Puff, Puff, Vape: Vaping Trends

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Disclosures

• I have no relevant financial relationships to disclose
Case

• 13 year old male p/w syncope while at school. He was found unresponsive in the bathroom lying next to vomitus.
• Arouses only partially upon stimulation by school staff.
Objectives

- Who, what, how, why vape?
- Toxicity of products
- Clinical conditions
- Treatment
- Next frontiers in vaping
Vaping

• “Vape," or electronic cigarette, is a device that heats up a liquid to create a vapor to inhale.
• $182.84B by 2030
• Compound annual growth rate of 30.0% from 2022 to 2030
• The rise of tobacco
• The rise of vaping
Adolescents

• National Youth Tobacco Survey, 2021; Monitoring the Future survey
• Disposable, flavored products more popular than any traditional cigarette
• 2 million US middle and high school students reported using e-cigarettes
• 8 of 10 used flavored e-cigarettes
• 40.5% of 12th graders reported vaping in the past year
• Disposable e-cigarette use since 2019…..
  • Increased 1000% among high school students
  • Increased 400% among middle school students

Johnston et al. 2019; Miech et al. 2019; NIDA 2019
Marketing

- Over 24 million adolescents exposed yearly to vaping ads
- Features adolescents
- Focus on teens not currently nicotine users
- Instagram ads
- Emphasize culture of e-cigarette use
- Vaping is an adult behavior
- “We’re all adults here. It’s time to take back your freedom”
- Sexual component; female models in suggestive clothing
- “Vaping tricks”
- JUUL
Youth

Percentage of minors who have used e-cigarettes, by age

Note: Data shows regular e-cigarette users who have used an e-cigarette in the past 30 days.
E-Cigarettes Enticing to Youth

- “Vaping is less harmful than traditional smoking”
- Lower per use cost than traditional cigarettes
- Lack of pyrolytic smoke is appealing (no “smell stigma”)
- People of all ages taking up the habit

Dai and Hao 2016; Anand et al 2015
How Vaping Pens Work
1st Generation, Disposable E-Cigarettes

**THE CARTRIDGE**
This holds the e-liquid (substance). It comes prefilled or refillable. It is usually combined with an atomizer as one unit.

**THE ATOMIZER**
It is a coil that is a heating element which helps convert e-liquid to tiny airborne droplets (aerosol).

**THE SENSORS**
E-cigarettes without a power button will turn on when the user inhales through it. E-cigarettes with or without a power button require sensors to turn on.

**THE BATTERY**
It is a rechargeable lithium ion battery, which provides enough current to heat the atomizer to 400 degrees Fahrenheit in seconds.
2nd Generation, Refillable
3rd Generation, Tanks or Mods
4th Generation, Pods
Case

• 13 year old male p/w syncope while at school. He was found unresponsive in the bathroom lying next to vomitus.
• Arouses only partially upon stimulation by school staff.
• Seizure witnessed by EMS during transport to ED
• Muscle fasciculations present in ED
• HR 152 BP 84/51 RR 12 Temp 36.9°C Pulse Ox 94% RA
• What is the toxicity?
E-Liquid

- Psychoactive agents
- Solvents
- Flavoring compounds (>7,000 commercially available)
Nicotine

- Found in traditional cigarettes (10-30mg) and e-cigarettes (30mL bottles, 36mg/mL)
- Highly addictive
- E-liquid has high concentration
- Binds nicotinic cholinergic receptors
- Early: sympathetic nervous system stimulation
  - N/V, tachycardia, hypertension, fasciculations, seizures, salivation, bronchorrhea, hyperpnea, pallor, dizziness
- Late and higher doses: parasympathetic nervous system stimulation
  - Diarrhea, apnea, bradycardia, hypotension, paralysis, dysrhythmias
- Treatment is supportive
Nicotine

• Freebase
  • Unprotonated
  • “pure”
  • Vaporized easily
  • Absorbed across tissues easily
  • High concentrations unpleasant to consume

• Nicotine salt
  • Very high concentrations of nicotine (50mg/mL)
  • Increased addictive potential

Goldenson et al. 2017
Δ-9 Tetrahydrocannabinol

- Psychoactive component of cannabis
- Vitamin E (tocopheryl) acetate used as thickening agent
- Disrupts phospholipid bilayers
- Hypothesized to decrease the effectiveness of pulmonary surfactant

Other Substances

• Cocaine
• Heroin
• Fentanyl
Toxicity
Other chemicals

• Propylene glycol and vegetable glycerin
  • Largest volume solvent in e-liquids
  • Dilutes psychoactive agent to desired concentration
  • Creates consistency allowing agent to be vaporized
  • “Cloud thickness”

• Diacetyl (butane-2,3-dione)
  • Food additive
  • Used to deepen e-cigarette flavors
  • Injures small airways in the lungs

• Formaldehyde
  • Causes lung disease and contributes to heart disease

• Acrolein
  • Most often used as a weed killer
  • Can cause pulmonary injury

Khlystov and Samburova 2016
E-Cigarette or Vaping Use-Associated Lung Injury

- EVALI
- February 2020: 2,807 cases and 68 deaths, median age 19
- Criteria
  - Recent vaping
  - Pulmonary infiltrates on chest imaging
  - Absence of pulmonary infectious
- Modification of vaping devices
- Use of black-market modified e-liquids
- Pathology reports findings consistent with fibrinous pneumonitis, diffuse alveolar injury
- Vitamin E acetate found in all lung fluid samples of fatal cases

Layden et al. 2020, Mukhopadhyay et al 2020 Christiani 2020; Layden et al. 2020; Pray et al. 2020
Bronchiolitis Obliterans

• “Popcorn Lung”
• Injury to small airways of the lung
• Discovered when popcorn factory workers becoming ill
• Culprit butane-2,3-dione(diacetyl): additive used to simulate butter flavor for popcorn
• Inhaled diacetyl causes inflammation and may lead to permanent scarring in the smallest branches of the pulmonary tree
• “Diacetyl free” product still contained measurable diacetyl
• Bronchiolitis obliterans has no lasting treatment

Kreiss et al. 2002 Farsalinos et al. 2015; Allen et al. 2016; Rutledge 2018
Vaping-Related Lipoid Pneumonia

• Develops when fatty acids enter the lungs
• Inhaling oily substances found in e-liquid
• Resulting pulmonary inflammatory response
Primary Spontaneous Pneumothorax
Cancer?

• Vaping products have not been around long enough to assess
• Secondhand smoke harmless?
  • Nicotine
  • Ultrafine particles
  • Diacetyl
  • Benzene (found in car exhaust)

Khlystov and Samburova 2016
Cardiovascular Effects

• Daily vaping associated with increased risk of myocardial infarction
• Relatively less than daily traditional cigarette use
• Increased platelet activating factor receptor activity

Overbeek et al, 2020
Calls to Poison Centers

Electronic Cigarette and Liquid Nicotine Cases

All Ages

National Poison Data System, American Association of Poison Control Centers, 2022
Burns
Summary

• Number of people vaping has increased significantly
• Adolescents particularly susceptible
• Can be significant acute toxicity from the e-liquid
• Long term clinical repercussions
• Cancer risk?
• Future toxicity risks
Questions?