

The Vaping Epidemic in Adolescents

Louella Amos, MD

Associate Professor of Pediatrics

Division of Pulmonary and Sleep Medicine

Medical College of Wisconsin

Children's Wisconsin



Children's
Wisconsin



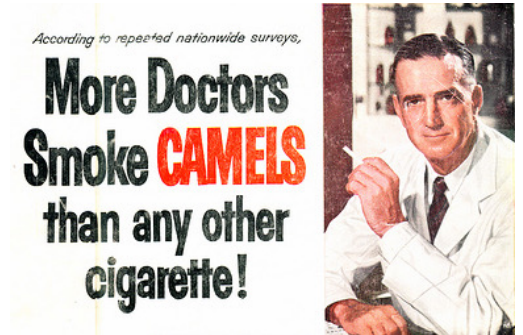
Late 19th century

1913: 1st cigarette introduced

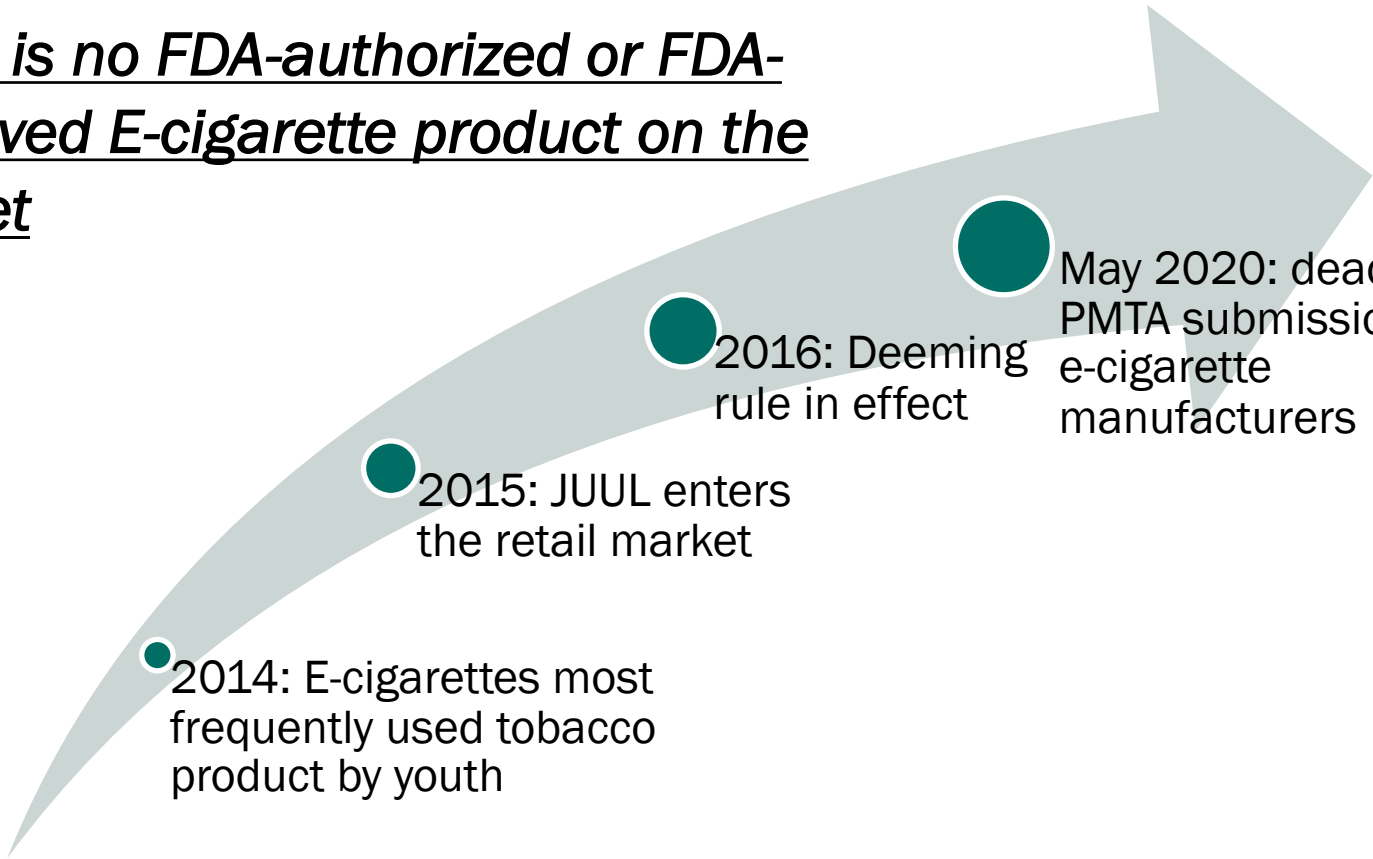
1998 Tobacco industry settlement

E-cigarettes enter the US markets in 2007

2009 Family Smoking Prevention and Tobacco Control Act (FSPTCA)



There is no FDA-authorized or FDA-approved E-cigarette product on the market



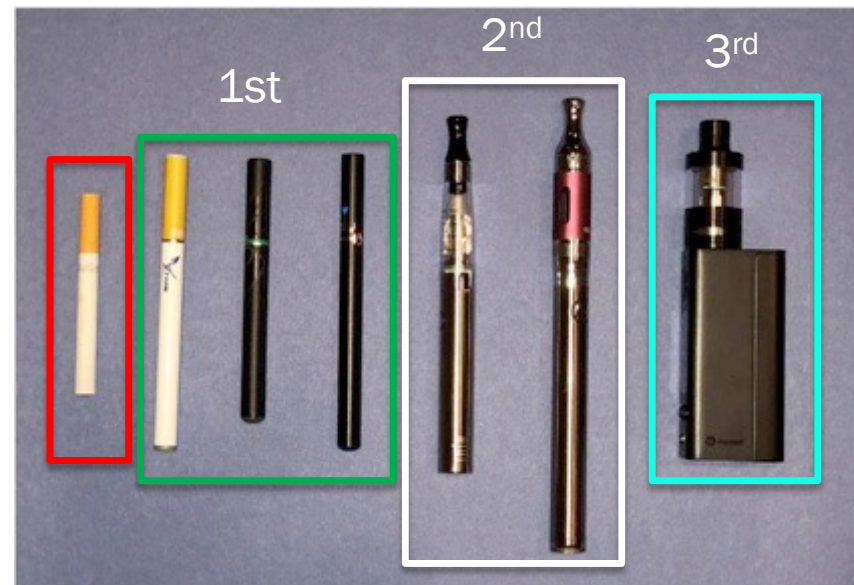
What are e-cigarettes?

- Battery
- Heating coil or atomizer
- Reservoir/tank
- Mouthpiece
- Sensor or user actuated button to activate the heating coil



What are e-cigarettes?

- Traditional cigarette
- 1st generation e-cigarettes: resemble traditional cigarettes, disposable or reloadable cartridge
- 2nd generation e-cigarettes: refillable reservoirs, known as vapes or vape pens
- 3rd generation e-cigarettes: can modify wattage/voltage, known as mods or tank systems



Pediatrics 2019;143(6)e20182741

What are e-cigarettes?

- 4th generation e-cigarettes: do not resemble traditional cigarettes



What are e-cigarettes?



What is in e-liquid?

- Humectants: propylene glycol, vegetable glycerin
- Nicotine (3-50 mg/mL) derived from tobacco, THC, methamphetamine
 - “Carts” = cartridges containing cannabis oils
 - Dab = concentrated cannabis, can be vaporized using a modified vape pen
 - Dripping = Putting drops of e-liquid directly onto an atomizer’s coil and immediately inhaling the vapor that is produced

Pediatrics 2019;143(6)e20182741

What is in e-liquid?

- Thousands of flavorings
 - Benzaldehyde (fruit), cinnamaldehyde (cinnamon), diacetyl, acetoin (butter), alcohol
 - Flavoring (menthol, fruits, desserts, candy, soda)
 - Ingredients vary depending on brand and type of ENDS
 - Detailed toxicological evaluation of each flavoring is not available

National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division 2018. Toxicology of E-Cigarette Constituents

What is in e-liquid?

- JUUL pods (prefilled cartridges) contain 0.7 mL of e-liquid
 - 5% (59 mg/mL nicotine)
 - 3% (35 mg/mL nicotine)
 - Nicotine concentration in 1 pod ~1 pack of cigarettes

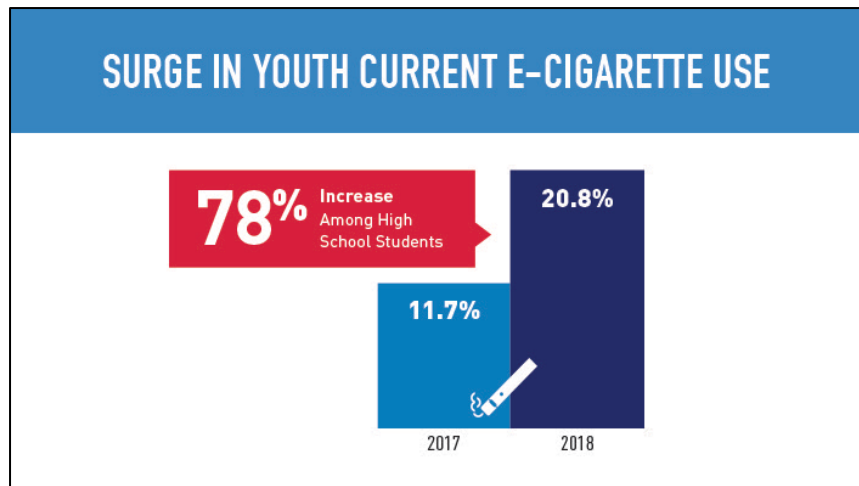
Pediatrics 2019;143(6):e20182741

Why was the focus on JUUL?

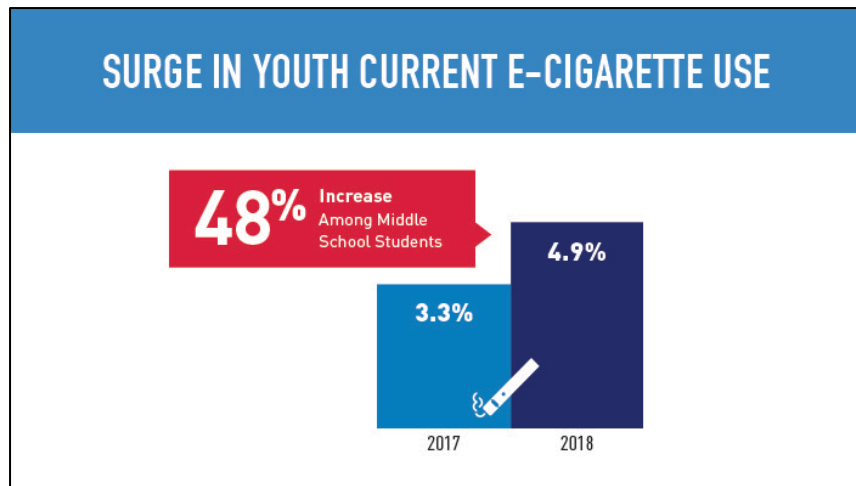
- April 2018: JUUL had 54.6% of e-cigarette market
- November 2018: JUUL had 76.1% of e-cigarette market
- Rapid uptake by adolescents
- Sleek design
- Easy to hide in school and at home
- Rechargeable with a USB port
- High nicotine concentration

NYTS 2018 (cdc.gov)

High school students



Middle school students



2019 NATIONAL YOUTH TOBACCO SURVEY

S H O W S

YOUTH e-cigarette use at
ALARMING
LEVELS

OVER 5 Million
youth are currently using e-cigarettes



NEARLY 1 Million
used the product daily

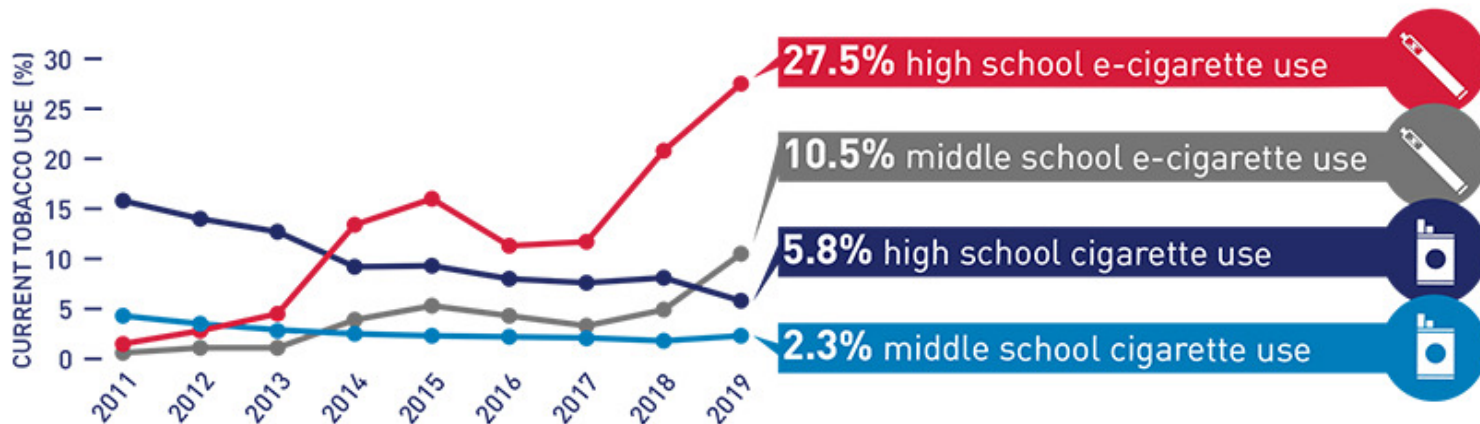


ABOUT
1.6 MILLION
youth used the product frequently
(on 20 or more days per month)

MAJORITY of the current
e-cigarette users reported

JUUL 
as their usual brand

Current e-cigarette use has **INCREASED DRAMATICALLY**, while current cigarette use has dropped, **UNDERMINING PROGRESS** toward reducing overall tobacco use

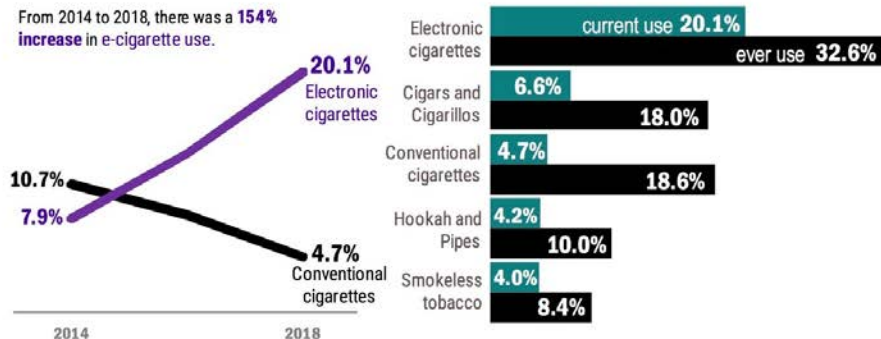


High School Snapshot

Youth Tobacco Survey 2018

As conventional cigarette use is declining, e-cigarette use is rising.

From 2014 to 2018, there was a **154% increase** in e-cigarette use.



1 in 5 

Wisconsin high schoolers use e-cigarettes.

1 in 4

of those who have ever used e-cigarettes first tried an e-cigarette before age 16.



16%

of e-cigarette users also smoke conventional cigarettes.



89%

would not use unflavored tobacco products.



more than **half**

of current smokers usually smoke menthol-flavored cigarettes.

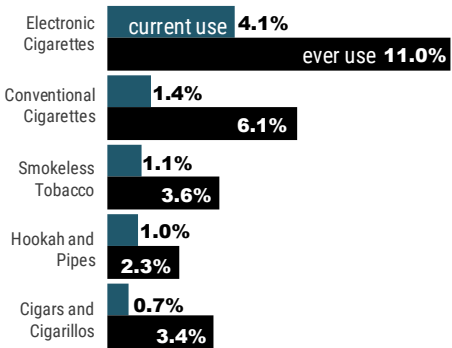
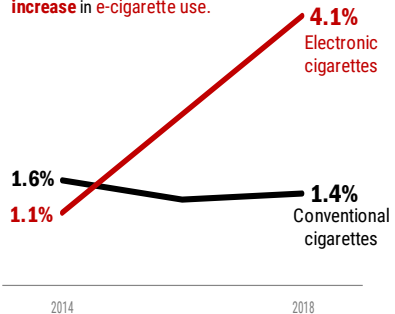


Middle School Snapshot

Youth Tobacco Survey 2018

As conventional cigarette use has declined, e-cigarette use is rising.

From 2014 to 2018, there was a **272% increase** in e-cigarette use.



1 in 9 Wisconsin middle schoolers have ever tried e-cigarettes.

96% of those who have ever used e-cigarettes first tried an e-cigarette before age 13.



47% of those who have ever used e-cigarettes tried e-cigarettes before any other product.



95% would not use unflavored tobacco products.



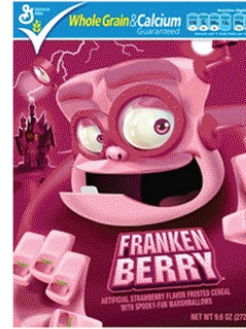
93% think smoking does not make you look cool.



Why are children using e-cigarettes?

- 2013-2014 survey: 81% reported primary reason for use is the availability of appealing flavors. (Villanti et al. Am J Prev Med 2017)
- NYTS 2016 (Tsai et al, MMWR 2018):
 - 39% use by friend or family member
 - 31% availability of flavors such as mint, candy, fruit, or chocolate
 - 17% believe that they are less harmful than other forms of tobacco

E-liquid or food product?



FDA warns companies to stop misleading kids



CENTER FOR TOBACCO PRODUCTS



E-liquid or food product?



FDA warns companies to stop misleading kids



CENTER FOR TOBACCO PRODUCTS



E-liquid or food product?



FDA warns companies to stop misleading kids



CENTER FOR TOBACCO PRODUCTS



How did you get your e-cigs?

- Friends who were 18 or older
- Old vapes that kids were willing to give away
- If you look old enough, aren't scared, have money and get lucky, it's pretty easy to get vapes at gas stations

Why are kids vaping?

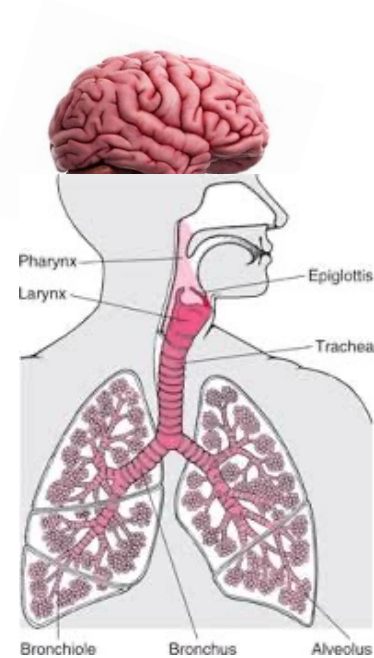
- Teens aren't attracted to cigs when vaping is an option. Vapes smell and taste better. They don't make you stink or give it away. It's less harsh on your throat. They say it's better for you than cigs. We like the buzz.

How did you start vaping?

- Some of my friends vaped and enjoyed it, so I started to hit them and enjoyed them as well. I vaped more at school than anywhere else, but it soon became an addiction outside of school.

Nicotine addiction

- Nicotine
 - Addictive
 - Monthly smoking can increase the likelihood of developing dependence
 - Lungs provide a large surface area for nicotine absorption
 - The high reinforces use and leads to neuroadaptation



Nicotine withdrawal symptoms

Headaches

Irritability

Anxiety

Difficulty
concentrating

Restlessness

Tremor

Sweating

Dizziness

Hunger

How are e-cigarettes harmful?

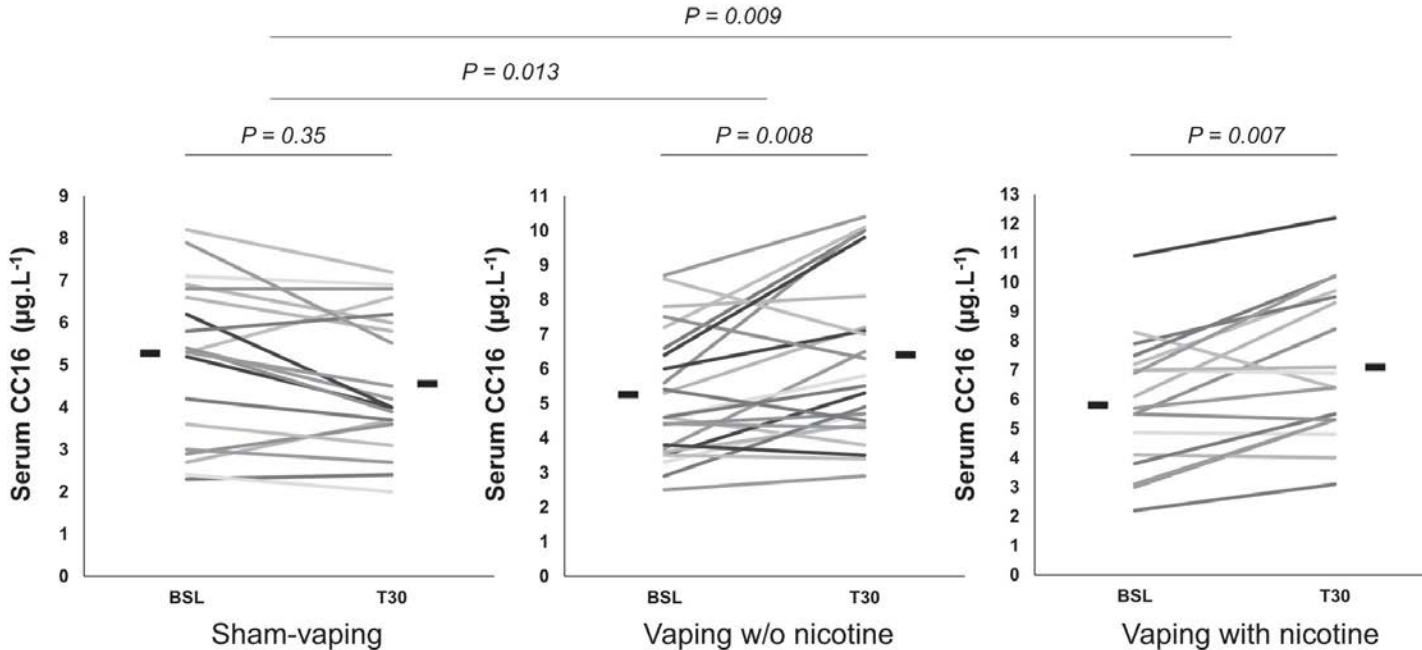
- Decomposition products of propylene glycol and glycerol:
 - Formaldehyde, acetaldehyde and acetone (volatile organic compounds or VOCs)
 - Heavy metal particles

(National Academies of Sciences, Engineering, and Medicine; Health and Medicine Division 2018. Toxicology of E-Cigarette Constituents)
- Higher urine concentrations of nicotine, metals and VOCs than non-users (JAMA Netw Open 2018;1(8):e85937)
- Urine cotinine concentration among adolescents using JUUL was higher than the urine cotinine concentration of those who smoked conventional cigarettes (Tob Control 2019;28(6):676-677)

How are e-cigarettes harmful?

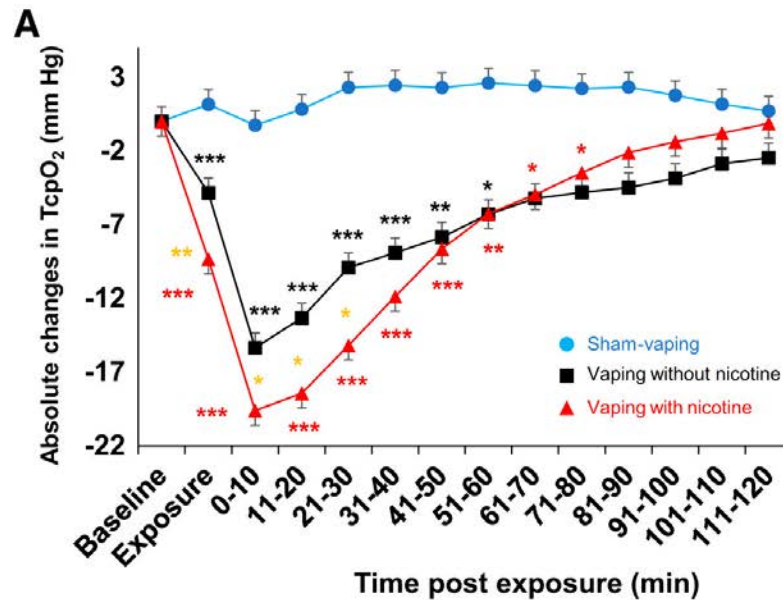
- Am J Physiol Lung Cell Mol Physiol 2019; 316(5):L705-L719
 - 4th generation e-cigarette vaping causes lung inflammation and disturbance in gas exchange
 - With or without nicotine

How are e-cigarettes harmful?

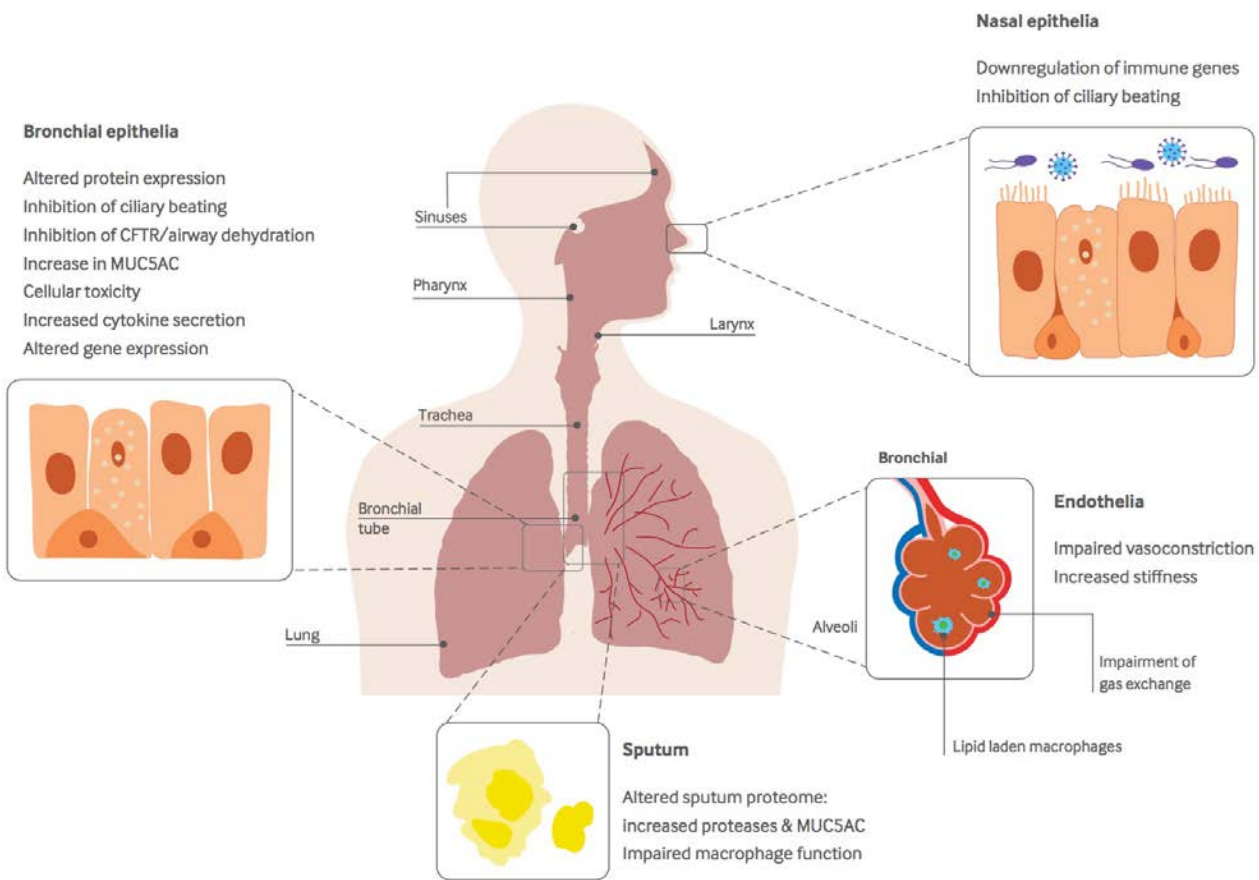


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How are e-cigarettes harmful?

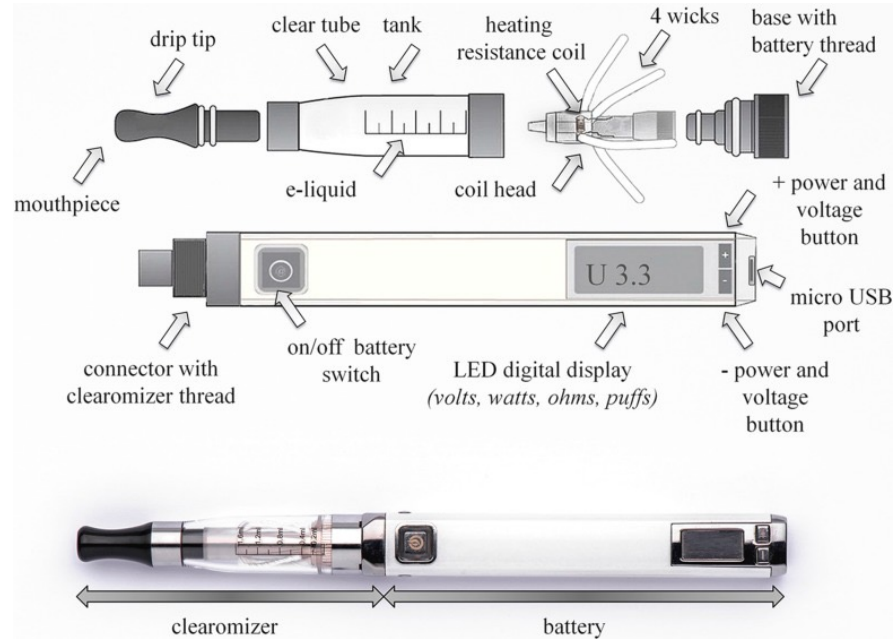


Am J Physiol Lung Cell Mol Physiol 2019; 316(5):L705-L719



BMJ 2019;366:I5275

Vaping cannabis



Int J Environ Res Public Health. 2015 Aug 21;12(8):9988-10008

Vaping cannabis

- 9% risk of dependence
- Tolerance with chronic use
- Altered brain development
 - Significant deficits in learning new skills, working memory and attention

NEJM 2014;370:2219-27

Vaping cannabis

- Butane hash oil (BHO) with THC content above 60%
- Total THC (75.5%) recovered by vaping cannabis cannot be achieved by smoking marijuana
- When smoking a joint, further losses in THC likely due to sidestream smoke
- High lung availability of THC → increased psychoactive and adverse effects

Forensic Sci Int. 2019 Feb;295:207-212

Vaping cannabis

- Cannabinoid hyperemesis syndrome
 - Abdominal pain
 - Nausea
 - Vomiting

Vaping cannabis

- Pesticides and fungicides
- Chemical solvents (butane, hexane, isobutene, isopropyl alcohol) used to create concentrates
- Flavors
- Cutting agents – diluting products with other chemical agents (vitamin E acetate)

Addiction. 2020 Mar;115(3):587-588

Vaping cannabis

- Vitamin E acetate
 - Pure THC oil viscosity = vitamin E acetate viscosity
 - Found in 94% of lung fluid in patients with vaping-related lung injury (was not seen in patients who did not have vaping-related lung injury)
 - Safe for topical use and oral consumption

NEJM 2019 doi: 10.1056/NEJMoa1916433

Vaping cannabis

- Vitamin E acetate
 - Affects surfactant function
 - Heating vitamin E acetate → creates ketene
→ lung irritant

NEJM 2019 doi: 10.1056/NEJMoa1916433

What are the adverse effects of e-cigarette use?

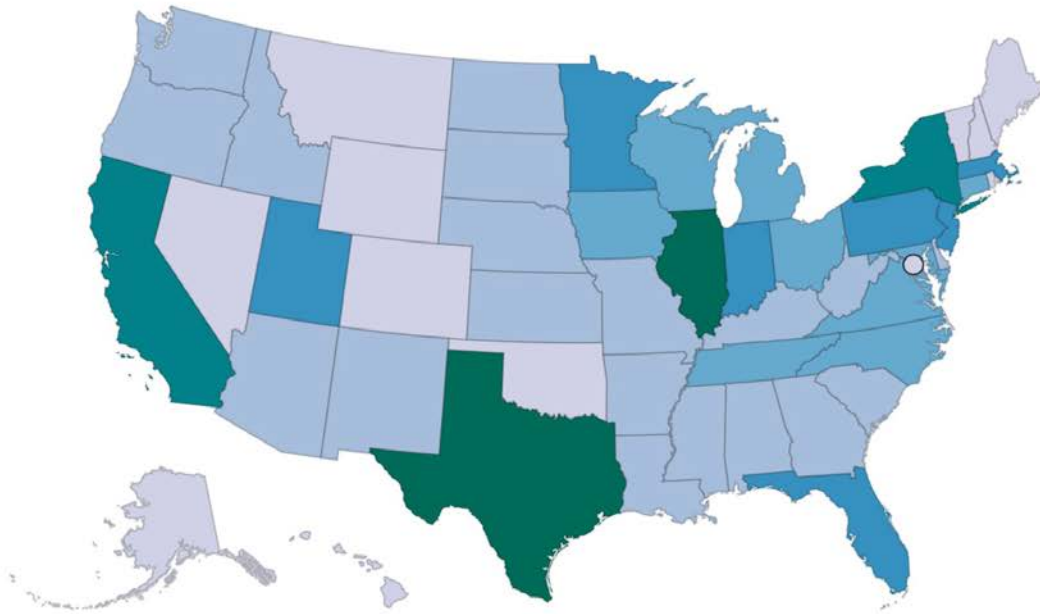
- Difficult to research and regulate
 - Range of devices
 - Rapid change in nomenclature and technology
 - Different substances

Lung Injury Timeline



- **As of February 18, 2020**, a total of 2,807 hospitalized e-cigarette, or vaping, product use-associated lung injury (EVALI) cases or deaths have been reported to CDC from 50 states, the District of Columbia, and two U.S. territories (Puerto Rico and U.S. Virgin Islands).
- **Sixty-eight deaths have been confirmed in 29 states and the District of Columbia (as of February 18, 2020):**
 - Alabama, California (4), Connecticut, Delaware, District of Columbia, Florida (2), Georgia (6), Illinois (5), Indiana (6), Kansas (2), Kentucky, Louisiana (2), Massachusetts (5), Michigan (3), Minnesota (3), Mississippi, Missouri (2), Montana, Nebraska, New Jersey, New York (4), Oregon (2), Pennsylvania, Rhode Island, South Carolina, Tennessee (2), Texas (4), Utah, Virginia and Washington (2).
 - The median age of deceased patients was 49.5 years and ranged from 15-75 years (**as of February 18, 2020**).
- Among the 2,668 hospitalized EVALI cases or deaths reported to CDC (**as of January 14, 2020**):
 - 66% were male
 - The median age of patients was 24 years and ranged from 13–85 years.
 - **By age group category:**
 - 15% of patients were under 18 years old;
 - 37% of patients were 18 to 24 years old;
 - 24% of patients were 25 to 34 years old; and
 - 24% of patients were 35 years or older.

Number of Hospitalized EVALI Cases or Deaths Reported to CDC as of February 18, 2020



Legend

Number of hospitalized EVALI cases or deaths per state

- 0 cases
- 1-9 cases
- 10-49 cases
- 50-99 cases
- 100-149 cases
- 150-199 cases
- 200-249 cases

Territories AS GU MH FM PW PR VI



EVALI: E-cigarette or vaping product use associated lung injury

GI symptoms:

- Abdominal pain
- Nausea
- Vomiting
- Diarrhea
- Weight loss

Nonspecific symptoms:

- Fevers
- Night sweats
- Fatigue

Respiratory symptoms:

- Shortness of breath
- Cough
- Chest pain
- No nasal symptoms

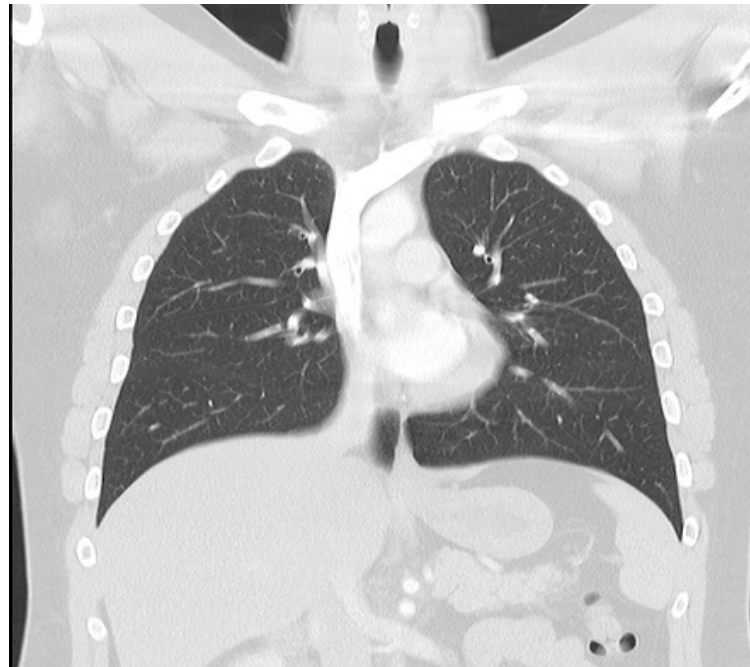
EVALI

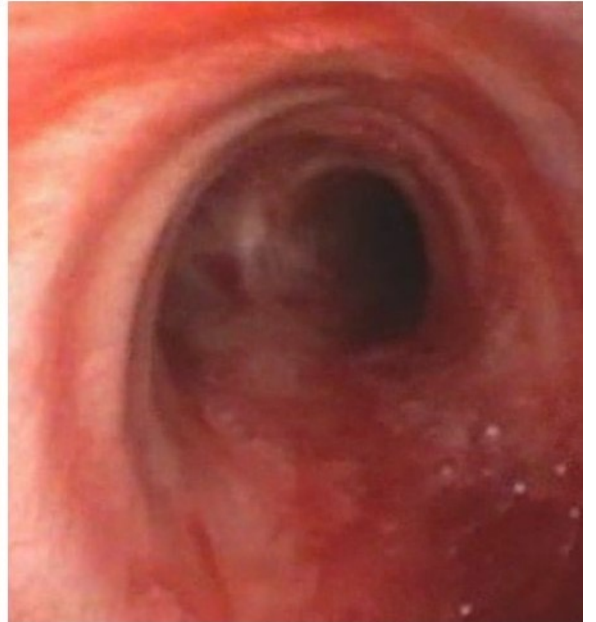
- History:
 - Use of e-cigarettes for several months to days prior to presentation to the hospital
 - Nicotine, THC products, CBD products – often a combination of nicotine and THC products

Inhalation injury



Normal lungs





EVALI

- Hospitalized on the general floor or the ICU
- Respiratory support:
 - Oxygen to mechanical ventilation
- Treatment:
 - Oral or IV steroids



The Adolescent Health Paradox

- Adolescence is a developmental period of strength and resilience both physically and cognitively
- Mortality rates increase by 200% in adolescents

An aerial photograph of a large, modern hospital campus. The image shows multiple multi-story buildings, parking lots filled with cars, and green spaces. The entire image is overlaid with a semi-transparent blue gradient, which is darkest at the top and fades towards the bottom. The text "Thank you" is centered in the upper portion of the image.

Thank you