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Vaping Education in the Adolescent Population

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VAPING EDUCATION IN THE ADOLESCENT POPULATION

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ABSTRACT

The prevalence of e-cigarette use in the United States is drastically rising, deeming vaping an epidemic. With the surge in the use of e-cigarettes, cases of e-cigarette or vaping product use-associated lung injury (EVALI) are simultaneously increasing. The most common tobacco product used among adolescents are e-cigarettes, posing serious concerns regarding health consequences. Adolescents are unaware of the potential harmful effects of e-cigarette use, due to the lack of vaping education provided in high school curriculums.

The purpose of this research project is to educate high school students about the harmful effects of e-cigarette use. The need for vaping education was identified at St. Francis High School. Therefore, this research project consists of a video PowerPoint presentation containing significance of e-cigarette use, the harmful effects of vaping, and tools for vaping cessation. The presentation is to be implemented into the health curriculum at St. Francis High School. The project could be further administered on a broader spectrum throughout additional high schools in order to reach more adolescents and provide essential health information to this population.

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Introduction

Cigarette smoking has been around for hundreds of years and the negative health effects are widely acknowledged by the general population. The use of e-cigarettes has been on the rise in the United States (U.S.) since 2010 (Rigotti & Kalkhoran, 2019). Unlike cigarette smoking, vaping does not involve visible smoke or a tobacco scent (Gottschalk, Fraga, Hirschfield, & Zuckerman, 2019). Vaping is the act of inhaling and exhaling aerosol from an electronic cigarette device (e-cigarette) (Gottschalk, Fraga, Hirschfield, & Zuckerman, 2019). The e-cigarette device consists of a battery, which allows the liquid contents to be heated and transformed into an inhalable vapor. The aerosol consists of different components such as nicotine, additives, and flavors (U.S. Department of Health and Human Services, 2016).The e-cigarette was developed with hope of creating a less harmful method of smoking (Rigotti & Kalkhoran, 2019).

Many adolescents do not realize the harmful health consequences of vaping. Between 2011 and 2017, e-cigarette use increased in high school students, making e-cigarettes the most commonly used tobacco product among high school students (Rigotti & Kalkhoran, 2019). During crucial periods of mental and physical growth and development, the inhalation of harmful e-cigarette vapor can have devastating effects on the adolescent body (Gordon, 2019). Vaping releases nicotine into the body, which can lead to slow or delayed brain development, along with impaired memory, learning, self-control, mood, and attention in adolescents (Gordon, 2019). Vaping also irritates the lungs, causing severe lung damage and potentially death (Gordon, 2019). Not only does vaping affect the body, but nicotine consumption increases the risk for other addictions into their adult years (Gordon, 2019).

This community outreach project will focus on the issue of increased prevalence of vaping among the youth by creating and presenting an educational tool for high school students. The educational tool will inform students about the consequences of vaping and the harmful effects on the body. The tool will be made available to the schools for continued educational use. This project aims to educate students on the effects of vaping and to reduce e-cigarette usage among the youth.

Background

The vaping epidemic in the United States is on the rise. Jerome Adams, Surgeon General of the United States Public Health Service emphasizes, "... the importance of protecting our children from a lifetime of nicotine addiction and associated health risks by immediately addressing the epidemic of youth e-cigarette use" (U.S. Department of Health and Human Services, 2016). Middle and high school students have demonstrated a significant increase in e-cigarette use, which raises concern for overall tobacco use in younger populations (Rigotti & Kalkhoran, 2019). While vaping itself is problematic, the prevalence in adolescents has also led to an overall increase in tobacco use among high school students. The 2018 National Youth Tobacco survey reported high school student's tobacco use at 27.1%, deeming the use of e-cigarettes in adolescents greater than any other tobacco product (Food and Drug Administration, 2019). 21% of high school students and nearly 5% of middle school students reported participating in vaping in 2018 (Rigotti & Kalkhoran, 2019). In 2018, the National Youth Tobacco Survey reported an increase of 1.5 million students who used e-cigarettes in comparison to the previous year (Food and Drug Administration, 2019). Data over the years has solidified the fact that the prevalence of vaping is continuing to rise, therefore, addressing this problem is critical (Food and Drug Administration, 2019).

E-cigarette use is commonly advertised as a method to quit smoking, however, this method lacks scientific evidence and conclusive data regarding safety, efficacy, and the health effects of vaping (National Institute on Drug Abuse, 2019). Aside from smoking cessation, additional reasons that adolescents start vaping include influence from a friend or family member, the attraction to fun flavor pods, and the belief that vaping is less harmful than other forms of tobacco consumption (Tsai et al., 2018). Flavor additives often mask the taste of nicotine, allowing adolescents to enjoy the flavor without recognizing the amount of nicotine that is being consumed. Excess intake without knowledge of nicotine levels is common (Food and Drug Administration, 2019).

In comparison to other methods for smoking cessation, such as medications, vaping is a popular choice. Due to the familiar hand-to-mouth technique that cigarette smokers are accustomed to, which is simulated with vaping, as well as the favored taste and physical design of e-cigarettes, smokers are opting for e-cigarettes as their smoking cessation method (Rigotti & Kalkhoran, 2019). With the lack of medical knowledge surrounding the negative health effects of vaping, the use of e-cigarettes for smoking cessation has not gained approval from the Food and Drug Administration (National Institute on Drug Abuse, 2019).

More than 40% of young adults who vape have no history of smoking ("E-cigarettes: facts, states, and regulations," 2018). This demonstrates that a large percentage of users are not using vaping as a smoking cessation tool ("E-cigarettes: facts, states, and regulations," 2018). Young adolescents are first introduced to tobacco products through vaping, leading to the use of additional tobacco products such as cigarettes (National Institute on Drug Abuse, 2019).

The rapidly increasing numbers in adolescents using e-cigarettes, raises extreme concerns as new vaping-related illnesses are increasing (Centers for Disease Control and

Prevention, 2019b). Currently, more than 2,807 reported vaping-related medical cases from 50 states, The District of Columbia, and two U.S. territories are reported. Twenty-nine states and the District of Columbia have reported deaths due to vaping related cases (Centers for Disease Control and Prevention, 2019b). The CDC reports dramatically increasing statistics of vaping related illnesses each week (Centers for Disease Control and Prevention, 2019b). Determining the nature and specific cause of these cases and deaths is imperative, followed by public education related to the health effects of vaping. Clinicians are also impacted by the increased prevalence of vaping, as they must be educated in order to properly diagnose and treat patients with vaping related illnesses and lung injury (Centers for Disease Control and Prevention, 2019b).

Patients presenting with lung injuries related to vaping are commonly young and otherwise healthy individuals (Centers for Disease Control and Prevention, 2019b). Symptoms often onset over days to weeks and involve several body systems, including respiratory and gastrointestinal. Patients often present with a combination of one or more of the following: cough, chest pain, shortness of breath, abdominal pain, nausea, vomiting, diarrhea, fatigue, fever, and weight loss (Centers for Disease Control and Prevention, 2019b).

Problem Statement

Adolescents are at a higher risk for developing vaping-related health issues during this period of physical and mental maturation (U.S. Department of Health and Human Services, 2016). As the use of e-cigarettes rises, the incidence of vaping-related lung injuries increase (Rigotti & Kalkhoran, 2019). E-cigarette use is dangerous due to the fact that many users are unaware of the harmful effects it can have on the body. Young adults use e-cigarettes for different reasons, and over time these individuals can become addicted to the vaping substances

(U.S. Department of Health and Human Services, 2016). At this time, it is unknown as to what chemicals cause what health concerns or if it is a combination of the e-cigarette device itself and the different liquids. With the rise of e-cigarette use among adolescents, schools need educational tools, materials, and resources to educate students.

Purpose

The purpose of this project is to educate high school students about the harmful effects of e-cigarette use. The goal is to provide information about the active ingredients and harmful chemicals associated with vaping and the impact of e-cigarettes on the body in order to aid in healthy decision making. Resources for vaping cessation programs will be discussed to guide students who have a desire to quit the use of e-cigarettes. This project will implement an educational PowerPoint and handout to present to high school students. These tools will be provided to the high school for future use for continued e-cigarette education.

Significance of the Problem

Vaping-related lung injuries are currently an epidemic in the United States (U.S. Department of Health and Human Services, 2016). Medical providers, including physician assistants, are evaluating otherwise healthy patients who present with atypical respiratory, gastrointestinal and systemic symptoms (Centers for Disease Control and Prevention, 2019b). Presenting signs and symptoms may differ from case to case, however, the common denominator in these patients is the use of e-cigarettes. The CDC has coined the term EVALI (e-cigarette, or vaping, product use associated lung injury) to categorize these cases (Centers for Disease Control and Prevention, 2019b).

E-cigarette use is the most common form of tobacco consumption in the youth population (Blaha, n.d.). From 2001 to 2015, a 900% increase in the use of e-cigarettes among high school students was demonstrated. As the health complications of vaping are becoming known, the rapid increase of e-cigarette use is concerning (U.S. Department of Health and Human Services, 2016). Juul, a brand of an e-cigarette, accounts for 72 percent of e-cigarettes on the market and has been established as the vaping device of choice amongst teens (Raven, 2019). The Juul vaping device has a sleek design that mirrors a USB flash drive. According to Suchitra Kirshnan-Sarin, PhD, and co-leader of the Yale Tobacco Center for Regulatory Science, "When we ask teens about their vaping or e-cig habits, they don't even consider juuling to be part of that" (Raven, 2019). This proves the naivety of youth surrounding e-cigarette use. In an effort to limit the use of e-cigarettes in the youth population, an educational tool is necessary to educate adolescents on the health consequences and health consequences of e-cigarette use.

Barriers

Limited clinical knowledge exists surrounding the surge of vaping related illnesses. Investigators have yet to pinpoint the causative agent that is responsible for vaping related illnesses. With continued investigation, new information is consistently surfacing regarding vaping related illnesses. The Center of Disease Control (CDC) publishes current data every Thursday with updated statistics regarding vaping-related cases and deaths (Centers for Disease Control and Prevention, 2019b). Medical knowledge is always evolving with research and this presentation may need to be routinely updated for students to include the most current information. The target population of this project are high school age students. Due to the nature of this age group, impacting the students may be challenging.

Definition of terms

The following definitions include commonly used terms within this paper.

Adolescents: a young person who is developing into an adult: one who is in the state of adolescence (Merriam-Webster, 2019).

Cessation: a temporary or final ceasing (Merriam-Webster, 2020).

Cigarette: a slender roll of cut tobacco enclosed in paper and meant to be smoked (Merriam-Webster, 2019).

EVALI: E-cigarette, or vaping, product use associated lung injury (Centers for Disease Control and Prevention, 2019b).

Epidemic: affecting or tending to affect a disproportionately large number of individuals within a population, community, or region at the same time (Merriam-Webster, 2020).

E-cigarette: a battery-operated device that is typically designed to resemble a traditional cigarette and is used to inhale usually a nicotine-containing vapor (Merriam-Webster, 2019).

Nicotine: a poisonous alkaloid C10H14N2 that is the chief active principle of tobacco and is used as an insecticide (Merriam-Webster, 2019).

Tetrahydrocannabinol (THC): either of two physiologically active isomers C21H30O2 from hemp plant resin *especially*: one that is the chief intoxicant in marijuana (Merriam-Webster, 2019).

Vaping: to inhale vapor through the mouth from a usually battery-operated electronic device (such as an electronic cigarette) that heats up and vaporizes a liquid or solid (Merriam-Webster, 2019).

Youth: the time of life when one is young *especially*: the period between childhood and Maturity (Merriam-Webster, 2019).

Conclusion

Vaping is on the rise among the youth population, bringing with it many health concerns. Researchers are actively investigating the vaping epidemic. It is vital that the youth are educated on vaping and the negative impact that e-cigarette use may have on their health. The aim of this project is to provide an educational tool to present to students to inform them about the negative health consequences of vaping. Chapter 2 will further discuss e-cigarettes use and EVALI.

Chapter 2: Literature Review

Introduction

Vaping is a current epidemic that is on the rise. In the United States (U.S.), e-cigarette use has upsurged since 2010 (Rigotti & Kalkhoran, 2019). In the last decade, adolescents have shown the most prominent increase in e-cigarette use, more than any other tobacco product (Rigotti & Kalkhoran, 2019). "In 2018, 21 percent of high school students reported current use of e-cigarettes, up from 12 percent in 2017, and almost 5 percent of middle school students reported current e-cigarette use" (Rigotti & Kalkhoran, 2019, para. 19).

The use of e-cigarettes is believed to be a smoking cessation tool. E-cigarettes taste and look like cigarettes, utilizing a similar user hand-to-mouth technique that simulates smoking, making them more appealing than other cessation methods, such as medications (Rigotti & Kalkhoran, 2019). Adolescents seek e-cigarette use for several reasons. One of the most common reasons for adolescent use of e-cigarettes is the belief of decreased consequences that are linked to smoking cigarettes (Rigotti & Kalkhoran, 2019). Aside from the perceived decreased health risks of vaping, adolescents use e-cigarettes to appeal to peers with potential to fit within social standards (Rigotti & Kalkhoran, 2019). Younger, more educated individuals with higher salaries are most likely to use e-cigarettes, in comparison to cigarette or non-smokers (Rigotti & Kalkhoran, 2019).

As of February 18, 2020, currently 2,807 lung injury cases are reported from all 50 states and two U.S. territories (Centers for Disease Control and Prevention, 2019b). Sixty-eight deaths have been confirmed in twenty-nine states and the District of Columbia (Centers for Disease Control and Prevention, 2019b). The U.S. Food and Drug Administration (FDA) is advising caution to the public regarding the vaping epidemic among adolescents in the United States. The

FDA is aiming to inform the public, especially parents and educators, about the discrete nature of vaping products. E-cigarettes often resemble flash drives and can be easily hidden and used inconspicuously (National Institute on Drug Abuse for Teens Blog Team, 2018). Therefore, it is vital that the general public is aware of the increased prevalence of vaping, along with the associated risks, in order to help prevent the vaping epidemic from spreading.

Vaping is the inhalation and exhalation of an aerosol that is produced by an e-cigarette (Gottschalk, Fraga, Hirschfield, & Zuckerman, 2019). A liquid cartridge inside the device is heated using a built-in battery, creating an inhalable vapor (Gottschalk et al., 2019). No visible smoke or tobacco scent is associated with vaping, although it is not just water vapor (Gottschalk et al., 2019). The vapor contains a combination of nicotine, additives, and flavor (U.S. Department of Health and Human Services, 2016).

History of Cigarettes: Development of the E-cigarette

The first use of cigarettes dates back to the late 19th century (U.S. Department of Health and Human Services, 2016). Since the invention of the cigarette, companies have continuously worked to develop and modify the next best product in the tobacco and smoking market. Beginning in the 1880's and 1890's, products claiming to block the harmful nicotine were first marketed, known as Dr. Scott's Electric Cigarettes (U.S. Department of Health and Human Services, 2016). These cigarettes utilized a cotton filter that supposedly eliminated the potentially harmful materials from the smoke. Dr. Scott's Electric Cigarettes did not require a match in order to light (U.S. Department of Health and Human Services, 2016).

By the early 20th century, the tobacco industry noted that the addictive quality of nicotine was the driving force for obtaining returning customers (U.S. Department of Health and Human Services, 2016). As a result, Camel, a well-known cigarette brand, introduced a high-nicotine

content cigarette to the market in 1913 (U.S. Department of Health and Human Services, 2016). Companies such as Lucky Stroke and Liggett & Myers began formulating new products to entice smokers, including blended cigarettes (U.S. Department of Health and Human Services, 2016). A blended cigarette combines multiple tobacco components, often including Flue-cured, air-cured, and sun-cured tobacco (Lawler et al., 2017). The tobacco industry thrived as it gained knowledge of the qualities of nicotine. This understanding led to continued adjustments of tobacco products targeted at specific users (U.S. Department of Health and Human Services, 2016). As the market for cigarettes continued to increase, companies began utilizing advertisements with physician testimonials to reassure the public of the safety of tobacco products, especially as new and supposedly safer options arose (U.S. Department of Health and Human Services, 2016). The Lucky Strike tobacco company was known in the 1930s and 1940s for their advertisements of blended cigarettes claiming, "We removed from the tobacco harmful corrosive ACRIDS (pungent irritants) present in cigarettes manufactured in the old-fashioned way" (U.S. Department of Health and Human Services, 2016, Early Efforts to Modify Cigarettes section). The use of health-related statements in advertising encouraged the public of the safety of smoking cigarettes during this time period (U.S. Department of Health and Human Services, 2016).

In 1964, the Surgeon General's report confirmed the link between cigarette smoking and an increased risk of mortality (U.S. Department of Health and Human Services, 2016). Smokers more commonly smoked filtered cigarettes, often believing that the filtered cigarettes were not associated with the increased risk of mortality as cigarettes were found to have (U.S. Department of Health and Human Services, 2016). However, per the Surgeon General's report in 2016:

> …the Surgeon General convened another group of experts on June 1, 1966, to review the evidence on the role played by the tar and nicotine content in health. The group concluded that "[t]he preponderance of scientific evidence strongly suggests that the lower the 'tar' and nicotine content of cigarette smoke, the less harmful are the effects" (U.S. Department of Health and Human Services, 2016, "Filters, Tar Reduction" section).

While cigarettes with lower tar and nicotine content were claimed to be less harmful, this statement remains in question. The benefits of smoking low-tar cigarettes had not been proven through research data. However, the tobacco industry took advantage of the claims from the expert panel in 1966 and used this information to market their healthier cigarettes to draw in users (U.S. Department of Health and Human Services, 2016). By displaying tar and nicotine values on their products, this further encouraged smokers to pursue the healthier alternatives that were being marketed (U.S. Department of Health and Human Services, 2016).

The similarity between nicotine addiction and other addictive substances, such as heroin, was first noted in the 1970's and 1980's (U.S. Department of Health and Human Services, 2016). With new data surrounding nicotine addiction, researchers began studying cigarettes in greater depth. While cigarette companies were aware of the addictive quality of nicotine and its role in the industry, this data was not widely known or accepted by the public (U.S. Department of Health and Human Services, 2016). However, by 1971, radio and television advertisement of cigarettes were banned due to the recognized toxic effects of nicotine and smoking (U.S. Department of Health and Human Services, 2016). In 1988, The Surgeon General's report published *The Health Consequences of Smoking: Nicotine Addiction*, which outlined the symptoms of nicotine addiction, including withdrawal and cravings. The 1988 report further

informed the public of nicotine addiction and associated health concerns (U.S. Department of Health and Human Services, 2016).

Throughout history, companies sought out alternatives for each new development of cigarette products that came to the market (U.S. Department of Health and Human Services, 2016). Evidence suggests that while Joseph Robinson patented an e-cigarette type device as early as the 1930's, he did not implement prototypes or plans for manufacturing. Therefore, the invention of e-cigarettes is most often credited to Herbert A. Gilbert (Consumer Advocates for Smoke Free Alternatives Association, n.d.).

Herbert A. Gilbert invented the first e-cigarette in 1963, completing the patent process two years later in 1965 (U.S. Department of Health and Human Services, 2016). His initial intention was to market a safer option to cigarette smoking. Herbert A. Gilbert noted on his patent application that his goal was to provide "a safe and harmless means for and method of smoking" (U.S. Department of Health and Human Services, 2016, Invention of the E-cigarette section). Gilbert stressed the importance of using heated and moisturized air for his product. He claimed this provided a higher level of safety, as opposed to using paper and tobacco products to smoke cigarettes (U.S. Department of Health and Human Services, 2016). Gilbert marketed this battery operated device which could heat the components without combustion (U.S. Department of Health and Human Services, 2016). While Gilbert had big plans, and did complete prototypes, he failed to successfully implement the production of his products. His patent expired before a company could pick up his invention and commercialize it (Consumer Advocates for Smoke Free Alternatives Association, n.d.). Ultimately, Gilbert's invention failed to make it to the market.

Numerous individuals and tobacco companies worked to create the first commercialized e-cigarette since the 1970s. Several patent applications were filed between 1970 and 1990 (Consumer Advocates for Smoke Free Alternatives Association, n.d.). When one of the largest tobacco companies in the United States contacted the FDA requesting to market their e-cigarette, the company was declined permission (Consumer Advocates for Smoke Free Alternatives Association, n.d.). This declination is a key event that resulted in decreased patent applications and attempts to create a marketable e-cigarette over the next several years. It was not until 2003 that the idea of e-cigarette production began resurfacing again (Consumer Advocates for Smoke Free Alternatives Association, n.d.).

Chinese Pharmacist, Hon Lik, created the first e-cigarette that had commercial success (U.S. Department of Health and Human Services, 2016). Lik originally worked for Golden Dragon Holdings, which soon rebranded under the company named Ruyan, meaning “like smoke” (Consumer Advocates for Smoke Free Alternatives Association, n.d.). With influence from his father who died of lung cancer due to smoking, Lik hoped to market the e-cigarette as a healthier alternative to cigarettes (Consumer Advocates for Smoke Free Alternatives Association, n.d.). Therefore, the first indications of using e-cigarettes for smoking cessation began with Lik’s invention in China (Consumer Advocates for Smoke Free Alternatives Association, n.d.). The product quickly gained attention and popularity in the United States. During the mid-2000’s, several companies, such as Ruyan and Janty, made the e-cigarette available in the U.S (U.S. Department of Health and Human Services, 2016). As a Chinese company, Ruyan applied for and achieved approval for a U.S. patent of their e-cigarette. Ruyan claimed their product “functions as substitutes for quitting smoking and cigarette substitutes” (U.S. Department of Health and Human Services, 2016, Invention of the E-cigarette section).

Within a few years, the number of sales of the e-cigarette rapidly increased in the United States (U.S. Department of Health and Human Services, 2016). With widespread interest, even nonsmokers became interested in the e-cigarette (U.S. Department of Health and Human Services, 2016). Seeing the success and future potential of the product, Imperial Tobacco Group invested $75 million to gain rights to the intellectual property from the e-cigarette made by Ruyan (U.S. Department of Health and Human Services, 2016).

Per the National Center for Chronic Disease Prevention and Health Promotion in the Office of the Surgeon General Report from 2016:

> …data from the National Youth Tobacco Survey, in 2011 the prevalence of current e-cigarette use (defined as use during at least 1 day in the past 30 days) among high school students was 1.5%; prevalence increased dramatically, however, to 16% by 2015, surpassing the rate of conventional-cigarette use among high school students. This equates to 2.4 million high school students and 620,000 middle school students having used an e-cigarette at least one time in the past 30 days in 2015 (U.S. Department of Health and Human Services, 2016, Invention of the E-Cigarette section).

With great concern of the health of the general population, especially youth, the FDA fought to gain control of e-cigarette regulation. In 2016, under the Family Smoking Prevention and Tobacco Control Act, the FDA was able to regulate not only the control of smokeless tobacco and cigarette products, but also all e-cigarettes (U.S. Department of Health and Human Services, 2016).

Types of E-cigarettes

E-cigarettes are available in several sizes and vary in appearance, although the method of nicotine delivery are similar. All e-cigarettes work by heating a liquid, which is then inhaled as

an aerosol into the lungs of the user (Perrine et al., 2019). The term “e-cigarette” encompasses the general category of vaping devices (Perrine et al., 2019). Common names for e-cigarettes include vapes, vape pens, e-hookahs, mods, cigalikes, or tank systems (Rigotti & Kalkhoran, 2019).

E-cigarettes are further classified into generations based on their design. First generation e-cigarettes resemble cigarettes in style and shape (Rigotti & Kalkhoran, 2019). While some companies deviated from cigarette colors, the shape of first generation e-cigarettes remained similar to cigarettes, cigars, or pipes. Each first generation e-cigarette is for single use and is disposed of once the vapor ceases to be produced (Rigotti & Kalkhoran, 2019). Second generation e-cigarettes consist of models that contain small, refillable cartridges which hold the liquid is heated into a vapor and inhaled. Medium-sized devices often resemble the shape of a writing pen, which hold more liquid than the first generation models. Another second generation device, referred to as a “tank system,” is desirable for significantly larger quantities of liquid. Third generation devices are structurally similar to the second generation, however, they are highly desired due to their customizability. Obtaining the term “personalized vaporizers,” users are able to control several aspects of the third generation devices, including the temperature at which the liquid is heated to. The newest creation of fourth generation products strays the furthest from cigarettes in style. Fourth generation devices are rechargeable and contain removable cartridges to further customize the nicotine and flavorings. The most common brand, Juul, resembles a flash drive. While the Juul contains a specific type of nicotine that causes less throat discomfort, the nicotine potency in the Juul is stronger than many other devices. The subtle nature of the Juul design makes this device especially popular amongst younger populations (Rigotti & Kalkhoran, 2019).

Upon development of varying designs and sizes of each generation, users often create their own e-cigarettes or modify their purchased e-cigarettes (U.S. Department of Health and Human Services, 2016). Recent concerns of illegal drug use have risen with the adaptability of newer generation e-cigarettes. Due to the ability to customize devices built from standard e-cigarettes, users can add any content to the product that is vaped, including illegal substances. Modification of an e-cigarette in a way that is not intended for use is known as hacking (Rigotti & Kalkhoran, 2019). Examples of hacking include refilling a single use cartridge or dropping the liquid directly on the heating coil to increase the compound concentrations (Centers for Disease Control and Prevention, 2019b). Altered tank systems are commonly used to add tetrahydrocannabinol (THC) to the product (U.S. Department of Health and Human Services, 2016). The action of superheating THC, or any cannabinoid, is known as dabbing (Siegel et al., 2019).

The e-cigarette market is currently thriving (U.S. Department of Health and Human Services, 2016). With the initial introduction of e-cigarettes to the United States in the 2000's, independent companies were solely responsible for sales (U.S. Department of Health and Human Services, 2016). However, as of 2018, e-cigarettes can be purchased at a variety of locations, including convenience stores, tobacco and specialized vape shops, and online. Retailers, such as the membership-only warehouse company known as Costco, are now selling e-cigarettes (U.S. Department of Health and Human Services, 2016).

Components of E-cigarettes

The components of an e-cigarette include a cartridge, a mouthpiece, atomizer, and battery (Rigotti & Kalkhoran, 2019). The cartridge houses the liquid ingredients, which can vary greatly

between devices. The components of an e-cigarette are illustrated in Figure 1 below (Rigotti & Kalkhoran, 2019).

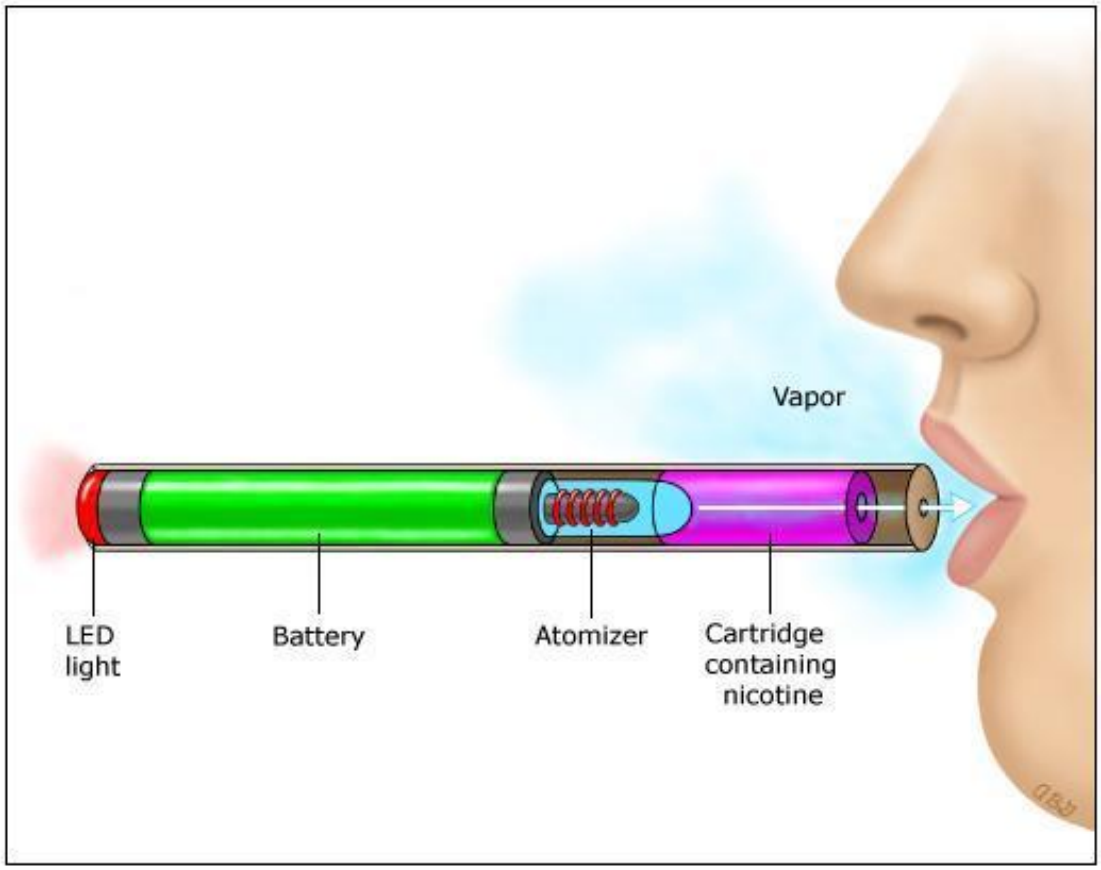

Figure 1. E-cigarette. (Rigotti & Kalkhoran, 2019).

Battery. Each e-cigarette contains a battery that operates the e-cigarette. The battery allows components of the e-cigarette to function, making the battery the main consistent power source of the e-cigarette (Rigotti & Kalkhoran, 2019). E-cigarettes can be classified based on the type of battery they use. A rechargeable e-cigarette allows the user to keep the same device and charge it when needed. A disposable e-cigarette does not have a reusable battery and is disposed of when the cartridge is emptied (Brown, 2014). Lithium batteries are commonly used in e-cigarettes as they are capable of storing large amounts of power in a compact device. The batteries in e-cigarettes may have a thermal runaway, in which the battery temperature can

significantly increase, causing a battery fire or explosion (Brown, 2014). The thermal runaway can cause injuries and burns specifically to the "thigh, groin, face, and/or hand" (Rigotti & Kalkhoran, 2019, Risks of devices section).

Atomizer. The heating source of an e-cigarette is the atomizer, which is powered by the battery. The atomizer heats the liquid inside the cartridge to the specific temperature, causing it to vaporize. The e-cigarette liquid components are vaporized into aerosol, inhaled into the lungs and exhaled by the individual (Rigotti & Kalkhoran, 2019). In September 2019, 1 in 4 teenagers reported using a vaping method known as dripping (National Institute on Drug Abuse, 2019). With dripping, individuals "produce and inhale vapors by placing e-liquid drops directly onto heated atomizer coils" (National Institute on Drug Abuse, 2019, E-cigarette Use in Teens section). E-cigarette users report more powerful vapor/throat pleasurable contact, generation of thicker vapor, and enhanced flavor production with the method of dripping (National Institute on Drug Abuse, 2019).

Mouthpiece. The mouthpiece component of an e-cigarette is used to inhale the vaporized e-liquids (Rigotti & Kalkhoran, 2019). The mouthpiece is the physical connection between the mouth of the user and the rest of the e-cigarette. The final stage of aerosol processing occurs within the mouthpiece. The temperature of the aerosol decreases en route to the mouth of the user (Brown, 2014). During the time of the passage, condensation occurs. The large condensation droplets may be removed from the passage and recycled by the e-cigarette for continued use (Brown, 2014).

Liquid Components. Several toxic chemical substances are found in the liquid vapor (Rigotti & Kalkhoran, 2019). The cartridge of the e-cigarette contains the liquid solution, typically in a 5 mL vial (Rigotti & Kalkhoran, 2019). Types of e-cigarette liquids include

commercial refillable, commercial non-refillable, homemade, and street sources (Seigel, 2019). When e-cigarette users refill the cartridge with unregulated substances, they are at a higher risk for harm due to vaping unknown ingredients (Rigotti & Kalkhoran, 2019). The aerosol found in e-cigarettes contain a number of compounds including nicotine, propylene glycol, formaldehyde, acetaldehyde glycidol, acrolein, acetal, and diacetyl (U.S. Department of Health and Human Services, 2016). E-cigarettes have the power to provide an elevated concentration of the ingredients, greater than any cigarette can provide. A cigarette burns tobacco and generates smoke, whereas an e-cigarette heats the e-liquid and vaporizes it. Both of these techniques allow the ingredients to be inhaled into the body (Rigotti & Kalkhoran, 2019). Different routes of e-liquid exposure, including skin contact or oral inhalation, can cause harm, including "seizures, anoxic brain injury, lactic acidosis and death" (Rigotti & Kalkhoran, 2019, Risks of devices section).

Nicotine. Acute administration of nicotine via e-cigarettes has negative health effects that can lead to addiction and adverse health conditions. Most e-cigarettes contain nicotine as a main liquid ingredient. The nicotine content in cartridges vary, but often come in concentrations of 6 mg/mL, 12 mg/mL, 18 mg/mL, and 24 mg/mL (Rigotti & Kalkhoran, 2019). In comparison to the e-cigarette nicotine concentration, an average pack of cigarettes contains around 20 mg/mL of nicotine. Not only is nicotine a harmful substance when inhaled, it can be lethal when ingested. It is important to keep e-cigarette cartridges out of reach for children, as 10 mg/mL of nicotine is enough to fatally harm a child (Rigotti & Kalkhoran, 2019). Due to the rise in e-cigarette use, Minnesota law requires nicotine cartridges to be sold in child-resistant packaging (Sale of electronic delivery device; packaging, 2019).

Nicotine is a psychomotor stimulant drug and has many harmful health effects on the body (Rigotti & Kalkhoran, 2019). During adolescent years, brain development is pertinent, which explains why young adults are more susceptible to long-term consequences of nicotine. Nicotine is highly addictive in any form. With repeated e-cigarette use, the body and brain become increasingly dependent on nicotine (Levine et al., 2011).

Nicotine enters the blood and stimulates the adrenal glands, releasing the hormone, epinephrine (National Institute of Drug Abuse, 2019). Epinephrine induces systemic responses in the body and stimulates the central nervous system. Exposure to nicotine also causes cardiovascular effects such as increased heart rate, increased blood pressure, and a greater cardiac output (National Institute of Drug Abuse, 2019). Along with the release of epinephrine, nicotine increases the body's level of dopamine, a chemical messenger in the brain, which strengthens feelings of pleasure and satisfaction (National Institute of Drug Abuse, 2019). Consequences of nicotine exposure in young adults include reduced impulse control, deficits in attention and cognition, "mood disorders and permanent problems with impulse control – failure to fight an urge or impulse that may harm one's self or others" (National Institute of Drug Abuse, 2019, para. 7).

Cannabinoids. In the majority of the reported cases of e-cigarette or vaping product associated lung injury (EVALI), users reported tetrahydrocannabinol (THC), a cannabinoid, in the e-cigarette, along with nicotine and flavorings. Several cannabinoids can be purchased on and off the market to be placed inside the e-cigarette (Centers for Disease Control and Prevention, 2017). No two batches of synthetic cannabinoids have the exact same ingredients, resulting in different side effects from one batch to another. Cannabinoids are highly addictive as they cross the blood brain barrier and affect brain function (Centers for Disease Control and

Prevention, 2017). Symptoms from synthetic cannabinoid use include breathing problems, gastrointestinal problems, kidney failure, sleepiness, dizziness, confusion, concentration problems, and agitation, amongst others (Centers for Disease Control and Prevention, 2017). While the etiology of EVALI cases are currently under investigation, e-cigarette use has been linked to the development of idiopathic acute eosinophilic pneumonia (AEP). EVALI and AEP have a close relationship due to "a strong inflammatory stimulus that recruits macrophages and neutrophils to lung tissue" (Arter, Wiggins, Hudspath, Kisling, Hostler & Hostler, 2019, Discussion section). Next, pro-inflammatory cytokines and tumor necrosis factor are induced, "which may be the inciting event causing eosinophil-rich exudate within the alveoli" (Arter, et al., 2019, Discussion section). The diagnosis of AEP linked to EVALI is under continuous investigation.

Propylene Glycol. Propylene glycol reserves the moisture of the liquid while suspending and delivering the flavorings (Rigotti & Kalkhoran, 2019). Minor eye and respiratory irritation, including an increased risk of developing asthma, can occur from the propylene glycol aerosol. When propylene glycol is heated, it decomposes and can form human carcinogens such as propylene oxide, acetaldehyde, and formaldehyde (Rigotti & Kalkhoran, 2019). These carcinogens are dangerous due to the irritation and damage caused to the lining of the cells in several parts of the body. The irritation results in difficulty breathing, nausea, skin irritation, coughing, wheezing, and many other side effects (Rigotti & Kalkhoran, 2019).

Vitamin E Acetate. In several e-cigarettes, vitamin E acetate (vitamin E oil) makes up 50% of the liquid. While vitamin E oil is safe for topical use in creams and oral use in vitamin supplements, it is safety with inhalation is unknown (Abbott, 2019). Vitamin E acetate is not approved by the U.S. Food and Drug Administration as an additive to vape products. Therefore,

patients using liquid cartridges containing Vitamin E most likely purchased them off market or illegally (Abbott, 2019). Vitamin E acetate potentially causes lipoid pneumonia, which is a reaction in the lungs causing inflammation from inhaling fats or oils (Abbott, 2019). While inhaled Vitamin E acetate has not been confirmed as the cause of lung injury from using e-cigarettes, a potential link to EVALI exists (Abbott, 2019).

Flavorings. Unique and appealing flavorings are a major draw to e-cigarettes. In a study by Landry, 29.5% of individuals started vaping because of the appeal and curiosity of the flavorings and 62.9% of e-cigarette users purchase a flavor other than tobacco (Landry et al., 2019). The FDA has deemed several flavorings safe for consumption, however, the impact of their inhaled aerosol form is yet to be determined (U.S. Department of Health and Human Services, 2016). Many flavorings can be added into an e-cigarette cartridge, such as "tobacco, menthol, fruit, candy, other sweet, and coffee" (Landry et al., 2019, para. 1). Older adults are more likely to purchase menthol and tobacco flavorings (Landry et al., 2019). Fruit flavorings are especially appealing to adolescents (U.S. Department of Health and Human Services, 2016). Research has revealed "a link between cytotoxicity and certain flavorings used in e-cigarettes liquids, especially sweet and cinnamon flavors" (Rigotti & Kalkhoran, 2019, para. 38). Diacetyl, which is found in sweet-flavorings for e-cigarettes, has been linked to respiratory diseases (Rigotti & Kalkhoran, 2019). Benzaldehyde, a component of the cherry-flavorings, is linked to respiratory irritation (Rigotti & Kalkhoran, 2019).

Other. Another component of e-cigarettes are the metal nanoparticles from the heating coil components (Brown, 2014). These include, but are not limited to, chromium, manganese, arsenic, tin, lead, and nickel (Rigotti & Kalkhoran, 2019). According to the US Food and Drug Administration, in 2014, lead, nickel, and chromium are on the harmful and potentially harmful

constituents (HPHC) list (Brown, 2014). While the safety of these metallic nanoparticles have been studied and deemed harmful, their toxic effect when inhaled into the lungs is largely unknown (Brown, 2014).

Prevalence

E-cigarettes are the most commonly used tobacco product among adolescents (Blaha, n.d.). E-cigarette use is a major health concern in the U.S., as the rates of use have rapidly increased. From 2001 to 2015, a 900% increase was observed in high school students using e-cigarettes (U.S. Department of Health and Human Services, 2016). The National Youth Tobacco Survey reported that the most popular reasons for e-cigarette use were friend or family member usage, appeal of flavorings such as mint, candy, fruit, or chocolate, and the idea that e-cigarettes are less harmful than other forms of tobacco consumption (Tsai et al., 2018). In 2017, 61% of students reported using flavored e-cigarettes (Food and Drug Administration, 2019). Flavorings can mask the taste of nicotine, leading to unknown excess consumption (Tsai et al., 2018). As a main ingredient in e-cigarettes, nicotine consumption often leads to addiction and continued e-cigarette use (U.S. Department of Health and Human Services, 2016).

In the 2018 National Youth Tobacco Survey, a 1.5 million increase in student use of e-cigarettes was documented between 2017 and 2018 (Food and Drug Administration, 2019). A 78% increase in e-cigarette use among high school students was recorded, increasing overall use to 20.8% in 2018 (Food and Drug Administration, 2019). The 2018 survey also found a 48% increase in e-cigarette use in middle school students (Food and Drug Administration, 2019). “In 2018, more than 1 in 4 high school students and about 1 in 14 middle school students used a tobacco product in the past 30 days” (Centers for Disease Control and Prevention, 2019a, para.

1). The rapidly increasing rate of adolescent tobacco and e-cigarette use poses great concern due to the emerging health consequences.

E-cigarettes are frequently used among the young adult population, ages 18-24, however, the increase in e-cigarette use among adolescents is more prevalent. E-cigarettes remain the most popular tobacco product for adolescents ("E-cigarettes: facts, states, and regulations," 2018). The increase in e-cigarette use among adults over 25 years old is not as significant as with the adolescent population. While young adults reported using e-cigarettes in the last 30 days more than those over the age of 24, the adolescent population continues to have the highest use. ("E-cigarettes: facts, states, and regulations," 2018). Increased e-cigarette use is notable in all age groups, however, the rise among the youth population is the most dramatic and concerning.

Vaping related cases and death tolls are dramatically increasing weekly. "As of February 18, 2020, a total of 2,807 hospitalized EVALI cases or deaths have been reported to CDC from all 50 states, the District of Columbia, and two U.S. territories" (Centers for Disease Control and Prevention, 2019b, para. 2). The Center of Disease Control has collected data on 2,668 patients reporting vaping related lung injury (Centers for Disease Control and Prevention, 2019b). Of the 2,668 patients, 66% are male and the median age of the patients is 24 years old, with ages ranging from 13-85 years old (Centers for Disease Control and Prevention, 2019b). A total of 15% of the 2,668 cases reported were patients under the age of 18 years old (Centers for Disease Control and Prevention, 2019b). A rising total of sixty-eight deaths have been confirmed in twenty-nine states, including the District of Columbia, with more deaths currently under investigation (Centers for Disease Control and Prevention, 2019b). The mean age of the deceased patients is 49.5 years old, with a range of 15-75 years of age (Centers for Disease Control and Prevention, 2019b). The CDC discovered that the majority of the patients used e-

cigarettes containing THC (Centers for Disease Control and Prevention, 2019b). Further data associating THC use with the outbreak is supported by information collected from 2,022 patients who provided information about their vaping habits over the previous three months prior to the emergence of their symptoms (Centers for Disease Control and Prevention, 2019b). Approximately 82% reported using THC-containing vaping products, and approximately 33% testified to solitary use of THC-containing products (Centers for Disease Control and Prevention, 2019b). A concerning 78% of e-cigarette users reported purchasing their products from unregulated sources such as individual dealers, online, family, or friends (Centers for Disease Control and Prevention, 2019b).

As of February 18th, 2020 the Centers for Disease Control and Prevention reported that 68 deaths have been confirmed in 29 states and the District of Columbia:

> Alabama, California (4), Connecticut, Delaware, the District of Columbia, Florida (2), Georgia (6), Illinois (5), Indiana (5), Kansas (2), Kentucky, Massachusetts (5), Michigan (3), Minnesota (3), Mississippi, Missouri (2), Montana, Nebraska, New Jersey, New York (4), Oregon (2), Pennsylvania, Rhode Island, South Carolina, Tennessee (2), Texas (4), Utah, Virginia and Washington (2) (Centers for Disease Control and Prevention, 2019c).

The widespread prevalence of lung injury cases throughout the U.S. does not have a specific geographical pattern as the number of lung injury cases fluctuates throughout the United States (Centers for Disease Control and Prevention, 2019b). The Centers for Disease Control and Prevention reported the deaths nationwide as seen in Figure 2 (Centers for Disease Control and Prevention, 2019b).

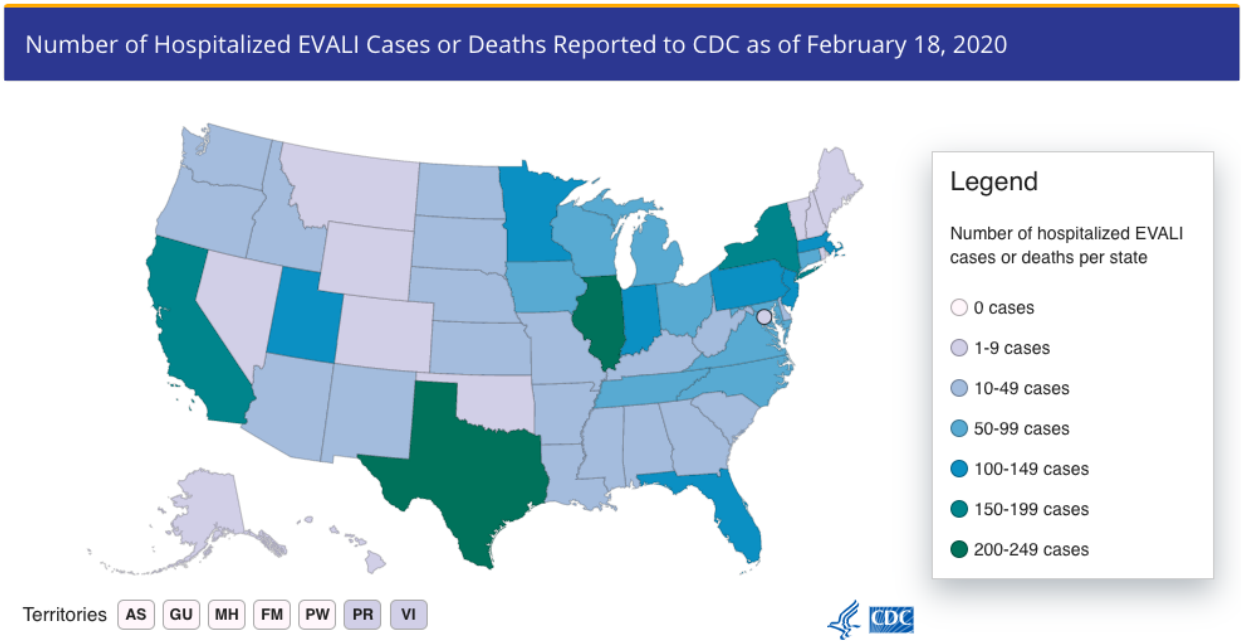

Figure 2. Number of hospitalized EVALI cases or deaths reported to the CDC as of February 18, 2020. (Centers for Disease Control and Prevention, 2019b)

Medical Evaluation

Patient History. In patients presenting with EVALI, specific questions must be addressed. Through the information and history provided by the patient, the clinician is able to narrow their differential diagnosis and exclude other possible causative agents of illness (Siegel et al., 2019). Clinicians must inquire about the patient's e-cigarette use within the last 90 days (Siegel et al., 2019). If the patient has a positive history for e-cigarette use, it is crucial to determine the ingredients in the cartridge, such as nicotine, cannabinoids, vitamin E acetate, flavorings, or other substances (Siegel et al., 2019). It is also pertinent to establish where the products were purchased, if they purchased refill cartridges, and if they use homemade or street sourced ingredients (Siegel et al., 2019). The e-cigarette manufacturer and specific brand of the

device must be noted on the patient's medical history. The patient's method of e-cigarette use, such as aerosolization, dabbing and dripping, should also be noted (Siegel et al., 2019).

Clinical Presentation. According to the Centers for Disease Control and Prevention (2019), patients presenting with EVALI are typically young and healthy individuals (Siegel et al., 2019). The presenting symptoms of EVALI often include an onset over days to weeks, which involve respiratory, gastrointestinal, and systemic body systems (Siegel et al., 2019). Respiratory symptoms include cough, chest pain, and shortness of breath. Gastrointestinal and systemic symptoms include abdominal pain, nausea, vomiting, diarrhea, fatigue, fever, and weight loss (Siegel et al., 2019).

Patient Recommendations. The commissioner of the Food and Drug Administration released a statement regarding recommendations to e-cigarettes users (Sharpless, 2019). Permanent cessation of e-cigarette use is in the best interest of patients, as this may speed up recovery from EVALI (Siegel et al., 2019). Individuals who choose to continue their e-cigarette use should refrain from modifying cartridges, purchasing products off the market, and using products containing THC (Sharpless, 2019). Patients should monitor their symptoms and contact their medical provider at the first sign of illness (Sharpless, 2019).

Vaping Cessation. Several tools are available to assist adolescents in vaping cessation. MyLife MyQuit, Smokefree Teen, Center for Young Women's Health, and Truth Initiative are vaping cessation programs available online (Rosen & Sockrider, 2019). Adolescents involved in a vaping cessation program have reported higher success rates in quitting (Rosen & Sockrider, 2019). Forty-eight controlled smoking cessation studies were included in a meta-analysis which concluded that adolescents involved with a cessation program were at a 2.9% advantage over individuals who were not involved in any program (Rosen & Sockrider, 2019). Participation in a

cessation program is more successful because they provide education and knowledge about the negative health consequences, along with supplying adequate coping strategies (Rosen & Sockrider, 2019).

Another factor that plays a role for adolescents in the success of cessation programs is the anonymity that many programs offer. Dr. Amanda Graham, senior vice president at Truth Initiative states:

> While the science behind overcoming nicotine addiction may be the same, e-cigarette users don't identify as smokers. They have different barriers to quitting, and, especially in the case of teens and young adults, many want an anonymous way to go about quitting without involving their parents or friends, which texting provides (Truth Initiative, 2019a).

Within the first five weeks of the initiation of the text-message program through Truth Initiative, over 27,000 adolescents and young adults enrolled (Truth Initiative, 2019b). Through the use of this program, enrollees were encouraged to determine a personal quit date (Truth Initiative, 2019b). "After just two weeks, more than half (60.8%) reported that they had reduced or stopped using e-cigarettes. At three months, 15.5% of respondents stated that they had quit vaping for 30-days or longer" (Truth Initiative, 2019b). The Truth Initiative and similar web and text based cessation programs have been proven successful in the adolescent population.

Conclusion

The increasing prevalence of e-cigarette use and EVALI cases are problematic. Due to rapidly rising rates of vaping among adolescents and the lack of knowledge surrounding the health-related consequences, providing education to this population is crucial. Chapter 3 will

introduce the methodology of presenting educational tools and providing resources to high school students.

Chapter 3: Methods

Introduction

The National Youth Tobacco Survey reported that the number of students who vape increased by nearly 1.5 million between 2017 and 2018 (Food and Drug Administration, 2019). The vaping epidemic continues to rise, especially among adolescents. Over 21% of high school students reported e-cigarette use in 2018, deeming vaping education an essential aspect of school curriculums (Rigotti & Kalkhoran, 2019). In this chapter, researchers discuss the St. Francis High School student population and their need for vaping education. The methods of the project included implementation of informative tools to educate the adolescent population. To reach this population, this project presented an educational PowerPoint to educate students about the vaping epidemic and the health consequences on the body. This project supplied the students with resources for vaping cessation and provided St. Francis High School faculty with the presentation for future use and continued education.

Rationale for Project

As of February 18, 2020, sixty-eight deaths and 2,807 EVALI-related hospitalizations have been confirmed. While EVALI-related hospitalizations and death rates are continuingly rising, the data on the average age of the patients affected are decreasing (Centers for Disease Control and Prevention, 2019b). A striking increase was demonstrated in high school students' use of e-cigarettes, rising 900% between 2001 and 2015 (U.S. Department of Health and Human Services, 2016). Therefore, with the upsurge in e-cigarette use among high school students, it was vital to educate these adolescents. The goal of this project was to educate adolescents on the harmful effects of vaping, as well as provide cessation resources and assist them in making healthy decisions surrounding vaping.

St. Francis High School did not have vaping education as part of their health curriculum for their students, per conversation with Glenn Morehouse. Glenn Morehouse is both a Bethel University Adjunct Professor and a St. Francis High School Scholastic Journalism teacher. Mrs. Morehouse demonstrated a passion for the need of vaping education within the St. Francis High School community. Mrs. Morehouse referred the research team to Alan Schlomann, the Health and Physical Education teacher at St. Francis High School. Mr. Schlomann was also passionate about the need for vaping education for high school students. Without a curriculum for addressing the vaping epidemic, the students did not have sufficient knowledge of vaping and its effects on health. With newly discovered data solidifying the detrimental health effects of vaping, adolescents needed to be informed. Over 4.9 million youth reported vaping in 2018 (Centers for Disease Control and Prevention, 2019a). The FDA noted:

> As adolescent brains are still developing, nicotine exposure during youth and young adulthood can change the way the brain works, leading to a lifetime of addiction and, in some cases, causing long-lasting effects such as increased impulsivity and mood disorders (Food and Drug Administration, 2019, para. 8).

Education during these critical development periods is essential. Due to the lack of an organized curriculum and faculty to address the issue, students were not being educated about the health consequences of vaping. Through extensive research, the research team gained a great understanding of the vaping epidemic, including: e-cigarettes, the effects of vaping, and prevalence among youth. Although new data is discovered daily concerning the specific causes and health outcomes of EVALI cases, this project was adequately equipped to provide students with accurate, up to date data that enhanced their knowledge surrounding vaping. Through this presentation, the research provided the students with facts surrounding vaping in order to

facilitate healthy decision making. This project intended to provide resources for vaping cessation, to further guide students who have a desire to quit currently or in the future.

Population

This project was implemented through St. Francis High School. Approximately 1,400 students attend this public school in St. Francis, Minnesota (Public School Review, 2020). The site of study was relevant due to the prevalence of vaping among high school students. With nearly a 78% increase of high school students reporting vaping between 2017 and 2018, education and intervention among this population was essential (Food and Drug Administration, 2019). The population was selected based on the lack of vaping education provided to St. Francis High School students. The sample population consisted of St. Francis High School students, both male and female. Mr. Schlomann was provided with the pre-recorded presentation to implement into his health classes. Due to the nature of the method of implementation of the presentation, the research team was unaware of the student population characteristics, such as race, ethnicity, religion, and socioeconomic status. Therefore, the characteristics of the population were not examined. No additional inclusion or exclusion criteria were considered.

Project Plan and Implementation

This presentation through St. Francis High School addressed the current vaping epidemic, the detrimental health consequences of vaping, and provided resources to students for vaping cessation. Upon conversation with Mrs. Morehouse and Mr. Schlomann, the need for vaping education at St. Francis High School was apparent. Students lacked factual knowledge on the health effects of vaping, therefore, this project provided the students with up to date information. The pre-recorded presentation was provided to Mr. Schlomann in August of 2020. The format of the recording allowed for continuous direct visualization of both the PowerPoint presentation and

the speaking member of the research team. Mr. Schlomann implemented the presentation into his health class curriculum at St. Francis High School.

In order to accomplish the goal of this project, a pre-recorded interactive PowerPoint presentation was created. The video presentation began with an introduction of the research team, followed by a 30 second attention-grabbing video describing the impact of vaping on adolescent's health (National Institute on Drug Abuse for Teens Blog Team, 2018). Next, the research team asked the students a series of three questions to facilitate self-reflection of the student's pre-presentation knowledge and personal experience with vaping related topics. For questions with a factual answer, the research team member paused and allowed the viewer to consider their answer before providing the correct answer. The questions and answers include:

1. Do you know someone who vapes/uses e-cigarettes?
    a. Yes
    b. No
        i. No specific correct answer
2. How many vaping-related deaths have occurred in the United States since August 2019?
    a. 8 deaths
    b. 39 deaths
    c. 68 deaths
    d. 78 deaths
        i. Answer: 68 deaths
3. All Juuls contain nicotine. True or False?
    a. True
    b. False
        i. Answer: True

The presentation continued by addressing the prevalence of vaping, components of e-cigarettes, EVALI case presentations, and the health consequences of vaping with emphasis on the adolescent population. Following the informative aspects of the PowerPoint, post-presentation questions were asked of the students. During this second period of questions, the research team followed the same format as the pre-presentation questions. These open ended questions and answers include:

1. What are the 3 most common harmful components of e-cigarettes?
    a. Answer: Nicotine, Cannabinoids (THC), Vitamin E Acetate
2. What are 3 parts of the body that are affected by vaping?
    a. Answer can include: brain, heart, lungs, stomach, kidneys, HEENT (head, eyes, ears, nose, and throat), skin, endocrine, reproductive
3. What is something you learned today that you didn't know before?
    a. Answer can include any information that students provide

After the final question period, the research team continued the pre-recorded presentation by showing a 4 minute and 23 second video. The video, titled “The Dangers of Vaping as a Teen, with Truth and Doug the Pug,” included a personal testimony from a teen who struggled with vaping and his nicotine addiction, resulting in severe health consequences. The video aimed to raise awareness about the dangers of vaping, which concluded by offering resources for vaping cessation (NowThis News, 2019), . Upon completion of the video, the research team further discussed the vaping resources that the video noted. The resources included the Truth Initiative’s specific vaping cessation program, known as BecomingAnEx. The Centers for Disease Control and Prevention website link was also addressed by the research team as an additional source for students to access up to date vaping information and EVALI statistics. At the conclusion of the presentation, the research team informed the students to direct questions to Mr. Schlomann, who

would contact the research team for follow-up answers. A handout was provided to Mr. Schlomann to be given to students upon completion of the presentation for future reference. The handout contained anonymous options to either text or make a phone call in order to assist students by providing support with vaping cessation. St. Francis High School was provided with the pre-recorded PowerPoint and informational handout for future use in order to continue reaching out to additional students. The pre-recorded PowerPoint and handout document were emailed to Mr. Schlomann. Mr. Schlomann was given the option to provide the research team with feedback regarding the implementation of the presentation.

While the goal of this project was to positively influence a vulnerable population, the possibility of ethical implications were also considered. Addiction and the use of tobacco products have emotional and social components. The PowerPoint presentation and handout were completed in an ethical fashion without judgement, shame, and a stigma towards individuals who vape. The research team solely provided facts, without providing personal opinions. This project did not contain any identifying factors of the students.

Project Tools

A pre-recorded PowerPoint was provided, consisting of approximately 20 minutes of lecture, including a 30 second introduction video, a 4-minute personal testimony video, and several minutes dedicated to interactive questions mixed in throughout the presentation. The PowerPoint included vaping education topics, such as: prevalence, components of e-cigarettes, EVALI case presentations, health consequences, and resources and recommendations for vaping cessation. The short video served as an introduction to the topic of vaping. The video provided a powerful visual of how the components of e-cigarettes affect various parts of the body. A variety of questions were asked of the students throughout the presentation to facilitate self-reflection and self-assess their personal knowledge of vaping.

Upon completion of the pre-recorded presentation, Mr. Schlomann provided the students with a handout, which included pertinent facts and resources for vaping cessation from the Truth Initiative, as discussed in the PowerPoint. The research team contacted a representative from the Truth Initiative and requested information about the cessation program and potential resources that could be utilized for the project. The BecomeAnEx digital cessation program through the Truth Initiative was used as a resource for students. The BecomeAnEx program, developed in conjunction with Mayo Clinic, has assisted over 800,000 smokers (Truth Initiative, 2019a). Through the program, students can text "DITCHJUUL" to 88709 or "QUIT" to 202-899-7550 (Truth Initiative, 2019a). The program provides anonymous age-appropriate support, advice, and individualized messages to best assist the user (Truth Initiative, 2019a).

Potential Barriers

With the adolescent population, unforeseen barriers may be encountered. Non-attentive students may pose as a barrier, as well as students who are unreceptive to the information. In order to counteract this barrier, the presentation will include a variety of videos and interactive questions to keep students engaged. Other potential barriers of the presentation include language barriers, varying reading comprehension levels, special needs of students, technology glitches, and student distractions such as cell phone use. The goal of this project is to make this presentation interactive and relatable in order to keep students engaged and attentive. While not all students will be receptive to the information due to their own opinions, the presentation will include factual information from reliable sources.

The goal of this project is to have St. Francis High School use this tool in future years to educate students about vaping. However, continued implementation cannot be guaranteed. Ensuring that the presentation is easily available to the school via email will make the PowerPoint and handout more likely to be utilized in the future.

The presentation must also consider that data surrounding the vaping epidemic is changing daily. The data included in the presentation may become outdated due to future research findings, new discoveries, and EVALI cases. St. Francis High School will be provided with credible resources containing the most up to date statistics and discoveries regarding the vaping epidemic. This project will encourage the school to utilize the resources and routinely update the information for the presentation.

Conclusion

Within St. Francis High School, a lack of vaping curriculum existed. Educating high school students on the vaping epidemic was essential due to the dramatic increase in the use of e-cigarettes among this population. It is imperative for adolescents, who are especially vulnerable to the health effects of vaping, to understand the detrimental consequences that vaping inflicts. In chapter 4, this project will discuss the presentation outcomes at St. Francis High School, limitations, and future implementation of this project within the school.

Chapter 4: Discussion

Introduction

This community research project served to educate students at St. Francis High School on topics surrounding the vaping epidemic. The project goals and outcomes are discussed in this chapter. Further discussion includes obstacles that were encountered throughout the implementation of the project and how the research team overcame the challenges. Overall, the COVID-19 pandemic posed the most significant limitation on the presentation of the project. The research team believes there is substantial potential for additional opportunities with future extensions from this research project.

Summary of Results

Vaping-related lung injuries have become increasingly prevalent with the heightened use of e-cigarettes (Rigotti & Kalkhoran, 2019). Due to the physical and mental developmental nature of the period of adolescence, this age group is at higher risk for experiencing adverse outcomes from vaping (U.S. Department of Health and Human Services, 2016). The U.S. Department of Health and Human Services deemed vaping-related lung injuries an epidemic in 2016, confirming the necessity of educating consumers on the harmful effects of vaping (U.S. Department of Health and Human Services, 2016). Adolescent naivety surrounding the consequences of vaping, along with the increasing e-cigarette use in this population, emphasized the lack of vaping-related education provided to high school students.

This community outreach project strived to fill the void of vaping education in the health curriculum at St. Francis High School. The research team was connected with Alan Schlomann at St. Francis High School through Glenn Morehouse. Glenn Morehouse is an associate professor at Bethel University in St. Paul, MN, as well as a journalism teacher at St. Francis. Mrs.

Morehouse believed that Alan Schlomann, the health teacher at St. Francis High School, was the best contact to facilitate the implementation of the research project. Through contact with Alan Schlomann, this project was implemented via an educational PowerPoint presentation recording and informative handout.

The final implementation and results of the project did not go as originally planned due to the COVID-19 pandemic. In March 2020, the skyrocketing of COVID-19 cases in the United States resulted in nation-wide shut downs. The educational system was highly impacted, forcing classes to be presented in virtual formats, including St. Francis High School. As a result, the project was unable to be presented face-to-face in a classroom setting at St. Francis High School as originally envisioned. To ensure the students would receive maximum impact from the project, the research team used the PowerPoint to record an interactive video lecture. The recorded PowerPoint presentation consisted of educational and personal testimonial videos, interactive question prompts, and information about vaping. Additional material included details about specific e-cigarette devices, the components of e-cigarettes, statistics about EVALI and the harmful effects of vaping, and cessation resources for students. The recording, along with the original PowerPoint and handout, were provided to Alan Schlomann for future implementation in his health classes.

Limitations

Several limitations were encountered during the implementation of this project. The main limitation experienced were the effects of COVID-19 on the final presentation at St. Francis High School. The original plan of the research team was to present a face-to-face interactive PowerPoint lecture at St. Francis High School. The date of presentation had been set for April 17th, 2020. Four of Mr. Schlomann's health classes were intended to receive the presentation

throughout the day. However, in March 2020, in-person classes at St. Francis High School ceased due to the COVID-19 pandemic. Therefore, presentation plans were set on hold. In August 2020, due to continued circumstances and limitations from the pandemic, the research team, in conjunction with Alan Schlomann, determined that the best option was for the research team to record the presentation. The recording, PowerPoint, and PDF of the handouts were provided to Alan Schlomann for use in his courses. Although the virtual method of presentation was unexpected, the research team believes the educational tool is still optimal in providing the students with an interactive learning experience for multiple reasons. The limitations of COVID-19 did not affect the content of the presentation. Only the mode of transmission was altered, which was modified from a face-to-face lecture to a pre-recorded presentation. In order to combat the lack of face-to-face interaction and discussion, thought-provoking questions, with time allowed for self-reflection, remained part of the presentation. Students were able to visualize the research team on video during the pre-recorded presentation, which enhances the personal connection between students and presenters. The pre-recorded format meets the same standards for educating St. Francis High School students on vaping.

In addition to facing the challenges of providing the presentation in a pre-recorded format, the reception of the material by the students is potentially affected. The recorded presentation removed the ability of the research team to interact in a live manner with the students. The ability of the research team to observe the implementation of the presentation and the student's engagement is impossible using the recorded format. The pre-recorded format poses the inability to gauge student's reactions, ask questions with real-time feedback, and facilitate further discussion. While the research team hopes the presentation will remain

implemented into the St. Francis curriculum in future years, the continued use of the presentation cannot be guaranteed.

Another major limitation due to COVID-19 is the lack of updated statistics regarding vaping provided by the CDC. Prior to the pandemic, the CDC began providing weekly updates including EVALI cases and deaths throughout 2019, however, the CDC has not published any EVALI data since February 25, 2020. There is a lack of updated information, making it difficult to assess trends and the full impact of the vaping epidemic.

Overall, several unexpected circumstances affected the original implementation of the research project. The research team believes that the materials and resources provided to St. Francis High School are substantial in providing vaping-related education to high school students. The overall goal of providing students with the necessary resources and information to assist in making informed, healthy, and educated decisions regarding e-cigarette use was still achieved.

Further Projects

Several opportunities for further projects can stem from this research. The first option is to complete the project as originally intended through a face-to-face presentation. The research may also be presented in a live online video format of the presenters choice. Aside from completing the same project in a different presentation format, a future project could implement vaping education in a variety of settings, such as additional high school classes, middle school classes, or teacher in-services. Continued efforts for future projects must include updated statistics and findings surrounding EVALI, as well as tailoring the information presented to the specific population of choice.

Conclusion

The vaping epidemic and associated EVALI cases in the United States are on the rise (U.S. Department of Health and Human Services, 2016). The significant increase in e-cigarette use among high school students deems the need for appropriate vaping education (U.S. Department of Health and Human Services, 2016). The adolescent population is especially vulnerable to the health consequences of vaping due to the physiologic development occurring during the adolescent years. The EVALI cases confirm the detrimental effects that can ensue as a result of e-cigarette use in adolescents (U.S. Department of Health and Human Services, 2016).

The sales of e-cigarettes are currently thriving, with multiple models and designs available for purchase (Rigotti & Kalkhoran, 2019). The flourishing e-cigarette market, along with the associated increased prevalence of vaping among the adolescent population, is especially concerning due to the potential for negative health consequences. The CDC has reported the link between use of e-cigarette liquid components and EVALI cases (Centers for Disease Control and Prevention, 2019b). Therefore, the research team identified the need for providing education to the adolescent population (U.S. Department of Health and Human Services, 2016). The selected population was Alan Schlomann's 10th grade health students at St. Francis High School. A recorded PowerPoint presentation was produced by the research team to be implemented in Mr. Schlomann's health curriculum. A vaping cessation handout and resources were provided with the recording for Mr. Schlomann to offer his students.

Through the duration of the project, the research team acquired an abundance of knowledge surrounding the vaping epidemic and EVALI. Although unexpected limitations were encountered in the original method of delivery, the goal of providing students at St. Francis High School with an educational tool was accomplished. The research team believes that several

advances can be made following this project in order to continue providing at-risk populations with education surrounding vaping.

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APPENDIX A

Vaping PowerPoint Presentation

Vaping Education in the Adolescent Population

August, 2020

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Students of the Bethel University Physician Assistant Program (St. Paul, MN)

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Shania Scheidt, PA-S

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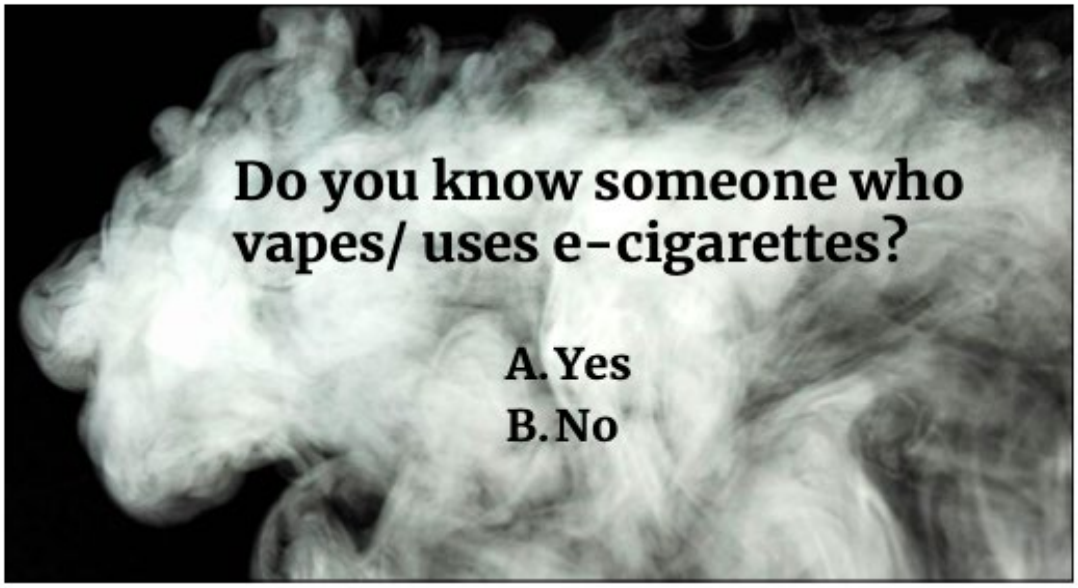
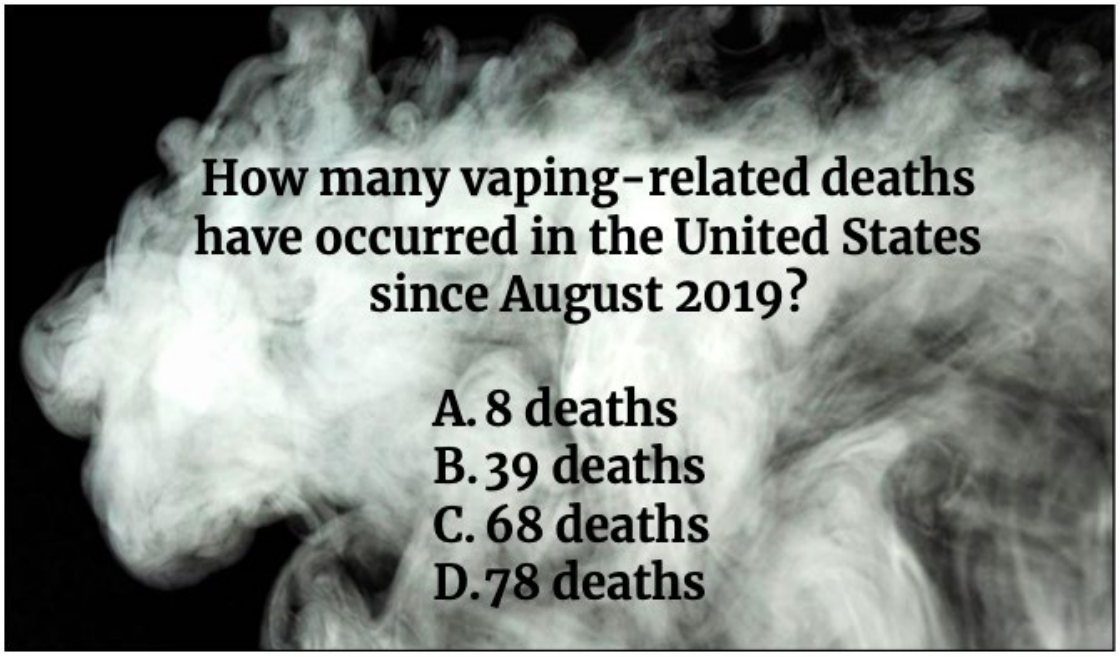
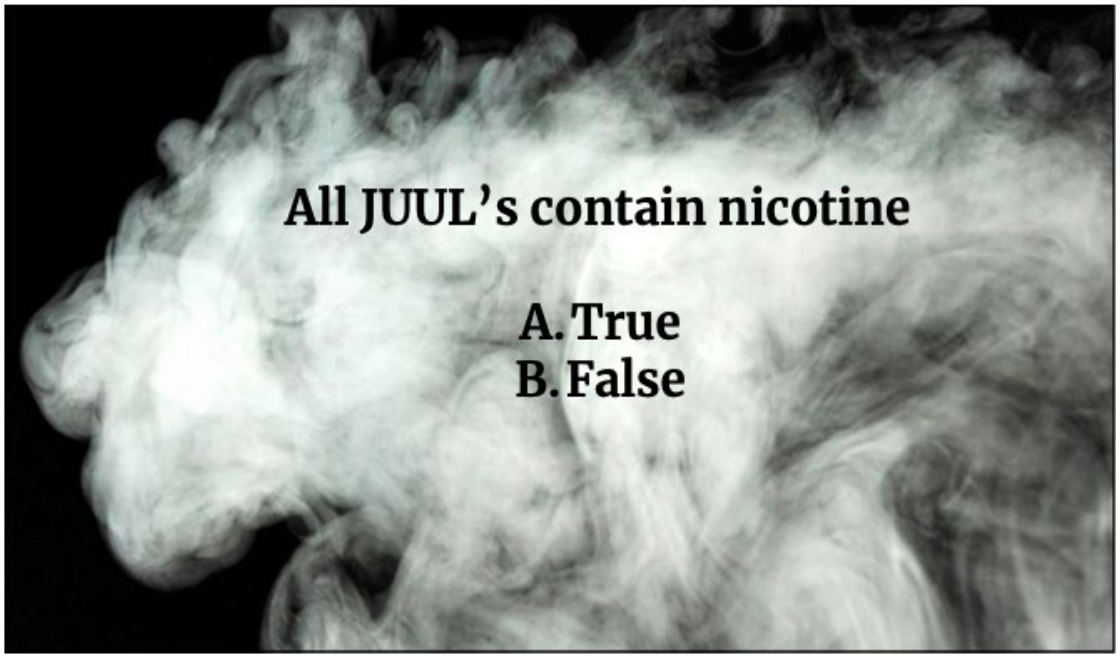
Bachelor of Science- USF

Video Link: https://www.youtube.com/watch?v=zYuyS1Oq8gY#action=share




How many vaping-related deaths have occurred in the United States since August 2019?
A. 8 deaths
B. 39 deaths
C. 68 deaths
D. 78 deaths


All JUUL's contain nicotine
A. True
B. False

SIGNIFICANCE

From August, 2019 - February, 2020, in the United States:

- **68** vaping-related **deaths**
- **2,807** vaping-related **hospitalizations**

WHAT IS VAPING?

Inhalation and exhalation of an aerosol that is produced by an electronic cigarette device (e-cigarette).

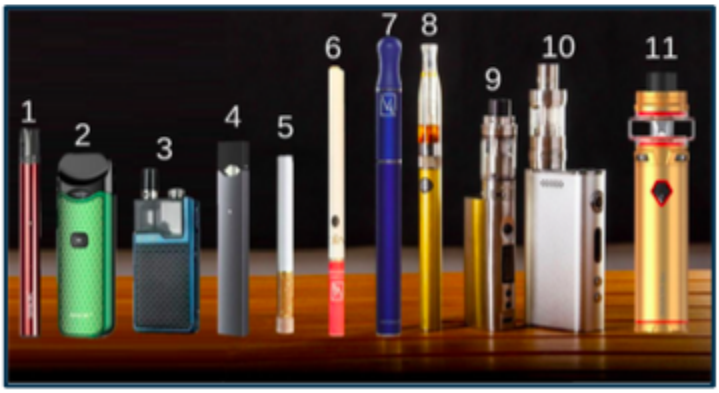
- **Vaping:** the action of using an e-cigarette.
- **E-cigarette:** the physical device used to vape
  - Vape pen, vapes, e-hookah, the "Juul"

WHY E-CIGARETTES?

- **Alternative to smoking cigarettes**
  - MYTH: Believed to be less harmful
  - TRUTH: The FDA states that e-cigarettes contain many of the same toxic chemicals as traditional cigarettes
- **Smoking cessation tool**
  - MYTH: Vaping is a safe and helpful way to quit smoking
  - TRUTH: The FDA has not approved e-cigarettes as a proper vaping cessation tool
- **Other reasons:**
  - Social component, especially in younger users
  - Flavors

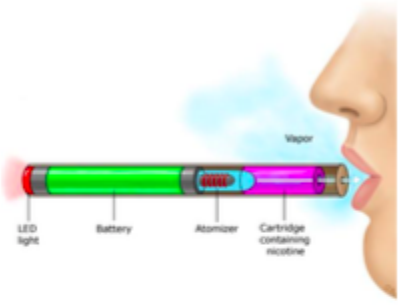
TYPES OF E-CIGARETTE DEVICES

1. Refillable Vape Pod
2. Refillable Pod
3. Refillable Pod
4. Prefiled Pod
5. Disposable E-Cig
6. Cartridge E-Cig
7. Refillable Cartomizer
8. Refillable Cartomizer
9. Box Vape Mod
10. Box Vape Mod
11. Tube Vape Mod



COMPONENTS OF THE E-CIGARETTE

- **Battery:** allows the liquid contents to be heated and transformed into an inhalable vapor.
- **Aerosol** can contain: nicotine, cannabinoids (THC), vitamin E acetate, flavors, and other additives.
  - Propylene glycol (liquid) → formaldehyde (aerosol)
  - It's NOT "just water vapor!"
- No visible smoke, no tobacco scent

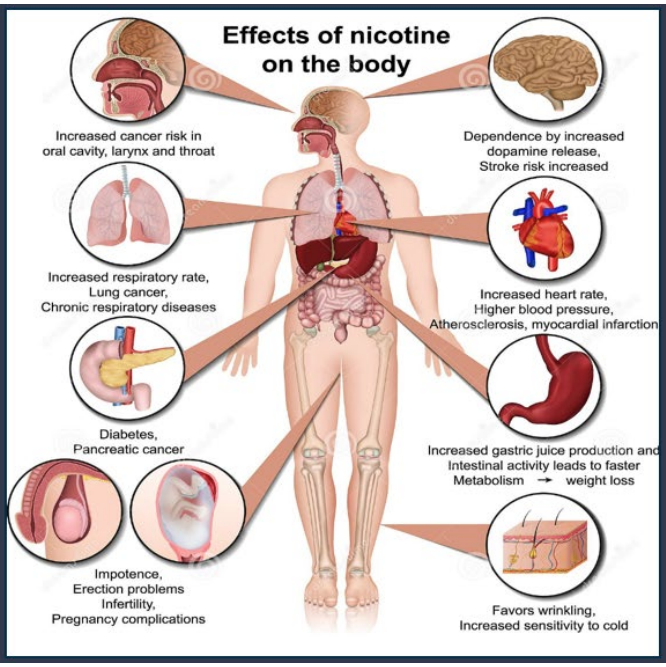


HARMFUL EFFECTS OF COMMON E-CIGARETTE COMPONENTS

- **Battery** ("thermal runaway"): Increased temperature can lead to fire or explosion, causing injuries and burns
- **Liquid components** including: **Nicotine, Cannabinoids, and Vitamin E acetate (oil)**

Nicotine

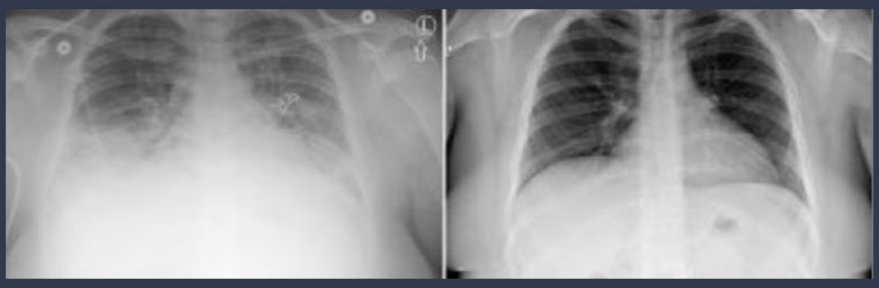
- **BRAIN**
- **HEART**
- **LUNGS**
- **STOMACH**



Cannabinoids (including THC)

- **BRAIN-NEUROLOGICAL:** sleepiness, dizziness, confusion, concentration problems, and agitation.
- **LUNGS:** breathing problems
- **STOMACH:** changes in appetite and thirst
- **KIDNEYS:** kidney failure

Vitamin E Acetate



- The CDC announced that Vitamin E acetate was identified in 48 of 51 case patients (94%)
- Safe for topical use in creams and oral use in vitamin supplements
- Safety is unknown for inhalation
  - NOT an approved additive to vape products
  - Can lead to lipoid pneumonia (inflammation in the lungs from inhaling fats or oils)

EVALI Outbreak

EVALI = E-cigarette, or Vaping, product use Associated Lung Injury

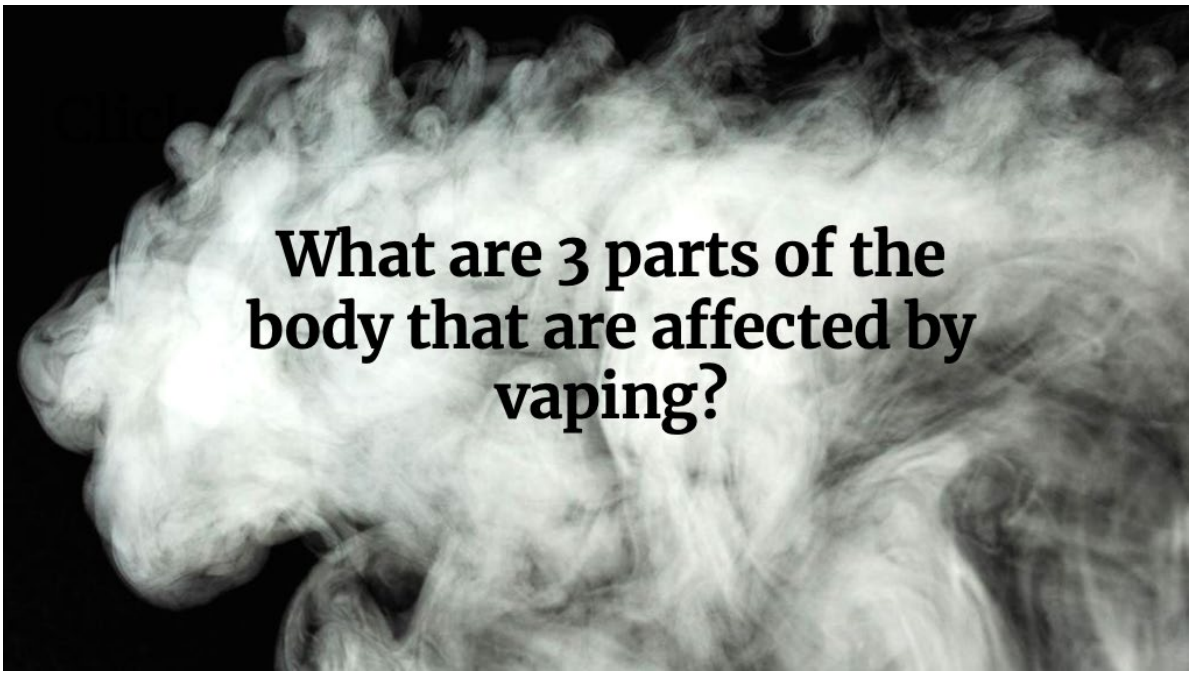
- Termed by the CDC in August, 2019…"after health department officials across the country began to work together to study cases of severe, sometimes fatal, lung infections that arose suddenly in otherwise healthy individuals… all reported they had recently used e-cigarette or vaping products."

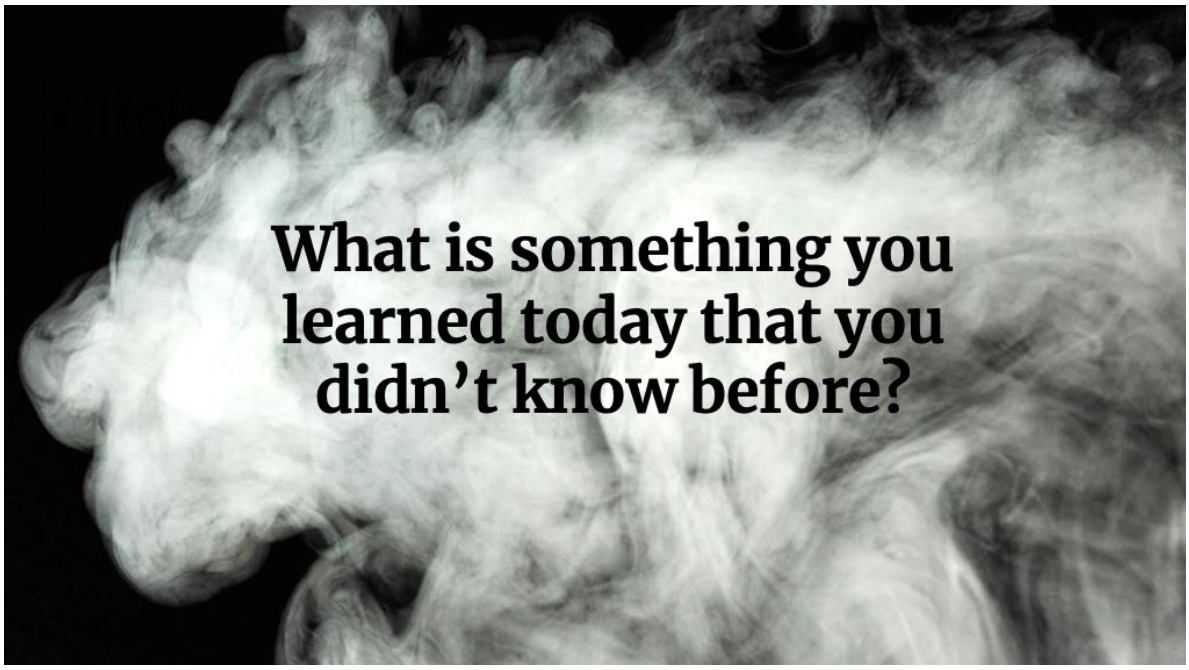
As of February 18, 2020:

- **68 deaths** in 29 states and the District of Columbia
  - 15 to 75 years old
  - More deaths are under investigation
- **2,807 cases of** EVALI have been reported to the CDC in all 50 states.
  - 13 to 85 years old
  - 52% of patients < 24 y/o

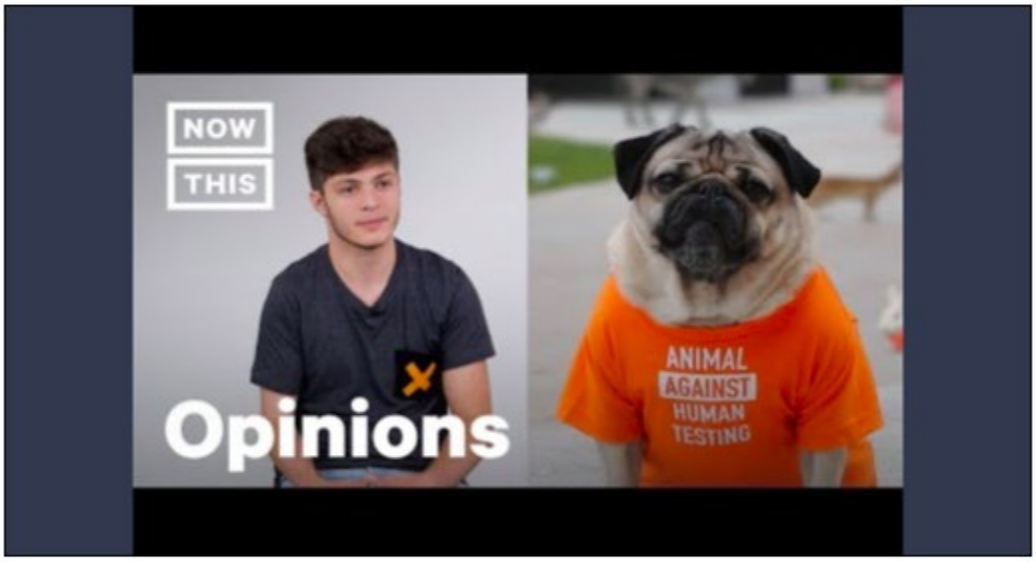
EVALI Patient Profile

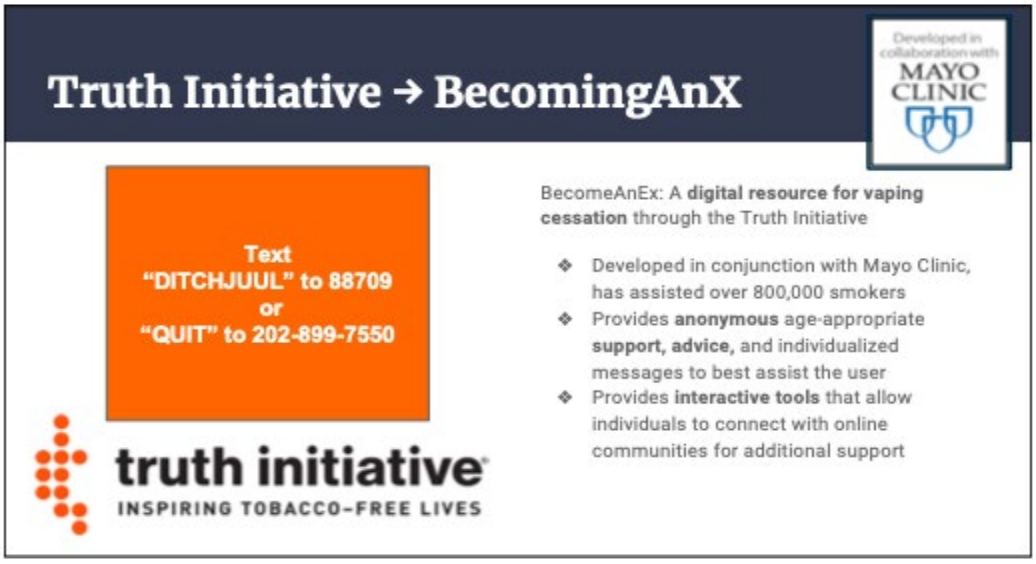
- **Patient History**
  - E-cigarette use in last 90 days
  - Documentation of exact substances vaped, such as nicotine, cannabinoids and flavorings
  - Origin of products, location of production
- **Clinical Presentation**
  - Respiratory: Cough, chest pain, and/or shortness of breath
  - Gastrointestinal: Abdominal pain, nausea, vomiting and/or diarrhea
  - Systemic: Fatigue, fever and weight loss
- **Laboratory Findings**
  - Bronchoalveolar lavage (BAL) fluid samples
    - Vitamin E acetate
    - THC
    - Nicotine


What are 3 parts of the body that are affected by vaping?


What is something you learned today that you didn't know before?

Video Link: https://www.youtube.com/watch?v=58QJlV5-hao#action=share





Resources for more vaping information:

Truth Initiative:

- Prevention
- Tobacco-free Promotion
- Cessation tools

Centers for Disease Control and Prevention:

- Weekly updates on the EVALI outbreak
  - Death toll, hospitalizations
- The latest up to date information on health consequences and components of vaping

CDC

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APPENDIX B

Vaping Informational Handout

truth initiative
INSPIRING TOBACCO-FREE LIVES

TEXT

“DITCHJUUL” to 88709

OR

“QUIT” to 202-899-7550

truth initiative
INSPIRING TOBACCO-FREE LIVES

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INSPIRING TOBACCO-FREE LIVES

TEXT

“DITCHJUUL” to 88709

OR

“QUIT” to 202-899-7550

- Amount of nicotine in 1 vape pod = 20 cigarettes
- All JUUL e-cigarettes contain nicotine
- 5mg of nicotine (1/4 of a vape pod) per day is enough to establish an addiction

TIME TO QUIT?

- Amount of nicotine in 1 vape pod = 20 cigarettes
- All JUUL e-cigarettes contain nicotine
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TIME TO QUIT?

- Amount of nicotine in 1 vape pod = 20 cigarettes
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TIME TO QUIT?

APPENDIX C

St. Francis High School Permission Email

Alan Schlomann Wed, Feb 26, 2:50 PM (7 days ago)
to me, Jill, Glenn

Alexa,
April 17th would work perfect! All 4 in one day is also ideal. Here is my schedule for that day:

1st hour- 7:45-8:47 Health
2nd hour- 8:53-9:55 Health
Saints Time 10:01-10:31 No presentation
3rd hour - 10:36-11:38 Health
Lunch
4th hour - 12:15-1:17

Just let me know and I will get it on my calendar.

Thank you,

Al Schlomann

Health/Phy Ed Teacher

District 15 Phy Ed Curriculum Specialist

Head Girls Golf Coach

Phy Ed/Health Department

763-213-1607

alan.schlomann@isd15.org

St. Francis High School

3325 Bridge St

St. Francis, MN 55070

This sounds like a good plan to wait and see what happens over the next month/s. In the meantime, I have attached our PowerPoint and a PDF of the handout. We do need specific approval for both the PowerPoint and the two videos included which would be included in the presentation. The links for the videos are in the PowerPoint and I will also include them below. Please let us know when you have reviewed the materials and if you approve.

Also, we are hoping to bring in candy to facilitate engagement during the presentation. We would like to bring in allergen-friendly candy only, including Starburst, Skittles, or Sour Patch Kids. If this is allowed, we again need approval from you.

Video #1 https://www.youtube.com/watch?v=zYuyS1Oq8gY#action=share
Video #2 https://www.youtube.com/watch?v=58QJIV5-hao#action=share

We look forward to hearing back from you!

Thanks again,
Alexa Trakalo

4 Attachments

Alan Schlomann Apr 13, 2020, 12:31 PM (2 days ago)
to me, Jill, Glenn

Alexa,
I have looked at the powerpoint and watched both videos, and I think it all looks great! This is exactly what I was envisioning when we were setting this up for my students. Yes, I think the candy incentive would be fine as well.

We can stay in contact as we get closer to May and figure out how this will work. I appreciate all the time and energy you and your team have put into this presentation.

Let me know if you need anything else from me at this time.

Thanks,

Al Schlomann

Health/Phy Ed Teacher

District 15 Phy Ed Curriculum Specialist

Alan Schlomann Mon, Apr 13, 12:31 PM (2 days ago)

to me, Jill, Glenn

Alexa,
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