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AIHA White Paper: Electronic Cigarettes in the Indoor Environment

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AIHA White Paper: Electronic Cigarettes in the Indoor Environment



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White Paper: Electronic Cigarettes in the Indoor Environment



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October 19, 2014

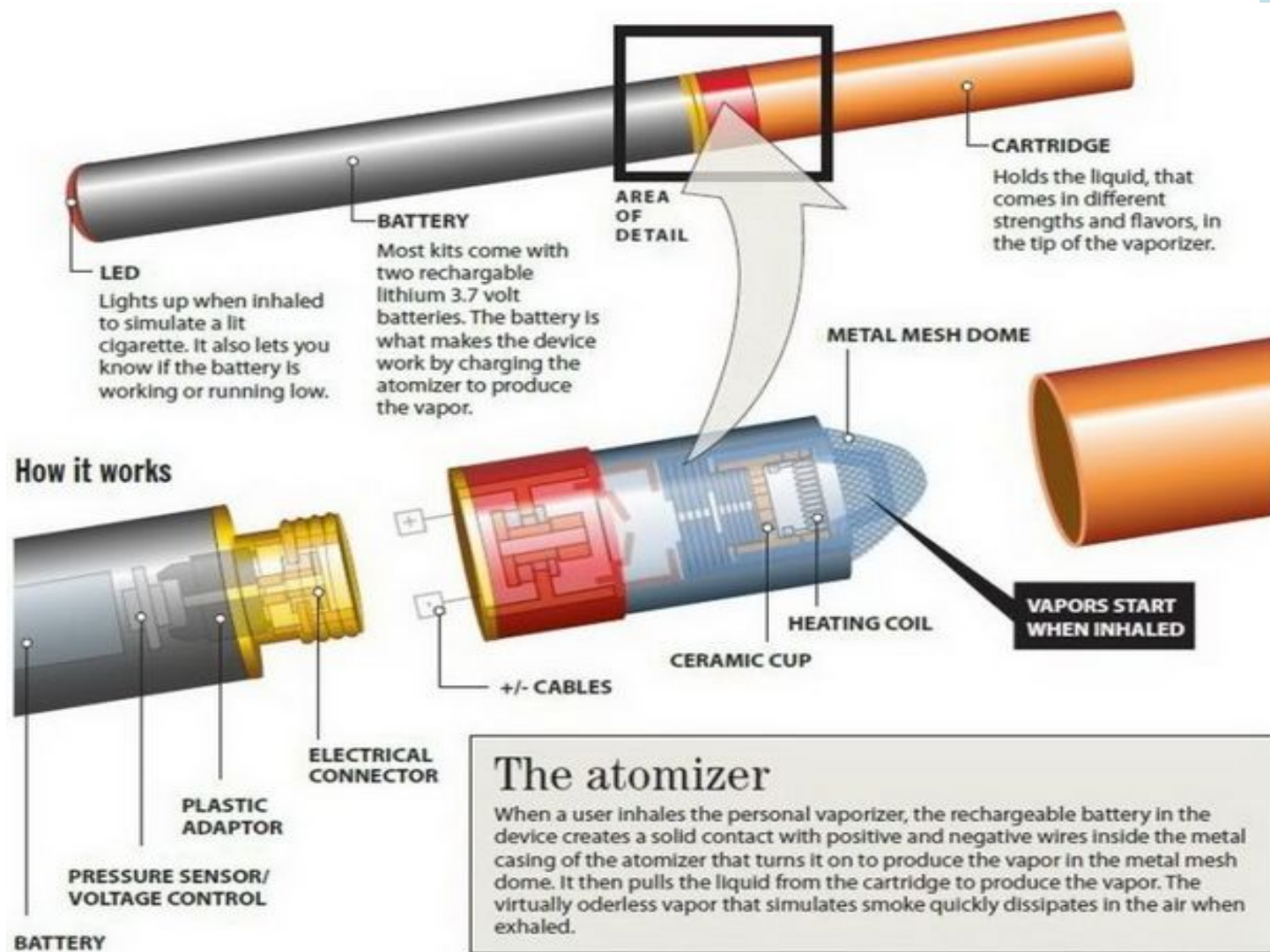
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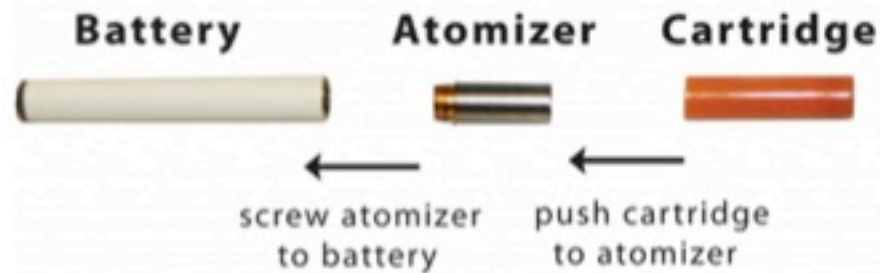
Anatomy of an E-Cigarette



First Generation ECs (‘cigalikes’)



- Disposable
- Re-chargeable with pre-filled cartridges



Second Generation ECs



- Refillable with liquids



Third Generation ECs ('mods')



Statistics

- More than 460 different e-brands currently on the market.*
- Over 7,700 unique e-cigarette flavors.* * As of January 2014
- China produces approximately 90 percent of the world's e-cigarettes.
- Chinese manufacturers are expected to ship more than 300 million e-cigarettes to the US and Europe this year.

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

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



Statistics

- E-cigarette sales in the U.S. were estimated at \$2.2 billion in 2014.
- Sales expected to grow nearly 25% per year through 2018.
- In 2014, an estimated 2.5 million middle and high school students used e-cigarettes.
- There is some recent evidence that e-cigarette use can be a gateway to conventional cigarette use initiation during early adolescence.

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





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Primary Components



- Propylene Glycol/
Vegetable Glycerin
- Nicotine
- Flavorings



Propylene Glycol/Vegetable Glycerin

- 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*



*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.

Lauterbach, J.H. & Laugesen, M. (2012). Comparison of toxicant levels in mainstream aerosols generated by Ruyan® electronic nicotine delivery systems (ENDS) and conventional cigarette products. *Toxicologist*, 126, 1

Lauterbach, J.H., Laugesen, M., Ross, B.B., 2012. Suggested protocol for estimation of harmful and potentially harmful constituents in mainstream aerosols generated by electronic nicotine delivery systems (ENDS). *Toxicologist*, 126, 1

Uchiyama, S., K. Ohta, Y. Inaba, & N. Kunugita. (2013). Determination of carbonyl compounds generated from the e-cigarette using coupled silica cartridges impregnated with hydroquinone and 2,4-dinitrophenylhydrazine, followed by high-performance liquid chromatography. *Analytical Sciences*, 29 (12), 1219–1222

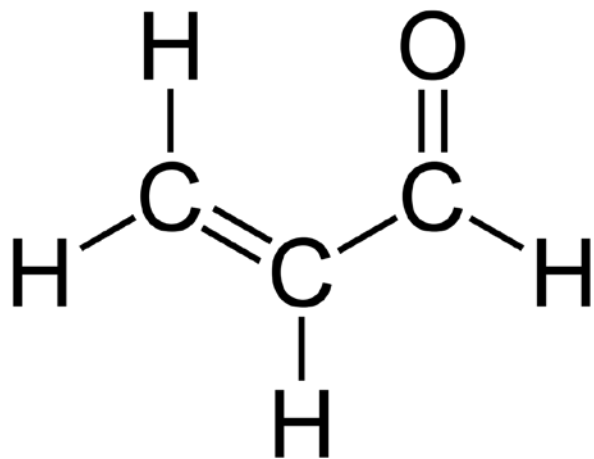


Formaldehyde

- 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

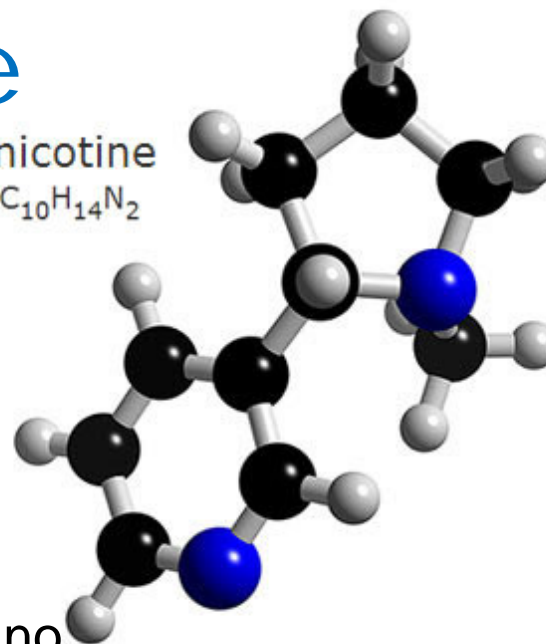


- Causes irritation to the nasal cavity, damage to the lining of the lungs and is thought to contribute to cardiovascular disease in cigarette smokers
- Found in vapor only (formed as a result of heating process)



Nicotine

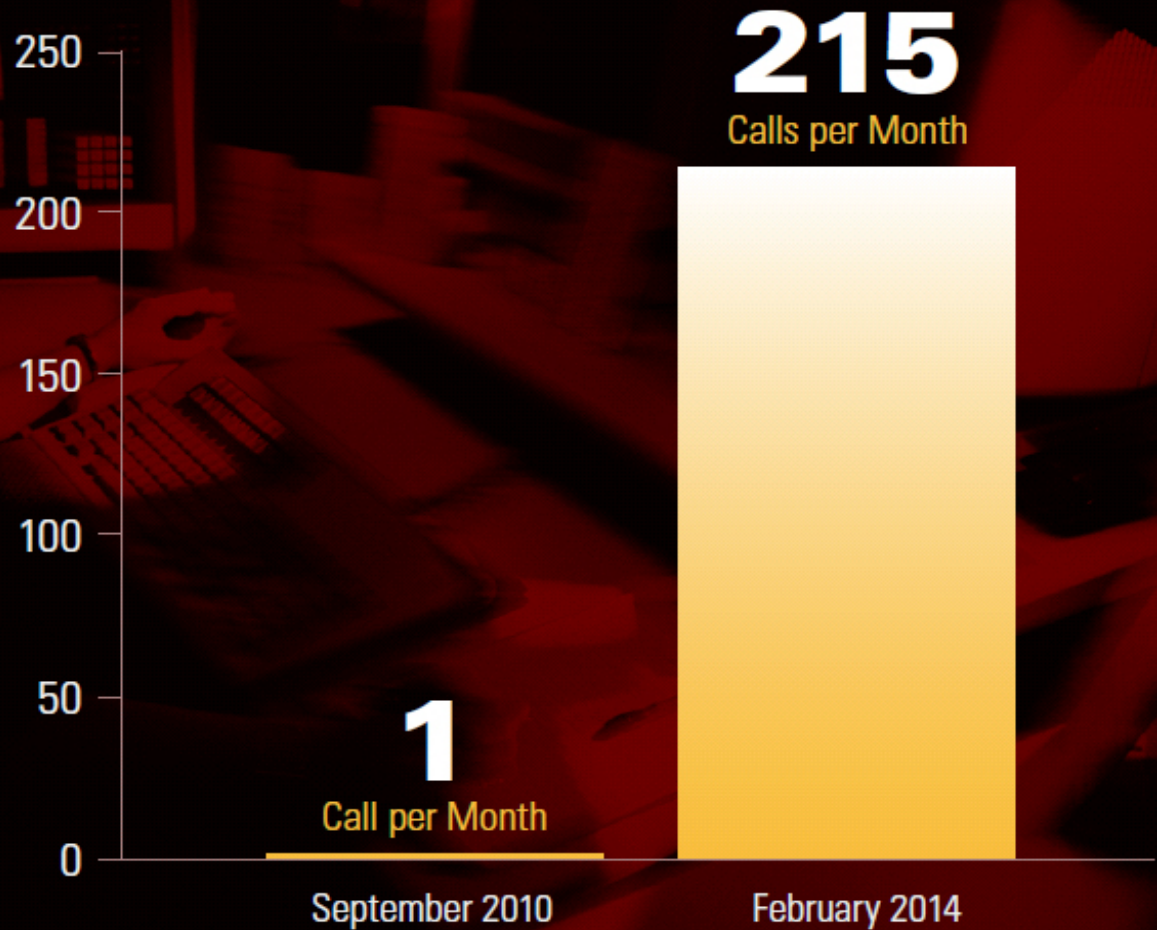
nicotine
 $C_{10}H_{14}N_2$



- Health Effects
 - Addictive
 - Teratogenic
 - 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 (8/6)
 - Concentration and delivery inconsistencies (1/3)
 - Nicotine found in the vapor, but lower than found emitted from conventional cigarettes (3/1)



Poison center calls involving e-cigarettes





**Works
for You**

**NICOTINE POISONINGS UP AS E-CIG POPULARITY GROWS
ONE THIRD OF VICTIMS ARE TWO YEARS OLD**

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.



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Flavorings





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Other Additives



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



Other Additives



Generally Recognized as Safe (GRAS)?



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



Diacetyl and Acetyl Propionyl

- Diacetyl and acetyl propionyl are GRAS but are associated with respiratory disease when inhaled
 - The risks associated with inhalation of acetyl propionyl 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 acetyl propionyl 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



Flavoring Concerns

- No research on potential health effects of aerosolized vapor exposure
- No research on pyrolyzation products of flavorings
- Benzaldehyde has been detected in cherry flavoring
- Methyl anthranilate was detected in grape flavoring
- 1-hexanol was detected in apple flavoring.
- Manufacturing of many flavoring sources are outside the US (China)



Additional Potential Exposures

- Tobacco-Specific Nitrosamines (TSNAs)
- Acetic Acid
- BTEX
- Isoprene
- Diethylene Glycol (antifreeze)*

*Food and Drug Administration. (2009) FDA news release: FDA and public health experts warn about electronic cigarettes. Retrieved from

www.fda.gov/newsevents/newsroom/pressannouncements/ucm173222.htm



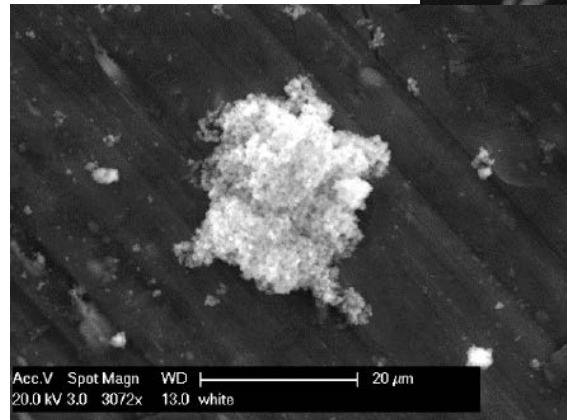
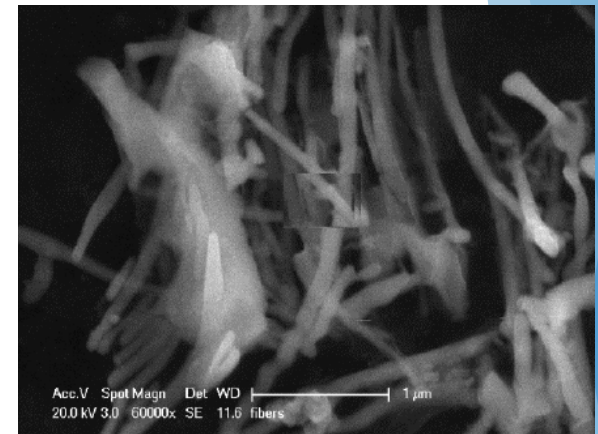
Tobacco-Specific Nitrosamines (TSNAs)

- 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 to form TSNAs over time
 - Third-hand exposure?



Additional Potential Exposures

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



Second-Hand Exposure Concerns

- Nicotine (teratogen and addictive)
- Flavorings (nut and other allergies)
- Formaldehyde (carcinogen)
- Acrolein (listed as a Hazardous Air Pollutant by the EPA)
- Acetaldehyde (possible human carcinogen)
- Fine/Ultrafine Particles
- Tin, Lead, Nickel, Chromium



Cloud Chasing



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



Some Reported Health Effects

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

IT'S **NOT JUST
"HARMLESS WATER VAPOR"**

**E-cigarette aerosol contains
at least **10 chemicals** on
California's Prop 65 list of
chemicals known to cause
**cancer, birth defects or other
reproductive harm.****

TOLUENE
ACETALDEHYDE
BENZENE
CADMIUM
FORMALDEHYDE
ISOPRENE
LEAD
NICKEL
NICOTINE
N-NITROSONORNICOTINE



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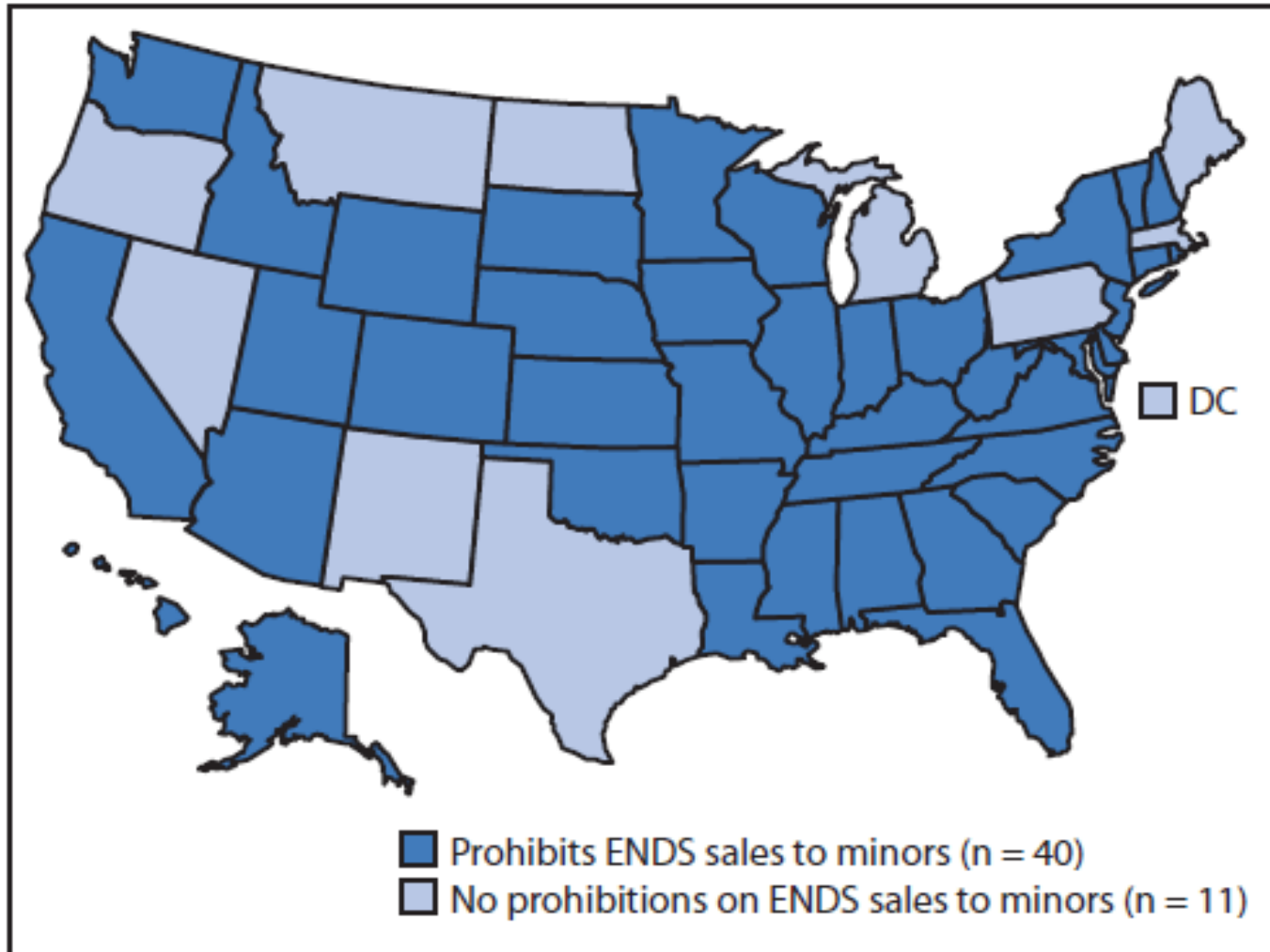
Effects on the Immune System

- Johns Hopkins study exposed mice to e-cigarette vapor for two weeks in amounts that approximated human e-cig exposure, then exposed them to *Streptococcus pneumoniae* and influenza A virus.
 - E-cigarette vapor alone produced mild effects on the lungs, including inflammation and protein damage
 - E-cigarette exposure inhibited the ability of mice to clear bacteria from their lungs and the viral infection led to increased weight loss and death indicative of an impaired immune response.

Sussan, T. E., Gajghate, S., Thimmulappa, R. K., Ma, J., Kim, J.-H., Sudini, K.,... Biswal, S. (2015). Exposure to electronic cigarettes impairs pulmonary anti-bacterial and anti-viral defenses in a mouse model. *PLoS ONE PLOS ONE*. doi :•DOI: 10.1371/journal.pone.0116861 **IAQA 19th Annual Meeting**



State Regulations

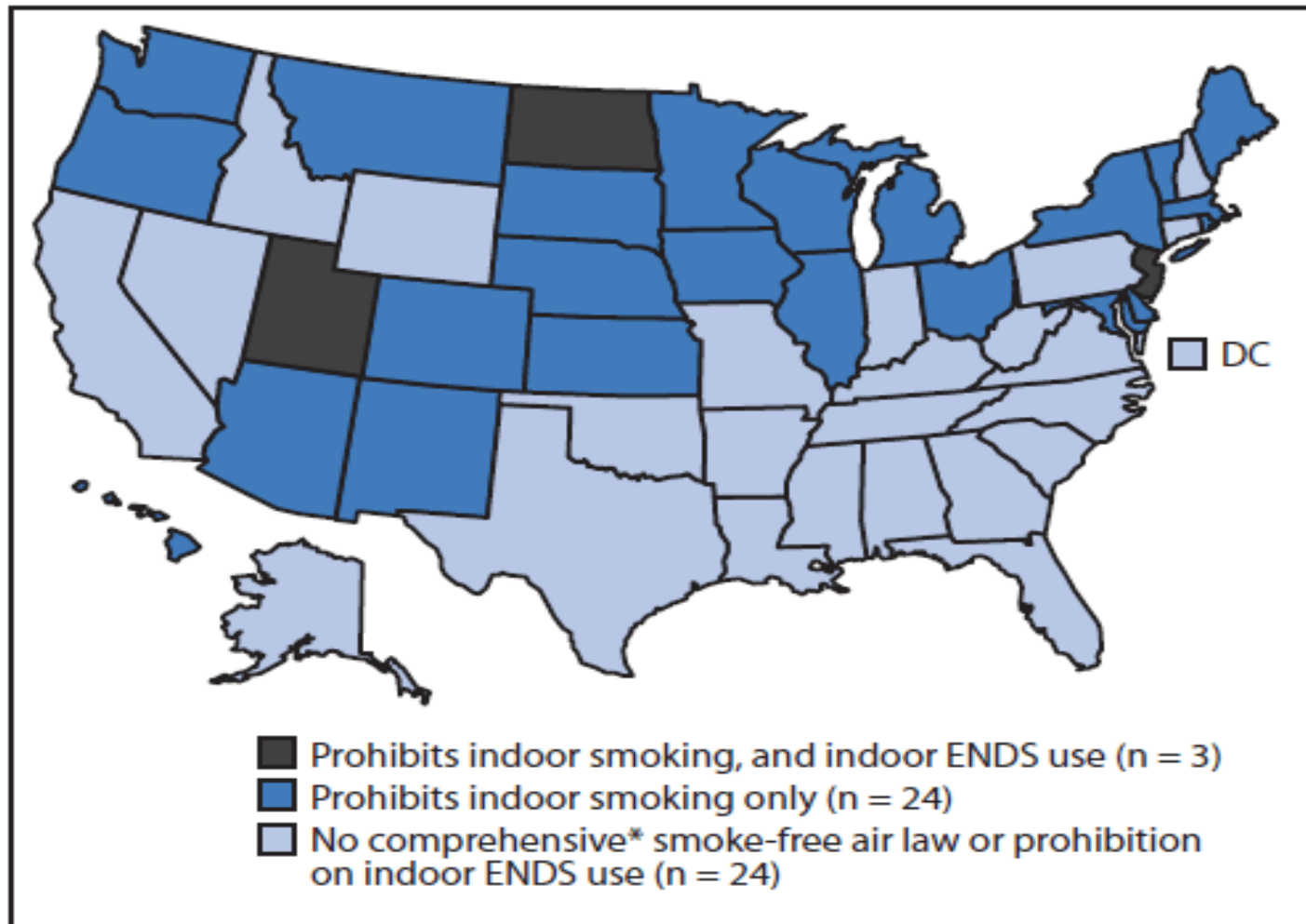


Centers for Disease Control and Prevention. State Laws Prohibiting Sales to Minors and Indoor Use of Electronic Nicotine Delivery Systems — United States, November 2014. Morbidity and Mortality Weekly Report. December 12, 2014 / 63(49);1145-1150

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State Regulations



Centers for Disease Control and Prevention. State Laws Prohibiting Sales to Minors and Indoor Use of Electronic Nicotine Delivery Systems — United States, November 2014. Morbidity and Mortality Weekly Report. December 12, 2014 / 63(49);1145-1150

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Food and Drug Administration (FDA)

- The FDA currently regulates only e-cigarettes that are marketed for therapeutic purposes.
- However, the FDA has proposed a rule extending its tobacco product authorities to cover additional products that meet the legal definition of a tobacco product, such as e-cigarettes



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

- 2015 Addenda Supplement to ANSI/ASHRAE Standard 62.1-2013 “revises the current definition of ETS (environmental tobacco smoke) to include emissions from electronic smoking devices, as well as cannabis smoke. The existing requirements for separation of ETS-free spaces from ETS spaces remains unchanged.”



White Paper: Electronic Cigarettes in the Indoor Environment



American Industrial Hygiene Association®



October 19, 2014

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Conclusions - AIHA White Paper Recommendations

“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”



Conclusions - AIHA White Paper Recommendations

Research on e-cigarettes should be conducted in at least the following areas:

1. Health effects from inhaling e-cigarette ingredients that are reported to be generally recognized as safe (GRAS) via ingestion, but which have not yet been evaluated for inhalation toxicity, as well as their thermal degradation products;
2. Effects of second-hand emissions, third-hand exposures, and nicotine addiction from e-cigarettes;
3. Understanding the dynamics of pre- and post-respiration aerosols and their fate in the environment; and
4. Lifecycle and end-of-use issues.*



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 offer recycling programs
- There is at least one disposal company that is disassembling the components, recycling the batteries, metal, and plastic components that can be recycled, then disposing of the nicotine by incineration.



Conclusions - AIHA White Paper Recommendations

Risk-based regulation of e-cigarettes should be adopted using reliable safety, health, and emissions data, due to concerns about primary and secondary exposure to vapors and fluids (e-juices) used to charge e-cigarettes.



Conclusions - AIHA White Paper Recommendations

Four areas of regulation relating to the safety of primary users and people exposed to second-hand vapors or e-juice products should be considered:

1. All e-cigarette devices, whether they are used for therapeutic or recreational purposes, should be evaluated for potential physical and/or electrical hazards by a regulatory agency;
2. The health risks and economic consequences of accidental exposure to e-juices by children, adults and pets should be addressed, including proper labeling and child-resistant packaging requirements;



Conclusions - AIHA White Paper Recommendations

Risk-based regulation recommendations (cont.):

3. All future e-juice components that may be used by consumers should be fully evaluated for any potential hazards (e.g., toxicity, flammability, safety hazards, secondary exposures, etc.) prior to introduction into the marketplace; and
4. As e-cigarettes are a source of pollutants, their use in indoor environments should be restricted, consistent with current smoking bans, until, and unless, research documents that they will not significantly increase the risk of adverse health effects to occupants.



Bibliography

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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



Questions?



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