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Improving Informed Decision Making to Reduce the Health Risks of Vaping Among Adolescents: A Quality Improvement Project

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Improving Informed Decision Making to Reduce the Health Risks of Vaping Among Adolescents: A Quality Improvement Project

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Abstract

Background: Smoking continues to be a concerning topic among healthcare providers it is a common risk factor among all major diseases. A new variant, in the form of electronic nicotine delivery systems (ENDS) have arrived at this mix. E-cigarettes, or vapes, have become the most often used tobacco product among young people since 2014 (Sharma et al., 2021). Statistics from the CDC show that in 2022, over 2.5 million youth, including 14.1%‡ of US middle and high schooler kids are not just experimenting with e-cigarettes, but are using them frequently, leading to an addiction that is difficult to break. The facts are as follows, 46% of high school e-cigarette users reported vaping on 20 or more days/month, 30.1% reported daily use, in total, 700,000 middle and high school students are vaping every single day (Centers for Disease Control and Prevention, 2022).

Purpose: The purpose of this author's project is to inform users (especially teens), healthcare providers and public policymakers, about the short- and long-term hazards of vaping. In 1997, Kevin Dooley introduced the concept of a complex adaptive system (CAS), which he defined as a group of partially autonomous agents interacting in a way that is interdependent and produces system-wide patterns. His concept gives the theoretical framework for this project, where shared attitudes toward physical activity, healthy choices and self-awareness affect the health trends in any given group or community.

Methodology: In this Quality Improvement Project, an educational program was designed and delivered at the clinical site using Survey Monkey. Pretest and post-tests scores were compared and evaluated for their statistical significance. The goal was to improve provider's knowledge

regarding vaping health risks so they could have a more objective conversation with their patients.

Conclusions/Results: After completion, it was computed that 88.3% of them were willing to include this new information in their daily practice/discussions from a 16.7% that would do so rarely. Aim was to increase patient's awareness of the risks through the provider's knowledgeable interactions which would ensure the desired outcome for the target population, defer usage altogether. Providers obtained the tools needed to establish an interesting discussion with today's teenagers. Regrettably, e-cigarettes are still marketed as a healthier alternative to smoking, therefore creating a false sense of safety around the usage of these devices.

Discussion/Implication for practice: Longitudinal studies are still in their infancy to provide enough data to evaluate the significant health effects of their usage currently. Although it has been demonstrated that ENDS enhance the years of life gained through their influence on smoking cessation, they also disproportionately increase the years of life lost due to an increase in youth-related smoking initiation. Every significant U.S. public health authority, including the U.S. Surgeon General, the U.S. Preventive Services Task Force, the CDC, and even the FDA itself, has concluded that there is insufficient evidence to draw the conclusion that using e-cigarettes to quit smoking is an effective strategy. Therefore, it is imperative for the practitioners to have an objective discussion with their patients in other to create a knowledgeable foundation for when they are to make these decisions.

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I. Introduction

Smoking continues to be one of the top causes of preventable illness and death worldwide, even though it has become less popular over the past 50 years (Wein & Hicklin, 2022). The advancement of a tobacco-free world is at risk due to the recent appearance of a new smoking method: e-cigarettes. Thanks to the swift entry and rapid growth of these vaping products onto the market over the past 10 years, the use of electronic nicotine delivery systems (ENDS) has rapidly increased. Because of the recent adoption of this trend, long-term effects have not yet been determined, but there is enough evidence to suggest that to lessen the health risks and issues it presents, immediate investigation and action are needed. One of the main concerns is the way these devices are offered; they are especially appealing when presented as a smoking cessation alternative and marketed to younger people.

Problem Statement/Significance to Nursing

Young people who start using tobacco products are more likely to continue doing so as adults and to suffer from the many adverse effects of chronic smoking. Vaping and any other nicotine product have the potential to cause damaging respiratory consequences in addition to other health problems (Lemey et al., 2020). Therefore, it is critical to act early to stop tobacco usage before it even begins, especially in young adults. Such intervention would prevent the harmful health effects of youth tobacco use and lower the high risk of addiction. Part of this effort is the Global Youth Tobacco Survey, a U.S. Centers for Disease Control and Prevention project. Beginning in the late 1990s, the rate of teen smoking in the United States had gradually dropped, but once vaping was introduced, the reduction was reversed, pushing primary care professionals to act, according to Sockrider et al. (2022). Some attribute this increase to the

containment of the COVID-19 pandemic, but the reality is that an immediate action plan is required to reverse this trend and return it to its original course.

In the U.S., vaping has quickly surpassed cigarettes as the preferred method for young people to consume nicotine. In 2019, 10% of middle school kids and more than 20% of high school students admitted to using e-cigarettes at the time. According to data from the Global Youth Tobacco Survey, from 2012 to 2019, 9.2% of adolescents in the 12 to 16 age range vape now. The incidence varied widely among the nations analyzed, and it was lower in middle-income nations compared to either high- or low-income nations. Sadly, 80% of people who start smoking as teenagers will continue to do so as adults (Centers for Disease Control and Prevention, 2022).

Usually, people start using tobacco and other nicotine products in their teens, either by smoking or vaping through electronic cigarettes (e-cigarettes) or other devices. Nowadays, many youngsters choose noncombustible tobacco or nicotine products, notably vaping devices, over traditional tobacco (Wein & Hicklin, 2022). Therefore, it is important to start screening for all kinds of nicotine usage in clinical settings. Simply asking the patients if they smoke is insufficient. When asked only about smoking, patients may forget to disclose the use of other nicotine, flavored liquids, or hash oil devices they may be using as the word “smoking” is mostly associated with traditional tobacco cigarettes. Although some will disagree, many people employ one of these alternate methods and not consider it smoking, thus healthcare professionals should use different questions to acquire accurate information about their usage.

II. Literature Review/Evidence Related to the Clinical Question

Search Strategy

This is a narrative and informational review. This author conducted an extensive survey of scholarly sources on this specific topic. A literature review was conducted using databases and sources such as FIU Library online, Google Scholar, UpToDate, CINAHL Complete, PubMed, MEDLINE, and Centers for Disease Control and Prevention (CDC) were used to compile the articles used in the body of this paper to present an overview of current findings, allowing the author to identify relevant theories, methods, and gaps in current knowledge within the existing research as well as health risk and healthcare cost implications. The search was limited to full-text research articles in English or Spanish, published between 2012 and 2022 that included health care providers' knowledge about e-cigarette usage, health risks associated with vaping, anesthesia implications of e-cigarette use, healthcare cost of vaping, and physiologic changes due to e-cigarette smoking. Key words used in the literature search included vaping, e-cigarettes, electronic nicotine delivery systems, adolescents, cultural trends, perception, healthcare cost, and physiologic implications. The final search generated 35 articles (N = 35); 23 were omitted after careful screening, leading to the review of 12 full-text articles. The goal of this literature review is to arm pediatricians, adolescent medicine specialists, and other primary care physicians with information on the health risks associated with e-cigarette use by developing adolescents, helping to close the knowledge gap. The teenagers' perception on the topic, the physiological changes after usage, and the economic effects of this new trend will also be discussed in this review. Its objective is to raise awareness of the harmful health effects of ENDS use among the younger population, particularly among adolescents 12 to 18 years old, and to aid them in making well-informed decisions about whether they should even try them.

Background

What Are Vapes/E-Cigarettes?

E-cigarettes/vapes are battery-powered devices that emit an aerosol that users inhale after heating a liquid that often contains a combination of nicotine, flavoring chemicals, propylene glycol, and glycerin (Sharma et al., 2021). Another name for these devices that have a battery, an atomizer (or heating element), and a reservoir for e-liquid in the form of cartridges, tanks, or pods that deliver an aerosol to the user's lungs through inhalation is electronic nicotine delivery systems (ENDS) (Rogers et al., 2021). With e-cigarettes being the most popular type, electronic nicotine delivery systems have been created to resemble pipes, hookahs, cigars, and cigarettes. (Simpson et al., 2021). They were mostly produced and marketed internationally by independent e-cigarette firms after being launched to the American market in the middle of the 2000s. There are now three major categories of e-cigarettes; however, they have undergone fast diversification and investment from the tobacco industry since then (Rogers et al., 2021). The three categories of e-cigarettes are as follows:

- Disposables: the device is discarded after e-liquid is exhausted
- Closed reusable systems: user purchases prefilled e-liquid cartridges
- Open reusable systems: the device contains a tank reservoir that users refill with e-liquids of their choice.

Retailers and customers refer to them by a variety of names, such as mod, vape, or electronic hookah. They are referred to as electronic nicotine delivery devices, nicotine vaping products, or e-cigarettes in scholarly literature (Sharma et al., 2021).

Breakdown of E-Cigarette Compounds

Depending on the type of device and its settings, e-liquids can experience a wide variety of temperatures. Organic molecules included in e-liquids are capable of thermally breaking down into smaller substances. These items contain hundreds, if not thousands, of hazardous substances (Margham et al., 2016) such as acetaldehyde, acrolein, diacetyl, and formaldehyde, which all have all been linked to vaping in a variety of studies. Both acrolein and formaldehyde are known carcinogens and strong irritants. Glycidol and acetol, intermediate breakdown products, have been observed, suggesting that heated PG/VG undergoes oxidation to form these carbonyls (Margham et al., 2016).

Toxins from tobacco and e-cigarettes are among the xenobiotics that are metabolized by the cytochrome P450 family of enzymes. Although considerably less so than in the liver, they are also expressed in the lungs. Recent research suggests that vaping may increase toxicity for dual users by increasing the formation of cancer-causing benzo(a)pyrene metabolites through the cytochrome P450 aryl hydrocarbon pathway (Margham et al., 2016).

Unfortunately, except from the nicotine concentration and the proportion of vegetable glycerin to propylene glycol, the liquid composition of these devices is not known to the general population, making it challenging to foresee the health impacts they will incur, particularly on the heart and lungs (Margham et al., 2016).

Chemical Composition of Aerosol from an E-Cigarette

According to Margham et al. (2016), generally, e-cigarettes have a battery unit that powers an atomizer or heating coil that turns a liquid into an aerosol. Most e-liquids typically include nicotine and flavors in addition to excipients including propylene glycol (PG), vegetable glycerol (VG), and water. Some other chemicals found in these liquids include nicotine breakdown products, tobacco-specific nitrosamines, tobacco alkaloids, volatile organic

compounds, aromatic amines, carbon dioxide, polycyclic aromatic hydrocarbons (PAHs), phenolics, metals, and carbonyls. The reported amounts of carbonyl emissions can be higher than those found in cigarette smoke when utilized at very high-power settings. The most harmful substances detected on e-cigarettes are these carbonyl emissions, coupled with the carbonyl's formaldehyde, acetaldehyde, and acrolein molecules (Margham et al., 2016).

Of the 150 measurands that were analyzed in the e-cigarette aerosol for this study (Margham et al., 2016), 104 were not found, and 21 were present because of laboratory background. This is the foundation behind the positive presentation of these devices as a smoking cessation alternative given that they, in fact, contain fewer chemicals when compared to traditional tobacco cigarettes. Nine of the other 25 aerosol ingredients were found at concentrations too low to be measured, and only 16 were produced entirely or in part by e-cigarette use (Margham et al., 2016). Although the composition of the aerosol from an e-cigarette is less complex than that of cigarette smoke and contains far fewer toxicants, the presence of certain of these toxicants in e-cigarettes raises concerns about the safety of their use. As depicted by these researchers, under dry-puff conditions, where e-liquid conveyance to the atomizer is insufficient for the applied electrical power setting and greater levels are required, levels of these carbonyls can approach those from regular tobacco cigarettes.

The carbonyls in the experiment by Margham et al. (2016) displayed the most complex behavior. Since formaldehyde, acetaldehyde, and acrolein are recognized as thermal degradation products of glycerol, a well-known ingredient in e-liquids, they concentrated on the emissions of these three compounds. However, the majority of this research shows a correlation between the lower levels of chemical measurements in e-cigarette emissions compared to tobacco cigarettes,

even though there are still some health dangers and stated that no single study to date has tried to thoroughly define the chemical makeup of e-cigarettes.

The number of puffs taken with e-cigarettes is one key element influencing the detected contamination in e-cigarette aerosols, as indicated by Margham et al. (2016). The study also confirmed that the presence of toxicants in e-cigarette aerosols makes their usage unlikely to be risk-free even if it showed how relatively simple their chemical makeup is compared to that of a tobacco cigarette. Another important fact is that, on average, there were 200 puffs from an e-cigarette compared to 10 to 11 puffs from a tobacco cigarette, demonstrating that the total amount inhaled was almost 20 times higher with e-cigarettes and increasing exposure to these chemicals enormously.

Safety of E-Cigarettes

As already mentioned, e-cigarette vapor's toxicity is still not fully understood. The bulk of the ingredients in e-liquids, except for nicotine, is on the FDA's Generally Recognized as Safe (GRAS) list (Margham et al., 2016). The bulk of the compounds on the GRAS list was created with the intention of being food additives, and a crucial requirement of the GRAS statute is that the item "must be proved to be 'generally recognized' as safe under the conditions of its intended use." As a result, the effects of many GRAS components on the pulmonary system are unknown because they have not been evaluated for inhalation toxicity (Margham et al., 2016). On its website, the Flavor and Extract Manufacturers Association of the United States voiced worries regarding the usage of GRAS ingredients in e-liquids. It is crucial to remember that e-cigarettes were commercially available to the general population before the cardiopulmonary effects of e-cigarettes were researched on the theory that they were covered by GRAS. Arguments claiming e-cigarettes have not significantly increased disease incidence in the previous 10 years are

premature because it typically takes decades for smokers to acquire cardiovascular disease (CVD) or chronic obstructive pulmonary disease (COPD) (Do et al., 2020).

Physiological Implications

Vaping: Anesthesia Considerations for Patients Using Electronic Cigarettes

The effects of patients' smoking on perioperative care are commonly known to anesthetists. However, among teenagers and young adults, electronic cigarettes are a relatively recent phenomena that has become very popular. Healthcare professionals generally lack expertise about the long-term impact of electronic cigarettes on health. According to Hobson et al., 2020, these devices' liquid and heating elements release compounds that can be hazardous to multiple organs both acutely and chronically, but there has not been a definitive consensus regarding the issue. One topic that has been discussed is that the pulmonary, cardiovascular, immunologic, and pharmacologic impacts of electronic cigarettes are particularly significant on a cellular level (Hobson et al., 2020). Electronic cigarettes (ECs), which are marketed as a viable substitute to traditional cigarettes, contain nicotine and other toxic byproducts that may significantly raise the risk of problems during general anesthesia.

A total of 306 health care professionals (HCPs) and 24 in-patients were polled for the Hobson et al. (2020) study. The study investigated the readiness of the providers to tell patients of the health hazards connected with using e-cigarettes as well as their understanding of the implications of doing so. Findings showed that both the healthcare professionals and the in-patients polled had gaps in their knowledge and misconceptions about the value and use of e-cigarettes. HCPs stated that they had been asked by patients about e-cigarettes, but they were unconfident in their ability to answer these queries. It was obvious that initiatives should be taken to provide HCP training opportunities and spread information about e-cigarettes (Hobson

et al., 2020). In order to provide consistent data, more studies and instructions are required to address the safety and effectiveness of using e-cigarettes (McClelland et al., 2020)

Recent research has shown that EC are not as safe as they were first thought to be and may even have harmful consequences on health (McClelland et al., 2020). Despite claims made by merchants that EC are a useful aid for quitting smoking, a recent study by the Centers for Disease Control and Prevention (CDC) discovered that people who use EC to quit smoking cigarettes do not actually cease using cigarettes; instead, they continue to use both products (Hobson et al., 2020). The CDC amended its statements against e-cigarettes in August 2018, highlighting the dangers of additional chemicals found in EC to the lungs and other organ systems in addition to the addictive and harmful effects of nicotine. The FDA website states that a warning has also been issued regarding the serious danger that exposure to or ingestion of e-liquids can cause in young children, including seizures, comas, respiratory arrest, and even death (Hobson et al., 2020). Given the warnings and well-documented data showing these devices detrimental health impacts, anesthesia providers are a particular provider group that might benefit from further research into the concrete ramifications and health implications that vaping can cause. Preoperative screening methods for e-cigarette or vaping use, particularly among the young population, lack clear recommendations and should be implemented.

The consequences of concurrent use of traditional cigarettes and ECs are a crucial factor that anesthetists must consider. Additional care must be exercised if patients utilize both products. The Vardavas et al. (2013) study found that among healthy smokers who also vaped for 5 minutes, there was an increase in impedance, peripheral airway flow resistance, and oxidative stress. E-cigarette vapors have a clear association with inducing respiratory system inflammation and apoptosis or necrosis, much like regular cigarettes do. Therefore, intra-

operative and postoperative pulmonary problems are more likely to occur in patients who vape. Vapers who are having general anesthesia should have their cardiovascular health checked by anesthesiologists. Glycerol heating can cause acrolein to develop in the e-liquid. Acrolein long-term inhalation slows the flow of endothelial progenitor cells and encourages atherosclerosis, which speeds up the aorta's hardening process by 1.6 times (Vardavas et al., 2013).

Pulmonary Implications of E-Cigarettes

Increasing amounts of in vitro, animal, and human research are showing that using e-cigarettes can have serious lung damage. Multiple respiratory system areas and functions are impacted by electronic cigarettes, including airflow, oxidative stress levels, lung development, and host defense against bacterial and viral infections. According to a Garcia-Arcos et al. (2016) study, inhaling nicotine-containing e-cigarettes promotes airway hyper reactivity, distal airspace enlargement, mucin synthesis, and cytokine and protease expression, which are all symptoms of chronic obstructive pulmonary disease (COPD). Any environmental substances that are inhaled work primarily on the airway epithelial cells, which can lead to a variety of respiratory issues such airway inflammation and an increase in the frequency and intensity of viral infections of the respiratory tract.

Inhaled EC nicotine has been demonstrated to cause respiratory tract infections in addition to lung inflammation. The most frequent cause of acute upper respiratory tract infections is the human rhinovirus (HRV), which can also lead to acute exacerbations of lower airway illnesses including asthma and COPD (Garcia-Arcos et al., 2016). Interleukin (IL)-6, a pro-inflammatory cytokine, is frequently linked to exposure to tobacco smoke and causes acute lung inflammation. Increased IL-6 levels in sputum have been found in smokers with COPD

during virus-induced exacerbations and plays an important role in the progression of COPD severity (Garcia-Arcos et al., 2016).

To determine whether EC liquid, like conventional cigarettes, causes viral infection and inflammation in primary human airway epithelial cells, Wu et al. (2014) undertook a study. According to their research, even nicotine-free e-liquid encourages the release of inflammatory mediators and the spread of HRV. Additionally, both nicotine-free and nicotine-containing e-liquids suppress the innate immunity of the lungs, which is important for lung defense against HRV infection. By changing the innate immunity/host response, electronic nicotine delivery devices improve the aggressiveness of the colonizing bacterial and viral infection.

According to Goniewicz et al. (2013), heating e-liquids to high enough temperatures causes the presence of formaldehyde, acrolein, and acetaldehyde carbonyls to be detectable. These substances harm the lungs' lining and irritate the nasal cavity in addition to being carcinogenic, which contributes to increased airway reactivity. In addition, heavy metals are released in the aerosol from e-cigarettes, according to chemical composition analyses conducted in numerous research. In 2018, Zhang et al. discovered heavy metals in e-cigarette smoke, including tin, nickel, lead, and chromium. Heavy metals that are inhaled can accumulate in the alveoli and harm the lungs, resulting in coughing, dyspnea, chest discomfort, pulmonary edema, and abrupt respiratory failure.

Cardiovascular Implications of E-Cigarettes

Numerous epidemiologic studies indicate that cardiovascular disease is the secondary cause of one-third of smoking-related fatalities (CVD) (Hobson et al., 2020). Despite being advertised as being healthier than smoking cigarettes, e-cigarettes have also been demonstrated to have catastrophic effects on the cardiovascular system. The main CVD concerns when it

comes EC aerosol come from nicotine, carbonyls, and other particles. It is generally known that nicotine has a negative effect on the cardiovascular system. Under general anesthesia, nicotine's stimulation of the ganglionic and central nervous systems (CNS) increases the release of several catecholamines, causing hemodynamic instability (Hobson et al., 2020). The propensity of nicotine to release catecholamines, which causes dramatic changes in blood pressure, endothelial dysfunction, an increase in lipids, and insulin resistance, is a major factor in many cardiovascular issues. Increases in heart rate, blood pressure, myocardial contraction, myocardial oxygen consumption, myocardial, and peripheral vascular resistance are only a few of the acute adverse effects of nicotine (Hobson et al., 2020). Nicotine poisoning frequently results in nausea, vomiting, tremors, diaphoresis, sweating, tachycardia, seizures, and occasionally death.

It is generally known that smoking influences the embryonic stage, especially fetal heart development and function, which can cause a variety of issues associated to pregnancy (Hobson et al., 2020). Their study of human embryonic stem cells produced enough data to advise children, teenagers, pregnant women, and women of reproductive age against using e-cigarettes due to the potential long-term effects on cardiac and brain development.

Drug-to-Drug Interactions

The interactions between EC and anesthetic medications, such as volatile agents, opioids, and neuromuscular blocking medications, must be understood by anesthetists. In practically all samples of smoke that have been found, e-cigarettes have been demonstrated to create volatile organic compounds (VOC), including toluene (Hobson et al., 2020). When VOCs are inhaled in high quantities, they can cause drowsiness, immobilization, anesthesia, and unconsciousness, while exposure to them in moderate amounts can affect behavior and neurologic function. More precisely, in their research, Hobson et al., (2020) suggested that toluene exhibits many of the

same CNS-depressant effects as drugs like barbiturates, ketamine, and the often-used inducer isoflurane. When it comes to surgical patients, anesthetists must be ready to present data and statistics comparing EC to conventional cigarettes.

Furthermore, it is widely known that smoking during the run-up to surgery has a negative impact on how well surgery goes. Nicotine is linked to a higher risk of surgical site necrosis and infection, which slows the healing of wounds (Hobson et al., 2020). These investigators go on to say that some EC brands may have worse effects on tissue perfusion because they contain more nicotine than regular cigarettes. Additionally, there is evidence to support the notion that EC may negatively impact wound healing and cause some of the same physiologic changes as traditional cigarettes whether nicotine is present.

Implications for Adolescents

Cardiopulmonary Consequences of Vaping in Adolescents

Despite the U.S. Food and Drug Administration not having certified e-cigarettes as a cessation aid, the business has mostly advertised their products in this way to people who are trying to stop smoking traditional cigarettes (Wold et al., 2022). However, their uniqueness and adaptability have made these devices accessible to unanticipated users, especially teens, which is a major cause for concern. Many new users of e-cigarette products, according to Wold et al., (2022), have never smoked traditional cigarettes. The research community is becoming more and more interested in understanding the respiratory and cardiovascular effects of e-cigarette usage. One problem in understanding its effect in adolescents comes because most available studies are conducted in adults. The respiratory and cardiovascular effects in this demographic are not solely attributed to e-cigarette use as with age come other comorbidities. Likewise, studies on the consequences of e-cigarette usage on different organs have been conducted on adult animals,

making extrapolating the health impacts to teenagers challenging (Wold et al., 2022). Given that any foreign chemical inhaled can have an impact on the cardiovascular and pulmonary systems, a more comprehensive understanding of the pathways involved in toxicity could directly assist researchers to cutting-edge therapeutic treatment approaches. These products are new; hence, there are no long-term epidemiology studies available. Moreover, e-cigarettes can be customized in a variety of ways, including power output, e-liquid concentration, and taste variety, which makes it difficult to control all the variables involved in these devices.

To make it worse, e-cigarettes' ability to deliver nicotine has improved over time, and depending on the device and the user, users can now obtain plasma nicotine levels like those of traditional smokers (Wold et al., 2022). Wold et al. (2022) revealed that generation one to three e-cigarettes produced lower plasma nicotine levels than combustible cigarettes. Some tests even found them to be lower across, but the authors theorized that this was because the test subjects had no prior exposure to the substance. Hence, the rationale behind the benefits of these devices for quitting smoking and the foundation for such suggestions. Although, there was no change in the plasma cotinine levels between the groups in other studies that compared long-term, real-world exposure to e-cigarettes and combustible cigarettes (Wackowski et al., 2021). This suggests that over time, vapers may puff more frequently to make up for their decreased delivery efficiency.

The U.S. Food and Drug Administration (FDA) has not recognized e-cigarettes as smoking cessation aids, and it is vital to note this significant distinction. It is important to distinguish between quitting smoking and quitting nicotine. According to a meta-analysis presented in the review made by Wackowski et al., (2021), using e-cigarettes decreased the likelihood of stopping tobacco usage altogether. There is no proof that using e-cigarettes can

help adolescents quit smoking. However, it is noteworthy that U.S. federal tobacco regulatory policy is shifting toward requiring a reduction of nicotine in combustible cigarettes to levels that will not sustain tobacco addiction while making e-cigarettes and other less harmful alternative forms of nicotine available for adults (Wackowski et al., 2021).

Pulmonary Effects in Adolescents

It is well recognized that numerous inhalants have physiological, inflammatory, host defense, and other pathological effects on the pulmonary system, which lead to a variety of lung disorders. In relation to e-cigarettes, epidemiological studies have discovered higher rates of wheezing, airway reactivity, bronchiectasis, a higher prevalence of asthma, and an exacerbation of the condition (Tsai et al., 2020). Additionally, bronchial biopsies from vapers showed significant changes in gene expression that are suggestive of immunosuppression. According to bench and animal studies, vaping weakens the host's defenses and increases susceptibility to bacterial and viral infections (Tsai et al., 2020). The dose makes the poison, according to an old saying in toxicology. Although e-cigarettes contain fewer chemicals than traditional cigarettes, it is important to note that the chemical concentrations in the lungs are unknown, and inhaled toxins are a genuine and legitimate issue.

Cardiovascular Effects in Adolescents

When the cardiovascular effects of smoking are evaluated regardless of the delivery method, there is evidence of numerous acute hemodynamic alterations, including increased arterial stiffness, decreased endothelial function, elevated blood pressure, heart rate, and sympathetic tone (Tsai et al., 2020). Another problem is that exercise increases myocardial blood flow but does not alter ventricular relaxation. Additionally, short-term e-cigarette usage increases the levels of oxidative stress indicators. The initial nicotine exposure appears to be responsible

for many of the vascular side effects. Although one study identified no long- or short-term effects on endothelial function in young, healthy adults who were exclusively e-cigarette users, much of the currently available information is based on investigations of young adults who were either smokers or nonsmokers (Tsai et al., 2020).

This author should mention that most of the e-cigarettes utilized in the Wold et al., (2022) study had a lower nicotine content than the e-cigarettes commonly used by teenagers. Unfortunately, no studies that are currently available have specifically looked at cardiovascular health in teenagers under the age of 18, who may be more susceptible to acute toxicities. According to several reviewed research, long-term e-cigarette use is also linked to elevated levels of pro-inflammatory white blood cells, oxidative stress, and systemic inflammatory biomarkers in young adults (Tsai et al., 2020). Therefore, it is reasonable to conclude that using e-cigarettes exclusively will probably raise adolescent users' cardiovascular risk.

Tetrahydrocannabinol and EVALI

In the United States, multiple clusters of vaping-related lung ailments were identified in 2019. The Centers for Disease Control and Prevention first used the term EVALI (Electronic/Vaping Associated Lund Injury) to define these ailments. It soon became evident that tetrahydrocannabinol (THC) vapers were the main victims of this new ailment of users with serious lung conditions that required hospitalization as presented in several international reports (Wold et al., 2022). THC or marijuana smokers are the main group affected by EVALI. Moreover, 80% of individuals with EVALI reported taking THC, compared to just 14% who said they exclusively used nicotine. As per current FDA reports, it is essential to note that even though there are presently no particular recommendations for helping teenagers to stop vaping nicotine or marijuana, more than 152 different THC-containing product brands have been found

nationally available, with Vitamin E acetate, being one of the main substances closely associated to this EVALI phenomenon (Wold et al., 2022). Abdominal pain, nausea, vomiting, or diarrheal symptoms, combined with shortness of breath, a cough, dyspnea with exertion, or chest discomfort, are the most common findings in EVALI cases (Cobb & Solanki, 2020). One of the most defining symptoms of EVALI is the co-existence of gastrointestinal and respiratory symptoms, which helps distinguish this disease state from other lung disorders caused by vaping. The epithelial injury and formation of foamy macrophages that are hallmarks of inhalation toxicity are consistent with the pathophysiology of lung injury in EVALI. Independent of any particular treatment, patients improve when they stop vaping, supporting the diagnosis (Cobb & Solanki, 2020).

Repercussions for Adolescents

The possibility of an elevated CVD in vapers is suggested by evidence of systemic inflammation and endothelial dysfunction (decreased nitric oxide generation), which are comparable to those reported in smokers (Choudhary et al., 2022). Furthermore, the use of e-cigarettes reduces sleep quality and may have an impact on mental health. This is because they activate dopamine reward pathways, which can result in addiction. The set points for addictive behaviors as an adult are fundamentally altered by the use of addictive substances throughout adolescence (Choudhary et al., 2022). This is quite alarming because vaping may cause psychopathology, lifelong addictions, and disruption in both social and professional situations. Additionally, because lung development continues into the early 20s, adolescents who vape run the risk of delaying or altering this development, never developing their full lung function potential, and eventually developing lung disease due to a modulation of the lung's inflammatory and immune state (Traboulsi et al., 2020).

Knowledge, Concerns, and Healthcare Practices Among Physicians

Given the inconsistent and scant evidence about the usefulness of e-cigarettes, the U.S. Preventive Services Task Force and American College of Physicians advised against using them as a smoking cessation tool. However, most marketing firms use this incentive as their main pillar. In this cross-sectional study, conducted by Kanchustambham et al. (2017), a convenience sample of a cohort of physicians at the SLU School of Medicine were asked about their awareness of and views toward e-cigarettes. Internal medicine (35%), internal medicine subspecialties (27.8%), and pulmonary service (12%) accounted for most of the responders. The findings showed wide variations in the advice doctors gave patients when they inquired about e-cigarettes. Only 63% of those surveyed were familiar with what the term "vape" meant. Even among respondents who said they were "extremely familiar" or "somewhat familiar" with this term, 28% were unable to accurately identify what the word "vape" really meant. Most responders supported FDA rules and warning labels like those found on cigarette goods, but the main issues worrying them were the lack of data on the product's long-term safety, the complete absence of FDA regulatory oversight, and their use as appealing starter products for young non-smokers and gateway to smoking for adolescents (Kanchustambham et al., 2017). On the other hand, they found that healthcare professionals who saw e-cigarettes as a harm-reduction aid were more inclined to recommend them. However, while some were aware of the diethylene glycol content and the majority were just concerned with the nicotine content, most were not aware of the propylene glycol content. One common consensus among the responders was that they all agreed that the FDA should impose rules and warning labels like those found on cigarette goods.

Kanchustambham et al. (2017) learned that regardless of their degree of training or specialty, 53% of the practitioners said that their patients who wished to quit smoking had

inquired about e-cigarettes. The fact that only 9% of respondents said they were very knowledgeable with the subject and 25% said they were not at all familiar with e-cigarettes suggest that there is a lack of information and awareness across all levels of training and specialties. More troubling is the finding that 28% of health care professionals did not know what was in an e-cigarette or what the term "vape" meant, demonstrating a discrepancy between reported or perceived knowledge and actual understanding regarding e-cigarettes.

Another intriguing conclusion in this study was that 51% of respondents thought that using e-cigarettes could reduce harm. This view among doctors was not shown to be substantially correlated with training level, provider specialty, or level of e-cigarette familiarity. Unfortunately, promoting their use for harm reduction without taking into account the explosive rise and usage of e-cigarettes among U.S. adults and minors may end up doing more harm than good, especially given the aggressive marketing and advertising strategies used for e-cigarettes (Kanchustambham et al., 2017). Interestingly, the study also revealed that 18% of the respondents advocated using e-cigarettes to stop smoking despite the inconsistent and scant data supporting this claim. It also demonstrated that doctors were more inclined to suggest e-cigarettes when they held a more favorable opinion of them and saw them as methods for harm reduction. Physicians generally learned more about e-cigarettes through their patients, the press, and marketing than from scholarly sources like evidence-based guidelines. The researchers Kanchustambham et al. (2017) claimed that their study was the first to assess physicians' perceptions of e-cigarettes, which the author thought to be intriguing.

Initiation, Usage and Perception by Adolescents

The Williams et al. (2021) study was beneficial to this author in helping to better understand the various aspects that contribute to e-cigarette usage initiation among the teenage

demographic and how to strengthen preventative efforts. High school students in Canada participated in this study. There were significant discrepancies between male and female attitudes regarding this topic. Intriguingly, e-cigarette use was not substantially correlated with changes in mental health and well-being measures, according to Williams et al. (2021). It was not linked to anxiety or sadness; rather, it was linked to poor emotional control. This discovery revealed that e-cigarette use among female students may be a coping mechanism. Therefore, educating female students about alternate, healthy coping mechanisms may be a key element of e-cigarette prevention efforts (Williams et al., 2021).

Alcohol, cannabis, and tobacco usage were all significantly related with starting to use e-cigarettes (Williams et al., 2021). The biggest danger was presented by recent cigarette use for men and alcohol usage for women. The clustering of substance uses and health-risk behaviors among adolescents has been observed in several studies, and it is likely that impulsivity and intense sensation seeking are the underlying risk factors for these behaviors. It was observed that students who abstained from other substance use, notably alcohol, cannabis, and cigarette smoking, at both baseline and follow-up, had decreased odds of starting an e-cigarette according to Williams et al. (2021).

The study also explained how marijuana usage was linked to the use of e-cigarettes among female students whereas alcohol use ever and recent cigarette smoking were linked to the use of e-cigarettes among both male and female students. Behaviors such as skipping class and receiving lower grades were also linked to an increased likelihood of starting an e-cigarette habit, but curiosity about a new product is one of the main reasons adolescents try e-cigarettes. What is worse is that this population may be motivated by a marketing campaign that appeals to young people in general for such lifestyle choices. It is generally suggested for children and teens to

complete at least 60 minutes of moderate to vigorous exercise (MVPA) per day, employ fewer than 2 hours of screen time, and obtain 8 to 10 hours of undisturbed sleep (Colditz et al., 2017). None of these recommendations are followed in today's social media-obsessed culture, especially when teenagers have unrestricted access to cellphones and other electronic devices. Williams et al. (2021) overall findings revealed that, over the course of a year, nearly one-third (29%) of Canadian secondary school students who had not yet started using e-cigarettes reported doing so, indicating a sharp rise in the use of e-cigarettes among students. To arrive at their conclusions, they used a sizable longitudinal dataset based on school records to investigate the factors related to e-cigarette use. This is the study's key strength. Such access supplied enough data to back up the necessity for more aggressive e-cigarette prevention programs targeting youth demographics. Alarmingly, they learned that nearly one-third of the sample of previous nonusers started using e-cigarettes in just 1 year, concluding that prevention strategies should concentrate on a variety of health-risk behaviors if we are to attain the goal of stopping young people from starting to use e-cigarettes. It is important to note that ninth-grade students had a higher chance of initiating usage (Williams et al., 2021) compared to senior students; thus, such strategies should be started as early as possible since taking preventive action before high school may be beneficial.

Adolescents' Health Perceptions of E-Cigarettes

To account for general health attitudes in this cohort, the author employed this systematic study done among teenagers aged 12 to 17 who resided in the U.S., UK, Canada, Australia, and New Zealand. It is significant to note that, although not to the same extent as in the U.S., rising rates of teen vaping have also been observed in the UK, Canada, Australia, and New Zealand (Sharma et al., 2021). The various regulatory regimes that these other nations have developed in contrast to those carried out by the U.S. may be to blame for the disparities in adolescent uptake

among these countries. Teenagers are increasingly using e-cigarettes, especially in high-income nations, according to Sharma et al. (2021). They examined a total of 18 quantitative research and seven qualitative studies in their review, and four key themes emerged from the data:

1. Perceived relative harm of E-cigarettes versus that of cigarettes.
2. Perceived findings indicating that adolescents have more favorable perceptions of e-cigarettes than of traditional cigarettes.
3. Perceived benefits and safety of e-cigarettes.
4. Sources of E-cigarette information and exposure.

Although most teenagers believed that e-cigarettes were less harmful than cigarettes, their opinions on the matter were frequently divided. Friends, family, retail point of sale, TV and online advertising, national agencies, healthcare practitioners, and personal experience were some of the sources of information regarding e-cigarettes. Teenagers' perceptions appear to be influenced by marketing, social and family networks, and advertising. (McClelland et al., 2020) In 2018, more than 3.6 million American teenagers, including 1 in 5 high school students and 1 in 20 middle school students, used e-cigarettes, according to the U.S. Surgeon General, public health experts, and the former commissioner of the U.S. Food and Drug Administration. According to the Surgeon General's advice on e-cigarette use among kids from 2020, 3.6 million American teenagers, including 19.6% of high school students and 4.7% of middle school students, used them (Sharma et al., 2021).

Perceived Risks

In this research by Sharma et al., (2021), 12 studies looked at the perceived advantages and allure of e-cigarettes, while the remaining 25 studies investigated individuals' opinions of the danger or negative health impacts of e-cigarettes. Seven of these studies evaluated knowledge

of electronic cigarettes, three studied attitudes toward them, and four investigated general views about them (e.g., are cool, healthy, harmful). According to the majority of the research, between 33% and 45% of adolescents did not know how toxic e-cigarettes were compared to cigarettes, and at least one-third of participants thought that e-cigarettes were less harmful than cigarettes. (Sharma et al., 2021).

According to polls of American teenagers mentioned by Sharma et al., 2021, dual users of e-cigarettes reported fewer health risks than non-users. Teenagers in the United States also claimed that e-cigarettes posed fewer short- and long-term health concerns than other tobacco products, highlighting the need for improved information and more dependable sources for such information. Only 12% of respondents said they were unsure about the effects of e-cigarettes on their health or that they might be unsafe/harmful despite the absence of data supporting their safety (Sharma et al., 2021), thus revealing the dire need for better education among this population.

Perceived Benefits

According to 56% of the participants, the main advantages of e-cigarettes are that they are healthier than traditional cigarettes. Four percent of participants who had never smoked or ever heard of e-cigarettes thought they were very unlikely to be addicted due to the minimal quantity of nicotine in them, while 16% said it would be simple to stop using them if they so desired (Sharma et al., 2021). E-cigarettes can contain up to 18% nicotine, which makes such assumption absolutely false. (McClelland et al., 2020). Other findings included that the vapes and flavors of e-cigarettes were thought to be more enticing and less hazardous than tobacco-flavored e-cigarettes by some teenagers, who claimed that using them helped them reduce stress.

E-cigarette experimentation and use were regarded as enjoyable social activities that allowed users to try new flavors and learn about smoke tricks with their friends (Sharma et al., 2021).

Sources of Information

Peers, friends, and families exposed most teenagers to e-cigarettes. Additionally, they were made aware of e-cigarettes through marketing and promotion on signs, billboards, television, print, radio, at retail points of sale, on all social media platforms, and online (Sharma et al., 2021). Moreover, among those who are already using e-cigarettes or cigarettes, this review revealed evidence that overall adolescents believe e-cigarettes to be healthier than cigarettes. (McClelland et al., 2020). Unfortunately, research points to the possibility that countries' regulatory frameworks—less liberal or more restrictive—can influence how this harm is perceived (Sharma et al., 2021).

Healthcare Costs

A Canadian study by Pound and Coyle (2022) estimated that the costs of tobacco use in 2012 were CAD 16 billion, with most indirect costs (CAD 9.5 billion) related to lost wages from long-term disability and premature mortality related to smoking, and the largest portion of direct costs (CAD 6.5 billion) associated with health care expenses. Therefore, the government of Canada has set a target to reduce smoking prevalence to below 5% by 2035.

The authors discovered that numerous health cost-related problems were linked to the effects and implications of smoking habits. From the 2017 Canadian Tobacco, Alcohol and Drug Survey (CTADS), precise information on smoking and vaping status was taken. In Canada, electronic nicotine delivery systems (ENDS) were used by 32% of teenagers aged 15 to 17 who had ever smoked daily and 11% of young adults under 25 who had never smoked before they started smoking traditional cigarettes (Cobb & Solanki, 2020). The fact that vaping is becoming

increasingly common is also concerning. The percentage of Canadian teenagers aged 15 to 19 who supported vaping rose from 20% to 36% between 2013 and 2019. The study's data came from lung cancer, coronary heart disease, chronic obstructive pulmonary disease (COPD), or stroke and lung cancer, which account for around 75% of smoking-related deaths in developed nations (Pound & Coyle, 2022).

Following data analysis, Pound and Coyle (2022) outlined the effects of ENDS under three alternative scenarios on life expectancy, quality-adjusted life years (QALYs), and smoking-related health care expenses in Canada. Such scenarios were:

1. The status quo, with current access to ENDS
2. A complete ban of ENDS
3. Limited access to ENDS for smoking cessation only, by prescription

The justification for harm reduction techniques is the enormous health and financial benefits of quitting smoking. ENDS are thought to be safer than cigarettes since they do not involve the combustion of tobacco, and they can help smokers switch to a less dangerous habit as a result. The study's findings, however, were quite alarming. The fact that the scenario of entirely unavailable ENDS outperformed the status quo shows that the long-term negative effects of increased smoking initiation in young vapers outweigh the positive effects of ENDS on smoking cessation (Pound & Coyle, 2022). This is much more obvious in scenario three, when ENDS are not available to kids but are still available for quitting smoking, producing the most dramatic and favorable results. This study concludes that utilizing electronic nicotine delivery systems (ENDS), often known as vaping, is a frequent method of quitting smoking. However, the possibility that using ENDS may increase young cigarette smoking start raises serious safety concerns (Pound & Coyle, 2022). Because of this, ENDS may help people quit smoking, but its

influence on young people's decision to take on smoking is troubling. The results on the impact of electronic nicotine delivery systems (ENDS) on health outcomes and costs in Canada was evaluated after data analysis. They were based on ENDS' impact on smoking cessation and smoking start rates (Pound & Coyle, 2022).

They also found that although a complete ban on ENDS would provide the best protection to the population that has never smoked, and it would invalidate any health benefits that smokers who have switched to ENDS have achieved by reducing or quitting their cigarette use. Concluding that, even though the data suggested that restricting ENDS' accessibility to the Canadian population could improve population health and lower healthcare costs, this option was not feasible. A preferable choice would be to make it possible for smokers to obtain ENDS through a doctor, allowing them to continue receiving their benefits while reducing exposure among children (Pound & Coyle, 2022). The primary issues with outright banning ENDS were that it might lead to the creation of a black market and an increase in dangerous goods.

III. Purpose

The purpose of this project was to inform consumers—particularly teens, providers, and public policymakers—about the short- and long-term consequences of vaping. The project also sought to change existing behaviors and have an impact on future research techniques and clinical practice recommendations by providing essential background information on the cardiopulmonary effects of vaping. This author hoped to emphasize that young people who begin using tobacco products are more likely to do so in adulthood and to experience the numerous negative consequences of long-term smoking. Therefore, one must try to educate the new generations as to equip them with the knowledge to make better informed decisions.

PICO Question

What effect would lecturing adolescents (P) regarding the specific health risks of vaping (I) have in their decision of trying it (O), compared to leaving them with their current general information (C)?

DNP Project Clinical Question

Would an educational tool for healthcare professionals be able to close the current information (knowledge) gap regarding the health effects of teen vaping, modifying their current approach and practice guidelines and evoking such conversations with them?

Objectives

The quality improvement project objectives were as follows:

1. Create a training resource for healthcare professionals at Nicklaus Children's Hospital's Adolescent Medicine Office by March 2023 using internet resources such as UP TO DATE and MEDLINE recommendations to inform them about the effects of teen vaping usage.
2. Use Survey Monkey to conduct an online survey with 10 questions to assess the experience and familiarity of such providers with current practices and guidelines addressing the health risks of vaping, particularly in this population.
3. Use Survey Monkey to develop personalized interactive pre- and posttests that can be emailed directly to the healthcare professionals taking part in the quality improvement project to gauge the providers' knowledge and awareness on the health danger of vaping.
4. Deliver a PowerPoint training module electronically, together with culturally relevant educational interventions specifically geared at adolescents, for all the clinicians at Nicklaus Children's Hospital's Adolescent Medicine Office.

5. Educate at least 90% of the health care providers at Nicklaus Children's Hospital's Adolescent Medicine Office by implementing a recurrent educational session in the office about the health effects of vaping in adolescents every quarter, including the rotating residents and fellows.
6. Add to the current intake forms the specific question “Have you ever, or do you currently vape?” for patients 12 years of age and older.

IV. Definition of Terms

Electronic Nicotine Delivery Systems (ENDS)

A term used to describe vapes, vaporizers, vape pens, hookah pens, electronic cigarettes (e-cigarettes or e-cigs), e-cigars, and e-pipes.

Vaping

Vaping is the act of inhaling and exhaling the aerosol, often referred to as vapor, which is produced by an e-cigarette or similar device. The term is used because e-cigarettes do not produce tobacco smoke, but rather an aerosol, often mistaken for water vapor, that consists of fine particles.

E-Cigarettes

E-cigarettes are the most common form of electronic nicotine delivery systems (ENDS).

EVALI

EVALI stands for E-cigarette or Vaping Associated Lung Injury. It is an inflammatory response in the lungs triggered by inhaled substances.

Knowledge Gap

Knowledge gap is information that needs to be filled by new research because one may know little or nothing.

V. Conceptual Underpinning and Theoretical Framework of the Project

In 1997, Kevin Dooley introduced the concept of a complex adaptive system (CAS), which he defined as a group of partially autonomous agents interacting in a way that is interdependent and produces system-wide patterns that then influence the behavior of the agents. At all scales, one can spot patterns in human systems that are the outcome of interactions between the system's agents (Ellis, 2011). Thought patterns are created by the interactions of thoughts, experiences, and perceptions.

People inside a group or firm act out their roles, relationships, and expectations to create innovative or competing patterns. History, traditions, and expectations all influence how people behave in groups and communities, affecting the common behaviors that make up the culture of that group (Starnes-Ott et al., 2020). Shared attitudes toward physical activity, healthy choices, and self-awareness affect the health trends in any given group or community.

VI. Methodology

Study Design

As soon as the class started in August 2022, communication regarding this quality improvement (QI) project initiative began. At this time, all prospective participants have been informed of the nature and goal of this quality improvement project in collaboration with the DNP mentor, Dr. Comkornruecha. Based on the already available research, it was explained to them how it might enhance clinical practice and comprehension and possibly assist the target population—adolescents—in obtaining additional information from a reputable and official source to assist them in making better decisions. No particulars have been discussed yet, but participants *(N* = 6-9) were fully informed of the DNP project implementation plan once it has been approved.

Through the use of a voiceover PowerPoint instructional module, this quality improvement project seeks to educate at least 90% of the medical staff at the Nicklaus Children's Hospital Adolescent Medicine clinic. A survey inquiring about their willingness to participate was administered to serve as their initial consent. Then a pretest, and posttest evaluation was performed to gauge their understanding of the subject and the reasons the subject is not brought up explicitly during each patient interaction. An identifying name or number was assigned to each participant so that personal or medical information is not readily accessible. No upcoming publications will contain their individual information.

After receiving clearance from the administrative team, the participants' contact information was obtained from the office manager and an introductory email was sent to confirm consent and willingness to participate. At this point, any concerns or questions the participating subjects may have been addressed. One expectation is to get all the direct patient care providers to actively participate in the project. In the office, there is one physician, one nurse practitioner, two fellows, two to four residents that rotate monthly, and two medical assistants. Participation is voluntary and data collected from the survey, pretest, and posttest remained confidential with the DNP student and the medical director, Dr. Comkornruecha. This QI project can be repeated quarterly for the new rotating residents that may join the office in the future.

Setting

The setting for this project is the Adolescent Medicine office at Nicklaus Children's Hospital. Dr. Metee Comkornruecha, a board-certified in pediatrics and adolescent medicine physician, serves as its medical director and is also the mentor for this DNP student. The age range of the patients at the practice is 12 to 21 years. The office offers high-quality medical care to people from all walks of life regardless of race, ethnicity, religion, sexual orientation, or

financial situation. Every patient is given treatment at Nicklaus Children Hospital with the goal of fostering respect, dignity, and integrity. By giving each child the finest care possible, their goal is to "inspire hope and promote lifelong health" (Nicklaus Children's Hospital, 2022). "CREATE a healthy future for every kid" is their mission statement. Nicklaus Children has expanded its services from the Florida Keys to Jupiter, with several facilities throughout the participating counties.

Dr. Comkornruecha is an engaged member of the community who devotes a lot of his extra time to matters related to implementation of programs related to teen contraception, substance addiction, and STD prevention. He has made several media appearances discussing these topics as well as other issues pertaining to adolescents.

Sample

The focus of this QI endeavor is directed to all care providers in the office. One physician, one advanced practice registered nurse, two fellows, two to four residents, and two medical assistants work in the adolescent medicine department. (N = 6-9)

Intervention

The intention of this QI project is to strengthen the provider's expertise and awareness regarding e-cigarettes so they can include it in their encounters and encourage an honest discussion with the patients. These teenagers will thus be more aware of the health dangers these devices present.

All participants received a Survey Monkey link to access the pretest online. Such an examination gauged their level of comfort and familiarity with the subject. Additionally, it aims to ascertain how they acquired their existing knowledge regarding this topic. Then, a link to a voiceover PowerPoint training presentation was made available, followed by a posttest that

determined how much of their knowledge gap has been filled by this intervention, how comfortable they are using the new information, and how likely they are to start using it on every encounter with the target population.

This teaching module was created using materials from the web resources analyzed for this project. The evaluations are designed to assess the providers' current knowledge, experience, and familiarity with this topic, as well as their willingness to incorporate it into their daily patient encounters whenever indicated. Utilizing this readily available and secure web tool called Survey Monkey, the pretest and posttest were generated, administered, and collected. They were accessible online, 24 hours a day, 7 days a week, for their allotted timeframe, about 4 weeks in total.

Instruments

The instruments that were used for this project include the following:

- A yes or no survey assessing their willingness to participate.
- A pretest/survey.
- A posttest/survey.
- A PowerPoint presentation.
- Participants' identification email.

Variables

The variables for this study include the following:

- Current practice regarding this issue.
- Current knowledge, comfort, and familiarity level.
- Sources of information currently used about this topic.
- Willingness to incorporate this project into daily practice.

Data Collection Procedure

First, an introductory email was sent to assess their willingness to participate instead of obtaining a written consent. Then, the pretest is given prior to the provision of the educational training. After reviewing the PowerPoint presentation, the posttest is administered. The results serve as an instrument to find out where participants obtained their information prior to this intervention, how familiar or comfortable they are regarding the subject, and how willing they are to incorporate this subject into their daily practice. The tests consisted of 10 questions, geared to evaluate these variables. These tests were expected to take between 5 to 10 minutes to complete and were available for 2 weeks at a time respectively. After the completion of the pretest and the allowed time had passed, the educational PP was sent. It was made available for a week, then the 10-question posttest followed. The pretest and posttest questions remained the same, and scoring ranged from 0 to 10 with each YES valued at 1 point and each NO valued at 0.

These tests were created and distributed using Survey Monkey, and they were only available to the providers who volunteered and agreed to participate in this DNP quality improvement project. The pretest and post-test were available and accessible 24 hours a day. The PowerPoint presentation was accessible via email. At the end of the 4 weeks, the results were computed and recorded.

This DNP student maintained continuous communication with all participants via email or in person during office immersion hours throughout the implementation phase. Survey Monkey is the main software that was used to create and distribute the testing surveys; a password-protected feature was included to ensure the safety and confidentiality of the data. This DNP student monitored the progress of all the participants as needed, including their acceptance to participate in the QI project, the date and time the participants completed the

required tasks, and any other activities. Communication via other available software such as Zoom were also offered in case any clarifications are needed. Taking care of any necessary information on the implementation process, as well as responding to any queries or worries the participants may have.

Data Management and Analysis

The responses were kept protected and confidential, except from the principal investigator who is also the author of this quality improvement project. Data from Survey Monkey was kept private and only accessible with a username and password known by this author and possibly by the project mentor after he has completed his assessment. Information that may help identify the participants was not included in the results. The participants were assigned a name or number as an identifier instead. Data pertaining to the research study were kept private and secure, and only the author and the mentor were able to access them, except if an authorized party might need access to inspect the collected data.

All data were stored in the software used as the participants completed their required tasks (survey, pretest, and posttest). Then, such data was transferred to an Excel document to generate reports and analyze the results to present them.

As mentioned before, during the various stages of the QI project, this DNP student's contact information was provided to all participants. This DNP student could be reached any time a concern or question emerged or be contacted in person during immersion hours. For issues that emerge during the use of Survey Monkey while completing the required tasks, the software offers a customer support page with quick answers to common issues or a telephone number to contact for technical support.

Protection of Human Subjects

Regarding the protection of human subjects, it is unlikely that this quality improvement project contained any hazards that could have a detrimental effect on the participant's psychological, physical, social, or economic well-being. Also, there was very little chance of a confidentiality violation or legal risk within the nature of the project. The knowledge obtained from it and the potential to influence patients' decisions regarding their health risk-taking behavior were the main advantages of taking part in this quality improvement effort. Furthermore, it allowed participants to obtain accurate information from dependable sources that could facilitate an honest dialogue about this significant issue with their patients. Additionally, it familiarized healthcare professionals with this relatively new subject and equipped them with stronger responses for any questions patients may have.

It was important to make clear that subjects have the choice to withdraw from this study without any repercussions. This QI study was entirely voluntary; thus, its participants were free to leave at any time while it was being carried out. The contact information for this author and Florida International University's IRB was distributed to all healthcare practitioners taking part in the quality improvement effort in case any questions or issues should arise.

VII. Results

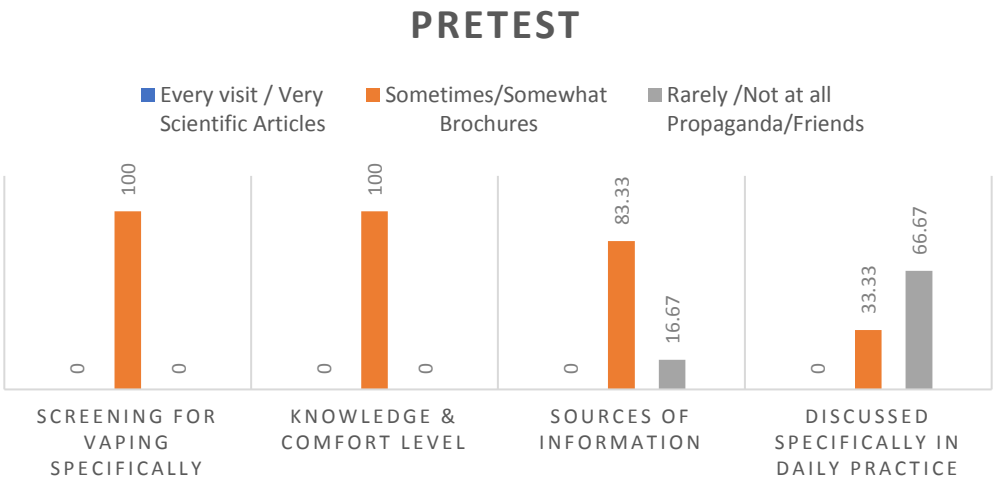


Figure 1. Pretest

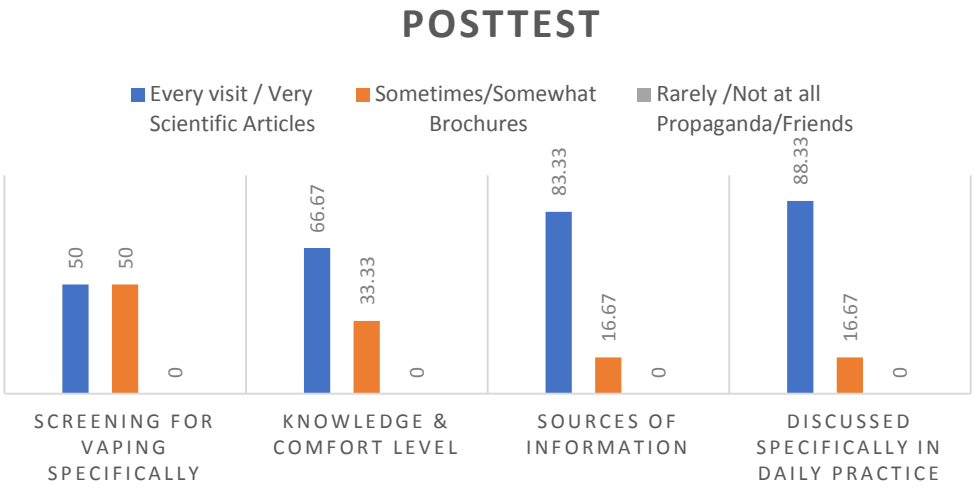


Figure 2. Post-test

The figures above depict the results compiled through the intervention phase of the project. When comparing the results of the posttest with those of the pretest, more awareness and disposition of the providers regarding the four variables measured was observed in all categories. This comparison translates into a better perception and understanding of the need to offer more information to young people regarding the dangers of smoking electronic cigarettes. The increase

in observations with respect to the initial situation denotes a positive effect of this strategy of training providers.

Individually, the variables associated with the sources of information and specific discussion in daily practices revealed an increase of 83.33% in the most favorable category. It allowed the investigators to think that the quality of the information to be shared on the subject matter could improve with a more widespread use of reliable scientific sources. Finally, it should be noted that because of the training work carried out between both tests, absolutely all respondents understood that the subject is important enough to address it at least sometimes in their daily contacts with the patients. The rarely option registered 0% in the four variables measured in the posttest.

Statistical Treatment of the Survey

As part of the research methodology, and regardless of the visible results in the posttest, with the evident improvement in the perception of the problem by the participants, the data was subjected to statistical tests that would evaluate the statistical significance of the measured results.

Sample Preparation

For the conditioning of the samples, an element of hierarchization of the observations was used with the objective of allowing the subsequent statistical evaluation of the results.

Table 1

Data Sample Conditioned To Be Statistically Evaluated

Temporary Option	Relevance Value
Rarely	0
Sometimes	0.5

Every visit	1

Table 2 shows the observations registered in the survey once each one has been multiplied by its respective hierarchical value (relevance value). The statistical description of the samples is as follows, four variables with three possible responses, times 6 participants for a total data of 24. Therefore, the pretest and post-test are computed as follows.

Table 2

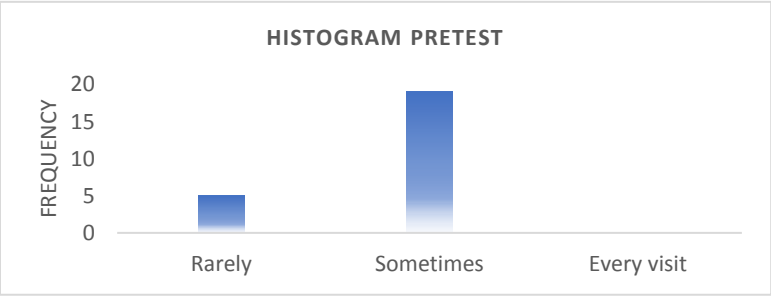
Preparation of Observations Recorded in the Survey

Pretest	**Post test**
0	0.5
0	0.5
0	0.5
0	0.5
0	0.5
0.5	0.5
0.5	0.5
0.5	1
0.5	1
0.5	1
0.5	1
0.5	1
0.5	1
0.5	1

0.5	1
0.5	1
0.5	1
0.5	1
0.5	1
0.5	1
0.5	1
0.5	1
0.5	1
0.5	1

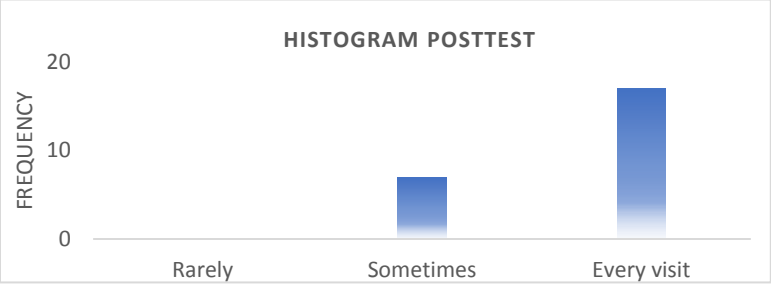
Pre-test

Event	Frequency
Rarely	5
Sometimes	19
Every visit	0



Post-test

Event	Frequency
Rarely	0
Sometimes	7
Every visit	17



For a small sample size (n < 30), as is the current case, it is considered appropriate to apply the Central Limit Theorem (Kwak & Kim, 2017) to the analysis. According to this theorem, a valid assumption could be that the data is not normally distributed; however, this must be verified first. Based on that assumption, it was necessary to run a non-parametric test for the comparison of both samples (LaMorte, 2016). For these cases, there are several statistical tests that could be applied according to the characteristics of small samples to determine the one that best fits the current study. The following 3 elements were tested:

Normality: Is the data approximately normally distributed? To evaluate the “normality” of the samples, a Shapiro-Wilk test was used (Choueiry, 2022).Independence: Are the observations independent? As the study case refers to a pretest and a posttest observation, the samples are considered paired. This characteristic rules out statistical tests used for independent samples like the Mann-Whitney test (LaMorte, 2016).3. Homogeneity of variance: Is the variance of the

pretest scores approximately equal to the variance of the posttest scores? To prove this, a Fisher test was used (Bind & Rubin, 2020).

Normality test

Shapiro-Wilk test

Shapiro-Wilk test		
	Pretest	Post test
P-Value	0.0001	0.0001
Alpha	0.05	0.05
Evaluation	P-value<alpha	P-value<alpha
Conclusion	Non normal	Non normal

As neither of the samples show a normal distribution, the t-Student test could not be applied to the current survey.

Homogeneity of variance: Fisher Test.

By using the Fisher's test, it is established that there is homogeneity in the variances of both samples.

Fisher test	
F (Observed value)	0.80
F (Critical value)	2.31
p-value	0.59
alpha	0.05

Evaluation	p-value > alfa
Conclusion	Ratio between Variance 1 and Variance 2 is 1

There is homogeneity of the variances.

Therefore, considering that the samples have the following characteristics:

1. n<30

2. non-parametric distribution. Neither the pretest sample nor the posttest sample are normally distributed.

3. Paired samples. Survey based on time, from a pre-test situation to a post-test situation.

4. Homogenized variance

The Wilcoxon test is considered as the most suitable test to evaluate two related samples (LaMorte, 2017).

Hypothesis:

H0: The distribution of the two samples is the same.

Ha: The distributions of the two samples are different.

Wilcoxon Test	
N+	0
Expected value	11
Variance (N+)	5.500
P-Value	<0.0001
alpha	0.05
Evaluation	P-value < alpha

Conclusion	Both distributions are significantly different, Ho is discarded, and Ha is accepted

The *p*-value of 0.001 was less than the commonly used alpha level of 0.05, thus the null hypothesis (H0) can be rejected. The mean difference between the pretest and posttest scores was zero. Therefore, according to this result, which validated the previous analysis, the conclusion was that the intervention had a significant effect on the participants' scores. This translates to a significant effect in how the participants understand and perceive the vaping issue among adolescents and how willing they are to change their daily practice habits to screen for vaping. It also meant that they would discuss the matter with their patients more often to better inform them and influence their future decisions regarding this issue, which is the overall goal of this project.

VIII. Discussion

Limitations

The validity and generalizability of the project outcomes were compromised by the sample size ($n = 6$). With such a small sample size, no control group, and no capacity to attribute causation, this retrospective analysis cannot establish causality. Only medical professionals working in the hospital's adolescent medicine department were included in the sample. It was possible that the duration of the educational training module and the time allotted for the surveys' pre- and post-testing also played a role. The small size may also reflect the providers' interest in

the topic given the little time available for open conversations and their already limited consulting time.

Another contributing factor might be the fact that the clinic has only one attending physician, two fellows, and two Advanced Practice Registered Nurses (APRNs). They compel the long-term provider's roster. There were a couple of residents that rotate monthly. Therefore, the sample pool was quite small. The goal of the intervention was to lay the groundwork for healthcare professionals to highlight the health risks that teen vaping poses. The topic of quitting smoking in general was covered. The point of this QI project was to encourage prevention among this population by focusing on vaping-specific issues at every opportunity. This author hoped that by educating these patients on the health risks associated with this practice, they will be better prepared to choose not to use ENDS devices when given the option. The intention was to dispel the widespread perception among teenagers that vaping is harmless.

IX. Implications for Advanced Practice Nursing Discussion

The main advantage of this Quality Improvement Project was to reach out to the adolescent population that is being affected by this new form of addiction, especially since most of them do not recognize the health risks of vaping. Most teenagers that vape do not understand that it is a form of smoking. Therefore, they would answer NO when asked if they smoke, but many of those would answer YES is asked, specifically, "do you vape?" By implementing this primary prevention initiative, the providers at the chosen organization would have the chance to enhance their capacity to accurately and comfortably identify patients at risk for using ENDS and address it during their routine smoking screening, just the wording needs to be changed. By learning more about this subject, such providers may get useful knowledge that would give them the tools needed to establish an interesting conversation with today's teenagers. This researcher

sought to improve caregivers' knowledge, attitude, behavior, familiarity, and desire to incorporate this topic specifically into their daily encounter routines through a comprehensive educational module.

It is well recognized that giving providers the tools they need increases their propensity to accept new procedures. To reach more of them, though, further preparation and time are needed. A patient's experience and outcomes in this primary setting may be enhanced with the continued implementation of this quality improvement project if more physicians were to adopt the proposed intervention.

It is understood that timing restraints are a significant challenge. According to Rogers' diffusion of innovation theory, persistence and patience are essential when trying to persuade a group of people to accept new products, concepts, and behaviors. Complete adoption needs time to be deemed a realistic prospect. At first, only minor adjustments should be anticipated, but this DNP student hopes this quality improvement project will become one of many minor initiatives that would help this notion be widely implemented and adopted.

Replicating similar initiatives is necessary to support their validity, generalizability, and dependability. More education is essential for the results of this quality improvement project to spread and explore the knowledge and desire of more care professionals to use it as one of their prevention and teaching interventions. Investigators should continue to concentrate on accurately identifying the providers' attitudes, assumptions, and obstacles because doing so may help explain why they are reluctant to alter their existing practice.

X. Conclusion

Although evidence on safety and efficacy of ENDS is emerging, care providers should be honest with their clients, making clear that the long-term safety is not yet established. They

should instead say that what is known is that they appear to be a lower risk alternative to cigarettes, yet still hazardous for one's health. The research shows a need for increased training and assistance for providers regarding ENDS use, which would enable them to better advise their clients on making evidence-based decisions.

There is ample evidence that e-cigarettes can lead the way to the initiation of traditional cigarettes; therefore, the potential for them to renormalize smoking and serve as a gateway for youth smoking cannot be discounted. Although e-cigarettes contain fewer chemicals than traditional cigarettes, it is important to note that the chemical concentrations in the lungs are unknown, and inhaled toxins are a genuine and legitimate issue. Preoperative screening methods for e-cigarette or vaping use, particularly among the young population, lack clear recommendations and should be implemented. Propylene oxide, which is listed by the International Agency for Research on Cancer as a class 2B carcinogen, can be produced by the thermal breakdown of propylene glycol when the e-liquid is heated (Pound & Coyle, 2022). Although it has been shown that ENDS increase the number of years of life gained through their influence on smoking cessation, they also disproportionately increase the number of years of life lost due to increased youth-related smoking initiation. The concern that longitudinal studies lack sufficient data to assess the significant health repercussions of their use is accentuated by the fact that they are still relatively new.

Doctors frequently receive more information on e-cigarettes from patients, the media, and marketing than from scientific sources like evidence-based guidelines. More research and guidelines are needed to address the effectiveness and safety of using e-cigarettes and to give uniform data. Due to the exponential growth in e-cigarette awareness and use paired with the strong marketing by tobacco companies, doctors are talking to their smoker patients more and

more about using e-cigarettes, but they lack the training and scientific data to support their claims. Teenagers specifically are exposed to these devices by peers, friends, or families. They too are made aware of e-cigarettes through marketing and promotion on signs, billboards, television, print, radio, at retail points of sale, on all social media platforms, and online posts. The purpose of this author's project was to inform users, especially teens and public policymakers, about the short- and long-term hazards of vaping, and to give important background information on the cardiopulmonary effects of e-cigarette use (vaping) in adolescents, and to influence future research approaches and practice guidelines.

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XII. Appendices

Appendix A: IRB Approval Letter

FIU | Research & Economic Development

FLORIDA INTERNATIONAL UNIVERSITY

MEMORANDUM

To: Dr. Eric Fenkl

CC: Lizzie Diaz

From: Carrie Bassols, BA, IRB Coordinator

Date: February 20, 2023

Proposal Title: "Improving Informed Decision Making to Reduce the Health Risks of Vaping Among Adolescents"

The Florida International University Office of Research Integrity has reviewed your research study for the use of human subjects and deemed it Exempt via the **Exempt Review** process.

IRB Protocol Exemption #: IRB-23-0052 **IRB Exemption Date:** 02/20/23
TOPAZ Reference #: 112640

As a requirement of IRB Exemption you are required to:

1) Submit an IRB Exempt Amendment Form for all proposed additions or changes in the procedures involving human subjects. All additions and changes must be reviewed and approved prior to implementation.
2) Promptly submit an IRB Exempt Event Report Form for every serious or unusual or unanticipated adverse event, problems with the rights or welfare of the human subjects, and/or deviations from the approved protocol.
1) Submit an IRB Exempt Project Completion Report Form when the study is finished or discontinued.

Special Conditions: N/A

For further information, you may visit the IRB website at http://research.fiu.edu/irb.

Appendix B: Letter of Support

EMAILS Received from Nicklaus Children Hospital

October 28th, 2022
Hello,
I am pleased to announce that Lizzie Diaz has been processed & approved in our system for an NCHS number (See below).
Diaz Lizzie 55919
FIU should let you know but I believe you can schedule your time with Dr. Comkornruecha directly. I am copying Elena Ortega to this email to confirm.
We are looking forward to having Lizzie as part of our Nursing Rotation Program.
Kind Regards,

Maria Salomon
Student.Prgm/Internship Specialist
Learning and Development Services
E: Maria.Salomon@nicklaushealth.org
www.NicklausHealth.org

October 28th, 2022
Good morning,
Lizzie, you can schedule your time with Dr. C. and start your hours.
Have a good day.

Elena Ortega, MSN, APRN, CCRN-K
Lead Clinical Development Specialist
Learning & Development Services
T: 786-624-3549
M: 305-281-6578
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Appendix C: Recruitment Letter

RECRUITEMENT LETTER

Recruitment Email for addressing current knowledge gaps among providers regarding the dangers pertaining to e-cigarette usage. Improving informed decision making to reduce the health risks of vaping usage among adolescents: A quality improvement project.

Dear Participants,

My name is Lizzie A Diaz, and I am a student from the Graduate Nursing Department at Florida International University. I would like to invite you to participate in a quality improvement project I am using for my doctoral thesis. The goal of this project is to address current knowledge gaps among providers regarding the dangers pertaining to e-cigarette usage, especially among adolescents. It strives to broaden the provider's expertise to initiate a more specific conversation with their patients. Hoping to assist teenagers in becoming more informed from a recognized and reliable source so they can make better informed decisions about this subject.

You are eligible to take part in this project because you are a care provider at Nicklaus Children's Hospital Adolescent Medicine office. I am contacting you with the permission of your Office Manager and Administrative Team at such a location. If you decide to participate in this project, you will complete a questionnaire, which is expected to take no more than 5 minutes. Then you will be asked to review a short educational module (PowerPoint or Pamphlet). After its completion, you will be asked to complete the post-test questionnaire, which consists of 10 questions and is expected to take approximately 5 minutes. *No compensation will be provided.*

Remember, this is completely voluntary. You can choose to be in the study or not. If you'd like to participate, please reply to this email stating your willingness to participate, which will serve as your consent. If you have any questions about the study, please email or contact me at ldiaz020@fiu.edu or (305)951-3954.

Thank you very much.

Sincerely,

Lizzie A. Diaz, APRN, FNP-BC

Appendix D: Table of Evidence

Author/ Date	Theoretical/ Conceptual Framework	Research Purpose / Objective / Question(s)	Methodology	Analysis & Results	Conclusions
Choudhary et al., 2022	Not specified	The primary objective of the study was to review vaping-associated PFT changes in the adolescent population	This is a retrospective descriptive study of patients seen in the pulmonary clinic or hospital with a history of vaping product use. Patients aged 12 years to 23 years, with a history of vaping and with at least one pulmonary symptom who were evaluated at the NYU Langone Hospital-Long Island Pediatric Pulmonary Clinic or NYU Langone Hospital-Long Island from June 2019 through February 2021 were enrolled retrospectively. Descriptive statistics (mean ± standard deviation for continuous variables; frequencies and percentages for categorical variables) were calculated for the overall sample using SAS version 9.4 (SAS Institute Inc., Cary, NC).	A total of 37 patients were included in our case series. Of these, 23/37 (62%) were male, and 14/37 (37.8%) were female. The most common presenting symptoms were respiratory symptoms (cough, chest tightness/pain, dyspnea) 35/37 (94.59%), constitutional symptoms 11/37 (29.73%), and GI symptoms 9/37 (24.32%). A total of 25/37 (67.5%) reported vaping THC (5 reported using only THC-containing products and 20 reported using both THC and nicotine-containing products), and 9/37 (24.3%) reported using only nicotine vapes.	Chronic use of e-cigarettes and the vaping product was associated with heterozygous abnormal PFT patterns in symptomatic patients seen in an outpatient setting. PFT may be used as a screening tool for identifying and monitoring the long-term pulmonary sequelae secondary to E-cigarette and vaping product use.

Do et al., 2020	Not specified	The purpose of this study was to evaluate vaping information reported to the program. Specifically, the objectives of this study were to describe the epidemiology (person, time, and exposure) of vaping-related reports and to examine temporal trends and compare reports related to vaping products to those of all other products. This study characterized and quantified trends associated with vaping reports received by the program over the past 5 years.	Data collated by the program were extracted for the period from 1 January, 2015 to 30 September, 2019. The data were summarized using descriptive statistics and trends were quantified for annual percent change. In order to compare characteristics of vaping reports, the proportionate injury ratios (PIRs) and corresponding 95% CIs were used to compare vaping-related injuries to all other reports received by the program.	A total of 71 vaping-related reports were received between 1 January, 2015 and 30 September, 2019. During this period, the annual percent change increase in the number of reports received was approximately 73% annually ($p < .05$). Among the reported injuries, 41% were burn injuries. Proportionally, there were more vaping reports involving males (PIR = 1.89; 95% CI: 1.51–2.36) and individuals between the ages of 15 and 19 years (PIR = 11.53; 95 % CI: 4.95–26.8) as compared to all other reports submitted to the program.	While the number of reports relating to vaping products is small, the results of this analysis suggest that certain groups, including males and youth, are more likely to be the subject of a vaping-related incident.
Garcia-Arcos et al., 2016	Not specified	Clinical study investigating the effects of exposure to aerosolized nicotine-free and nicotine-containing e-cigarette fluid on mouse lungs and normal human airway epithelial cells.	Mice were exposed to aerosolized phosphate-buffered saline, nicotine-free or nicotine-containing e-cigarette solution, 1-hour daily for 4 months. Normal human bronchial epithelial (NHBE) cells cultured at an air-liquid interface were exposed to e-cigarette	Inhalation of nicotine-containing e-cigarettes increased airway hyper-reactivity, distal airspace enlargement, mucin production, cytokine and protease expression. Exposure to nicotine-free e-cigarettes did not affect these lung parameters. NHBE cells	Exposure to inhaled nicotine-containing e-cigarette fluids triggered effects normally associated with the development of COPD including cytokine expression, airway hyper-reactivity and lung tissue destruction. These

			vapors or nicotine solutions using a Vitrocell smoke exposure robot.	exposed to nicotine-containing e-cigarette vapor showed impaired ciliary beat frequency, airway surface liquid volume, cystic fibrosis transmembrane regulator and ATP-stimulated K+ ion conductance and decreased expression of FOXJ1 and KCNMA1. Exposure of NHBE cells to nicotine for 5 days increased interleukin (IL)-6 and IL-8 secretion.	effects were nicotine-dependent both in the mouse lung and in human airway cells, suggesting that inhaled nicotine contributes to airway and lung disease in addition to its addictive properties. Thus, these findings highlight the potential dangers of nicotine inhalation during e-cigarette use.
Gentry et al., 2018	Not specified	To study smoking prevalence remains in some vulnerable groups, including those who misuse substances, have a mental illness, are homeless, or are involved with the criminal justice system. E-cigarette use is increasing and may support smoking cessation/reduction.	Systematic review of quantitative and qualitative data on the effectiveness of e-cigarettes for smoking cessation/reduction among vulnerable groups. Databases searched were MEDLINE, EMBASE, PsychINFO, CINAHL, ASSIA, ProQuest Dissertations and Theses, and Open Grey. Narrative synthesis of quantitative data and thematic synthesis of qualitative data.	2628 records and 46 full texts were screened; nine studies were identified for inclusion. Due to low quality of evidence, it is uncertain whether e-cigarettes are effective for smoking cessation in vulnerable populations. A moderate quality study suggested that e-cigarettes were as effective as nicotine replacement therapy. Four studies suggested significant smoking reduction; however, three were uncontrolled and had sample sizes below 30. A prospective cohort study found no differences between e-cigarette users and nonusers.	Further research is needed to identify the most appropriate device types for practicality and safety, level of support required in e-cigarette interventions, and to compare e-cigarettes with current best practice smoking cessation support among vulnerable groups. Qualitative thematic synthesis revealed barriers and facilitators mapping to each component of the COM-B (capability, opportunity, motivation, and behavior) model. Further research should consider appropriate devices for practicality and safety, concurrent support, and comparison with best practice

					smoking cessation support.
Graham et al., 2022	Not specified	To examine patterns of abstinence from e-cigarettes, combusted tobacco products (CTPs), both, or neither among young adults enrolled in a U.S.-based randomized trial of a text message vaping cessation intervention.	At baseline, 1829 young adult e-cigarette users were categorized as Exclusive E-cigarette Users (no past 30-day CTP use; n = 1036, 56.6%) or Dual Users (past 30-day CTP use; n = 793, 43.4%). Four groups were defined at 7-months: 1) Dual Abstinent, 2) Exclusive Vaping, 3) Exclusive CTP Use, and 4) Dual Users. The proportion of participants who were Dual Abstinent was the outcome of interest.	At follow-up, 22.1% (95% CI: 20.3, 24.1) of participants were Dual Abstinent, 44.8% (95% CI: 42.5, 47.1) reported Exclusive Vaping, 6.3% (95% CI: 5.2, 7.5) reported Exclusive CTP Use, and 26.8% (95% CI: 24.8, 28.9) were Dual Users. A higher proportion of participants randomized to Intervention were Dual Abstinent (25.9%, 95% CI 23.1, 28.9) compared to Control (18.5%, 95% CI 16.0, 21.1; p = .0002). Analyses of treatment effects on dual abstinence by baseline tobacco product use favored Intervention over Control among both Exclusive E-cigarette Users (p = .019) and Dual Users (p = .0014).	A text message vaping cessation intervention was effective in promoting dual abstinence from e-cigarettes and CTPs among young adults. The advantage of treatment over control was equivalent for Exclusive E-cigarette Users and Dual Users. Rates of dual abstinence were higher among exclusive vapers than dual users, signaling the need for more research to optimize cessation programs for poly-tobacco users.
Margham et al., 2016	Not specified	Analysis of Emissions from the E-Cigarette Aerosol and Cigarette Smoke Contribution and Significance of Air/Method Blank Contaminants to E-Cigarette Emissions	In total, 27 different analytical methods were used to quantify the emissions of 150 measurands, including 142 analytes and eight collated values, in the mainstream emissions from the e-cigarette, Ky3R4F, and air/method blanks. The methods used were largely based on Health Canada methods for cigarette smoke analysis, with additional methods developed by Labstat for the other HPHCs and e-cigarette compounds	One-hundred four chemical measurands were not detected in ePen emissions, and 21 were present due to laboratory background. Among the remaining 25 compounds, 9 were present at levels too low to be quantified and therefore 16 compounds were generated by the e-cigarette at quantifiable levels. Eight of these compounds are carbonyls or alcohols that have been linked to thermal decomposition of the aerosol carrier, three are major e-liquid ingredients, and three are	The study has demonstrated the relative chemical simplicity of the e-cigarette aerosol in comparison to that from a tobacco cigarette and also shown how levels of cigarette smoke HPHCs are, on average, between 82 and >99% lower per-puff from an e-cigarette than from tobacco cigarette smoke. These findings are an example of what can be achieved in the design of an e-cigarette product if

			of interest. The methods were adapted for use with e-cigarettes where necessary.	impurities present in pharmaceutical-grade nicotine.	extensive duty-of-care work is conducted to identify and use device parameters and ingredients that offer as little potential for toxicant generation as is possible. On a wider level, these measurements provide additional support to views that e-cigarettes may represent a less harmful alternative to tobacco cigarette smoking, although the presence of toxicants in e-cigarette aerosols means that their use is unlikely to be risk-free.
McClelland et al., 2020	Not specified.	This study used a mixed methods approach to (a) understand the short-term physiological implications of vape use compared with people who do not vape and (b) investigate the reasons people choose to vape compared with those who choose not to vape.	Twenty-four people participated in the study: 12 self-identified as nonvapers, and 12 self-identified as people who vape. All participants were between 18 and 24 years old.	Qualitative analysis suggested people vape because they think it is cool, think it is less risky than smoking, and enjoy the social aspects of vaping. People who choose not to vape are concerned about the unknown health implications, think it is a waste of resources, and are apathetic toward it. Quantitative results revealed statistically significant increases in heart rate and decreases in the percentage of blood oxygenation after 20 minutes of vape use. Blood pressure, respiratory rate, and blood sugar scores did not significantly change after 20 minutes of vape use.	Significant differences found for systolic blood pressure, respiratory rate, and pulmonary function test became nonsignificant after controlling for gender. Both long- and short-term effects of vaping need to be further evaluated. The psychosocial reasons why certain people vape whereas others in the same peer group do not also need to be better understood.

				Differences in the frequencies of men and women across the two groups were found.	
Novelli et al., 2022	Not specified	The purpose of this systematic review is to identify how EVDS use affects the pulmonary system in order to support future anesthetic guidelines for patients who vape.	Systematic Review. An electronic search of databases CINAHL and PubMed was performed in October 2020.	This review identified six EVDS-induced pulmonary implications warranting anesthetic consideration: alterations in pulmonary function tests, disrupted ventilation, impaired mucociliary clearance, tissue destruction, a disrupted immune response, and oxidative stress with DNA fragmentation.	A total of 38 studies described the effects of EVDS on pulmonary function, airway epithelial tissue, and inflammatory mechanisms that may lead to chronic pulmonary disease. Anesthesia providers are encouraged to assess patients for EVDS use during the preoperative period and use the information generated by this systematic review to drive subsequent care.
Pound and Coyle (2022	Not specified.	To determine the impact of electronic nicotine delivery systems (ENDS) on health outcomes and costs in Canada, based on their effect on smoking cessation and smoking initiation rates.	They used gender-specific Markov models to estimate lifetime discounted life years, quality-adjusted life years (QALYs) and smoking-related health care costs for cohorts of males and females aged 15 to 19 years, in scenarios in which (1) ENDS are available (status quo); (2) ENDS are completely unavailable; and (3) ENDS are available for smoking cessation through health care provider prescription, in addition to currently recognized smoking cessation tools.	Analysis was from the perspective of a publicly funded health care system. The results of this study show that, under our study assumptions, restricting access to vaping is likely to result in increased population health and reduced health care costs. Policy changes restricting access to vaping need to be examined with caution to avoid unintended consequences such as negative health impacts for current and former smokers who rely on vaping as a harm reduction strategy. Thus, situations in which ENDS are unavailable or available	These results showed that a policy change whereby ENDS were unavailable to the Canadian population or available through prescription only would likely increase population health and reduce health care costs.

				through prescription only are dominant over the status quo.	
Rogers et al., 2021	Not specified	To assess the quality of evidence on the effectiveness of local U.S. laws restricting the sale of flavored tobacco products.	We conducted a systematic search and qualitative scoping review of English-language papers published through May 2020 that evaluated flavored tobacco sales policies implemented by US jurisdictions during 2010–2019. We constructed a conceptual model for flavored and menthol tobacco sales restriction outcomes, assigned GRADE quality of evidence ratings to policy outcomes evaluated through the included studies, and summarized factors that might explain weak or inconsistent findings.	We found moderate to high quality of evidence associating policy implementation with reduced availability, marketing, and sales of policy-restricted products, and decreased youth and adult tobacco use of these products; however, policy exclusions and exemptions, implementation challenges, tobacco industry actions (e.g., marketing of concept-named flavored products; exploiting policy exemptions for certain store types), and consumer responses (e.g., cross-border or illicit purchasing) might undermine or mitigate intended policy effects.	Flavored and menthol tobacco product sales restrictions implemented and evaluated in US jurisdictions appear to have achieved some of their intended outcomes; however, deficiencies in study designs, methods, and metrics could contribute to equivocal findings on quality of evidence associating policy implementation and outcomes. Gaps in the evidence are beginning to be filled with research using more rigorous study designs, improved measurement and analytic methods, and longer-term follow-up.
Sharma et al., 2021	Not specified	A total of four main themes emerged from the study findings: (a) perceived relative harm of E-cigarettes versus that of cigarettes, (b) perceived health effects of e-cigarettes, (c) perceived benefits and safety of E-cigarettes, and (d)	A total of 27 articles were subjected to quality appraisal using the Joanna Briggs Institute's critical appraisal checklists. A total of seven qualitative and 18 quantitative studies were included in the review, and the study characteristics, results, and limitations were extracted.	Most adolescents perceived e-cigarettes to be less harmful than cigarettes; however, often, their health perceptions of e-cigarettes were conflicting. Sources of exposure to e-cigarette information included friends, family, retail point of sale, TV and online advertising, national agencies, healthcare providers, and from direct experience.	Findings indicate that adolescents have more favorable perceptions of e-cigarettes than of cigarettes; however, these perceptions are conflicting. Advertising, marketing, and peer and family networks appear to influence adolescents' perceptions. More research is required to better understand

		sources of e-cigarette information and exposure.			adolescents' health perceptions of e-cigarettes and where they source information from.
Tsai et al., 2020	Not specified	E-cigarette aerosols are exceedingly different from conventional tobacco smoke, containing dozens of chemicals not found in cigarette smoke.	Peer reviewed human and animal studies published to date and summarize the cardiopulmonary physiological changes caused by vaping. In terms of cardiac physiology, acute exposure to e-cigarette aerosols in human subjects led to increased blood pressure and heart rate, similar to traditional cigarettes.	Chronic exposure to e-cigarette aerosols using animal models caused increased arterial stiffness, vascular endothelial changes, increased angiogenesis, cardiorenal fibrosis and increased atherosclerotic plaque formation. Pulmonary physiology is also affected by e-cigarette aerosol inhalation, with increased airway reactivity, airway obstruction, inflammation and emphysema. Further work is needed to define the long-term cardiopulmonary effects of e-cigarette use in humans.	It is highly likely that chronic use of e-cigarettes will induce pathological changes in both the heart and lungs. Data from both humans and animal models are consistent in demonstrating that vaping of e-cigarettes causes health effects both similar to and disparate from those of cigarette smoking.
Vardavas et al., 2012	Not specified	This study aimed to assess whether using an e-cigarette for 5 min has an impact on the pulmonary function tests and fraction of exhaled nitric oxide (Feno) of healthy adult smokers.	Thirty healthy smokers (aged 19-56 years, 14 men) participated in this laboratory-based experimental vs control group study. Ad lib use of an e-cigarette for 5 min with the cartridge included (experimental group, n = 30) or removed from the device (control group, n = 10) was assessed.	Using an e-cigarette for 5 min led to an immediate decrease in Feno within the experimental group by 2.14 ppb (p = .005) but not in the control group (p = .859). Total respiratory impedance at 5 Hz in the experimental group was found to also increase by 0.033 kPa/(L/s) (p < .001), and flow respiratory resistance at 5 Hz, 10 Hz, and 20 Hz also statistically increased. Regression analyses controlling for baseline measurements indicated a statistically significant decrease in Feno	E-cigarettes assessed in the context of this study were found to have immediate adverse physiologic effects after short-term use that are similar to some of the effects seen with tobacco smoking; however, the long-term health effects of e-cigarette use are unknown but potentially adverse and worthy of further investigation.

				and an increase in impedance by 0.04 kPa/(L/s) (p = .003), respiratory resistance at 5 Hz by 0.04 kPa/(L/s) (P = .003), at 10 Hz by 0.034 kPa/(L/s) (p = .008), at 20 Hz by 0.043 kPa/(L/s) (p = .007), and overall peripheral airway resistance (β, 0.042 kPa/[L/s]; p = .024), after using an e-cigarette.	
Wu et al., 2014	Not specified	Hypothesized that e-cigarettes have detrimental effects on human airway epithelial functions. X. The effects of e-liquid on the production of pro-inflammatory cytokine IL-6, HRV infection and the expression of host defense molecules (e.g., short palate, lung, and nasal epithelium clone 1, SPLUNC1) in primary human airway epithelial cells from young healthy non-smokers was examined.	To examine the effects of e-cigarette liquid (e-liquid) on pro-inflammatory cytokine (e.g., IL-6) production, HRV infection and host defense molecules (e.g., short palate, lung, and nasal epithelium clone 1, SPLUNC1) in primary human airway epithelial cells from young healthy non-smokers. Additionally, we examined the role of SPLUNC1 in lung defense against HRV infection using a SPLUNC1 knockout mouse model. We found that nicotine-free e-liquid promoted IL-6 production and HRV infection.	Data are presented as means ± SEM. One-way analysis of variance (ANOVA) was used for multiple comparisons, and a Tukey's post hoc test was applied where appropriate. Student's t test was used when only two groups were compared. A p value<0.05 was considered significant. Addition of nicotine into e-liquid further amplified the effects of nicotine-free e-liquid. Moreover, SPLUNC1 deficiency in mice significantly increased lung HRV loads. E-liquid inhibited SPLUNC1 expression in primary human airway epithelial cells. These findings strongly suggest the deleterious health effects of e-cigarettes in the airways of young people. we confirmed the beneficial role of SPLUNC1 in lung defense against HRV infection using a SPLUNC1 knockout mouse model.	This is the first study to demonstrate the adverse effects of e-cigarettes on primary airway epithelial functions from young people. The data suggests that even nicotine-free e-liquid promotes pro-inflammatory response and HRV infection. Moreover, both e-liquid without nicotine and with nicotine inhibits lung innate immunity (e.g., SPLUNC1) that is involved in lung defense against HRV infection. This data will guide future studies to evaluate the impact of e-cigarettes on lung health in human populations and help inform the public about potential health risks of e-cigarettes.

Appendix D: Pretest and Posttest

QI project PRETEST questionnaire

Question Title
1. How often do you discuss smoking and its health risks with your patients:

- Every visit
- Sometimes
- Rarely

Question Title
2. How often do you specifically ask patients if they vape?

- Every visit
- Sometimes
- Rarely

Question Title
3. How often do you include education regarding the risks pertaining to the use of electronic nicotine delivery systems (ENDS) in your patient encounters?

- Very visit
- Sometimes
- Rarely

Question Title
4. Where do you primarily get information about this topic?

- Media/Patients/Friends
- Promotional Brochures
- Scientific Articles
- Other (please specify)

Question Title
5. What does the term EVALI stand for?

- Electronic/Vaping Associated Lung Injury
- E-cigarette and Vapors Associated Lung Injury
- Evaluation of Vaping Accompanying Lung Insult

Question Title
6. What specific symptom differentiates EVALI from other lung-related injuries?

- Co-existence of respiratory distress symptoms

- Co-existence of gastrointestinal symptoms
- Co-existence of cardiovascular symptoms

Question Title

7. What has the Surgeon General declared regarding ENDS usage among adolescent

- It is a concern
- It is being addressed
- It is an epidemic

Question Title

8. How is ENDS marketed in the public eye?

- As a healthier way to use tobacco
- As an aid to quit smoking
- Both

Question Title

9. How fast do teenagers that use vapes get addicted to nicotine compared to the ones who use traditional cigarettes?

- Faster, because ENDS devices deliver higher concentration of nicotine
- Slower, because ENDS devices deliver lower concentration of nicotine
- Same rate, as both products provide equal amount of nicotine

Question Title

10. How familiar, confident, and knowledgeable are you about vaping's health-related risks?

- Very
- Somewhat
- Not at All

QI project POST-TEST questionnaire

Question Title

1. How familiar and confident do you feel now about discussing vaping-related health risks with your patients?

- Very
- Somewhat
- Not at all

Question Title

2. After completing this activity, how often will you specifically discuss vaping with your patients?

- Every visit

- Sometimes
- Rarely

Question Title

3. Following your review of the educational module, how important is it to discuss this topic with your patients to help them make better-informed decisions?

- Very
- Somewhat
- Not crucial

Question Title

4. Where will you primarily get information about this topic?

- Media/Patients/Friends
- Promotional Brochures
- Scientific Articles
- Other (please specify)

Question Title

5. What does the term EVALI stand for?

- Electronic/Vaping Associated Lung Injury
- E-cigarette and Vapors Associated Lung Injury
- Evaluation of Vaping Accompanying Lung Insult

Question Title

6. What specific symptom differentiates EVALI from other lung-related injuries?

- Co-existence of respiratory distress symptoms
- Co-existence of gastrointestinal symptoms
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Question Title

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- Faster, because ENDS devices deliver higher concentration of nicotine
- Slower, because ENDS devices deliver lower concentration of nicotine
- Same rate, as both products provide equal amount of nicotine

Question Title

10. How likely are you to include education about vaping's health-related risks with your patients now?

- Very
- Somewhat
- Not at All