



# The health effects and new trends of electronic cigarettes

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**Abstract:** Electronic cigarettes (E-cigarettes/EC's), also referred to as “vaping”, has become increasingly popular in the United States over the past few years. This rapidly growing epidemic has been recognized as a major public health concern. EC's are devices that produce an aerosol by heating liquid containing nicotine, tetrahydrocannabinol (THC), cannabinoid (CBD) oils, or other unregulated substances and additives. Vaping may elicit severe respiratory ailments that are suspected to be worse than those caused by cigarette smoking. Several research dissertations illustrate the correlation between short-term inhalation exposure of the nebulized liquid from EC's and alterations in normal lung function, including inflammation of lung parenchyma. The morbidity and mortality rates seen with vaping associated lung injuries (VAPI) are rising exponentially. As of February 18, 2020, vaping has drawn controversial attention following 68 confirmed deaths, out of 2,807 hospitalized e-cigarette or vaping product use-associated lung injury (EVALI) cases reported by the CDC from all 50 states, the District of Columbia, and two US territories including Puerto Rico and US Virgin Islands. Moreover, there has been a dramatic increase of EC use among adolescents, with the median age being 24 years old 76% of these patients are less than age 35. Literature also suggests that vaping is a form of “harm reduction” as an alternative modality for smoking cessation. Focus has been limited to the unregulated class of these products, which contains the main psychoactive chemical found in cannabis called THC. Thus, the proliferating number of cases pose significant challenges for healthcare professionals. In attempt to mitigate this public health crisis, providers must increase communal awareness and provide education regarding the detrimental health implications exacerbated by vaping.

**Keywords:** E-cigarettes; vaping; e-cigarette or vaping product use-associated lung injury (EVALI)

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## Introduction

ECs are modifiable handheld devices that produce an aerosol, or vapor, by heating up a liquid concentrate containing a wide variety of flavorings, nicotine or THC. Mostly manufactured in China, some products offer quality control, resulting in variability on how EC's heat and convert the solution to an aerosol, consequently the levels delivered to users and the air pollution generated by the exhaled aerosol (1). The US patent application describes

EC devices as “an electronic atomization cigarettes that function as substitutes for quitting smoking and cigarette substitutes.” They were marketed as healthier alternatives to cigarette smoking, however, there is very limited data its potential health effects and its efficiency as a smoking cessation treatment. Although ECs promote a less harmful alternative to tobacco cigarettes, concerns for long-term health risks remain.

This outbreak has prompted the CDC to conduct several ongoing studies to inform the public of its effects and

statistical analysis of the e-cigarette, or vaping, product use-associated lung injury (EVALI). As of February 18, 2020, 2,807 cases of EVALI has been reported to the CDC from 50 states, the District of Columbia, and two US territories (Puerto Rico and US Virgin Islands). Among the 2,807 hospitalized EVALI cases, the median age of patients was 24 years with 76% of patients under the age of 35 (2). Sixty-eight deaths have been confirmed with all EVALI patients having reported a history of using e-cigarette, or vaping, products (2). Recent CDC laboratory analyses of bronchoalveolar lavage (BAL) fluid samples (fluid samples collected from the lungs) obtained from 29 patients with EVALI identified vitamin E acetate in all of the samples, which is used in some THC-containing products as a thickening agent. The CDC states this is the first time that studies have detected a concerning chemical in biologic samples from patients with these lung injuries, which provide direct evidence of vitamin E acetate at the primary site of injury within the lungs. Vitamin E is found in many foods and is available as dietary supplement and/or used in cosmetic products. It doesn't usually cause harm when ingested as a vitamin supplement or applied to the skin, however, research suggests that when vitamin E acetate is inhaled, it may interfere with normal lung function (2).

The prevalence of EC use has increased exponentially over the past 10 years. In 2010, a total of 1.8% of US adults reported using an EC at some in time. ECs provide an alternative to smoking tobacco products as a form of "harm reduction" (3). Although tobacco smokers were among those most likely to be current users of ECs, a third of current e-cigarette users had never smoked tobacco or were former smokers. The evolving trepidation is the startling rise of e-cigarette use among adolescents. According to 2018 National Youth Tobacco Survey (NYTS) data, current e-cigarette use, or vaping, among middle and high school students has alarmingly increased between 2017 and 2018, with over 2.6 million teens currently using cigarettes in 2018 (4). Awareness increases regarding the harmful effects of electronic cigarettes or vaping products as more studies and literature continue to emerge (3).

## Methods

Several studies have been conducted to provide data on the efficacy of e-cigarettes as a smoking cessation aid. An online survey piloted by Miller, Mayer, and Hajek, illustrated subjective reports of respiratory symptoms in smokers who switched from smoking tobacco to ECs for a minimum of

at least 2 months (5). For the purpose of this survey, the respiratory symptoms were focused on the common cold and no other respiratory diseases (i.e., asthma, COPD, etc.). Of the 941 responses received from two large German vape forums (E-Rauchen-Forum and Dampftreff-Forum), 29% of responders reported no change in their respiratory symptoms, 5% reported worsening respiratory symptoms, and 66% reported an improvement in symptoms. The findings of an improvement in respiratory health among individuals that quit smoking is not surprising, considering smoking contributes to an increased susceptibility to respiratory infections (5). However, there may be a link to inhaled propylene glycol (a key ingredient in most e-liquids) that could magnify this effect. "In a classical experiment an amount of 1 mg of propylene glycol vapor in 2–4 million cc of air produced complete sterilization in which pneumococci, streptococci, staphylococci, *H. influenza* and other microorganisms as well influenza virus had been sprayed" (5). Nevertheless, controlled studies are warranted to substantiate the findings of this survey to determine if there is any degree of antimicrobial protection from vaping.

Dinakar and O'Connor [2016] examined the potential positive and negative health effects of ECs (3). *In vivo* studies with mice demonstrated that short-term exposure to inhalation of nebulized nicotine-containing liquid from ECs is associated with inflammation in the lungs and systemic and pulmonary oxidative stress. This was accompanied by alterations in normal pulmonary endothelial barrier function. Another study showed that mice exposed to EC aerosol had diminished levels of glutathione and increased levels of proinflammatory cytokines in the lungs. Mice exposed to EC aerosol at two weeks time, had significantly impaired pulmonary bacterial clearance as compared to those only exposed to ambient air status post intranasal infection with *S. pneumonia*. Some studies did suggest that the use of ECs may be less hazardous than conventional cigarettes, though further data/analysis needs to be collected. A tobacco-industry study found that there are acute increases in blood pressure and heart rate in humans following tobacco-cigarette use, which were greater than those related to EC use (3). There is an acute delay in myocardial relaxation and an increase in arterial stiffness caused by tobacco smoking that was not observed after EC use. It is clear that there are biologic effects and possible health-related effects due to the use of ECs on persons who do not smoke conventional tobacco products (3). This area of research continues to become more prominent as

epidemiologic data indicate that E-cigarette use is growing among adults and minors, which may prompt nicotine addiction in these age groups that would otherwise have been nonsmokers.

Electronic cigarettes are not only used to deliver nicotine for tobacco users but is another method for inhaling cannabinoids. A new trend has emerged using ECs to deliver cannabis. There are many countless ways to consume cannabis, however, inhalation remains the most popular method of cannabis consumption (6). It is claimed that EC aerosol contains fewer harmful chemicals than ordinary tobacco cigarettes, as well as regular marijuana cigarettes. It also gives recreational cannabis users a way to conveniently and discretely vape by eliminating the distinct smell of traditional cannabis smoke (6). Although this method of inhaling cannabinoids is just as effective in delivering its euphoric effects when compared to smoking cannabis leaf, the associated health effects are of rising concern.

In a preliminary report, an ongoing investigation of pulmonary disease with E-cigarette and related product use in Wisconsin and Illinois occurred between April and August of 2019. The population (a total of 82) in the case series presented was a generally young and healthy set of individuals, with the median age being 19 years (7). Thirty-two percent (32%) of the total case patient set (53 of the 82) was under the age of 18 years. EC products were further classified to include those containing THC (84% use), nicotine only (17% use), and those with nicotine and THC (44% use) (7). All of the subjects were noted to present with bilateral infiltrates on imaging of the chest, with 94% requiring hospitalization, 32% of which were intubated and mechanically ventilated, and a single death reported. Each patient reported EC use within 90 days of symptom onset; presenting with a combination of respiratory, gastrointestinal, and constitutional symptoms. The symptoms included shortness of breath, cough, chest pain, nausea, vomiting, abdominal pain, and fever. Various tests were performed by infectious disease for potential viral, bacterial and fungal pathogens, which were mostly negative. A similar pathophysiological mechanism of lung injury exists with the patients described, to those described in literature on EC-associated illness in previous literature. With cases continuing to be reported across at least 25 states nationwide, with no single product or substance being associated with the illness, recommendations continue to include abstaining from EC use. For smokers transitioning away from traditional tobacco use, care should be directed

under a health care provider.

The technological innovation of the electronic cigarette has attracted many young people deeming it “cool”, causing this “new youth culture of vaping.” ECs hold a strong presence among several social media platforms, in which most adolescents have access to. They have been advertised by influencers on social media who have portrayed the product to be a healthy and fun alternative to cigarettes. Marketing of this product incorporate different attractive flavorings, including “fruit medley” or “cool mint” with trendy customizable options for skins and parts with a sleek, modern design. ECs are easy to conceal from authority figures, especially when on school grounds or in class. The US Surgeon General stated that from 2011–2015 there has been a 900% increase of EC use among high school students. ECs are now the most commonly used tobacco product among youth; an estimated 3 million US adolescents currently use e-cigarettes, including many who have never used conventional cigarettes (8). There are major concerns that e-cigarette use among youth may be a gateway to conventional cigarette smoking, which is a leading cause of morbidity and mortality in the United States (8).

## Results

Findings of vaping used as a tool for smoking cessation included a reduction in the frequency of respiratory infections as well as an improvement in respiratory health, although there are biologic effects and possible health-related effects due to the use of ECs on persons who did not smoke conventional tobacco products previously. Of those who were studied to have used EC products containing either THC or nicotine, all of the subjects were noted to present with bilateral infiltrates on imaging of the chest, with 94% requiring hospitalization, 32% of which were intubated and mechanically ventilated, with a single death reported.

## Conclusions

In summary, the numerous cases of pulmonary injury and deaths associated with EC use should be taken seriously and be further analyzed to better understand its true effects on the human body. One thing that is certain is that ECs contain tobacco, nicotine, and other harmful substances that are known to cause acute illnesses, although the long-term effects need to be furthered studied. A theme within many

of the research, suggested that adolescents and young teens are the target population of the product and those who have been affected. Adolescence is a time of great sensitivity to environmental factors, such as exposure to cannabis. Recent literature has demonstrated that its early, chronic use is correlated with a lower volume of the brain's grey matter, cognitive decline, and performance impairment. Although some studies suggest that ECs are less dangerous than smoking cigarettes or used as "harm reduction", further research is crucial to identify the health risks of ECs. Regulations by different states banned the use of flavored EC's and the marketing of vaping. Health policy makers must address the development of nicotine and cannabis vaping among adolescents and place tight regulations on access to EC products for minors along with methods of screening, prevention, and interventions. Recommendations issued by the CDC concerning vaping should be reviewed and followed. Ultimately, more emphasis should be placed on escalating public awareness of the potential effects of EC use to protect public health.

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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