ADOLESCENTS AND E-CIGARETTE USE: THE HIDDEN DANGER OF DEVELOPING E-CIGARETTE AND VAPING ASSOCIATED LUNG INJURY

Honors Thesis

Presented in Partial Fulfillment of the Requirements
For the Degree of Bachelor of Science in Nursing

In the Maguire Meservey College of Health and Human Services
at Salem State University

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Commonwealth Honors Program
Salem State University
2022

Abstract

Newer generations have opted out of the traditional cigarettes but instead smoking electronic cigarettes. Electronic Cigarettes (EC), produce an aerosol by heating a liquid that usually contains nicotine—the addictive drug in regular cigarettes, cigars, and other tobacco products—flavorings, and other chemicals. EC can come in various sizes, shapes and flavorings and typically is used as a recovery source for overcoming nicotine addiction and smoking cessation. Adolescents have become fascinated with EC causing a health crisis among the age group called EVALI (E-cigarettes or Vaping Lung Injury).

This thesis will be addressing the EC substance abuse in adolescents and why it is important for healthcare workers, nurses, and providers to be updated on the health issues that can occur from chronic use of EC. The thesis will address the psychological and risk factors that may influence teenagers into smoking EC, THC involvement with EVALI, the health history of adolescents, and the initial signs and symptoms of EVALI. Various sources from accredited academic databases will be used to relay pertinent information when it comes to smoking EC and the health impact of EVALI. Healthcare providers, public health administrators and other personnel that work with adolescents should have some foundational information when it comes to adolescents smoking EC and how EVALI can have an everlasting impact on their health.

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Acknowledgements

First and foremost, I would like to thank Professor Nancy Ebersole for her patience when it came to editing and constant support when I had personal doubts about my thesis.

I would like to thank Dr. Scott Nowka for his support throughout all 4 years in the honor's program and his positivity will always be appreciated.

I would love to dedicate this thesis to my mom and grandma, Bibiana Aniagu and Clementina Onwo, without their sacrifices, I would not be where I am today.

Electronic Cigarettes (EC) are becoming a coping mechanism used by adolescents to cope with the struggles of everyday life. Adolescents today are the biggest consumers of EC. The flavors, such as bubble gum, mint, etc. that EC come in are designed to attract this specific age group. EC are concealable making it easier to smoke in public places discreetly without facing consequences.

Electronic cigarettes are not without health risks. The most serious health complication from smoking is EVALI (E-cigarette/Vaping Associated Lung Injury). Adolescents who develop EVALI often require admission to critical care units and run the risk of death. It is for this reason that studying adolescent use of EC is necessary to inform healthcare providers and the public of the risk of using EC and developing EVALI.

Background

Adolescents do not have consistently physical and emotional maturity to assess risky behaviors and sound judgments. According to the Erikson Stages in psychosocial development, an adolescent is in the Identity vs. Role stage. "Teens need to develop a sense of self and personal identity. Success leads to an ability to stay true to yourself, while failure leads to role confusion and a weak sense of self" (Cherry, 2021). Adolescents will be facing everyday challenges and the choices they make should be wise and informed for their adult life. In the Identity vs. Role stage, adolescents tend to seek approval within their peer group rather than the adults. In their lives participating in trends, such as smoking EC, becomes an essential part of their everyday life.

Physically, an adolescent is going through puberty and must deal with the new growth of their bodies as well as dealing with their perception of it. Adolescents become

very aware of their body changes including body weight. In today's social standards, a certain body type is more appreciated than others and with adolescents aiming to seek approval from their peers and avoiding being ostracized, they would try anything to stay within 'normal' body weight, including binge-eating then purging and even smoking. Smoking EC is a coping way to avoid over-eating and maintain an ideal body weight (Tangella, 2016).

Prior to vaping, traditional cigarettes were used by adolescents. In the past decade, EC has been the latest device for nicotine use. "EC was first introduced in 2006 in the US and was promoted as a tool to help smoking cessation" (Shinbashi & Rubin, 2020). EC delivers nicotine through a battery-operated portable machine that aerosolizes it through heat for a nicotine rush. The devices can be reused, and the consumer can buy different flavorings such as bubble gum, mint etc. to enhance their smoking experiences. The use of EC has grown exponentially in middle and high school students since 2014 with the greatest growth between 2017 and 2019. "In December 2018, annual survey results showed 13.5% of 8th graders have used nicotine vape products in their lifetime with 6% of those surveyed reporting use in the preceding 30 days. These numbers increased to 20% from 34%, respectively, in the 12th grade population. Strikingly, early surveys from 2019 demonstrate even higher rates of frequent and daily use of e-cigarette products in middle and high school students, showing that prevalence more than doubled between 2017 and 2019" (Cao et al., 2020).

There are five different generations or modifications of EC. There was the 1st module that looked like the traditional cigarettes. Noting the popularity of their product among adolescents, companies started to make the models a bit more attractive to

adolescents. The last and most common version of EC is a pod- mod device, known as JUUL, making them easily concealed so that people can use them indiscreetly in non-smoking areas. “These are so small and easily concealed those users frequently vape constantly regardless of their environment (school, work, and on public transportation) by inhaling from their palm then exhaling into their sleeve” (Scheutz, 2020). The pod-mod also can use salt “nic” which is a more concentrated version of nicotine, making the effects of nicotine last longer (Hwang & O’Neil, 2020).” With the advancement of technology, nicotine companies can constantly update the look of their products to appeal to their adolescents all while continuing to be profitable.

Currently, there is more nicotine in EC being consumed compared to traditional cigarettes. Studies have failed to consistently show that e-cigarettes are better than placebo for smoking cessation (Shinbashi & Rubin, 2020). On the contrary, e-cigarette use is a gateway to combustible tobacco use, with e-cigarette users being far more likely to use both e-cigarettes and combustible tobacco (Shinbashi & Rubin, 2020). With the different flavorings the EC has to offer compared to regular cigarettes, it gained traction with younger consumers and since it is perceived as ‘less harmful’, people trust this product. According to Hwang & O’Neil, “Although some research suggests that e-cigarette use may be safer than smoking conventional cigarettes, e-cigarette use in adolescents is never considered safe. Nicotine is a highly addictive chemical and can prime the adolescents’ reward system in the brain, putting them at risk for addiction to not only nicotine but also other drugs in the future.”

The danger also lies in the e-liquid with nicotine needed to be aerosolized by the vaping product. “Users of e-cigarettes can inhale high concentrations of propylene glycol,

glycerol, volatile organic compounds, heavy metals, ultrafine particulates, and a variety of flavoring compounds. This means that e-cigarettes can produce mainstream aerosols with a particle and nicotine concentration like, or even higher than those emitted by conventional combustible cigarettes, making them highly addictive" (Shinbashi & Rubin, 2020). With the ability of alternating the e-liquid composition, EC companies can research and create "fun and new" flavors available to appeal to younger generations.

"Historically, adolescents were targeted with cigarette advertisement and had notably higher rates of initiation of tobacco usage" (Overbeek et al., 2020). Due to teens being easily persuaded, nicotine companies intentionally made their product have different flavorings to appeal to younger audiences to make bigger sales. "In this current decade, smoking nicotine has skyrocketed to a near breaking record revealed reports of nicotine use have doubled between 8th to 12th graders" (Rao et al. 2020). In public opinion, most consumers believe that EC is harmless and does not have the same toxic effects as a regular cigarette (Cao et al., 2020). While in fact, it is even more toxic and causes severe health issues such as a new phenomenon called Electronic/Vaping Associated Lung Injury also known as EVALI. According to public health records, "EVALI has 2155 total cases, which included 360 adolescents who were either hospitalized or deceased" (Shinbashi & Rubin, 2020). EVALI is only applied as a primary health problem to a patient, when all other possible respiratory diseases and disorders are eliminated. Since there is no current treatment, it often leads to death. As adolescents engage in EC use, the more likely to see a rise in EVALI hospitalization or death. To stop the overall progression of EVALI, healthcare professionals, teachers and

public health personnel should know the psychological factors and risk factors for adolescents when smoking EC.

In 2019, the CDC reported over "2800 cases of EVALI resulting in hospitalization and 86 deaths in June 2020" (CDC, 2021). The patient usually presents general respiratory symptoms such as cough, shortness of breath and chest pain. "With severe cases, EVALI has an effect on other systems in the body such as the gastrointestinal system (nausea, vomiting, diarrhea, abdominal pain, weight loss, anorexia), and general symptoms including muscle weakness, fever, fatigue, and headaches" (Shinbashi & Rubin, 2020). As an adolescent was hospitalized, the nursing staff and doctors would perform patient centered care including several types of respiratory treatments to combat EVALI including deep breath and cough techniques, medications such as bronchodilators, oxygen delivered through a nasal cannula, and as the condition worsens the use of mechanical ventilation, chest x-rays, and lung biopsies (Belok et al., 2020). To have a significant decrease in nicotine use for adolescents and the hospitalization/deaths from EVALI, a closer look at the perceptions of EC use, THC involvement, predictors and the signs and symptoms of EVALI must be identified to help educate the younger generations in hopes of primary prevention of health consequences in their future adult life.

Methods

A systematic review was conducted using the Cumulative Index of Nursing and Allied Health Literature (CINHAL) Plus Full Text databases to obtain relevant articles to review the health consequences of E-cigarettes or Vaping Associated Lung Injury (EVALI) from the excessive use of smoking Electronic Cigarettes (EC). Several articles

and journals were reviewed to determine which were suitable for the study of topic. Keywords with Boolean terms were used to narrow the topic for this literature review (see figure 1). Each article used was peer reviewed, written by registered nurses, doctors and medical professionals and written in English. 14 of these articles met the criteria of presenting data on EC use with adolescents, the psychosocial drive of smoking and the progression of EVALI. See Figure 1 below for journal/articles identification

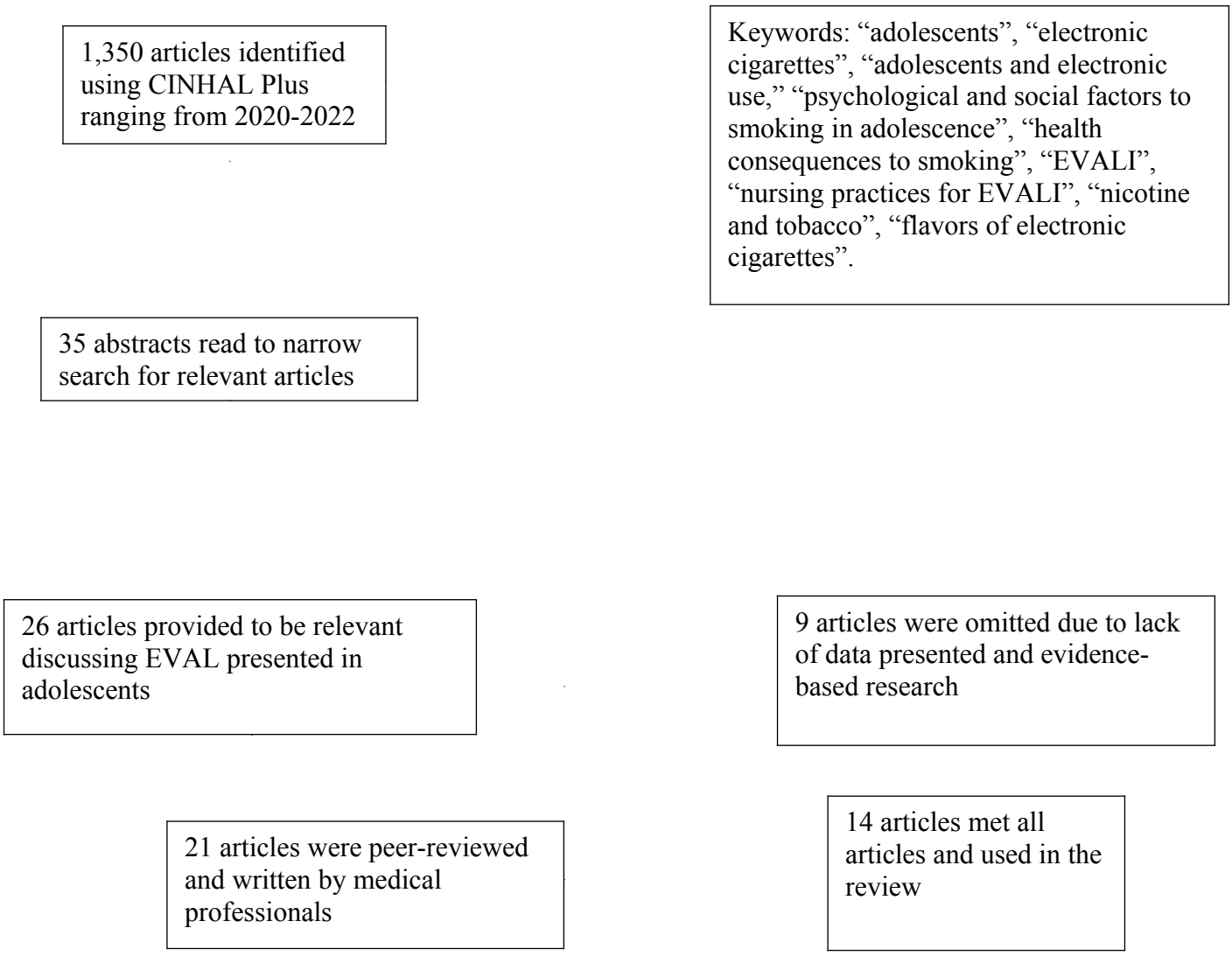

Figure 1: Journals/Articles Identification

Results

Perceptions and likelihood of smoking EC (Electronic Cigarettes)

(Moustafa et al., 2021) launched a clinical investigation on adolescent's risks on smoking EC before and after the EVALI breakout. Participants were 11th-grade students from four high schools in the suburban Philadelphia, PA area followed as part of a longitudinal survey study of e-cigarette, combustible cigarette, and other tobacco use (Moustafa et al., 2021). 28% adolescents self-reported that exclusively vaping THC-containing e-cigarettes (THC, tetrahydrocannabinol, the psychoactive compound in marijuana), 10.9% reported exclusively using nicotine-containing e-cigarettes, and approximately 50.8% reported using both (Moustafa et al., 2021). (Moustafa et al., 2021) asked several questions pertaining to nicotine, marijuana, perceived benefits, and risk. The data indicated what the adolescent's perception on smoking nicotine EC were. Adolescents who had minimal risk perception on EC were less likely to use it compared to those who had high perceptions and would smoke occasionally. Along with the different perceptions being asked, (Moustafa et al., 2021) also explored the adolescent's environment and the stigma of smoking electronic cigarettes. Peer vaping acceptance was measured with the item using the same scale as the perception risks. Adolescents who self-reported smoking EC and marijuana believe there is minimal risk of health consequences and perceive it to be harmless (Moustafa et al., 2021). As the EVALI outbreak was occurring, (Moustafa et al., 2021) conducted the same survey, and the results were significant. Those who have used EC devices and are told of the risk, they seem to cut back and tend not to smoke as much. However, after 6 months, adolescents

who perceived that EC was harmless after the EVALI outbreak, are likely to use EC devices but more excessively than before (Moustafa et al., 2021).

In research from (Rao et al. 2020), the journal speaks on the psychosocial risk factors that may contribute to an adolescent smoking EC and consequently developing EVALI. (Rao et al. 2020) used a retrospective chart review based on guidelines from the Centers for Disease Control and Prevention. Using the EVALI algorithm and inputting psychosocial risk factors, they were able to determine that presence of stressors in at least 3 of the 5 psychosocial risk domains was found in 54% of patients (Rao et al. 2020). These risk domains included home environment, academic difficulty, behavior problems, mental health, and substance use (Rao et al. 2020). Any of these stressor domains were found in patients admitted to the hospital for EVALI, contributing to the excessive use of nicotine and marijuana with EC devices.

THC is frequently associated with EVALI

THC can be liquified and put into the EC device like nicotine. When a patient is admitted to the hospital, THC is screened, along with VEA (Vitamin E Acetate), because both substances are linked to EVALI (CDC, 2021). Approximately 1 in 4 adolescent e-cigarette users admit to vaping with cannabis (Chidambaram et al., 2020). According to (Chidambaram et al., 2020), "91% (10/11) reported that they had vaped THC, 73% (8/11) vaped nicotine, and 64% (7/11) vaped both, at the time of presentation. 45% (5/11) patients had reported that they vaped other products such as cannabidiol (CBD), and two patients smoked combustible cigarettes." (Khan et al., 2021) conducted a chart review with 7 adolescent patients who were diagnosed with EVALI and admitted to Loma Linda University, Department of Emergency Medicine. Medical research suggests the use of

steroids for treatment of EVALI is recommended (CDC, 2021). Each patient who had THC in their system responded well to steroids given compared to other medications. Since EVALI is an unknown injury there was a need for observation of patients who admitted to using EC products including nicotine and marijuana.

(Rao et al. 2020) used an algorithm to find 13 hospitalized adolescent patients who were confirmed diagnoses with EVALI. According to (Rao et al. 2020), "Vaping tetrahydrocannabinol (THC) was reported in 92% of patients, and vaping nicotine was reported in 62% of patients." According to the patients, they reported buying D-9-tetrahydrocannabinol cartridges from dealers and acquaintances, a standard practice in this state without legal dispensaries (Rao et al. 2020). Since this is an underground practice, adolescents are unaware of what ingredients were used in making the liquified products. Adolescents who are unaware of VEA in the THC oils, make them the perfect victims of EVALI.

Predictors of EVALI are unreliable

EVALI does not have concrete pathophysiology or etiology of the illness. (Billa et al., 2020), focused on 3 adolescent patients to understand their physical history and correlate it to EVALI. None of the three patients had prior lung diseases or complications before being admitted to the PICU (Pediatric Intensive Care Unit). One of the patients had reported, "he was using a tetrahydrocannabinol (THC) oil vaporizer ("vape") daily for one year. He used multiple products from multiple sources over this time period. Five days prior to admission, he inhaled from a vape pen and immediately felt a 'burning in his lungs' which he had not experienced before" (Billa et al., 2020). The two other patients also did not have any pulmonary history or significant health issues. To reiterate,

each patient did not have any previous health problems but in the span of couple of days, all 3 patients were experiencing multitude of symptoms that mimic other systemic issues.

(Chidambaram et al., 2020) stated in their case review that, a total of 55% (6/11) of the patients had a prior diagnosis of asthma at the time of presentation. While (Rao et al. 2020), stated vaping tetrahydrocannabinol (THC) was reported in 92% of patients, and vaping nicotine was reported in 62% of patients. (Rao et al. 2020) also stated that all patients underwent evaluation for other conditions such as asthma, typical and atypical pneumonia, appendicitis, sepsis, and pulmonary embolism. 85% of patients had respiratory symptoms at presentation ranging from mild to severe. However, these 3 different case reviews show that there are no consistent predictors when it comes to EVALI. With little to no knowledge of pathophysiology and etiology, in order to diagnose EVALI a substantial number of symptoms must be presented along with the history of smoking EC products.

Presenting signs and symptoms of EVALI frequently lead to a misdiagnosis

EVALI presents at first a common respiratory illness such as community acquired pneumonia, respiratory arrest, parainfluenza and many more. Typically, at first each patient with EVALI presents with respiratory and or gastrointestinal symptoms. Their symptoms are mild and at the clinic they visit, doctors prescribe antibiotics to fight off respiratory infections such as pneumonia or the flu. However, after a couple of days pass by, symptoms worsen causing patients to go into respiratory arrest/failure (Billa et al., 2020). Referring to the 3 patients that were diagnosed with EVALI, all 3 patients were presented with both gastrointestinal and pulmonary symptoms when they were first

admitted to the PICU in the hospital. They first presented with low value respiratory rates (typical respiratory rates are 12-26 breaths per minute). Due to "the diffuse central ground glass opacities penetrating their lungs, all 3 patients ended up being intubated" (Billa et al., 2020). Intubation is only required when a patient can no longer breathe on their own and needs a ventilator. The medical team decided to do a blood and urine collection to see if they had acquired any infections that they were unaware of. Their lab work showed a negative infectious workup including respiratory pathogen panel (Billa et al., 2020). Therefore, respiratory infections were ruled out as a possibility of what was causing their symptoms. Again, each patient was treated with steroids, in which they showed significant improvement.

(Chidambaram et al., 2020) reviewed that all patients reported acutely with constitutional symptoms (fever, malaise, fatigue, headache), gastrointestinal symptoms (nausea, vomiting, abdominal pain, weight loss, anorexia), and respiratory symptoms (cough, chest pain, shortness of breath). Given the presentation being remarkably like a viral prodrome, for example influenza or COVID-19 infection, EVALI is a diagnosis of exclusion. (Rao et al. 2020) mentioned as well, that 85% of patients had respiratory symptoms at presentation ranging from mild to severe. Cough, shortness of breath, and chest pain were the most common complaints. Gastrointestinal (GI) distress with minimal or no respiratory symptoms characterized the presentation of 4 patients. "The most common symptoms reported in our study were cough, shortness of breath, and vomiting, each occurring separately in five patients" (Khan et al., 2021). (Hartnett et al., 2020) composed an investigation to track the EVALI outbreak that started in December 2019. "To date, the investigation has focused predominantly on the prospective identification of

new cases involving patients hospitalized with EVALI" (Hartnett et al., 2020). (Hartnett et al., 2020), noted that patients with EVALI showed initial signs of shortness of breath. "Without an EVALI related diagnosis, patients may represent less severe effects or were early signs of more severe injury, such as shortness of breath that later progressed to respiratory failure" (Harnett et al., 2020). In all EVALI patients, most of them mimic respiratory symptoms such as shortness of breath, and gastrointestinal symptoms, like nausea and vomiting.

Discussion

Based on the literature review conducted, perceptions adolescents have when it comes to EC, how THC is involved with EVALI, predictors of EVALI, as well as the presenting signs and symptoms are critical to assess and identify to avoid hospitalization and death. Adolescents who smoke EC may or may not be aware of EVALI, can either stop smoking or continue to smoke EC excessively. Adolescents who had low perception of smoking EC are less likely to smoke EC. Their environment and stress can contribute to them smoking but it is not a guarantee it will. Along with nicotine, THC and VEA may be the cause of EVALI resulting in hospitalization or death. An adolescent health history is not a predictable factor when it comes to developing EVALI. Some may or may not have respiratory issues prior to developing EVALI because health history is not a reliable predictor. Most adolescents will experience mild respiratory complications, specifically coughing and shortness of breath, before going into respiratory arrest/failure. After a first visit to a clinic or urgent care, the patient may be sent home on the assumption of a respiratory infection, such as the flu, COVID or pneumonia, before being admitted to the

hospital for EVALI. Essential information, such as the patient's past medical and everyday habits, is needed in order to treat adolescents promptly. As well with history, taking in the signs and symptoms of EVALI is crucial to avoiding intubating adolescents. Adolescents who present respiratory and gastrointestinal symptoms with confirming negative lab work of respiratory infections can lead to a diagnosis of EVALI. Educating adolescents on these substances and EC device products may result in fewer cases of EVALI but it is up to the individual whether to smoke EC or not. Public health administrators, healthcare workers and schools should all work together and educate adolescents on EVALI and the impact it could have on their health.

Conclusion

Electronic cigarettes were first introduced to ween from nicotine, but it has an opposite effect on the public, especially with adolescents who are now addicted. This new smoking device has single-handedly been the cause of EVALI, affecting an overall healthy age population to become admitted to hospitals after being misdiagnosed the first-time presenting symptoms.

Adolescents who often are misdiagnosed die due to the lack of evidence collected to properly treat EVALI. Once again, it is up to healthcare providers, public administrators, and schoolteachers to be aware of the signs & symptoms of EVALI, understand the perceptions adolescents have when it comes to EC and to educate the adolescents in their community of the risks when it comes to smoking electronic devices.

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