Review

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Maitri Patel * and Terry Oroszi *

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Maitri Patel [1]* and Terry Oroszi [1]*

[1] Wright State University, USA
* Correspondence: patel.1446@wright.edu (M.P.); terry.oroszi@wright.edu (T.O.)

Abstract: The electronic cigarette or e-cigarette is the new alternative method to deliver nicotine. In 2007, the United States introduced vaping devices on the market. Due to their attractive taste and lack of adverse effects, these vaping devices have gained popularity among youth and adults. However, there has been increasing evidence that vaping can cause severe lung injury, and these devices release toxic chemicals into the body. E-cigarettes are recognized as a global threat to public health. Nicotine, the most prevalent chemical in vaping devices, is associated with neurological problems and cognitive decline. Long-term use of e-cigarettes can cause adverse health problems, including respiratory illnesses, asthma, bronchitis, and lung inflammation. In 2019, the Centers for Disease Control and Prevention (CDC) officially declared vaping-associated illness EVALI (e-cigarette or Vaping Product Associated Lung Injury). The US Surgeon General published an alarm in December 2016 that e-cigarette consumption among adolescents and teens in the US is a "major public health concern" and that more young people are now vaping than smoking traditional cigarettes and cigars. Since its commercial introduction in 2003, modern electronic cigarettes (or E-cigarette s) have become increasingly popular with smokers, non-smokers, and those who used to smoke who have switched to them. With such a rise in consumption, people are becoming more aware of the irritating, harmful, and perhaps cancer-causing effects on the lungs. (Chadi et al., 2019; Dinardo & Rome, 2019; Lyzwinski et al., 2022; Marrocco et al., 2022; O'Callaghan et al., 2022)

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What is an e-cigarette or vaping?

E-cigarette s, or vape pens, are the most common electronic nicotine and other substances, such as tobacco delivery methods. The visual appearances are like traditional cigars or cigarettes. The significant difference is in the design of the e-cigarette. The electronic cigarettes contain three primary components; the first is a lithium battery, which is the primary power supply source. The second component is a heating element; the third is a reservoir for the 'e-liquid.' This e-liquid contains a solvent such as propylene glycol or vegetable glycerine. The device works as follows: When the user inhales the flavor chemicals, the heater is activated, which creates a negative pressure to close the switch; due to this negative pressure, the heater converts the e-liquid into the aerosol form that users inhale.

Newly developed batteries allow liquids to be heated to greater temperatures, which releases more nicotine; however, there is an increase in toxic chemicals, one such toxin being formaldehyde. The design, the ability to safely packaging of the e-liquid, and characteristics intended to reduce use-related risks are not standardized between devices. E-cigarettes have three main characteristics: disposable, rechargeable, and modular. Battery, circuitry, and effectiveness differ depending on the manufacturer, making it difficult to evaluate effectiveness (Dinardo & Rome, 2019; Swati Sharma, Fiza Nehvi, 2020).

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History of e-cigarette

The first commercial version of an electronic cigarettes was developed in China in 2003 for nicotine administration. Early e-cigarettes were introduced in the United States in 2006 and were promoted as smoking cessation aids. Initial administrative initiatives to forbid the importation and sale of the devices were legally disputed; as a result, sales of the devices in the United States as tobacco products are now permissible as long as they are not marketed for therapeutic effect. The initial documents stated that tetrahydrocannabinol drugs are available, but in the United States and other countries, nicotine-containing e-cigarettes are more popular than other, safe ingredients.

Administrative regulatory setting up different nicotine concentration limits, which is varies in countries. the lowest nicotine concentration limit in the European Union is 20mg/ml. this limit set for the safety and quality standard for the E-cigarette. On the contrary, the United States has a higher nicotine level which is 50 mg / ml. The United States who vape nicotine increased from 11% to 25% between 2017 and 2019, simultaneously with the rising sales of high-concentration devices like Juul (Juul Labs, San Francisco, California; Cobb, K. K., & Solanki, 2020)

Mechanism of electronic delivery system

Vaping devices turn a liquid into an aerosol. The initial liquid contains various chemicals known to cause lung inflammation. The purpose of this solvent liquid is to produce flavor during inhalation. There is no exact mechanism to conclude the vaping-associated lung injury.

The direct mechanism can be damage to the respiratory epithelium lesion due to inhaled high-toxin chemicals, leading to fibrosis in lungs as a result, which will decrease airway circulation and can cause lung inflammation. The most common nicotine substance found in vaping devices is a most common causal agent that negatively affects the lungs. A case report identified chlorine present. Chloride gas interacts with chlorine chemicals which cause pulmonary toxicity. The mechanism of this chemical is the formation of hydrochloride acid, a reaction between water molecular and chloride gas that directly harms the epithelium surface. When the inducible nitric oxide synthase (iNOS) pathway is activated, it produces reactive nitrogen molecules. Other chemicals that activate immune cell neutrophils, basophils, can directly damage the respiratory epithelium. (Alexander, L. E. 2020; Dinardo & Rome, 2019)

Introduction

The electronic nicotine delivery system, also called e-cigarette s or vaping has substantially increased in the USA since its release on the market in 2007. The introduction of such modern methods of addiction has spread like fire among the population of the US in a substantial manner. This addiction has mainly targeted young populations such as school-going children or young college-going students. It has seen such intense popularity among these people after the legalization of marijuana within multiple states of the United States. However, this intense increase in vaping consumption has led to severe health challenges, particularly with lung injury, which has reportedly led to several cases of hospitalization and death. Therefore, it is crucial to have an in-depth knowledge of such adverse health challenges among US citizens and what kinds of possible initiatives government agencies take care of to have control over this situation.

Background of Vaping and its adverse effect on Health

The increase in vaping among US citizens is increasing every year and lung injury cases are also on the rise. Exposure of the human lungs to various environmental agents and toxic gases is not new, but the addition of vaping is, and research suggests that if people vape, health hazards will rise. Rebuli et al. (2023) discussed that vaping or E-cigarette s use a liquid vapor named aerosolise which contains hazardous chemical compounds such as nicotine, tetrahydrocannabinol, and flavourings. Some of the ingredients used in vaping have toxic, irritative and carcinogenic elements, which can damage normal lung function and cause severe lung injury. Vaping gained popularity as a safe alternative to reduce the consumption of standard cigarette smoking, which witnessed a considerable

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increase in the number of vaping users. However, using this mechanism as an alternative to conventional smoking has not changed the adverse effects of smoking on health, and therefore vaping also weakens the immune system of its smokers and causes severe lung injury, leading to severe health challenges and death (Casanova et al., 2020).

Effect of smoking on young Americans.

In 2021 reportedly, 76% of college-going students were exposed to tobacco products through several means of advertising, and around 74% of the young population is exposed to vaping through social media platforms. There is a ban on the advertising of conventional tobacco products on TV and several other platforms, however, no such ban exists for E-cigarettes and related products. Hence, this is raising curiosity among the youths to try on the vaping. A study conducted by the National Academy of Medicine in 2018 reported that the increase in interest and consumption of vaping among the young population is leading to the smoking of cigarettes in the future. E-cigarettes can deliver several drugs such as marijuana and other harmful drugs (Cherian et al., 2020). In 2016, approximately one third of US high and middle school students consumed marijuana through electronic cigarettes.

Deliwala et al. (2020) have further emphasized that the use of E-cigarette s as an alternative to conventional smoking methods has witnessed a significant increase since its release in 2007. The presence of nicotine and other substances creates an addiction among young people to smoking, leading to severe harm to organs such as the brain and lungs. The increased popularity of these products is linked to intense and early marketing campaigns and the availability of several flavors, creating attraction among the students. After the outbreak of Covid-19, there has been a significant decline in vaping among the youth; however, there is no reduction in such activity among young people due to its addictive nature (Leas et al., 2021).

Market share of vape product

The number of vapers has dramatically increased from 7 million in 2011 to 41 million in 2018. The FDA claimed that more than 3.62 million youngsters in middle and high schools within the USA were users. In the same study sample, current consumption (use on at least once in the last 30 days) grew from 11.7 to 20.8 percent over a year. Also predicted is that by 2021, there will be about 55 million adult vapers, and the present value of the worldwide industry is predicted to be $19.3 billion, roughly three times from $6.9 billion five years ago. The United States holds the highest market share of vape products. (Swati and Nehvi, 2020)

Epidemiology data

The Center of Disease Control (CDC) and Prevention declared this health crisis in the United States in 2019 and labeled as' EVALI (electronic cigarette associated lung injury). Initially, a small number of patients reported suffering from respiratory disease symptoms, such as the EVALI case presentation. Subsequently, this number grew dramatically across the country. According to CDC (CDC 2020), in July 2019 electronic cigarettes or vaping associated lung injuries [EVALI] started in the United States. 2807 patients reported nicotine-induced EVALI cases in hospital among 68 patients who died from this outbreak in February 2020. Based on the data, approximately 54% of the patients reported that the leading cause of EVALI is due to nicotine product. According to the CDC report, vitamin E acetate is the primary culprit of these EVALI outbreaks (CDC, 2020).

The CDC, the US Food and Drug Administration (FDA), all state and local health agencies, and other clinical and public health sectors are investigating a multistate outbreak of lung injury linked to electronic cigarettes or vaping products. On January 21, 2020, there have been 2051 cases reported in all 50 states, and 60 fatalities in 27 states and the District of Columbia. Due to this increase in cases and mortality, the CDC and other government organizations are focusing on preventing EVALI by regulating ENDS or educating the public about their harmful effects.(Cobb & Solanki, 2020; Swati Sharma et al., 2020).

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Possible Reasons and symptoms of Vaping

Research showed that 80% of lung injury caused by the consumption of vaping or E-cigarette s is due to the presence of a toxic substance named THC. Almost 58% of lung injury cases are related to the consumption of nicotine and THC, while 13% of cases are reported to have the presence of nicotine only (Hswen and Yom-Tov, 2021). According to reports published by US Food and Drug Administration, E-cigarette s contain vitamin E acetate, which when heated and aerosolized can release a substance named ketene. It further irritates the airways among the users because it becomes an inflammatory cascade. It has also been observed that the burning of vitamin E in e-cigarettes may affect the surfactant function, which is then turned into atelectasis. Therefore, vitamin E may be the critical agent of lung injury due to its presence in E-cigarettes or vaping (Boudi et al., 2019). The symptoms identified among users of E-cigarettes or vaping are mainly shortness of breath, pleuritic chest pain, cough, and in some cases, hemooptysis. Patients also presenting with symptoms related to gastrointestinal problems, nausea, and abdominal pain, along with the combination of fever and chills (Ind, 2020).

Clinical studies have reported that most patients who suffer from lung injury due to consumption of E-cigarette s or vaping have the symptoms of bilateral hazy or consolidative opacities in the chest, as confirmed by their x-ray studies. Hooper and Garfield (2020) shared that the data reveal that the prolonged consumption of e-cigarettes or vaping is leading to chronic cardiac and pulmonary diseases, where certain cases are also related to chronic obstructive pulmonary disease, obstructive sleep apnea, and diabetes mellitus. Consumption of e-cigarettes has increased morbidity and mortality, leading to lung injury. The median age of people because of vaping is 51, of which one death per seven patients occurs after the discharge. 25% of hospitalization occurs within 48 hours after discharge of the patients, thus clearly indicating the alarming effects of vaping among citizens of the US (Hammond, 2019).

Despite the high number of cases related to vaping use, there is a lack of clinical guidelines and appropriate health policies that could determine whether lung injury cases are specifically due to vaping. COVID 19-related lung injures are similar to vaping injuries, indicating the need for policies and clinical guidelines that will help health experts identify the cause of lung injury. The absence of clinical guidelines makes it difficult to create standard treatment/procedures for people suffering from lung injury (Bizon et al., 2020).

Response of US Public Health and Regulatory Organizations to E-cigarette s and vaping-related cases

The lung injury associated with use of e-cigarettes or vaping products, also known as EVALI was first officially detected by the US Centers for Disease Control and Prevention (CDC) in 2019. Reports indicated a severe onset of pulmonary disease linked to vaping. Both the CDC and the FDA have reported EVALI-related cases between August 2019 to September 2019 with a peak of 215 cases registered during a single week. Lung-associated disease from vaping is on the rise, lung-associated disease from Covid-19 is rapidly declining. It is now the responsibility of the state department to record EVALI cases to allow the CDC to maintain its focus on COVID-19, and they have recognized the difficulty in distinguishing between lung injuries (Dave et al., 2020).

The US government is concerned about the increased adoption of electronic cigarettes or vaping among young citizens of the country. It is admissible that the consumption of E-cigarettes reduces the effect of nicotine at a significant level compared to conventional tobacco smoking. However, we cannot rule out the adverse effects because of the harmful effects caused by E-cigarette s or vaping that cause severe lung injury leading to premature death and disability. According to reports published by The American Thoracic Society, the US is witnessing cases of lung injury of around 30-40 million, and around 500,000 premature deaths are witnessed yearly due to the adverse effects of vaping. Government agencies implement several initiatives regarding vaping control among people in which more than 70% of people are interested in quitting smoking and out of which 50% of people attempt to quit each year. However, the results are alarming because only 7% of people succeeded in quitting each year. The American Thoracic Society also revealed in its report that this trend has been

observed for the last 20 years, and further studies suggest that the use of vaping has further increased people's dependency on nicotine and the number of people who are quitting smoking may reduce significantly (Sund et al., 2023).

Further studies have also revealed that many people who quit conventional tobacco smoking are shifting their smoking interest towards vaping or e-cigarettes. Several clinical trials show alarming results of an increased dependence of people towards nicotine due to the consumption of E-cigarettes. Studies have also shown that the use of conventional tobacco smoking has not decreased, and in many cases the same individuals use both. Therefore, it can be said that a considerable amount of risk is associated with reducing the consumption of nicotine or tobacco-like substances among youth and young people regarding the consumption of smoking, leading to the severe health problems, especially lung disease (Fuentes et al., 2019).

Public Health and Regulatory Bodies of Vaping

The introduction of E-cigarette s or vaping has undergone significant changes and alterations in terms of its shape, size, and the introduction of multiple flavors. Some e-cigarette manufacturers, like Jull Labs in CA, have changed their shape to pod-based, and other popular forms, such as a USB drive, have also become popular for young adults, particularly among middle- and high-school students. There has been a rise in lung injury cases in teens and young adults, as well as a rise in hospitalization because of lung disease after COVID-19. Therefore, significant public health and regulatory initiatives must be implemented to address this grim situation (Stoebner et al., 2019).

Identifying and Registering EVALI-related Cases in the US.

To start with this initiative, public health agencies need to quickly detect cases related to EVALI by using the FDA's electronic liquid sample collection mechanism. The outbreak of Covid has limited understanding or distinguishing the onset of lung disease due to EVALI or the adverse effect of Covid. It has happened mainly due to several events such as the chemical molecular analysis of the disease, the recovery period, and the similarities it carries with the symptoms of Covid. Therefore, the awareness among physicians of the detection of EVALI has reduced because they have now shifted their focus to detecting and treating symptoms related to Covid patients (Garg et al., 2022).

Therefore, it is essential to establish clinical parameters for detecting EVALI that health regulators should adequately fund. Several testing methods should be introduced, such as the biospecimens method and the e-liquid process, to detect the cases of lung disease related to EVALI. It is also essential to collect data of the patients affected by EVALI, which will be further used for research studies to understand better the onset, progression, recovery and perspective of the patients who have recovered from EVALI. This research data can be a helpful tool that will help the clinical specialist along with the scientists understand the pattern of the disease and how it affects the immunity of the people who are getting affected with lung disease due to EVALI (Mendelsohn et al., 2023).

Coding System to Record Vaping Practice among Youth

One of the most essential mechanisms to detect the number of people addicted to vaping or E-cigarette s is by using a coding mechanism which will help in accurately detecting the use and practice of E-cigarette s or vaping among youth. This universal coding system will have specific sets of parameters that will help the clinical experts identify probable symptoms of EVALI and the data collected will help them to prepare relevant treatment mechanisms to treat people suffering from lung disease because of the consumption of E-cigarette s or vaping. This kind of coding mechanism is necessary due to the lack of a clear set of International Classification of Diseases related to EVALI, creating an issue where there are unregistered cases related to EVALI due to the absence of a clear set of guidelines. The guidelines for determining and identifying vaping-related diseases will include the pattern of vaping among youths, such as the frequency with which they consume such substances. Second, it is important to keep track of the consumption of other harmful or tobacco

substances and vaping, which can increase the risk of lung disease. It has been observed that the increase in vaping addiction among young citizens is because of the lack of proper education among people on the harmful effects of vaping or e-cigarettes (Stanton et al., 2020).

Clinical follow-up of EVALI Patients

Patients with EVALI face many challenging situations due to the rate of their hospitalization within 48 hours after discharge from preliminary treatment. It is mainly occurring because many patients are already suffer from comorbid chronic health conditions or their addiction to some other substances, causing more complexities within their health parameters. The government health agencies are trying to form a separate set of health parameters that will help clinical experts to identify the symptoms of patients with EVALI and treat them accordingly to cure the patients, thus reducing their possibility of getting admitted in a shorter period. Therefore, it is essential to establish clinical training in exposure which will help to address the issue of delayed diagnosis or failed identification of the symptoms of EVALI. It is important to conduct a thorough study in this field to identify possible symptoms and the treatment procedures used so far to treat patients with EVALI.

It is also necessary to evaluate the ideal time for recovery of EVALI patients, which will help clinical experts to implement alterations in the composition of the medicine they administer to the patients. The next step is to implement a consensus on diagnostic criteria, where the clinical or health care provider must have updates on the diagnostic criteria of EVALI. It is essential to distinguish patients from SARS or Covid patients because it is essential to have a separate set of clinical procedures to treat EVALI patients to get good health outcomes, last but not least, an effective health policy from the FDA and the United States. Health agencies should properly treat EVALI patients, and it will also address the possible reason behind the onset of the disease among young patients (Pourshahid et al., 2022).

Conclusion

Vaping was introduced to the public as a safe alternative to traditional tobacco products. Not only was it safer, but the regulations on its usage were also nonexistent, so using E-cigarettes in locations that banned smoking made it an even better alternative for individuals addicted to nicotine. Although on the surface and in its marketing, vaping may have been seen as a better alternative, harmful compositions and the health risks associated with vaping or e-cigarettes still existed. Chronic health challenges such as lung injuries, thermal injuries, chronic cardiovascular disease, psychological effects, and, in some cases, life-threatening situations are on the rise in vaping patients.

The primary reasons identified for such an adverse effect are the presence of harmful compounds with the vaporization of E-cigarettes, such as THC, Vitamin E acetate, nicotine, and more. It is essential to conduct a thorough study of the effects of the compounds used in E-cigarettes for clinical experts to form the ideal composition to treat people suffering from lung injury due to the consumption of E-cigarettes. Therefore, a multidisciplinary approach is required to address the cases related to EVALI, together with a thorough research study in this field which will help identify the possible reason behind the increased interest in vaping among the young population and possible initiatives to reduce the impact of vaping on the said population.

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