

**UAB** THE UNIVERSITY OF ALABAMA AT BIRMINGHAM  
SCHOOL OF MEDICINE

# Vaping: An Emerging Threat to Pediatric Lung Health

Kyle Bliton, MD                      4/18/2024

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## Outline

- Review of Vaping Modalities and E-liquid Composition
- Epidemiology of Youth Vaping
- Factors Influencing Appeal of Vaping to Youth
- Federal and State Laws on Vaping
- Pathologic Effects and Diseases/Symptoms Associated with Vaping
- Overview of EVALI
- Vaping Cessation Medications

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## Vaping

- The inhalation of aerosolized liquid
- Introduced to the US market in 2006
- Sharp rise in popularity in the late 2010s
- Four common components
  - e-liquid storage container, heating coil (atomizer), battery, and mouth piece



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## Vaping Modalities

E-Cigarettes
Vape Pen
Vape Mod

JUUL
Puff Bar
Elf Bar

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## Dabbing

- Method to inhale highly concentrated forms of marijuana
- THC is extracted from plant using butane or other volatile solvents
- Dabs can be concentrated to >80% THC content
  - High grade marijuana has up to 20% THC composition
- Becoming highly popularized amongst teens given ability to inhale large quantity of potent THC quickly

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## E-Liquid Composition

- Composition of Average nicotine containing e-liquid
  - 90% carrier solvent such as propylene glycol or glycerol
  - 6% nicotine
  - Remainder: flavorings, processing aids, contaminants, and water
- Mass Spectrometry performed on 825 commercial e-liquids
  - 1507 unique compounds identified
  - ~50% of compounds were only recognized in one e-liquid product
  - 43% of detected chemicals were assigned as involved in flavoring
    - Diacetyl linked airway damage in animal models
    - Pulegone found to have carcinogenic effects in mice

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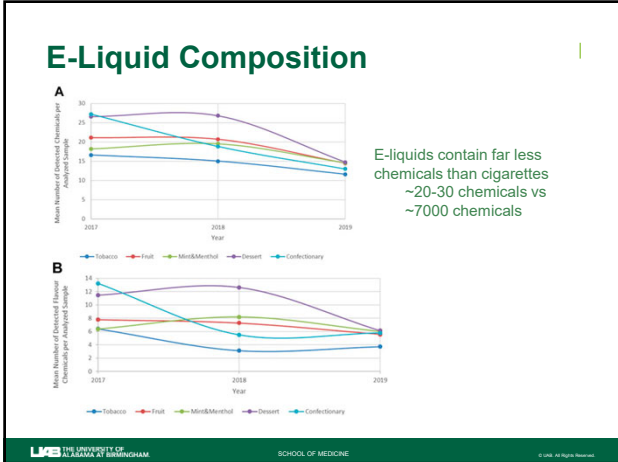
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### E-Liquid Composition

**Table 1 Substances Found in E-cigarette Liquids and Aerosols**

Substances identified	Carcinogens
Nicotine	Class 1 Potent carcinogens
Humectants/solvents (e.g. propylene glycol and glycerol)	Formaldehyde
Flavorings	Benzene4-(methylnitroso-amino)-1-(3-pyridyl)-1-
Carbonyl compounds (including aldehydes)	Butadiene
Tobacco alkaloids	Calcium
Tobacco-specific nitrosamines (TSNAs)	Class 2a Probable carcinogens
Free radicals and reactive oxygen species (ROS)	Acetaldehyde
Volatile organic compounds (VOCs) and phenolic compounds	1,2-Propanediol
Residual solvents	Isoprene
Polycyclic aromatic hydrocarbons (PAHs)	Benzo(a)pyrene
Phthalates	Benzo(b)fluoranthene
Metals	Benzo(k)fluoranthene
Caffeine	Indeno(1,2,3-cd)pyrene
Pharmaceutical compounds	Chromium
+Microorganisms	Lead
Substances present in combustible cigarettes but typically not identified in e-cigarette aerosols	Class 2b Possible carcinogens
Carbon monoxide	Acrolein
Tar	Toluene M,p-xylene
	Phenol
	Benzo(e)pyrene
	Benzo(g,h,i)perylene
	Chrysene
	Nickel (more in e cig.)

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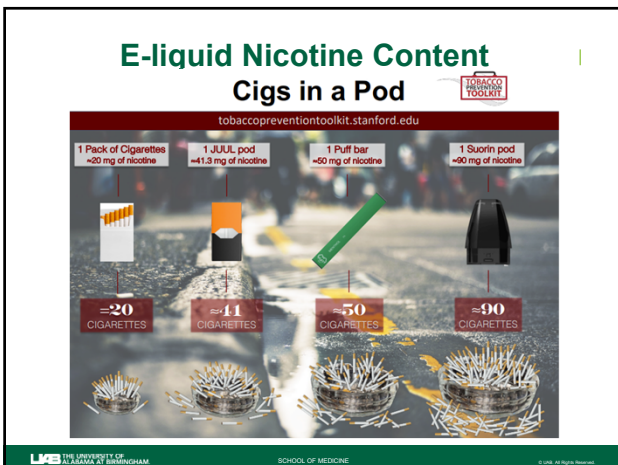
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## Why Teens Vape

**Family Uses Tobacco Products/Friends Peer Pressure**  
Self-reported as the leading reason for youth tobacco use on the NITTS-5

**Risk Perception**  
Adolescents believe that vaping is a less risky alternative to traditional cigarette smoking

**Variety of Flavors**  
Numerous flavors designed to mimic popular candies and various other sweet confections

**Mood Disorders**  
On survey, 43% of adolescents who vape cited their reason for doing so is self-medicate feelings of stress, anxiety, and depression

**Ease of Availability**  
Wide accessibility of Smoke/Vape shops and cheaper cost of e-liquids

**Curiosity**  
Reported as the top reason for vaping experimentation by adolescents in one study

**Advertising Toward Youth**  
Promotions using younger appearing models, pop-culture graphics, and utilize social media and influencers

**it's cool!**

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## Ease of Access

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## Advertisements

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"North Carolina is now the first state in the nation to hold JUUL accountable for its instrumental role in sparking the epidemic of youth vaping and its resulting nicotine addiction."

Attorney General  
**Josh Stein**

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16

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## Flavorings



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## Vaping Laws

- Federal Vaping Laws:
  - Family Smoking Prevention and Tobacco Control Act
    - Warning Labels on packaging, prevents selling to minors, advertising limitations, FDA regulates content
  - Tobacco 21- Passed in December 2019
    - Raised the legal age of purchase of tobacco products including e-cigarettes to 21 years
  - Vaping Flavor Ban - Passed in January 2020
    - Bans flavoring targeted towards children including mint, certain fruit, candy, and other sweet flavors

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## Vaping Laws

- Poorly enforced with a large delay in application review for flavorings of major brands
- Federal Taxation
  - Build Back Better Bill included a tax on electronic cigarettes/nicotine vapor products
  - ~\$1.15 tax per pod (Baseline cost \$3-\$7 per pod)

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19

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## Vaping Laws

- Alabama Vaping Laws:
  - Vaping devices are not considered tobacco products
    - No smoking signs are not considered to apply to e-cigarettes
    - No state laws regarding vaping use in public areas
    - No state taxation on vaping products
    - No additional tax outside of sales tax
  - Restrictions
    - Must be 21 years and older in agreement with federal law
    - Medical providers and daycare workers cannot use products while working
    - Prohibited in enclosed motor vehicle if passengers ≤14yo are present
  - Municipality Laws
    - Banned in workplaces, bars, and restaurants - Homewood, Fulda Dale, Mountain Brook, and Vestavia Hills
    - Banned in workplaces and restaurants - Bessemer

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20

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## Pathologic Effects of Vaping

- Cytotoxic Effects
  - Decreased cell metabolic activity, proliferation, and viability
  - Greatest effect with cinnamon, menthol, vanilla, and fruit flavors
- Oxidative Stress and Inflammation
  - Increased reactive oxygen species
  - Increased pro-inflammatory cytokines IL-6 and IL-8
- Impact on Immune Function and Susceptibility to Infection
  - Infected mice exposed to e-liquid vapor had increased viral load when infected with Rhinovirus
    - E-cigarette users six times likely to be diagnosed with COVID-19
  - Reduced macrophage antimicrobial activity
  - Increased methicillin resistant Staph aureus
  - Higher mortality in the setting of infection
  - Human studies found aberrant neutrophil activity and increased inflammatory response to influenza
- Genetic Effects
  - Impaired DNA repair mechanism and dose-dependent increase in DNA damage
  - Areas of DNA damage included those involved with cell assembly and movement

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21

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## Vaping and Chronic Disease

- Long-term effects of vaping still unknown
- Meta-analysis of 15 studies exploring risk of asthma symptoms in e-cigarette users when controlling for demographics, combustible tobacco use, and obesity
  - More asthma symptoms
  - Missed more days of school due to asthma symptoms
  - More likely to have an exacerbation in the past year (included SH exposure)
  - Dose responsive effect noted
  - Pooled OR of 1.4 for users vs non-users
- Meta-analysis of 9 studies exploring association between e-cigarette use and COPD (same variants controlled)
  - More likely to have a diagnosis of COPD
  - Highest likelihood of COPD diagnosis among dual users
  - More COPD exacerbations
  - Pooled OR of 1.5 for users vs non-users

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## Vaping in Chronic Lung Disease

- Vaping in patients with Asthma:
  - Prevalence higher than their aged-matched peers
  - Majority believed that vaping was a safer alternative to traditional cigarette smoking
- Vaping in patients with Cystic Fibrosis:



- Vaping exposure was associated with a 4.5 higher odds ratio of hospitalization when controlling for multiple covariates

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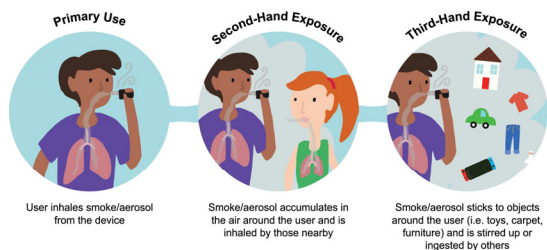
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## Types of Exposure



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## Second Hand Vaping Exposure

- HS primary e-cigarette users were more likely to have a diagnosis of chronic bronchitis with a dose responsive effect
- Retrospective observational study - Surveyed 2090 HS students who endorsed second hand vape exposure
  - Increased Bronchitis symptoms (Daily cough x 3 months, persistent phlegm production)
    - OR 1.4
  - More likely to endorse shortness of breath
    - OR 1.53
  - Association with wheezing was not statistically significant

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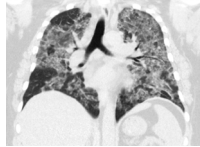
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## E-cigarette and Vaping Associated Lung Injury - EVALI

- New diagnosis first described in 2019 after epidemic in Wisconsin
- Presentation is acute or subacute
- Wide array of clinical manifestations with high rates of morbidity and mortality
- All modalities of vaping previously discussed have been linked to cases



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## Epidemiology

- CDC stopped trending cases in February 2020
  - >2800 cases were reported by that time with 68 deaths
- Median age of patients is 24 years old with 16% below 18 years old
- Type of e-liquid vaped:
  - THC products - 86%
  - Combined THC and Nicotine - 34%
  - Nicotine alone - 11%
- 78% of individuals report obtaining e-liquid through non-formal parties only such as friends, family, or non-certified dealers

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## Presentation

- Patients present with a wide array of acuity and severity
- Most common presentation day 2-3 with flu-like symptoms
- Respiratory:
  - Shortness of Breath 87%
  - Cough 83%
  - Chest Pain 55%
  - Hemoptysis 11%
- Gastrointestinal
  - Nausea 70%
  - Vomiting 66%
  - Diarrhea 43%



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## Diagnosis

- Diagnosis of exclusion, must rule out pulmonary infection first
- Diagnostic Criteria
  - Endorses vaping or dabbing within a 90-day period prior to symptom onset
  - Opacity noted on CXR or CT scan
  - Exclusion of infectious etiology:
    - Negative VRP and Rapid Flu
    - Consider blood cultures, sputum culture and BAL
    - Testing for opportunistic infections if warranted
  - Absence of other plausible diagnosis
- BAL can show abundant lipid laden macrophages and elevated 8-iso-prostaglandin F2 (oxidative stress biomarker specific in EVALI cases)

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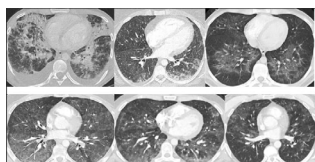
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## Radiographic Findings



- 83% with opacities on initial CXR
- CTs with bilateral basilar consolidative and ground glass opacities

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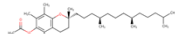
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## Pathophysiology

- BAL: Vitamin E Acetate on **48 of 51** EVALI patients (compared to healthy controls)

- Vitamin E Acetate:

- similar viscosity to pure THC oil allowing for use as a dilutant to decrease production costs



- has an aliphatic hydrocarbon tail that can align with the hydrocarbons in phospholipids found in surfactant which can transition it to a crystalline form causing **surfactant to lose its ability to maintain surface tension**



- heating can release ketene which is a **lung irritant** at high concentrations



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## Management

- Decide if inpatient hospitalization is necessary
- Supportive care with oxygen supplementation and mechanical ventilation
- Empiric antimicrobial coverage
- Systemic glucocorticoids for patients with progressive disease
  - Methylprednisolone 0.5-1mg/kg/day x5-10 days
- Several cases of patients requiring ECMO

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## Prognosis and Follow-up

- Case series of 53 patients
  - 87% required supplemental oxygen
  - 36% required BiPAP
  - 32% required intubation and mechanical ventilation
- Prior to discharge patient should remain on supplemental oxygen for at least 24-48 hours
- Initial follow-up visit at PCP's office within 48 hours of discharge
- Follow-up in 2-4 weeks with a Pulmonologist
- Patients should strictly avoid any further use of e-cigarettes or vaping devices with emphasis on those containing THC and those purchased through non-commercial markets

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## Provider's Role

- Screening Questions
  - Has the patient ever vaped? If so, did vaping occur within the past 90 days?
  - What type(s) of vaping device were used?
  - What e-liquid products were vaped?
  - Were cartridges or pods reused? If so, were they filled with homemade, unlicensed, or commercially-licensed products?
  - Was the product concentrated prior to use?
  - When did the patient start vaping relative to the onset of symptoms?
  - How often was the patient vaping?
- Ask patient or family member to provide sample of patient's e-liquid for testing through the health department
- Report any suspected case to the state health department
- Counseling on cessation of vaping and/or tobacco smoking

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## Vaping Cessation Medications

- There are no FDA approved medications for smoking cessation in the Pediatric population
- Three types of medicinal therapies are approved in adults:
  - Bupropion
  - Varenicline (Chantix) ≥17yo
  - Nicotine Replacement Therapy (NRT)
    - Transdermal Patches, gum, lozenges, nasal spray, oral inhaler
- AAP recommends use of NRT in adolescence with nicotine addiction requires prescription
- Recommend combination long and short acting NRT
- NRT should be used in conjunction with behavioral counseling
- Varenicline with behavioral counseling was found to be twice as effective in achieving 30-day remission than placebo and counseling

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## The Paradox of Vaping

- Vaping for smoking cessation
  - Evidence often contradicts itself for studies have mixed results; however, new evidence points to yes
  - Vaping method 18% quit vs NRT 10% quit after 1 year; however, used multiple different NRTs
  - Vaping Method - 80% still vaping 1 year later vs NRTs - 9% still using 1 year later
- Risk of smoking initiation due to vaping
  - Consistent evidence supporting this link
  - 4-5x more likely to start combustible tobacco if h/v vaping
  - Those with h/v vaping who start smoking do so more intensely and frequently
  - 22% of new youth cigarette smokers had previously vaped
- Tobacco smoking worse than vaping?
  - All signs point to yes
  - Vaping still no better as it leads to increase atherosclerosis (MIs OR 1.4), can induce seizure activity, risk of toddler ingestion of e-liquid, and potential combustion of vaping device and burns
- How to regulate vaping
  - Taxation, online purchase restrictions, age limits, bans on advertisements and certain flavors
  - Currently cheaper to vape as one e-liquid pod is equivalent in nicotine to 1 pack of cigarettes, and cost 3x less on average

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**Thank you!**

**Email:**  
**kbliton@uabmc.edu**

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**Meaningful Interventions**  
Offering Support to Youth in Quitting Vaping

Robin B. Geum, Certified Tobacco Treatment Specialist  
UAB Heersink School of Medicine  
Lung Health Center | Department of Pediatrics  
rbergeum@uabmc.edu



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**Confident and Equipped**

You Can Help Your Patients and Students  
Quit Tobacco Use!

Tobacco use is the  
**LEADING CAUSE OF PREVENTABLE DEATH and DISEASE**  
in the United States.

Tobacco use and dependence is a chronic, relapsing condition that, like other chronic diseases, may require repeated intervention and long-term support. Most people who use tobacco want to quit, but most try to quit multiple times before succeeding.

As an educator or healthcare professional, you play a critical role in helping youth quit using tobacco.



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**3-Link Chain of Nicotine Addiction**

- 1 Mental**
- 2 Social**
- 3 Physical**

According to the American Lung Association, there is a "three-link chain" of physical, social and emotional patterns to smoking addiction. Those who smoke or vape have a better chance of quitting and staying smoke-free if they address all three parts of the chain:

**Mental:** The act of smoking is often a part of one's daily routines. Smokers tend to light up at specific times of day—when drinking coffee or dining—or when they're feeling a certain way. Like stressed out or excited. Cigarettes can become a crutch, almost like a steady friend. An effective method to quit smoking includes identifying these triggers, and managing and adjusting behaviors through a quit plan.

**Social:** Many smokers develop social groups around smoking—people who head out for a smoke break with friends or coworkers. Smoking can also be used as a social lubricant by asking, "Got a light?" In that sense, vying on social groups that support a quit smoking attempt can be helpful. In a recent survey, 89 percent of smokers reported that support from others is very beneficial to successfully quitting.

**Physical:** When inhaled, nicotine causes the release of chemicals called dopamine in the brain and makes you feel good. Unfortunately, after the dopamine release declines, these symptoms return which causes the smoker to crave another hit. Smokers who build up a tolerance and physical dependence on nicotine—they have to smoke more to feel the same effect. Nicotine replacement therapy (NRT) can help with these symptoms.

**NRT + COUNSELING + SUPPORT = A SUCCESSFUL QUIT AND STAY QUIT**

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### Signs and Symptoms of Vaping Addiction

Answering yes to any of these questions means it's time to get help quitting.

- Need to vape as soon as you wake up or during class
- Feel anxious or irritable when you want to vape
- Have trouble concentrating or sleeping
- Keep vaping even though you know it's bad for you
- Find yourself reaching for your vape without thinking about it
- Get interrupted by thoughts about vaping throughout the day

FDA Center for Tobacco Products | 10903 New Hanover Avenue | Silver Spring, MD 20993-0002  
Last Updated May 2021 CTP-476

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### Advise Quitting and Offer Treatment

- Ask every patient about their tobacco use at every visit.
- Offer patients who use tobacco help quitting at every visit.
- Advise patients who use tobacco that quitting is one of the most important things they can do for their health.
- Offer evidence-based cessation treatment, including counseling and medication.
- Offer referrals to additional cessation resources, including 1-800-QUITNOW.
- Follow up with patients to provide support throughout the quitting process.

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