# Respiratory Effects of Vaping

Young People, At Risk Patients, and The Lungs

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## Introduction

- Dan Dunmire is a Registered Respiratory Therapist and the Director of Clinical Services at Movair, an Austin, TX based medical device company. Beginning at UPMC Presbyterian in Pittsburgh, he spent ten years at the bedside in adult critical care in cardiac and neurological ICUs. Dan has also worked in the DME industry. Upon the launch of the LUISA ventilator to the US market, he took on the role of lead clinician at Movair. A lover of all things adrenaline-producing, his hobbies include skydiving, off-road driving, ziplining, and anything else that most "normal people" think is crazy. Dan lives with his wife and three kids in the Pittsburgh area.

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# Objectives

- At the end of this discussion, the attendee will be able to:

- Discuss the origin and recent history of vaping in the United States
- Understand the unique challenges surrounding regulation of commercial vaping products
- Evaluate and understand the effects of vaping on the respiratory system
- Identify different products available to make vaping more discreet and target certain audiences

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# A Unique Challenge

- Vaping, or the use of e-cigarettes, has grown greatly over the past two decades. While devices may be useful to help traditional smokers quit, concern persists around vaping in young adult populations.

- Like cigarettes generations ago, powerful marketing campaigns have driven vaping into the mainstream.

- Many devices look like common household or office items, allowing people to participate more discreetly. Because of these unique challenges, regulators have struggled to keep pace with new products and the online marketplace.

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# Cigarettes Re-Invented

- In 2003, the modern e-cigarette was born. By 2007, E-cigarettes were commercially available in the US market.
- Chinese pharmacist Hon Lik created a commercially marketable smokeless device after his father, a longtime smoker, died from complications of lung cancer.
- Hon is reported to have smoked 1-2 packs per day at the time of his invention and hoped that E-Cigarettes would be helpful in breaking his own addiction.
- Many advocates see E-cigarette usage as a safer alternative to traditional cigarettes, or a quitting aid, arguing that E-cigarette vapor is less harmful than traditional cigarette smoke.

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# A Quitting Aid?

- Many of the proponents of vaping and e-cigarette use cite it as a less dangerous or less addictive alternative to combustible cigarette use.
- Evidence is unclear as to whether e-cigarette usage is effective to quit combustible cigarettes. In the 2017 PATH study, results **showed that only 2.2% of smokers successfully moved from traditional cigarettes to e-cigarettes.** The same study found that smokers who attempted to switch to e-cigarettes were more likely to go back to traditional cigarettes that those who successfully used pharmacological quitting aids.[1]
- A 2023 literature review suggests that e-cigarettes may help wean smokers from more dangerous combustible cigarettes, although total smoking cessation was not an end-point in any of the studies included.[2]

1) R. Chen et al; Effectiveness of e-cigarettes as aids for smoking cessation: evidence from the PATH Study cohort, 2017–2019
2) A. Ashour; Use of Vaping as a Smoking Cessation Aid: A Review of Clinical Trials. Journal of Multidisciplinary Health; 2023.

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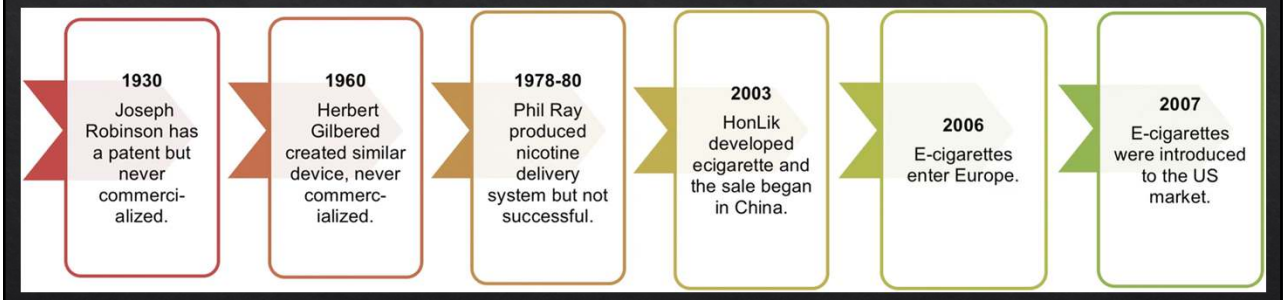
# A Brief History




S. Sapru et al; E-cigarettes use in the United States: reasons for use, perceptions, and effects on health. BMC Public Health, Iss. 20. (2020)

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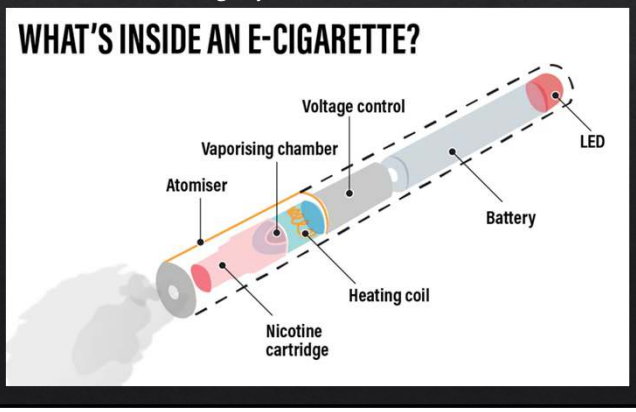
# What is an E-Cigarette?

The parts of an e-cigarette are listed here; in general:

The **battery** powers the device, while the **cartridge** contains the flavorings, nicotine, etc. The **heating coil** and **atomizer** heat the liquid into an aerosol, which is breathed into the lungs by the user.

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**Slide 7**

**DD0** Discuss background of Joseph Robinson, Herbert Gilbered, Phil Ray. Flesh out back story of Hon Lik

Dan Dunmire, 2023-09-20T02:27:46.084

# What's Inside?

- According to a National Academies of Sciences report in 2018, using e-cigarettes poses numerous health risks. It concluded that e-cigarettes both contain and emit a number of potentially toxic substances. The Academies' report also states there is moderate evidence that youth who use e-cigarettes are at increased risk for cough and wheezing and an increase in asthma exacerbations.[1]
- Some E-Cigarettes have been proven to contain herbicides, formaldehyde, and vegetable glycerin, among other substances. [2]
- Heating the chemicals found in E-Cigarettes to form a vapor can change chemical compositions or cause molecules to break down, creating more dangerous compounds.

1) National Academies of Sciences. PUBLIC HEALTH CONSEQUENCES OF E-CIGARETTES CONCLUSIONS BY LEVEL OF EVIDENCE. 2018.
2) Bein K, Leikauf GD. (2011) Acrolein - a pulmonary hazard. Mol Nutr Food Res 55(9):1342-60. doi: 10.1002/mnfr.201100279.

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# Prevalence of E-Cigarette Usage

- E-cigarette unit sales increased by 46.6% from January 2020–December 2022, from 15.5 million to 22.7 million units per 4-week period.[1]
- According to a recent study, there are over 9,000 device and flavor combinations of E-Cigarettes in the US market.[2]
- Disposable, flavored single-use E-Cigarettes currently make up ~51% of the total market.

1) F. Romeh et al. CDC Morbidity and Mortality Weekly Report. June, 2023. 72(25); 672-677
2) AP Health; 'Thousands of unauthorized vapes are pouring into the US despite the FDA crackdown on fruity flavors'; 2023.

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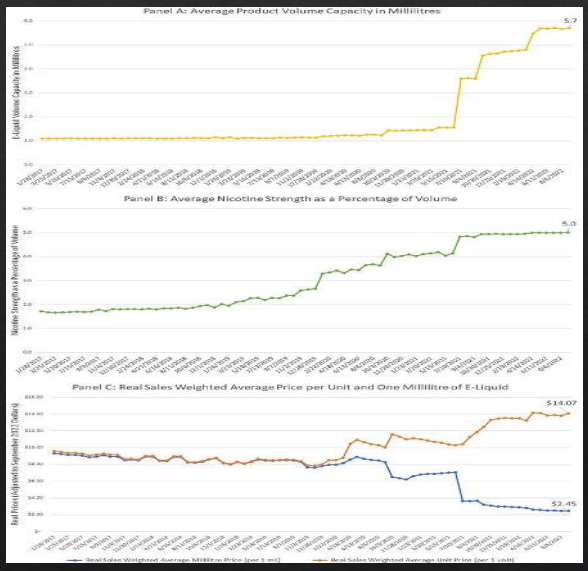
# Changing Composition

In a 2023 study of composition of E-cigarette liquid, the Truth Initiative found that from January 2017 through September 2022, disposable e-cigarettes quintupled in e-liquid capacity and nearly tripled in average nicotine strength, while decreasing threefold in price per milliliter of e-liquid.[1]

This has the potential to make an under-regulated sector of the market both more accessible and more addictive.




1) M. Diaz et al. Bigger, stronger and cheaper: growth in e-cigarette market driven by disposable devices with more e-liquid, higher nicotine concentration and declining prices. Truth Initiative, Washington DC

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# Regulation Policies

- In December 2019, two key pieces of legislation went into effect. The Tobacco 21 Act raised the age of purchase on tobacco products from 18 to 21 years of age. The FDA also announced that it would use its market review authority to regulate and ban flavored e-cigarettes, except menthol flavoring.
- While these policies were well intentioned, there are significant blind spots in regards to enforcement, specifically involving online retailers and disposable, single-use products, which were not included in the flavorings ban.

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# Challenges of Regulation

- Among the difficulties when it comes to regulating e-cigarettes is the ability to balance effective regulation with potential unintended effects.
- While a portion of the adult population uses e-cigarettes to help aid smoking cessation, the dangers presented to young people are both real and alarming.
- An outright ban on e-cigarette products is not feasible and would harm the portion of the population who are using vaping to effectively stop smoking cigarettes. Other suggested alternative are age limits or stricter regulations on the online industry, although the market is likely more agile than the FDA.

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# Marketing and Accessibility

- With the staggering availability of different flavors, as well as devices designed for discretion, many young people are willing to try E-Cigarettes, often even in previous non-smokers.[1]
- According to a recent CDC report, "among e-cigarette users aged 18–24 years, 16.3% were current smokers, 22.3% were former smokers, and **61.4% had never been cigarette smokers."**[1]
- Because of inconsistent industry regulations, online manufacturers continue to produce and market unapproved products. Sweet flavors are also used to appeal to younger generations, compounding a difficult issue.

1) Percentage Distribution* of Cigarette Smoking Status† Among Current Adult E-Cigarette Users,§ by Age Group — National Health Interview Survey, United States, 2021; Weekly / March 10, 2023 / 72(10);270

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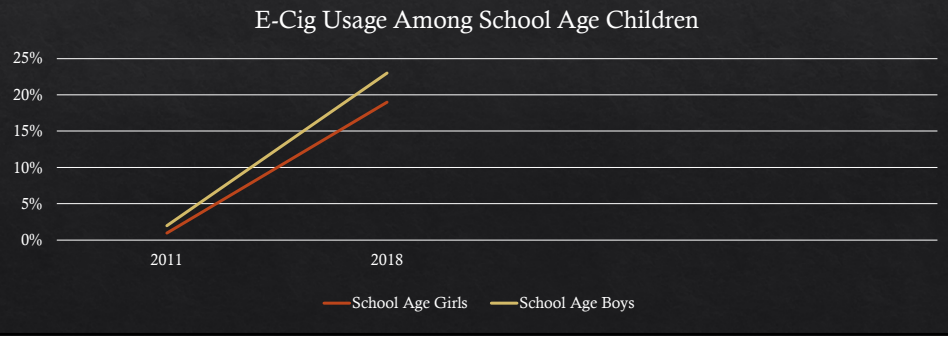
# Usage Among Young Adults

- E-cigarettes come in a variety of shapes and sizes and are often geared toward teens and young adults featuring **bright colors, attractive packaging,** and **diverse flavors.**
- Between 2011 and 2018, E-cigarette usage among school age children increased by ~20%, with distribution between males and females remaining largely unchanged.

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# Advertising Campaigns

Spreading the Word

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# New Warnings Issued

- In late August of this year, the FDA issued warning letters to the distributors of fifteen specific E-cigarettes that were determined to be "a shamelessly egregious attempt to target kids" according to Bryan King, Director of FDA's Center for Tobacco Products.




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# A New, Old Tactic

- Much of the current marketing surrounding E-Cigarette use has its roots in early advertising for cigarettes, pipes, and other tobacco products.
- As E-cigarette usage increased, advertising has also become more direct.
- Although commonly accepted as a potential quitting aids, much of the marketing suggests not quitting at all.

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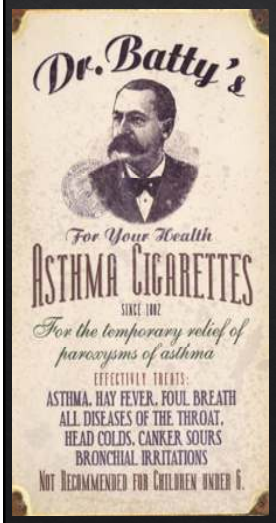
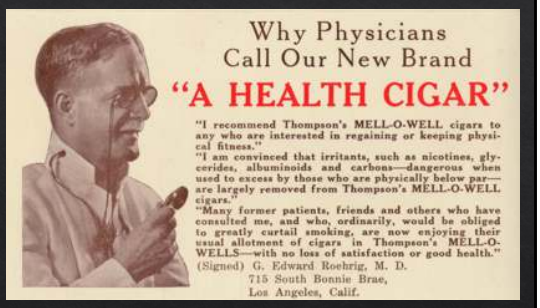
# Vintage Nicotine Ads









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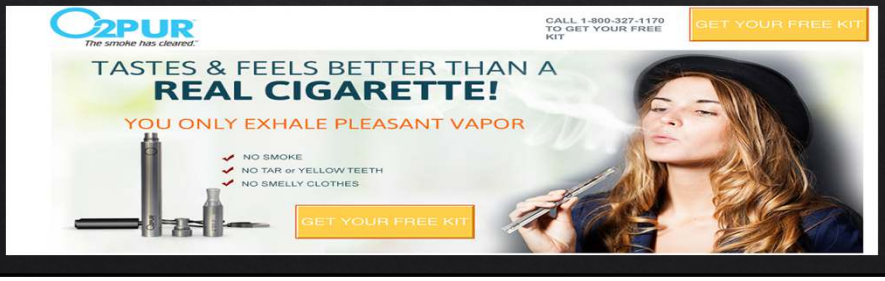
# A New Generation of Advertising

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# Available Devices

A hoodie manufactured specifically for e-cigarette use.


Many E-Cigarette manufacturers have designed products to resemble school supplies and other common items

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# Respiratory Effects

How Does E-Cigarette Use Effect the Lungs?

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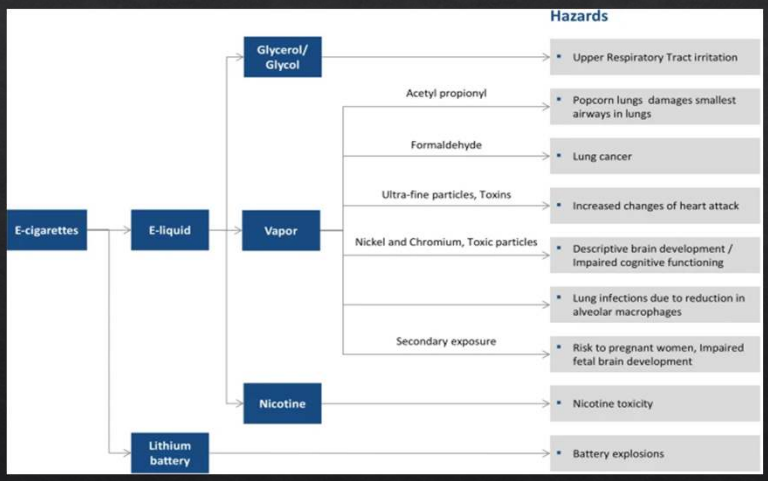
# E-Liquid Composition and Effects




1) S. Sapru et al; E-cigarettes use in the United States: reasons for use, perceptions, and effects on health. BMC Public Health 20 (1518); 2020.

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# Respiratory Effects of Vaping

- Aside from potential dependence on nicotine, many of the chemicals present in E-Cigarette vapor are associated with respiratory issues.
- Glycerin and glycol are nearly universally present in vapor, causing much of the "cloud" from E-Cigarettes.[1]
- A recent study suggests that both chemicals are toxic to small airway epithelial cells, and potentially more problematic for patients with COPD. Results showed that propylene glycol decreased cell proliferation, and also promoted cell apoptosis.[1]

1) M. Komura, et al. Propylene glycol, a component of electronic cigarette liquid, damages epithelial cells in human small airways. Respiratory Research 216 (23); 2022.

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# Respiratory Effects of Vaping

- As with traditional cigarette smoking, E-Cigarette usage is dangerous to delicate lung tissue.
- Small airway irritation, bronchoconstriction, exacerbation of underlying lung disease and other respiratory issues are associated with vaping, as well as adverse effects from potential nicotine dependence. These issues are amplified in young adults and teenagers when lungs are still developing.

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# "Popcorn Lung" and more

- There are more than 9,000 unique e-liquid flavor/device combinations available, according to a 2014 study. Many sweet flavors are created with saccharides, which degrade and produce aldehydes when heated.[1]
- Diacetyl, acetylpropionyl (also known as 2,3-pentanedione), and acetoin are chemicals used by food manufactures to add creamy flavors like butter, caramel, butterscotch, piña colada, and strawberry to food products. Studies have shown the presence of these chemicals in up to 90% of E-Cigarette liquid.
- These chemicals have been linked to bronchiolitis obliterans in factory workers where they were produced, heated, and aerosolized.[1]

1) National Academies of Sciences. PUBLIC HEALTH CONSEQUENCES OF E-CIGARETTES CONCLUSIONS BY LEVEL OF EVIDENCE. 2018.

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# Bronchiolitis Obliterans

- In the early 2000's eight workers at a microwave popcorn plant in Missouri were recognized to have recurring pulmonary symptoms. When researchers dug into possible causes, the chemicals used in buttered flavoring were isolated as the most probable cause.
- Four of the initial eight patients continued to get progressively worse and were listed for lung transplant.
- Bronchiolitis obliterans, or obliterative bronchitis is defined as "a type of obstructive lung disease of the small airways. It is a rare disease with characteristic features of fibrosis of terminal and distal bronchioles and spirometry showing airflow obstruction. Usually, this leads to a progressive decline in lung function."[1]
- Like other diseases of occupational exposure, bronchiolitis obliterans is incurable, and requires lifelong management.[2]

1) Bronchiolitis Obliterans. StatPearls, NIH.
2) Cleveland Clinic: What is Bronchiolitis Obliterans?

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# Bronchiolitis Obliterans (cont.)

- When HRCT was performed on the lungs, all workers tested exhibited marked bronchial wall thickening and significant air trapping. Bronchiectasis was noted in five of the scans, as well. [1]
- A New England Journal of Medicine investigative article identified irreversible fibrotic small airway disease, bronchial wall thickening, mucous hypersecretion and HRCT changes consistent with bronchiolitis obliterans in four e-cigarette users in 2022.[2]
- In general, though the body of evidence is still mounting and further studies are warranted, significant damage to lung tissue can be caused by compounds found in E-Cigarettes, particularly in young people.

1) M. Akpinar, et al. Bronchiolitis obliterans syndrome in popcorn production plant workers. ERS 2004 (24.)
2) L. Hariri, et al. E-Cigarette Use, Small Airway Fibrosis, and Constrictive Bronchiolitis. NEJM Evid 2022;1(6)

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# EVALI

- In late 2019, over 2,800 cases of EVALI, or E-Cigarette or Vaping Associate Lung Injury were reported in US patients, many of which were young adults. EVALI was responsible for at least 68 deaths.[1]
- The causative factor was determined to be e-cigarettes containing THC compounds and vitamin-E acetate, which was used as a thickening agent.
- Although PFTs post-hospitalization did not always indicate irreversible airway disease, EVALI underscores the danger posed by underregulated devices and inhaling unknown materials.

1) Pulmonary Illness Related to E-Cigarette Use in Illinois and Wisconsin - Final Report. NEJM, 2020.

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# Chronic Lung Conditions

- Aside from acute risks posed by some chemicals found in E-Cigarettes, likelihood of developing chronic lung disease is also significantly increased.
- In a wide-ranging study reviewing links between e-cigarette usage and lung disease, participants were found to be at a 75% greater risk of developing chronic disease than those who don't smoke or vape.[1]
- Findings from the same study suggest that dual users (users of both combustible and E-Cigarettes) have higher risk of pulmonary and cardiac complications.

1) A. Osei et al; Association Between E-Cigarette Use and Chronic Obstructive Pulmonary Disease by Smoking Status: Behavioral Risk Factor Surveillance System 2016 and 2017. American Journal of Preventative Medicine. 58(3); pgs 336-342. 2020.

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# Conclusion

- Although generally considered safer than combustible cigarettes, E-Cigarettes still pose significant health risks, especially in the young adult population.
- While potentially useful for weaning from combustible cigarettes, data shows that many young people who had never smoked are current E-Cigarette users.
- Although regulation is catching up with the market in some regards, significant gaps exist in regards to flavorings and devices designed to target vulnerable populations.
- Research is ongoing to evaluate long-term effects of E-Cigarette usage, but current research raises significant concern.

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