., K. Knysak, M. Gawron et al. 2013. "Levels of selected carcinogens and toxicants in vapour from electronic cigarettes" Tobacco Control doi:10.1136/tobaccocontrol-2012-050859.
- iii. Kosmider L, Sobczak A, Fik M, Knysak J, Zaciera M, Kurek J, Goniewicz ML. 2014. "Carbonyl compounds in electronic cigarette vapors: effects of nicotine solvent and battery output voltage." Nicotine Tob Res.16(10):1319-26. doi: 10.1093/ntr/ntu078. <http://ntr.oxfordjournals.org/content/16/10/1319.long>
- iv. Arnold, C. 2014. "Vaping and Health: What Do We Know about E-Cigarettes?" Environmental Health Perspectives Vol. 122 (9). DOI:10.1289/ehp. <http://ehp.niehs.nih.gov/122-a244/>
- v. Grana, G., Benowitz, N., Glantz, S.A. 2014. "E-Cigarettes: A Scientific Review" Circulation. 129: 1972-1986. doi: 10.1161/CIRCULATIONAHA.114.007667. <http://circ.ahajournals.org/content/129/19/1972>
- vi. Williams M, Villarreal A, Bozhilov K, Lin S, Talbot P. 2013. "Metal and Silicate Particles Including Nanoparticles Are Present in Electronic Cigarette Cartomizer Fluid and Aerosol" PLoS ONE 8(3): e57987. doi:10.1371/journal.pone.0057987 journals.plos.org/plosone/article?id=10.1371/journal.pone.0057987
- vii. Alpert HR, Agaku IT, Connolly GN. 2015 "A study of pyrazines in cigarettes and how additives might be used to enhance tobacco addiction" Tobacco Control. doi:10.1136/tobaccocontrol-2014-051943. <http://tobaccocontrol.bmj.com/content/early/2015/05/03/tobaccocontrol-2014051943.full>
- viii. Offermann, Bud. 2014. "The Hazards of E-Cigarettes" AHSRAE Journal. http://bookstore.ashrae.biz/journal/download.php?file=2014June_038047_IAQ_Offerman_rev.pdf
- ix. Agency for Toxic Substances & Disease Research (ATSDR) Public Health Statements on these chemicals, <http://www.atsdr.cdc.gov/>

3. Vapor products use propylene glycol and glycerin as solvents to create the vapor. These chemicals may cause respiratory irritation when inhaled, and when heated they form carbonyl byproducts that have known health consequences including formaldehyde, acetaldehyde and acrolein.

Source: Kosmider L, Sobczak A, Fik M, Knysak J, Zaciera M, Kurek J, Goniewicz ML. 2014. "Carbonyl compounds in electronic cigarette vapors: effects of nicotine solvent and battery output voltage." Nicotine Tob Res. 2014 Oct;16(10):1319-26. doi: 10.1093/ntr/ntu078. <http://www.ncbi.nlm.nih.gov/pubmed/24832759>

4. The safety of flavorings used in vaping products is unclear.

- The Flavor & Extract Manufacturers Association of the United States (FEMA) states "E-cigarette and flavor manufacturers and marketers should not represent or suggest that the flavor ingredients used in e-cigarettes are safe because they have FEMA GRAS™ status for use in food because such statements are false and misleading."
- A recent article by the Harvard School of Public Health describes the results of testing of 51 types of flavored chemical mixtures sold for e-cigarette delivery (out of the over 7,000 flavors currently

marketed). Thirty-nine of them contained diacetyl, the chemical that is associated with bronchiolitis obliterans, also called “popcorn lung”. “Due to the associations between diacetyl, bronchiolitis obliterans and other severe respiratory diseases observed in workers, urgent action is recommended...”ⁱⁱ

Sources:

- i. Flavor & Extract Manufacturers Association of the United States. 2015. “The Safety Assessment and Regulatory Authority to Use Flavors – Focus on E-Cigarettes” http://www.femaflavor.org/sites/default/files/FEMAGRAS_Ecig_March_3_2015.pdf
- ii. Allen J, Flanigan S, LeBlanc M, Vallarino J, MacNaughton P, Stewart J, and Christiani D. Flavoring Chemicals in E-Cigarettes: Diacetyl, 2,3-Pentanedione, and Acetoin in a Sample of 51 Products, Including Fruit-, Candy-, and Cocktail-Flavored E-Cigarettes. *Environmental Health Perspectives* doi: 10.1289/ehp.1510185; <http://ehp.niehs.nih.gov/wp-content/uploads/advpub/2015/12/ehp.1510185.acco.pdf>

Nicotine: Addiction & Health Impacts

Nicotine is a highly addictive drug that has been extensively studied. Vapor products provide a new method of delivering nicotine to individuals who are already addicted, or to those who will likely become dependent. Nicotine exposure, firsthand or passively, can adversely impact maternal and fetal health during pregnancy, and may adversely impact adolescent brain development. High doses of nicotine, such as those in e-liquids, can cause immediate health emergencies and can be fatal if ingested or absorbed through the skin.

1. Current smokers are the most likely to try e-cigarettes and nicotine vapor products. However, about one-third (32%) of current adult users of nicotine vapor products are never or former smokers, suggesting that vapor products contribute to primary nicotine addiction.

Source: McMillen, R.C. *et al.* 2014. “Trends in Electronic Cigarette Use Among U.S. Adults: Use is Increasing in Both Smokers and Nonsmokers” *Nicotine Tobacco Research* <http://ntr.oxfordjournals.org/content/early/2014/11/06/ntr.ntu213.abstract>

2. Exposure to nicotine at a young age increases the number of nicotine receptors in the brain, which sets the stage for lifelong dependency and addiction. Virtually all daily smokers have smoked their first cigarette before age 26, and 90% have started before age 18.

Source: US Department of Health and Human Services, Centers for Disease Control and Prevention. 2012 Surgeon General's Report—Preventing Tobacco Use Among Youth and Young Adults. <http://www.surgeongeneral.gov/library/reports/preventing-youth-tobacco-use>

3. People addicted to nicotine experience many triggers for the urge to smoke. A recent study found that smokers watching people vaping in commercials had an increased urge to smoke cigarettes. And former smokers who watched vaping commercials indicated they were less likely to abstain from cigarettes than nonsmokers in a control group.

Source: Erin K. Maloney & Joseph N. Cappella. March 2015. “Does Vaping in E-Cigarette Advertisements Affect Tobacco Smoking Urge, Intentions, and Perceptions in Daily, Intermittent, and Former Smokers?” *Health Communications*, online. DOI:10.1080/10410236.2014.993496. http://www.tandfonline.com/doi/full/10.1080/10410236.2014.993496#.VYijk_lVhHw

4. Children who use e-cigarettes are more likely to intend to begin smoking combustible cigarettesⁱ; adolescents in Los Angeles high schools using e-cigarettes are more likely to go on to use combustible cigarettes in the ensuing yearⁱⁱ; and teens and young adults that use e-cigarettes are more likely to start using combustible cigarettes.ⁱⁱⁱ

Sources:

i Bunnell RE, Agaku IT, Arrazola R, et. al. 2014. Intentions to smoke cigarettes among never-smoking U.S. middle and high school electronic cigarette users. National Youth Tobacco Survey, 2011–2013. Nicotine and Tobacco Research. 2014 Aug 20 http://www.cdc.gov/tobacco/basic_information/e-cigarettes/youth-intentions/index.htm

ii Leventhal A, Strong D, Kirkpatrick M, et. al. Association of Electronic Cigarette Use with Initiation of Combustible Tobacco Product Smoking in Early Adolescence. JAMA 2015; 314(7)700-707.
Doi: 10.1001/jama.2015.8950
<http://jama.jamanetwork.com/article.aspx?articleid=2428954>

iii. Primack B, Soneji S, Stoolmiller M, Fine M, Sargent J. (2015) Progression to traditional cigarette smoking after electronic cigarette use among US adolescents and young adults. JAMA Pediatr. 2015;169(11):1018-1023.
doi:10.1001/jamapediatrics.2015.1742
<http://archpedi.jamanetwork.com/article.aspx?articleid=2436539>

5. In addition to causing addiction, nicotine negatively impacts multiple biologic processes that are important for fetal growth and development, immune function, the cardiovascular system, the central nervous system, and the genesis of cancer. Extensive research on nicotine in both human and animal studies has demonstrated adverse health effects on maternal and fetal health during pregnancy, including impaired fetal brain and lung development, preterm delivery and stillbirth.

Sources:

i. “The Health Consequences of Smoking—50 Years of Progress: A Report of the Surgeon General, 2014” U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2014. <http://www.surgeongeneral.gov/library/reports/50-years-of-progress/index.html>

ii. England LJ, Bunnell RE, Pechacek TF, Tong VT, McAfee TA. 2015. “Nicotine and the Developing Human: A Neglected Element in the Electronic Cigarette Debate.” Am J Prev Med. 2015 Mar 7. pii: S0749-3797(15)00035-5. doi: 10.1016/j.amepre.2015.01.015. [http://www.ajpmonline.org/article/S0749-3797\(15\)00035-5/abstract](http://www.ajpmonline.org/article/S0749-3797(15)00035-5/abstract)

iii. Ozturk F, Sheldon E, Sharma J, et.al. (2015) Nicotine exposure during pregnancy results in persistent midline epithelial seam with improper palatal fusion. Nicotine Tob Res. Oct 6, 2015. Doi: 10.1093/ntr/ntv227

6. Poisonings from liquid nicotine have been rapidly increasing since 2010 based on voluntary reporting to the Washington Poison Center. Liquid solutions containing concentrated nicotine are sold in packaging that is not child resistant and is currently unregulated at the federal and state levels.

Calls to the WA Poison Center on e-cigarettes and liquid nicotine increased 1000% from 2012 to 2014. Of 182 calls in 2014, 60% involved children aged 1-3. Reporting to the Washington Poison Center is voluntary, so this data is an underrepresentation of the true number of incidents.ⁱ

The amount of nicotine in e-liquids exceeds a fatal dose for a child, and a one year-old child in New York state died after exposure.

Sources:

i. Washington Poison Center. January 22, 2015. Toxic Trends Report. E-Cigarettes. Online at: <http://www.wapc.org/toxic-trends/e-cigarettes-you-4/>

II. American Association of Poison Control Centers. Dec. 12, 2014. News Release
https://aapcc.s3.amazonaws.com/pdfs/releases/Liquid_Nicotine_Death_Release.pdf

Health Impacts of Vaping & Exposure to Secondhand Vapor

Cigarette smoke contains more than 7,000 chemicals, including hundreds of known carcinogens (chemicals that cause cancer) and other toxic chemicals. Use of e-cigarettes may be “safer” than smoking cigarettes because the inhaled toxic compounds are fewer or in lower concentrations, but current research is insufficient to quantify the reduced risk. The vapor contains many potentially harmful chemicals in addition to nicotine and other chemicals (see section above), and only a few studies have directly examined the health impacts of inhaling these chemical mixtures. Some studies have found adverse biological effects of vaping.

Research on the health impacts of secondhand vapor is also limited, but studies of indoor air quality are identifying concerns. Research is especially needed to understand health risks of exposure to vapor for vulnerable populations, including children, pregnant women, and individuals with pulmonary and cardiovascular conditions.

1. A review of available peer-reviewed research on human health effects of e-cigarettes through September 2013 conducted by Dr. Callahan-Lyon of the FDA’s Center for Tobacco Products found limited data on short-term health effects and no data on long-term health effects of e-cigarette use, as well as limited data on secondhand and thirdhand (on surfaces) exposure to vapor. The review concluded “There are not adequate data to support the safety of long-term use of electronic cigarettes at this time.”

Source: Callahan-Lyon P. 2014. “Electronic cigarettes: human health effects” *Tobacco Control* 2014;23: ii36–ii40. doi:10.1136/tobaccocontrol-2013-051470. http://tobaccocontrol.bmj.com/content/23/suppl_2/ii36.abstract

2. A clinical study of 30 male and female smokers (aged 19-56 years and currently healthy) who used e-cigarettes for five minutes found immediate harmful effects on lung function, similar to some of the effects seen with smoking. Effects included increased lung airflow resistance, and an immediate decrease in concentration of exhaled nitric oxide which indicates oxidative stress and airway inflammation.

Source: Vardavas et al. 2012. “Short-term Pulmonary Effects of Using an Electronic Cigarette. Impact on Respiratory Flow Resistance, Impedance, and Exhaled Nitric Oxide”. *Chest* 141(6): 1400-1406.
<http://journal.publications.chestnet.org/article.aspx?articleid=1187047&issueno=6&rss=1&ssource=mfr>

3. The diverse chemical flavorings—more than 7,000 varieties—used in vapor products are a significant concern as respiratory hazards. The aerosolized vapor penetrates deeply into the lungs and chemical flavorings for ingestion in food have not been evaluated for safety when inhaled. A severe obstructive lung disease has been shown to be caused by inhalation of high doses of diacetyl, a buttery flavoring used in popcorn. Analysis of sweet flavored vapor products found diacetyl in 69% of 159 products tested.

Sources:

i. Barrington-Trimis, J.L., Samet, J.M., McConnell, R. Published Online Nov., 2014. “Flavorings in Electronic Cigarettes - An Unrecognized Respiratory Health Hazard?” *Journal of the American Medical Association (JAMA)*. 312(23):2493-2494. doi:10.1001/jama.2014.14830. <http://jama.jamanetwork.com/article.aspx?articleid=1935097>

ii. Flavor & Extract Manufacturers Association of the United States. March, 2015. "The Safety Assessment and Regulatory Authority to Use Flavors – Focus on E-Cigarettes"
http://www.femaflavor.org/sites/default/files/FEMAGRAS_Ecig_March_3_2015.pdf

4. E-cigarettes do not emit side-stream smoke as cigarettes do, but people near the user are exposed to exhaled vapor containing nicotine and other chemicals. Two indoor air quality studies designed to model real-world conditions where e-cigarettes are used, such as a bar or café, found elevated levels of nicotine, volatile organic compounds including carcinogens, metals, and ultrafine particulates. Levels of exposure to toxic chemicals from e-cigarettes was much lower than from conventional cigarettes; however, nicotine exposure was almost comparable in nonsmokers exposed secondhand to e-cigarettes and to conventional cigarettes.

Source: reviewed in Grana, G., Benowitz, N., Glantz, S.A. 2014. "E-Cigarettes: A Scientific Review" *Circulation*. 129: 1972-1986. doi: 10.1161/CIRCULATIONAHA.114.007667. <http://circ.ahajournals.org/content/129/19/1972>

5. Studies of secondhand exposure to vapor in controlled emissions chambers found an increase in levels of nicotine and ultrafine particles (PM_{2.5}). VOC levels may be associated with normal human expired air (formaldehyde, isoprene, acetone, ethanol, methanol).

Sources:

- i. Schripp T, Markewitz D, Uhde E, Salthammer T. 2013 "Does e-cigarette consumption cause passive vaping?" *Indoor Air* 23(1):25-31. doi: 10.1111/j.1600-0668.2012.00792.x. <http://onlinelibrary.wiley.com/doi/10.1111/j.1600-0668.2012.00792.x/epdf>
- ii. Czogala J., Gonewicz MJ, Bartlomiej F, et. al. (2013) Secondhand exposure to vapors from electronic cigarettes. *Nicotine & Tobacco Research* 16(6): 655-662. Doi: 10.1093/ntr/ntt203
- iii. Fenske JD, Paulson SE. (1999) Human breath emissions of VOCs. *Air & Waste Manage. Assoc* 49:594-598.

6. An exposure assessment published in the journal for the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) found that vaping in a small office space could produce chemical exposure levels that increase risks of cancer and non-cancer chronic health effects for the vapor product user, as well as increased hazard for others in the office due to exposure to nicotine and propylene glycol. This analysis also found that ventilation rates in the room could not practically be improved to mitigate the health risks for all of the vapor chemicals.

Source: Offermann, Bud. 2014. "The Hazards of E-Cigarettes" *AHSRAE Journal*.

http://bookstore.ashrae.biz/journal/download.php?file=2014June_038-047_IAQ_Offerman_rev.pdf

7. The American Academy of Pediatrics has published several articles reviewing what is known about health risks associated with components of vaping product chemical mixtures (e-liquid) and the aerosol generated by e-cigarettes. In addition to nicotine, numerous cancer-causing and/or toxic substances have been found in the chemical mixtures intended for e-cigarette use. These include aldehydes, nitrosamines, metals, alkaloids, and polycyclic aromatic hydrocarbons. They note a study which revealed that there were large discrepancies (as much as 89%) between the label and actual nicotine content. They note that the emissions from e-cigarettes are most accurately referred to as an aerosol, which is a suspension of fine particles in a gas. Non-users may be exposed to chemicals in the aerosol by secondhand inhalation, and "thirdhand" exposure on surfaces. Some of the known harmful toxic substances found in e-cigarettes aerosols include polycyclic aromatic hydrocarbons, nicotine, volatile organic compounds, ultrafine particles, particulate matter, and other chemicals. Metal and silicate particles have been found in some cases to occur at higher levels than in conventional cigarettes. Nicotine on surfaces has been shown to be increased after e-cigarette use.

Source: American Academy of Pediatrics Section on Tobacco Control. (2015) Electronic Nicotine Delivery Systems. *Pediatrics* 136(5). DOI: 10.1542/pes.2015-3222.

8. Inhaled fine particulate matter poses a known health risk to those who are exposed. Fine particles (also known as PM_{2.5}) are especially dangerous because they contain microscopic solids or liquid droplets that are so small they can get deep into the lungs and cause serious health problems. Numerous studies have linked PM_{2.5} with premature death in people with heart or lung disease, nonfatal heart attacks, worsened asthma, decreased lung function, and irritation of the airways. These particles are of special risk because they deliver any associated liquids or solids deep into the airways, making the substances easier for the body to absorb, and more difficult for the lungs to clear. Researchers at the Virginia Commonwealth University analyzed indoor air quality during a two day e-cigarette event held in a large room at a hotel. PM_{2.5} concentrations were higher than concentrations reported previously in hookah cafes and bars that allow cigarette smoking.

Source: Soule EK, Maloney SF, Spindle TR, et. al. (2016) Electronic cigarette use and indoor air quality in a natural setting. *Tobacco Control*. Doi: 10.1136/tobaccocontrol-2015-052772.

Increasing Use of E-Cigarettes and Vapor Products by Youth

The use of vapor products has risen at an alarming rate every year since these products came to the U.S. market in 2007. Kids who use vapor devices to inhale nicotine or marijuana are at risk for developing a life-long dependence. Washington State law has prohibited the sales of vapor devices containing nicotine to minors under 18 since 2013. However other regulations that reduce youth access to tobacco products have not been extended to e-cigarettes and vapor products. Lack of federal and state regulation of vapor products that allow unsubstantiated safety claims, widespread advertising, unrestricted sales, and use in public places all contribute to perceptions among youth that e-cigarettes are safe to use.

1. The 2014 National Youth Tobacco Survey found that use of e-cigarettes among middle and high school students tripled from 2013 to 2014. For the first time since the survey began collecting data on e-cigarettes in 2011, current e-cigarette use also surpassed current use of every other tobacco product overall, including conventional cigarettes.

Source: 2014 National Youth Tobacco Survey in Arrazola et al. "Tobacco Use Among Middle and High School Students — United States, 2011–2014" *MMWR*. April 17, 2015. Vol. 64. No. 14. Media summary: <http://www.cdc.gov/media/releases/2015/p0416-e-cigarette-use.html> Full study: http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6414a3.htm?s_cid=mm6414a3_w

2. The 2014 Washington State Healthy Youth Survey found:

- In Washington, for 10th graders overall, 18% report they are vaping compared to 8% who are smoking.
- More Kitsap County students across all grades use vapor products than use conventional cigarettes. Nine percent of 8th graders, 23 percent of 10th graders, and 27 percent of 12th graders in Kitsap County reported using e-cigarettes at least once in the past month.

Source: 2014 Washington Health Youth Survey. <http://www.askhys.net/>

3. More than a quarter of a million U.S. youth (263,000) who had never smoked a cigarette used electronic cigarettes in 2013, up from about 79,000 in 2011. Middle and high schoolers who had used vapor products were nearly twice as likely to have intentions to smoke conventional cigarettes than youth who had never used e-cigarettes.

Source: Bunnell RE, Agaku IT, Arrazola Ra, *et al.* 2014. "Intentions To Smoke Cigarettes Among Never-Smoking US Middle And High School Electronic Cigarette Users, National Youth Tobacco Survey, 2011--2013". *Nicotine Tob Res.* 2014:1-8. doi:10.1093/ntr/ntu166

4. Teens who are using e-cigarettes are often also smoking conventional cigarettes. In 2011, the CDC found that 61% of U.S. middle school students and 80% of US high school students who were vaping were also smoking.

Source: “Notes from the Field: Electronic Cigarette Use Among Middle and High School Students — United States, 2011–2012” MMWR September 6, 2013 / 62(35); 729-730.

http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6235a6.htm?utm_source=rss&utm_medium=rss&utm_campaign=notes-from-the-field-electronic-cigarette-use-among-middle-and-high-school-students-united-states-20112012

5. The American Academy of Pediatrics has published several articles expressing concern about the use of e-cigarettes in youth. Their September 2015 review article outlines several specific concerns. E-cigarettes may be attracting youth who may not otherwise have used tobacco products and several studies have noted high levels of dual use of e-cigarettes and conventional cigarettes. They note that e-cigarette use has been found to be associated with more likelihood of tobacco use. In addition, youth using e-cigarettes were less likely to stop smoking. Because cigarettes with candy and fruit flavoring encourage youth addiction, flavorings have been banned in conventional cigarettes since 2009, but this is not true for e-cigarettes. Finally, youth using e-cigarettes perceived them as healthier than cigarettes.

Source: American Academy of Pediatrics Section on Tobacco Control. (2015) Electronic Nicotine Delivery Systems. Pediatrics 136(5). DOI: 10.1542/pes.2015-3222.

Uncertainty about Effectiveness of Vapor Products as a Substitute for Smoking or Cessation Aides

Vapor products may, in the future, prove to be effective substitutes for individuals who are trying to stop smoking cigarettes.. Surveys often find that individuals state they are using vapor products to quit smoking and some studies have found that e-cigarette users self-report that they have reduced their cigarette consumption. However, there is no evidence at this time from controlled longitudinal population-based research that e-cigarettes and vapor products are effective smoking cessation aides. Controlled studies are finding that e-cigarette users are actually less likely to stop smoking. In addition, former smokers may be triggered to smoke again by seeing e-cigarette use or advertising.

1. The FDA has *not* approved any e-cigarettes or vapor products as smoking cessation products. Smoking cessation products (e.g. nicotine patches or pharmaceuticals like Chantix or Zyban) are regulated through FDA’s Center for Drug Evaluation and Research, which ensures that the products are safe and effective and that their benefits outweigh any known associated risks.

Source: FDA Smoking Cessation Products webpage. <http://www.fda.gov/ForConsumers/ConsumerUpdates/ucm198176.htm>

2. A 2014 metaanalysis of the five available population-based studies on e-cigarette use and quitting smoking found that e-cigarette use is associated with significantly *lower* odds of quitting smoking cigarettes.

Source: Grana, G., Benowitz, N., Glantz, S.A. 2014. “E-Cigarettes: A Scientific Review” Circulation. 129: 1972-1986. doi: 10.1161/CIRCULATIONAHA.114.007667. <http://circ.ahajournals.org/content/129/19/1972>

3. A 2016 metaanalysis of 38 studies on smoking cessation published during 2015 showed: “As currently being used, e-cigarettes are associated with significantly less quitting among smokers.” E-cigarette users were 28% less likely to quit smoking.

Source: Kalkhoran S and Glantz A. (2016) E-cigarettes and smoking cessation in real-world and clinical settings: a systematic review and meta-analysis. *The Lancet* Vol 4(2):116–128 DOI:: [http://dx.doi.org/10.1016/S2213-2600\(15\)00521-4](http://dx.doi.org/10.1016/S2213-2600(15)00521-4).
<http://thelancet.com/action/showFullTextImages?pii=S2213-2600%2815%2900521-4>

4. A recent controlled study that followed 1000 California smokers using e-cigarettes for a year found they were significantly less likely to reduce their cigarette consumption and less likely to quit smoking compared to smokers who never used e-cigarettes.

Source: Wael K. Al-Delaimy, Mark G. Myers, Eric C. Leas, David R. Strong, and C. Richard Hofstetter. “E-Cigarette Use in the Past and Quitting Behavior in the Future: A Population-Based Study.” *American Journal of Public Health*: June 2015, Vol. 105, No. 6, pp. 1213-1219. doi: 10.2105/AJPH.2014.302482.
<http://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2014.302482>

5. Two well-executed studies show e-cigarette use is associated with significantly less tobacco use cessation. Both followed smokers over time and compared quitting cigarettes among smokers who use e-cigarettes with smokers who did not use e-cigarettes. One, based on a large national study, found that e-cigarette users were less than half as likely to have quit smoking than smokers not using e-cigarettes.ⁱ The other study followed people in a smoking cessation program and found that e-cigarette users were about a third less likely to quit smoking.ⁱⁱ

Sources:

i.Yuyan S, Pierce J, White M, et. al.(2015) E-cigarette use, smoking cessation and change in smoking intensity in the 2010/2011 TUS-CPS longitudinal cohort. Presented at Society for Research on Nicotine and Tobacco meeting.
<https://tobacco.ucsf.edu/two-more-well-done-studies-show-e-cig-use-associated-significantly-less-quitting-smoking>

ii.Pavlov d, Ivanova A, Hussain S, et. al. Adoption of e-cigarettes during tobacco dependence treatment is associated with poorer quit outcomes. Presented at Society for Research on Nicotine and Tobacco meeting for 2015.
<https://tobacco.ucsf.edu/two-more-well-done-studies-show-e-cig-use-associated-significantly-less-quitting-smoking>

Use of THC and other drugs in vapor devices

Vapor products can be used to deliver drugs other than nicotine, and are commonly used with marijuana or concentrated extracts of marijuana, like THC. Some marijuana e-liquids dissolve the THC in the same chemical solvents used in nicotine e-liquids others use oils to generate vapor, and others are designed to vaporize loose leaf marijuana.

1. Marijuana retailers in Washington State sell a variety of e-cartridges pre-loaded with THC solutions for use in vape pens and other vapor devices. Sales of THC concentrates are allowed under Washington State’s recreational marijuana law. Customers may purchase up to seven grams of marijuana extract/concentrate for inhalation.

Source: Washington State Liquor Control Board. FAQs about I-502 Rules. http://www.liq.wa.gov/marijuana/faq_rules

2. At least one company is marketing a disposable vape pen containing marijuana called JuJu Joints. The company is based in Washington State and the product is currently sold by marijuana retailers in Washington and Colorado.

Sources: JuJu Joints company website: <http://jujujoints.com/> and Peikoff, K. New York Times “No Smoke, but Haze Around E-Joint”. Jan.12, 2015. <http://www.nytimes.com/2015/01/13/health/with-the-e-joint-the-smoke-clears-.html>