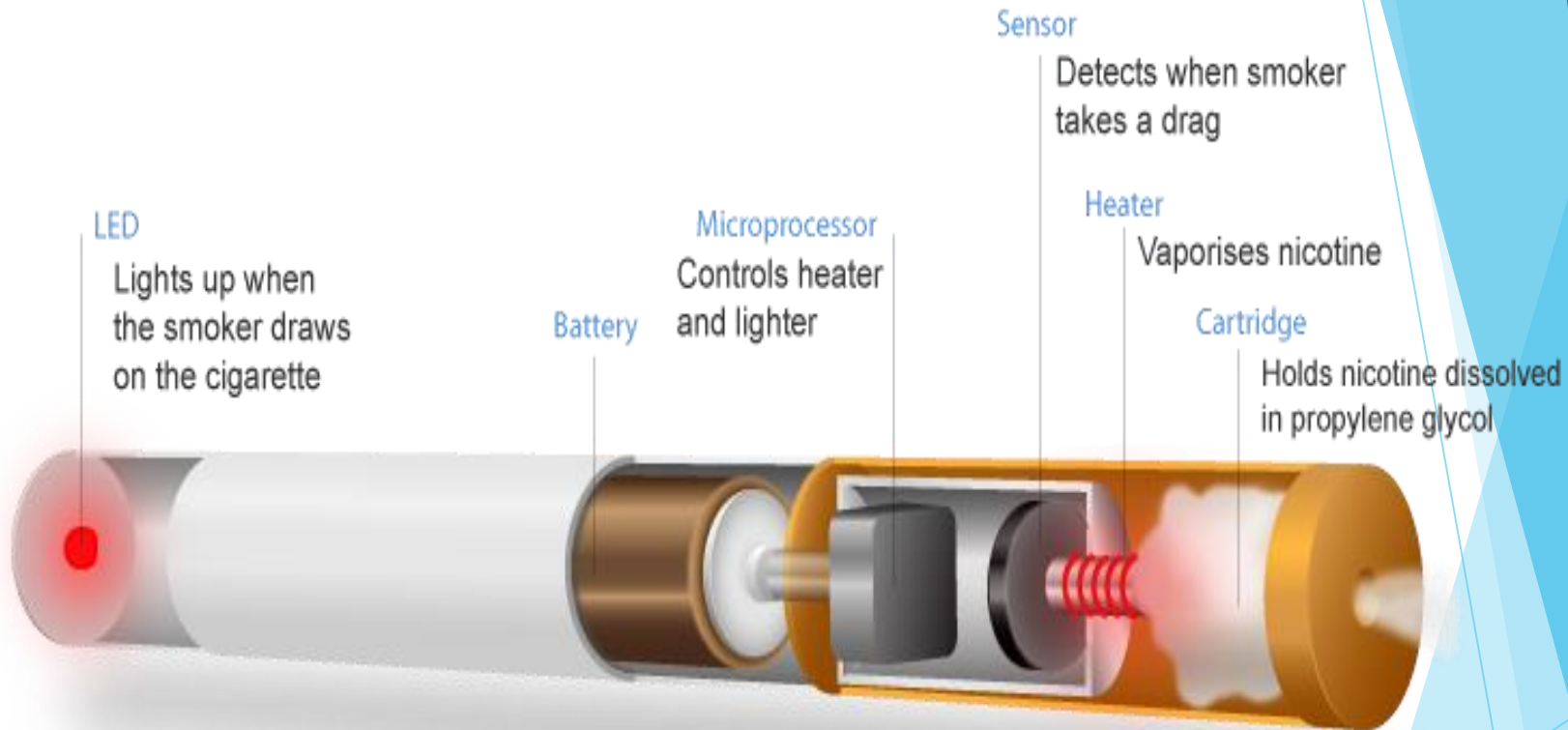


# Electronic Cigarettes in the Indoor Environment

Cheri Marcham, PhD, CIH, CSP, CHMM, FAIHA  
[march617@erau.edu](mailto:march617@erau.edu)

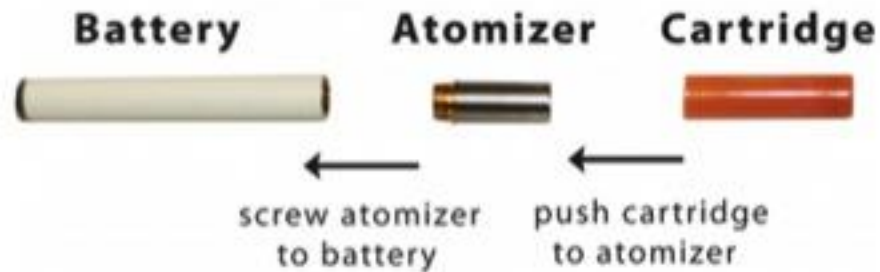
# Anatomy of an E-Cigarette



# First Generation ECs (‘cigalikes’)



- Disposable
- Re-chargeable with pre-filled cartridges



# Second Generation ECs

- Refillable with liquids



# Third Generation ECs ('mods')





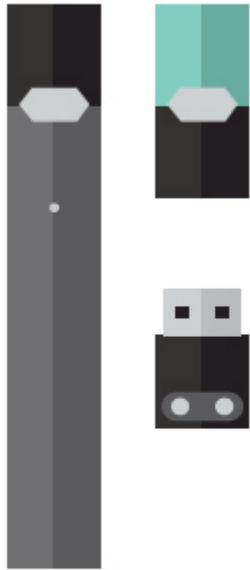
# Cloud Chasing



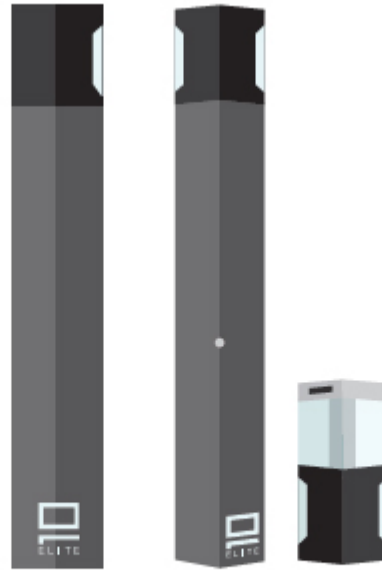
<https://www.youtube.com/watch?v=EVPz7uu4LQs>



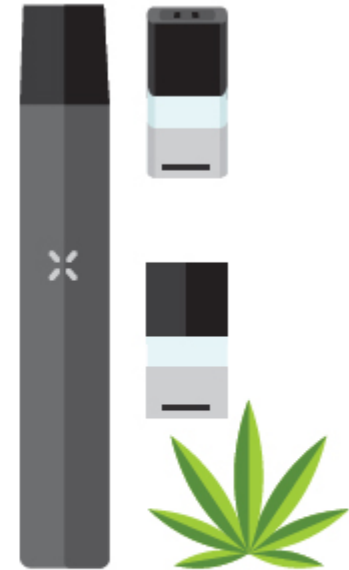
# Fourth Generation



JUUL



MarkTen Elite



PAX Era

Source: [https://www.cdc.gov/tobacco/basic\\_information/e-cigarettes/factsheet/index.html](https://www.cdc.gov/tobacco/basic_information/e-cigarettes/factsheet/index.html)

# Statistics

- More than 460 different e-brands on the market.\*
- Over 7,700 unique e-cigarette flavors.\* As of January 2014
- China produces approximately 90% of the world's e-cigarettes and 91% of US imports
- Chinese manufacturers shipped more than 300 million e-cigarettes to the US and Europe in 2014
- 2016 GAO import data are in dollars (includes parts, liquids, and devices) = \$342,257,308.00

Barboza, D. (2014, December 13). China's e-cigarette boom lacks oversight for safety. *The New York Times*. Retrieved from [http://www.nytimes.com/2014/12/14/business/international/chinas-e-cigarette-boom-lacks-oversight-for-safety-.html?\\_r=0](http://www.nytimes.com/2014/12/14/business/international/chinas-e-cigarette-boom-lacks-oversight-for-safety-.html?_r=0)

U.S. Government Accountability Office. (2017, April 24). *Electronic cigarettes: US Imports in 2016*. Retrieved from <https://www.gao.gov/assets/690/684227.pdf>

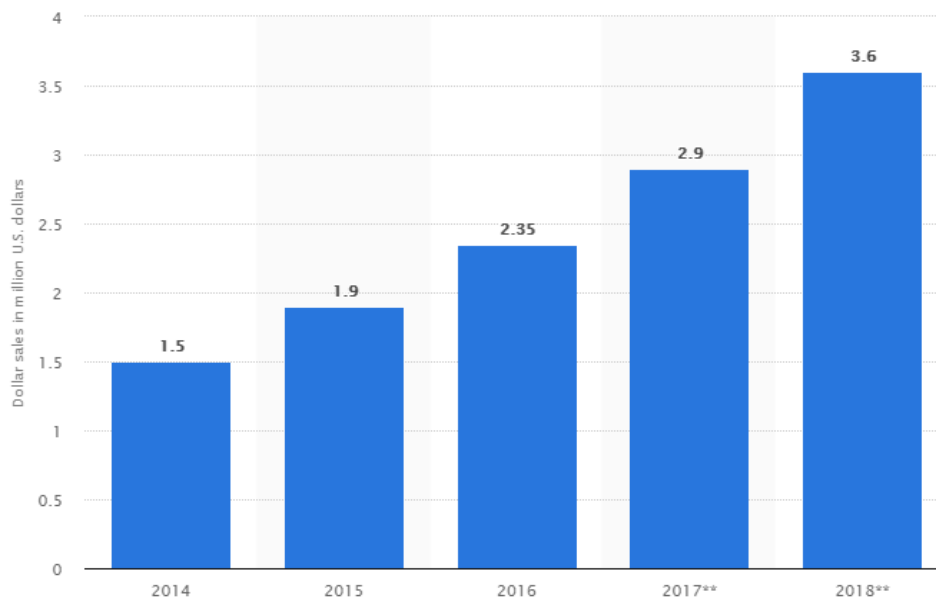
Zhu, S. (2014). Four hundred and sixty brands of e-cigarettes and counting: Implications for product regulation. *Tobacco Control*. doi:10.1136/tobaccocontrol-2014-051670



Consumer Goods &amp; FMCG &gt; Tobacco &gt; U.S. e-cigarettes dollar sales 2014-2018

PREMIUM +

## Electronic cigarettes (e-cigarettes) dollar sales in the United States from 2014 to 2018 (in billion U.S. dollars)\*



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SETTINGS

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PNG



PDF



XLS



PPT



DESCRIPTION

SOURCE

MORE INFORMATION

This statistic shows the estimated dollar sales of electronic cigarettes in the United States from 2014 to 2016 and provides a forecast for 2017 and 2018. E-cigarettes were estimated to reach 2.35 billion U.S. dollars in sales in 2016.



Data visualized by + a b l e a u

[About this statistic](#)

© Statista 2018

[Show source](#)

+ Revenue from cigarette sales in

China 2011-2017

+ Annual growth in the revenue of

cigarette sales in China 2011-2017

+ U.S. C-stores: e-cigarettes dollar

sales 2017, by brand

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OK

# Statistics

- In 2015, 99.0% of e-cigarette products contained nicotine
- In 2014, an estimated 2.5 million middle and high school students used e-cigarettes.
- In 2018, this number increased to more than 3 million
  - 1 in 5 high school kids; 1 in 20 middle school kids
  - “JUUL was not specifically mentioned in the (CDC) survey, many teens refer to JUUL use as ‘juuling,’ indicating they may not consider it to be using an e-cigarette.”
  - Only 25% of individuals who recognized the product and 37% of past users reported that JUUL always contains nicotine

Marynak, K. L., Gammon, D. G., Rogers, T., Coats, E. M., Singh, T., & King, B. A. (2017). Sales of nicotine-containing electronic cigarette products: United States, 2015. *American Journal of Public Health*, 107(5), 702-705. doi:10.2105/AJPH.2017.303660

Fox, M. (2018, June 7). Vaping, Juuling are the new smoking for high school kids. *NBC News*. Retrieved from <https://www.nbcnews.com/health/health-news/vaping-juuling-are-new-smoking-high-school-kids-n881121>

Willett J.G., Bennett M., Hair E.C., Xiao, H. Greensberg, M. Harvey, E. Cantrell, J. & Vallone, D. (2018). Recognition, use and perceptions of JUUL among youth and young adults. *Tobacco Control*. doi: 10.1136/tobaccocontrol-2018-054273

# Statistics

- In June 2018, in the US, it was estimated that about 68% of current EC sales are JUUL products
- Middle and high school students, as well as young adults, make up a large fraction of JUUL consumers
- Nicotine content in JUUL is increasing

<https://www.cnn.com/videos/health/2019/02/07/e-cigarettes-juul-nicotine-arms-race-sanjay-gupta-pkg-vpx-newday.cnn>

Zaleski O. E-Cigarette Maker Juul Labs Is Raising \$1.2 Billion. *Bloomberg*.

<https://www.bloomberg.com/news/articles/2018-06-29/e-cigarette-maker-juul-labs-is-raising-1-2-billion> .

Published June 29, 2018. Accessed September 9, 2018

Huang, J., Duan, Z., Kwok, J., Binns, S., Vera, L.E., Kim, Y., Szczypka, G., and Emery, S.L. (2018). Vaping versus JUULing: how the extraordinary growth and marketing of JUUL transformed the US retail e-cigarette market. *Tob. Control*, tobaccocontrol-2018-054382. doi: 10.1136/tobaccocontrol-2018-054382

# Statistics

- There is some evidence that young people who use e-cigarettes may be more likely to smoke cigarettes in the future.
  - Among high school students that were electronic nicotine delivery system (ENDS) users, 25% went on to be conventional tobacco product users, compared with 9% in the population that had never used an ENDS

Leventhal, A.M., Strong, D.R., Kirkpatrick, M.G., Under, J. B., Sussman, S., Riggs, N.R., Stone, M.D., Khoddam, R., Sarnet, J.M. & Audrain-McGovern, J. (2015). Association of electronic cigarette use with initiation of combustible tobacco product smoking in early adolescence. *JAMA*. doi:10.1001/jama.2015.8950

Rigotti, N.A. (2015). E-cigarette use and subsequent tobacco use by adolescents: New evidence about a potential risk of e-cigarettes. *JAMA*, 314(7), 673-674. doi:10.1001/jama.2015.8382

# Statistics

- In England, 25% of 11-15 year olds had tried an e-cig in 2016 (22% in 2014)
- Data collected over a 12-month period of 13-14 year olds in the UK confirmed a sizeable relationship between use of e-cigarettes and subsequent initiation of cigarette use, but whether friends smoke cigarettes was a more accurate predictor of initiating cigarette use than e-cig use

British Medical Association. (2018). *E-cigarettes: Balancing risks and opportunities*. Retrieved from <https://www.bma.org.uk/-/media/files/pdfs/collective%20voice/policy%20research/public%20and%20population%20health/e-cigarettes-position-paper-v3.pdf?la=en>

Conner, M., Grogan, S., Simms-Ellis, R., Flett, K., Sykes-Muskett, B., Cowap, L., . . . Siddiqi, K. (2017). Do electronic cigarettes increase cigarette smoking in UK adolescents? Evidence from a 12-month prospective study. *Tobacco control*. doi: 10.1136/tobaccocontrol-2016-053539



# Food and Drug Administration

- August 8, 2016, the FDA regulation banning the sale of e-cigarettes to minors became effective
  - Photo ID required
  - Retailers may not hand out free samples
  - No sales in vending machines
- The FDA now requires manufacturers, importers, and retailers to report ingredients and place health warnings on products and advertisements
- Vape shops that mix e-liquids supposed to be regulated as a retailer and a manufacturer

# FDA Crackdown

- September 12, 2018: Warning that teenage use of electronic cigarettes has reached “an epidemic proportion,” the FDA has given Juul Labs and four other makers of popular vaping devices 60 days to prove they can keep them away from minors. If they fail, the agency said, it may take the flavored products off the market.
- June – September, 2018: FDA sent warning letters to 1,100 retailers — including 7-Eleven, Walgreens, Circle K, and gas stations, and issued another 131 fines, ranging from \$279 to \$11,182, for selling e-cigarettes to minors.
  - The adolescent brain is particularly vulnerable to addiction
  - Does not fully develop until age 25

Food and Drug Administration. (2018). Warning letters and civil money penalties issued to retailers for selling JUUL and other e-cigarettes to minors. Retrieved from

<https://www.fda.gov/TobaccoProducts/NewsEvents/ucm605278.htm>

Kaplan, S. & Hoffman, J. (2018, September 12). F.D.A. targets vaping, alarmed by teenage use. *New York Times*. Retrieved from <https://www.nytimes.com/2018/09/12/health/juul-fda-vaping-ecigarettes.html>

# FDA Crackdown

- November 2018: FDA Commissioner Scott Gottlieb, MD.  
“Based on our evidence, we believe the presence of flavors is one component making these products especially attractive to kids. The mandate to reverse this trend in youth addiction to nicotine is one of my highest priorities.”
  - Proposed ending sales of e-cigarette products in flavors that appeal to kids
  - Banning flavors in cigars, including little cigars
  - Banning the marketing of e-cigarette products using children’s cartoon or animated characters, or names of products favored by kids like brands of candy or soda

American Cancer Society. (2018). FDA Proposes Regulations as Teen E-Cigarette Use Skyrockets 78% in 1 Year. Retrieved from <https://www.cancer.org/latest-news/fda-proposes-regulations-as-teen-e-cigarette-use-skyrockets-78-percent-in-1-year.html>

# Long-term Public Health Concerns?



According to repeated nationwide surveys,

## More Doctors Smoke **CAMELS** than any other cigarette!

Doctors in every branch of medicine were asked, "What cigarette do you smoke?" The brand named most was Camel!

You'll enjoy Camels for the same reasons so many doctors enjoy them. Camels have cool, cool *mildness*, pack after pack, and a flavor unmatched by any other cigarette. Make this sensible test: Smoke only Camels for 30 days and see how well Camels please your taste, how well they suit your throat as your steady smoke. You'll see how enjoyable a cigarette can be!

THE DOCTORS' CHOICE IS AMERICA'S CHOICE!

MARGARET O'HARA says: "I pick Camels. They agree with my throat and taste wonderful."

DICK BOWEN says: "I get more pleasure from Camels than from any other brand."

RALPH BELLAMY agrees: "Camels suit my taste and throat. I've smoked 'em for years!"

For 30 days, test Camels in your "T-Zone" (T for Throat, T for Taste).

He's one of the busiest men in town. While his door may say *Office Hours 2 to 4*, he's actually on call 24 hours a day.

The doctor is a scientist, a diplomat, and a friendly sympathetic human being all in one, no matter how long and hard his schedule.

According to a recent Nationwide survey:

## MORE DOCTORS SMOKE CAMELS THAN ANY OTHER CIGARETTE

DOCTORS in every branch of medicine—113,597 in all—were queried in this nationwide study of cigarette preference. Three leading research organizations made the survey. The gist of the query was—What cigarette do you smoke, Doctor?

The brand named most was Camel!

The rich, full flavor and cool mildness of Camel's superb blend of costlier tobaccos seem to have the same appeal to the smoking tastes of doctors as to millions of other smokers. If you are a Camel smoker, this preference among doctors will hardly surprise you. If you're not—well, try Camels now.

Your "T-Zone" Will Tell You...

T for Taste...  
T for Throat...  
that's your proving ground for any cigarette. See if Camels don't suit your "T-Zone" to a "T."

**CAMELS** Costlier Tobaccos







# Primary Components



- Propylene Glycol/  
Vegetable Glycerin
- Nicotine
- Flavorings

# Propylene Glycol/Vegetable Glycerin

- Propylene glycol used in theatrical fog:
  - Exposure may contribute to both acute and chronic health issues, such as asthma, wheezing, chest tightness, decreased lung function, respiratory irritation, and airway obstruction
  - Irritated mucous membrane symptoms associated with acute exposure to glycol-based fogs
  - Systemic symptoms (acute headache, dizziness, drowsiness, tiredness) associated with glycol fog



Varughese, S., Teschke, M., Brauer, Y. Chow, C. Van Netten, C. & Kennedy, S.M. (2005) Effects of theatrical smokes and fogs on respiratory health in the entertainment industry. *American Journal of Industrial Medicine*, 47, 411–418

# Propylene Glycol/Vegetable Glycerin

- Pyrolysis/heating glycerin forms acrolein, formaldehyde and acetaldehyde in the vapors

Geiss, O., Bianchi, I., Barhona, F., & Barrero-Moreno, J. (2014). Characterisation of mainstream and passive vapours emitted by selected electronic cigarettes. *International Journal of Hygiene and Environmental Health*, 281, 169-180

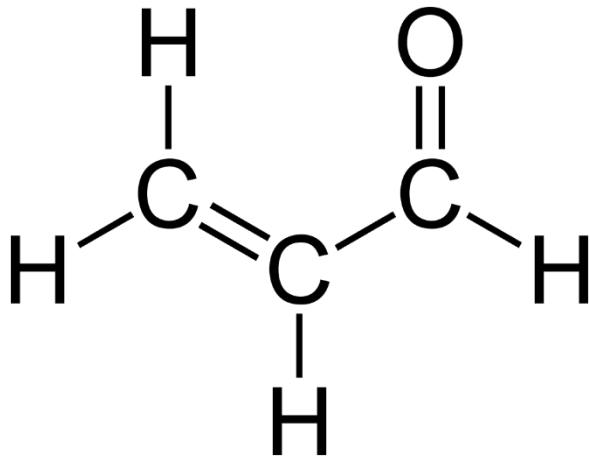
Goniewicz, M.L., Knysak, J., Gawron, M., Kosmider, L., Sobczak, A. Kurek, J., Prokopowicz, A. ...& N. Benowitz. (2013). Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tobacco Control*. 0:1-7 doi:10.1136/tobaccocontrol-2012-050859.

# Formaldehyde

- A known degradation product of propylene glycol and glycerin
- Found in vapor and in small amounts in some studies of some liquids
- Higher airborne concentrations with higher voltage second and third generation units
- Known human carcinogen



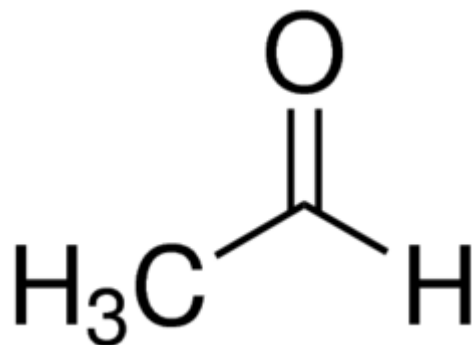
# Acrolein



- Causes irritation to the nasal cavity, damage to the lining of the lungs and is thought to contribute to cardiovascular disease in cigarette smokers
- Found in vapor only (formed as a result of heating process)

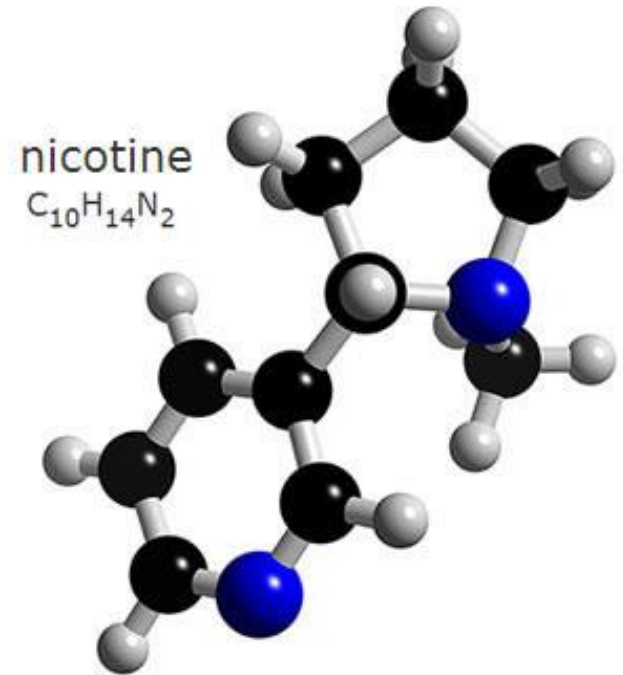


# Acetaldehyde



- Irritation of the eyes, skin, and respiratory tract
- Probable human carcinogen

# Nicotine



- Health Effects
  - Addictive
  - Teratogenic
  - Can harm adolescent brain development
  - Increases heart rate, respiratory rate, blood pressure, and level of alertness
- E-Cig Labeling
  - Some cartridges labeled as containing no nicotine did, in fact, contain detectable levels of nicotine
  - Concentration and delivery inconsistencies
- Nicotine found in vapor and secondhand emissions, but lower than what's emitted from conventional cigarettes

# Poison center calls involving e-cigarettes





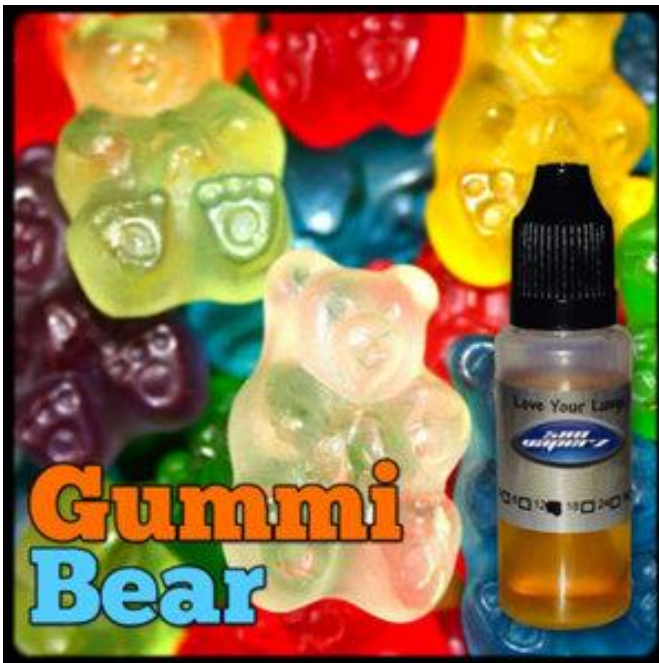
The first reported child's death from accidentally ingesting e-liquid was in early December of 2014 involving a 1-year old in Fort Plain, New York.



# Flavorings









"Unicorn Vomit is a rainbow of flavors that comes straight from the puke of a unicorn. Taste of sweet candy and ice cream flavors."

"...everyone knows Unicorns are made of cupcakes and rainbows! This tastes like blueberry cupcakes with white chocolate frosting and a raspberry on top!"



Jackler, R. K., & Ramamurthi, D. (2017). Unicorns cartoons: Marketing sweet and creamy e-juice to youth. *Tobacco Control*, 26(4), 471-475. doi:10.1136/tobaccocontrol-2016-053206



# Additives



Food and Drug Administration. (2010). Warning letter. Retrieved from <http://www.fda.gov/ICECI/EnforcementActions/WarningLetters/ucm225187.htm>

# Other Additives







90% of the legal cannabis grown and produced is extracted for edibles or vaping



# Generally Recognized as Safe (GRAS)?





Diacetyl as a food additive is GRAS, but aerosolized exposures can cause bronchiolitis obliterans



[Display Settings:](#) ☒ Abstract[Send to:](#) ☒

*Int J Occup Environ Health.* 2012 Jan-Mar;18(1):29-42.

## Bronchiolitis obliterans and consumer exposure to butter-flavored microwave popcorn: a case series.

Egilman DS, Schilling JH.

Department of Family Medicine, Brown University, Providence, Rhode Island, USA. degilman@egilman.com

### Abstract

Respiratory exposure to diacetyl and diacetyl-containing flavorings used in butter-flavored microwave popcorn (BFMP) causes lung disease, including bronchiolitis obliterans (BO), in flavorings and popcorn manufacturing workers. However, there are no published reports of lung disease among BFMP consumers. We present a case series of three BFMP consumers with biopsy-confirmed BO. We review data relating to consumer exposures, estimate case exposures, and compare them to diacetyl-containing flavoring-exposed manufacturing workers with lung disease. These consumer cases' exposure levels are comparable to those that caused disease in workers. We were unable to identify any other exposures or diseases known or suspected to cause BO in these cases. BFMP poses a significant respiratory risk to consumers. Some manufacturers have substituted diacetyl with other alpha-diketones that are likely to pose a similar risk. Simple consumer practices such as cooling the popcorn bag would eliminate the risk of severe lung disease.

PMID: 22550695 [PubMed - in process]

# Diacetyl and Acetylpropionyl

- Diacetyl and acetylpropionyl (aka 2,3-pentanedione) are GRAS but are associated with respiratory disease when inhaled
  - The risks associated with inhalation of acetylpropionyl may be as high as from diacetyl based on inhalation studies with rats
- 159 samples purchased from 36 manufacturer and retailers in 7 countries\*
  - Diacetyl and acetylpropionyl were found in 74.2% of the samples
    - Even found in samples from manufacturers who clearly stated that these chemicals were not present

\*Farsalinos, K. E., Kistler, K. A., Gilman, G., Voudris, V. (2015) Evaluation of electronic cigarette liquids and aerosol for the presence of selected inhalation toxins. *Nicotine & Tobacco Research*, 168-174, doi: 10.1093/ntr/ntu176

# More Diacetyl and Acetylpropionyl

- In a different study, diacetyl found in the vapor, but not in the liquid, of 39 of 51 different e-liquid flavors that were tested
- Acetylpropionyl/2,3-pentanedione and acetoin (substitutes for diacetyl) detected in 23 and 46 of the 51 flavors tested
  - Rats inhaling 2,3-pentanedione developed necrotizing rhinitis, tracheitis, and bronchitis comparable to diacetyl-induced injury, and 2,3-pentanedione was found to alter gene expression in the brain

Allen, J.G., Flanigan, S.S., LeBlanc, M., Vallarino, J., MacNaughton, P., Stewart, J.H., & Christiani, D.C. (2015). 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*. Advance online publication. doi: 10.1289/ehp.1510185

Hubbs, A. F., Cumpston, A. M., Goldsmith, W. T., Battelli, L. A., Kashon, M. L., Jackson, M. C., . . . Sriram, K. (2012). Respiratory and olfactory cytotoxicity of inhaled 2,3-pentanedione in Sprague-Dawley rats. *Am J Pathol*, 181(3), 829-844. doi:10.1016/j.ajpath.2012.05.021

# JUUL Flavor Cytotoxicity

- Nicotine plus flavor, nicotine alone, and ethyl maltol flavor were strongly correlated to cytotoxicity
  - 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT), Neutral Red Uptake, (NRU) and Lactate Dehydrogenase (LDH) culture assays
  - Ethyl maltol is described as “caramelized sugar and cooked fruit” or “cotton candy”
- Flavor chemicals alone and menthol were weakly correlated to cytotoxicity

Omaiye, E., McWhirter, K.J., Luo, W., Pankow, J.F., Talbot, P. (2018). Toxicity of JUUL fluids and aerosols correlates strongly with nicotine and some flavor chemical concentrations. (Online preprint)

# Flavoring Concerns

- Benzaldehyde was detected in cherry flavoring, but also in 75% of 145 e-cig refill liquids
  - Cytotoxic and genotoxic to cell cultures
- Vanillin, cinnamaldehyde, eugenol (clove), acetylpyridine (corn), and menthol are harmful to the endothelium
  - Cinnamaldehyde present in 51% of 39 refill liquids
  - Cinnamaldehyde is also highly cytotoxic
- Methyl anthranilate was detected in grape flavoring
- 1-hexanol was detected in apple flavoring

Behar, R.Z., Luo, W., Lin, S.C., Wang, Y., Valle, J., Pankow, J.F. & Talbot, P. (2016). Distribution, quantification and toxicity of cinnamaldehyde in electronic cigarette refill fluids and aerosols. *Tobacco Control*. doi:10.1136/tobaccocontrol-2016-053224

Fetterman, J. L., Weisbrod, R. M., Feng, B., Bastin, R., Tuttle, S. T., Holbrook, M., . . . Hamburg, N. M. (2018). Flavorings in tobacco products induce endothelial cell dysfunction. *Arterioscler Thromb Vasc Biol*, 38(7), 1607-1615. doi:10.1161/atvbaha.118.311156



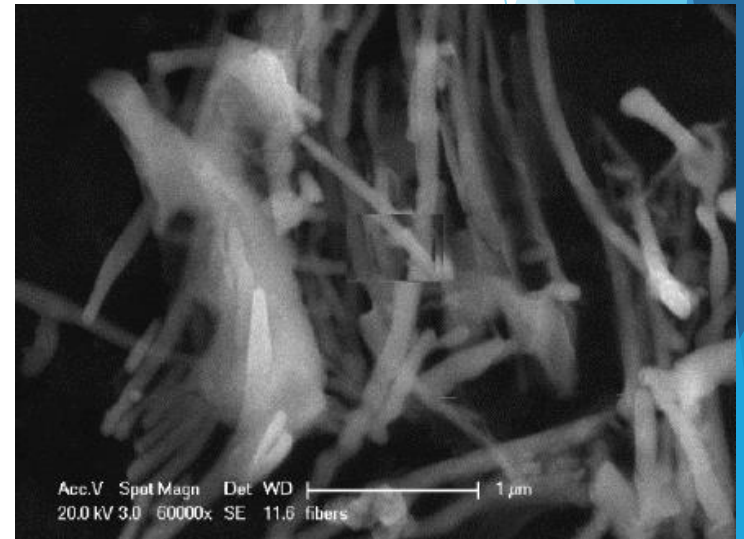
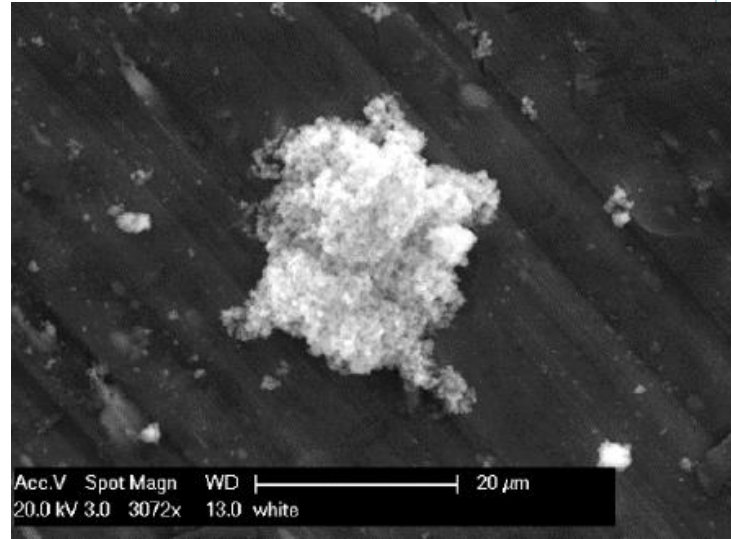
# Flavoring Concerns

- Little research on potential health effects of aerosolized vapor exposure
- No research on pyrolyzation products of flavorings
- Manufacturing of many flavoring sources are outside the US (China)



# Additional Potential Exposures

- Tin
- Lead
- Nickel
- Zinc
- Copper
- Chromium
- Silicon fibers
- Nanoparticles



Aerosols from popular disposable e-cigs contained at least 35 elements/metals, 21 of which were not found in cigarette smoke

Williams, M., Bozhilov, K., Ghai, S., & Talbot, P. (2017). Elements including metals in the atomizer and aerosol of disposable electronic cigarettes and electronic hookahs. *PLoS One*, 12(4), e0175430.

# Second-Hand Exposure Concerns

- Nicotine\*
- Formaldehyde\*
- Acrolein
- Acetaldehyde\*
- Fine/Ultrafine Particles
- Tin, Lead, Nickel, Chromium\*\*
- Flavorings
  - Nut and other allergies
  - Diacetyl,\* 2,3-Pentanedione,\* 2,3-Hexanedione\*



\*NIOSH performed a HHE in a vape shop where very few customers vaped, but the employees all did throughout the day. Airborne samples found detectable levels of all of these in ambient air, but none of the concentrations were above occupational exposure limits.

\*\*NIOSH found these metals in surface samples in the vape shop.

# When Cloud Chasing Spills Over: A Different Kind of ‘Vapor Intrusion’

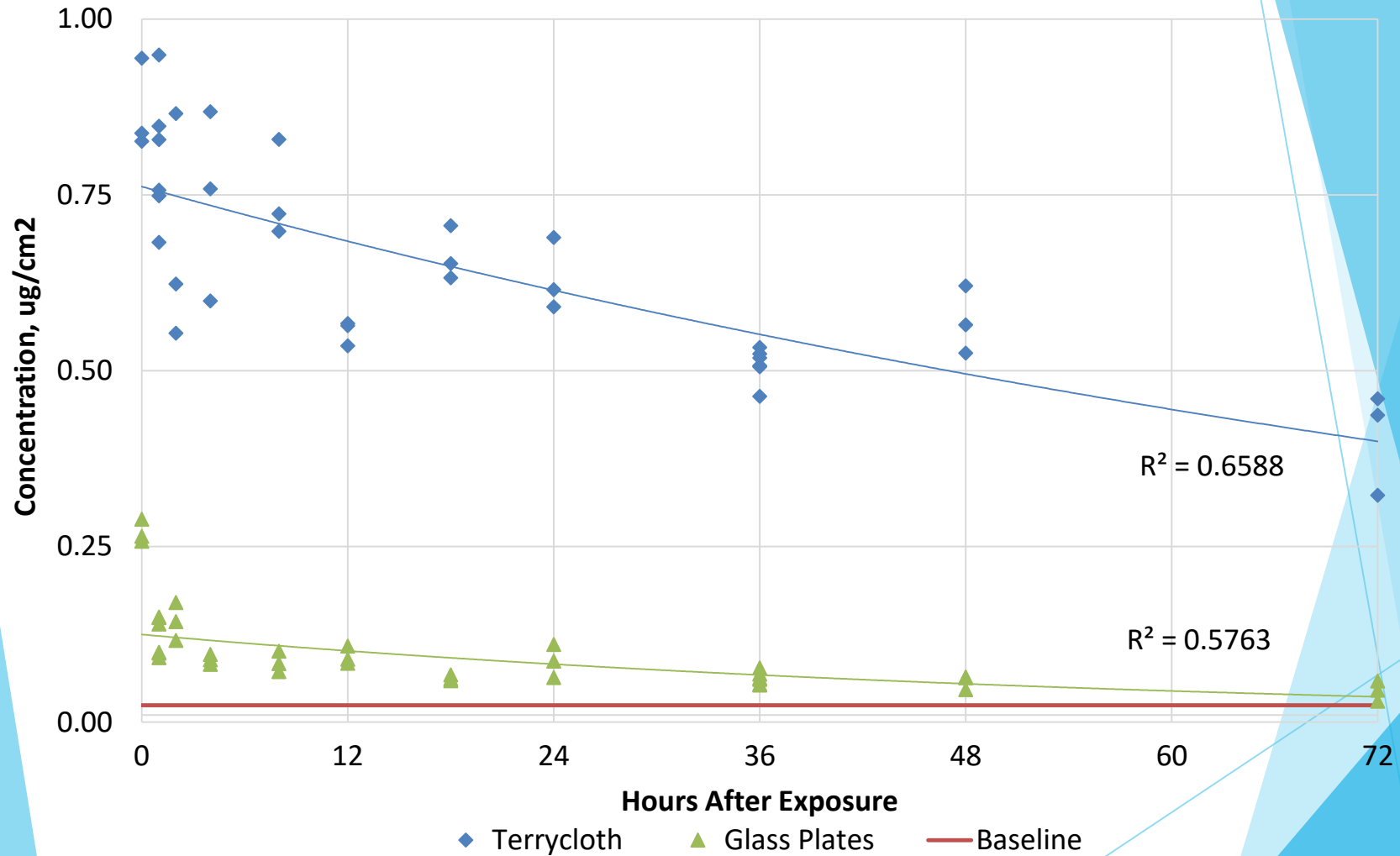
- ▶ Floyd (2017) showed that e-cig aerosols can spread through HVAC systems to adjacent parts of a building.
- ▶ Nicotine contamination was found on surfaces in shops adjacent to small vape shops.
- ▶ Cleaning regimens in the vape shops were very aggressive (daily or twice daily) and this seems to control surface contamination adequately within the shops, but adjacent shops did not clean display cabinets as frequently, resulting in elevated nicotine contamination.

Floyd, E. (2017). When cloud chasing spills over: A different kind of ‘vapor intrusion.’ American Industrial Hygiene Conference and Exposition, Seattle, Washington, June 6, 2017.

# Tobacco-Specific Nitrosamines (TSNAs)

- Some TSNAs are known human carcinogens and are suspected to contribute to the cancer burden of smokers
- Small amounts of TSNAs have been found in e-liquids and vapor
- Residual nicotine from tobacco smoke has been shown to react with ambient nitrous acid and ozone to form TSNAs over time
- Will nicotine from electronic cigarettes (ECs) persist and do the same?
  - This could impact the health and safety of cleaning personnel/subsequent occupants of the rooms/lavatories where vaping has occurred (third-hand exposure)

# Residual Nicotine after Vaping



▶ Glass – 4 days

▶ Terrycloth – 16 days



# Residual Nicotine Study

## Conclusions

- Persistence on both surfaces longer than expected
- Retention of nicotine on porous, hydrophilic surfaces longer than nonporous
- Potential risk for third-hand exposure should be considered
- If nicotine persists on a surface or is continually replenished, it may reside long enough to react with ambient ozone and nitrous acid to form TSNAs and other carcinogenic byproducts
- Longer term studies are needed
- Use of ECs should be consistent with traditional cigarette smoking policies

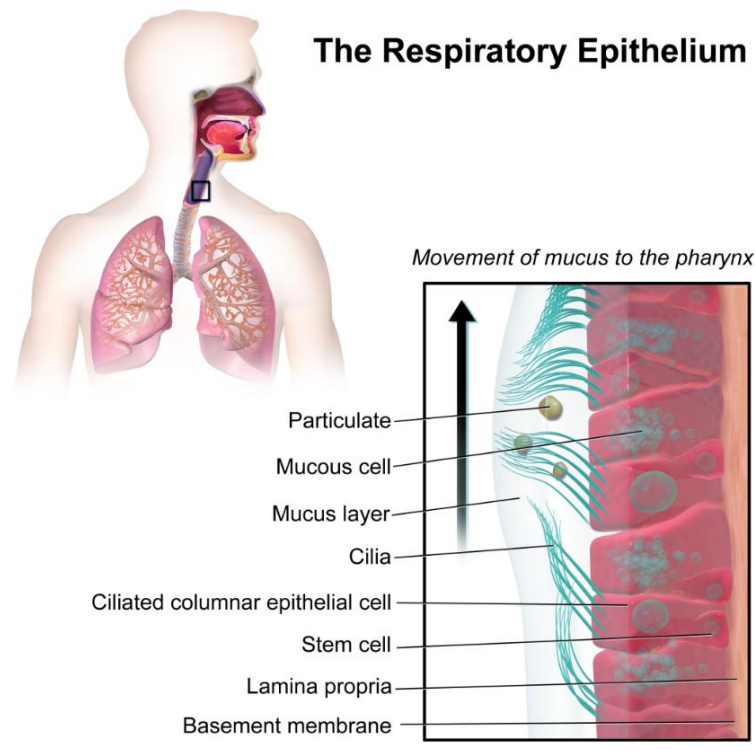
# Some Reported Health Effects

- Mouth and throat irritation
- Dry cough
- Nausea
- Dizziness
- Changes in heart rhythm
- Changes in blood pressure



# Mucociliary Clearance

- Acrolein, formaldehyde, acetaldehyde all individually shown to reduce mucociliary clearance
- Chronic exposure to propylene glycol alone stimulated mucociliary clearance, but chronic, daily, 20 min-exposure to nicotine/propylene glycol mixture slowed mucociliary clearance



Lin, V., Raju, V. S., Tang, L., Li, Y., Wilson, L., Berryhill, T.,...Rowe, S. (2017). C73 New mechanisms and therapies in COPD: Role of acrolein in cigarette smoke-induced mucociliary clearance defects. *American Journal of Respiratory and Critical Care Medicine*, 195, 1.

Fló-Neyret, C., Lorenzi-Filho, G., Macchione, M., Garcia, M.L.B., & Saldiva, P.H.N.. (2001). Effects of formaldehyde on the frog's mucociliary epithelium as a surrogate to evaluate air pollution effects on the respiratory epithelium. *Brazilian Journal of Medical and Biological Research*, 34(5), 639-643.

Sisson J.H., Tuma, D.J. & Rennard, S.I.. Acetaldehyde-mediated cilia dysfunction in bovine bronchial epithelial cells. *Am J Physiol*. 1991 Feb; 260(2 Pt 1):L29-36.

Laube, B.L., Afshar-Mohajer, N., Koehler, K., Chen, G., Lazarus, P. & Collaco, J.M. (2017). Acute and chronic in vivo effects of exposure to nicotine and propylene glycol from an E-cigarette on mucociliary clearance in a murine model, *Inhal Toxicol*, 29(5):197-205.

# E-cigs and Infection

- Sussan et al. (2015) exposed mice to e-cigarette vapor containing menthol and 1.8% nicotine via a whole-body exposure system for 1.5 hours, twice per day for 2 weeks and then infected those mice with *S. pneumoniae* or mouse adapted influenza A/California/4/2009 H1N1.
  - “E-cig exposure reduces pulmonary bacterial clearance in mice infected with *S. pneumoniae*”
  - “E-cig exposure impairs viral clearance and causes significant morbidity and mortality in mice following influenza virus infection”

Sussan, T. E., Gajghate, S., Thimmulappa, R.K., Ma, J., Kim, J., Sudini, K.,...Biswal, S. (2015). Exposure to electronic cigarettes impairs pulmonary anti-bacterial and anti-viral defenses in a mouse model. *PLoS ONE*, 10(2), E0116861.

# Life Cycle Issues

- Some are single use or disposable
- Lithium ion batteries
- Nicotine (acute hazardous waste)
  - EPA: “unused (unsold, expired, or returned) nicotine-containing products, including patches, gums, lozenges, inhalers, nasal sprays, and e-cigarettes, are classified as P075 listed acute hazardous wastes when discarded.”
- Some manufacturers and disposal companies offer recycling programs, disassembling the components, recycling the batteries, metal, and plastic components, then disposing of the nicotine by incineration.



Environmental Protection Agency. (2015). Hazardous waste status of e-cigarettes under RCRA. Retrieved from <https://yosemite.epa.gov/osw/rcra.nsf/0c994248c239947e85256d090071175f/ee5ae44acee473b585257e810070f655%21OpenDocument>



# Safety Issues

- Several incidents of fires and explosions have been reported from the lithium-ion batteries used to charge e-cigarettes.
  - Incorrect chargers or over-tightening of the screwed connection to the charger, which can damage the battery cells and lead to overheating.
  - Many lithium-ion batteries used in e-cigarettes do not have overcurrent or overcharge protection, so if they are left charging, the coil can overheat and cause the battery to explode.

<https://www.nbcnews.com/business/consumer/what-s-causing-some-e-cigarette-batteries-explode-n533516>

<http://time.com/5280288/florida-e-cigarette-explosion-death/>

# WHO

- The World Health Organization (WHO) has recommended that consumers be strongly advised not to use electronic nicotine delivery systems, including e-cigarettes, until they are deemed safe and effective and of acceptable quality by a competent national regulatory body.

# NIOSH

- NIOSH Current Intelligence Bulletin 67 published April 2, 2015 recommends that employers “establish and maintain smoke-free workplaces that protect those in workplaces from involuntary, secondhand exposures to tobacco smoke **and airborne emissions from e-cigarettes and other electronic nicotine delivery systems.**”

(emphasis added)

# ANSI/ASHRAE 62.1

- ANSI/ASHRAE Standard 62.1 contains requirements for ventilation of spaces that are free of environmental tobacco smoke (ETS).
- Also contains requirements for separation of an ETS-free area from any spaces containing ETS.
- Addendum c to 62.1-2013 clarifies that the definition of ETS “includes smoke produced from the combustion of cannabis and controlled substances **and the emissions produced by electronic smoking devices.**”
  - “The existing requirements for separation of ETS-free spaces from ETS spaces remains unchanged.”

# ANSI/ASHRAE 62.1

- ETS-free areas at positive pressure to ETS areas
- Solid walls, floors, ceiling, and doors with automatic closing mechanisms to separate ETS areas from ETS-free areas
- No recirculation or transfer of air from ETS area to ETS-free area
- Signage for ETS areas

# ***White Paper: Electronic Cigarettes in the Indoor Environment***



American Industrial Hygiene Association®



AIHA Board Approval Date: January 21, 2019

*Sponsored by the AIHA®  
Indoor Environmental Quality Committee and  
Risk Committee*



# **AIHA White Paper: Electronic Cigarettes in the Indoor Environment**

- “E-cigarettes should be considered a source of volatile organic compounds (VOCs) and particulates in the indoor environment that have not been thoroughly characterized or evaluated for safety.”
  - Quoted by NIOSH in the 2015 Current Intelligence Bulletin 67 “Promoting Disease and Injury Through Workplace Tobacco Policies”
- “As e-cigarettes are a potential source of pollutants (such as airborne nicotine, flavorings, and thermal degradation products), it is prudent to manage and control vaping in indoor environments consistent with current smoking policies, until and unless research demonstrates that these devices will not significantly increase the risk of adverse health effects to occupants.”

# Bibliography

- **AIHA White Paper: *Electronic Cigarettes in the Indoor Environment***  
[https://www.aiha.org/government-affairs/PositionStatements/Electronic%20Cig%20White%20Paper%20Update%20Final\\_01212019.pdf](https://www.aiha.org/government-affairs/PositionStatements/Electronic%20Cig%20White%20Paper%20Update%20Final_01212019.pdf)
- **NIOSH Current Intelligence Bulletin 67: *Promoting Health and Preventing Disease and Injury Through Workplace Tobacco Policies* (NIOSH Publication No. 2015-113)**  
[http://www.cdc.gov/niosh/docs/2015-113/pdfs/fy15\\_cib-67\\_2015-113\\_v3.pdf](http://www.cdc.gov/niosh/docs/2015-113/pdfs/fy15_cib-67_2015-113_v3.pdf)
- **ANSI/ASHRAE Addenda a, c, j, k, q, r, and s to ANSI/ASHRAE Standard 62.1-2013: *Ventilation for Acceptable Indoor Air Quality***  
[https://www.ashrae.org/File%20Library/docLib/StdAddenda/62.1-2013\\_2015Supplement\\_20150203.pdf](https://www.ashrae.org/File%20Library/docLib/StdAddenda/62.1-2013_2015Supplement_20150203.pdf)



Marcham, C. L. & Springston, J.P. (2017). E-cigarettes: A hazy hazard. *Professional Safety* 62(6), 46-51

The background features abstract, overlapping geometric shapes in various shades of blue, ranging from light sky blue to deep navy blue. These shapes are primarily located on the right side of the frame, creating a modern, dynamic feel. The rest of the background is a solid, very light blue.

**QUESTIONS?**