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Abstract

Cigarette smoking is associated with many health risks and complications. Despite smokers' strong desire to quit, most battle with nicotine withdrawal and relapse. Because electronic cigarettes (e-cigarettes) do not contain tobacco, some believe them to be safer than traditional cigarettes and have used them as a replacement or adjunct nicotine source to prevent withdrawal symptoms. Electronic cigarettes are designed to mimic traditional cigarettes and expel a vapor composed of nicotine, water, glycerol, propylene glycol and other flavorings. Many e-cigarette companies use appealing platforms, which promise smoking cessation and harm reduction, to attract consumers; however, several studies have found e-cigarettes actually contain ingredients that are harmful to one's health. Studies have demonstrated that the use of e-cigarettes can be toxic to patients' health if patients do not research the products they intend to purchase. The flavoring of e-cigarettes may be a major contributor to e-cigarette cytotoxicity. If flavoring and other cytotoxic contents of e-cigarettes can be eliminated, e-cigarettes may be useful in smoking reduction and cessation. Many clinicians today support traditional forms of nicotine replacement therapy for smoking cessation rather than e-cigarettes. Due to the lack of regulation and studies by the U.S. Food and Drug Administration, e-cigarettes may not be as safe as users may perceive and should not be a preferred product for smoking cessation therapy until they are further studied and regulated.

Key Terms

Electronic Cigarettes; Nicotine; Pharmacies; Safety; Smoking Cessation

Introduction

Cigarette smoking is linked to multiple, serious health risks. Smoking impairs almost every organ in the body, causes several diseases, increases healthcare costs and negatively impacts the overall health of people who choose to use these products.[1] While only 18 percent of the U.S. population were smokers in 2012 compared to 42 percent in 1965, there are still about 42 million Americans who continue to smoke.[2] In 2012, about 21 percent of all American men and about 16 percent of all American women smoked. Furthermore, smoking is a problem among adolescents, and it is estimated that each day more than 3,200 teenagers smoke for the first time.[3] This results in nearly 14 percent of high school students and 4 percent of middle school students being considered as current cigarette smokers.

Smoking not only impacts a person's health but also affects the public environment.[4] Smoke contains carcinogens, toxic metals and poisonous gases that are harmful to not only the smoker but also to the people around the smoker. Additionally, second-hand smoke harms the atmosphere by degrading air quality and significantly contributes to littering, where cigarette butts are listed as the most littered item. It is also extremely costly to clean up littering related to smoking.[5] For example, in places like San Francisco, it costs up to $10.7 million to remove cigarette butts from public spaces each year. The production of cigarettes alone is also detrimental to the environment, as for every 300 cigarettes that are produced, one tree is consumed.[5,6] Improper discarding of cigarettes has been found to cause destructive wildfires which leads to damaged properties, vegetation, forestry, animal habitats and death.[6]

Smoking cessation can help decrease the risk of smoking-related diseases and add years to past-smokers' lives.[7] According to a survey by the Centers for Disease Control and Prevention (CDC) in 2010, almost 70 percent of adult smokers said they wanted to quit smoking completely. Smokers in the beginning stages of quitting often experience severe withdrawal symptoms due to nicotine addiction.[8] Nicotine, the primary psychoactive chemical in tobacco, is highly addictive, and smokers who quit often experience intense withdrawal symptoms including extreme nicotine cravings, depression, anxiety, difficulty sleeping, nightmares, headaches, increased appetite and weight gain.[9] Medications containing nicotine such as lozenges, gums and patches can help to decrease the withdrawal symptoms and cigarette cravings, when used correctly, and could potentially double a smoker's chances of quitting.[8] Some people have turned to e-cigarettes as a nicotine replacement or adjunct therapy option for smoking cessation.[10] Electronic cigarettes provide patients with the sensation of smoking; however, what most people do not know is that e-cigarettes have not been proven safe or effective in smoking cessation.

Hon Lik, a pharmacist and smoker in China, developed e-cigarettes in 2003 after his father died of lung cancer.[11] Electronic cigarettes were later introduced to the United States in late 2006 and early 2007. However, e-cigarettes did not become popular until 2013 when a number of large tobacco companies invested in their production.[12] As a two-packs-per-day smoker, Hon Lik developed e-cigarettes in hopes of producing a method that would help himself quit. In the past he had tried nicotine patches, but they failed to give him the "rush" associated with smoking cigarettes he enjoyed. Thus, e-cigarettes were designed to imitate "smoke without fire."[13]

Electronic cigarettes vaporize a mixture of liquid nicotine, water, glycerol, propylene glycol and other flavorings.[12] They consist of an atomizer, which heats the liquids into a vapor; a

cartridge, which holds the e-liquids; and a rechargeable battery, which powers the atomizer. Electronic cigarettes contain no tobacco, odor or smoke. Most are designed to be used and appear as a cigarette so that when a user draws on it, visible vapor is produced while a light-emitting diode (LED) portrays a real cigarette glow. Aside from the traditional tobacco and menthol flavors, more than 200 other flavors, such as bubblegum and cherry, exist. Before using an e-cigarette, the user must first attach the cartridge.[14] Most e-cigarettes are activated when a user inhales, causing the atomizer to heat the liquid and turn it into a vapor, while other e-cigarettes are activated with a switch. Inhalation of the vapor through the mouthpiece delivers nicotine to the user's lungs and, upon exhalation, gives an appearance similar to a cloud of smoke.

Emerging Trends

Electronic cigarette use has risen rapidly over the last few years. The number of adults in the United States who used an e-cigarette rose from 3.3 percent in 2010 to 8.5 percent in 2013, and the number of current cigarette smokers who have used e-cigarettes has risen from 9.8 percent to 36.5 percent.[15] From 2013 to 2014, the number of high school students who used an e-cigarette in the past month tripled to 13.4 percent, and the number of high school students that have never used cigarettes, but have used e-cigarettes, increased to an estimated 250,000.[16] Marketing of e-cigarettes by tobacco companies is extensively aimed at youth under the age of 21 years, specifically high school students, where companies invest in advertising their products through magazines, movies, sponsorship of concerts and auto races, and celebrity endorsements and researching youth behaviors to generate attracting themes.[16-18]

Currently, only e-cigarettes marketed for therapeutic purposes are regulated by the U.S. Food and Drug Administration (FDA) Center for Drug Evaluation and Research (CDER).[19] Other tobacco products, such as cigarettes, smokeless tobacco and roll-your-own tobacco are currently regulated by the FDA Center of Tobacco Products (CTP). However, to address the public issue of unhealthy tobacco use, a rule named "Tobacco Products Deemed To Be Subject to the Food, Drug & Cosmetic Act" has been proposed by the FDA to expand its authority to regulate all products that are considered tobacco products, including e-cigarettes.[20] State and local governments also have laws about tobacco products, which include prohibiting smoking and tobacco in public places, taxing tobacco products, enforcing Medicaid to cover smoking cessation programs and prohibiting the sale of flavored tobacco products.[21] In 2006, Ohio instituted a statewide ban against tobacco requiring businesses and organizations to prohibit smoking.[22]

Electronic Cigarettes: Cytotoxicity and Other Health Risks

While e-cigarettes are becoming a popular alternative to tobacco cigarettes, many health professionals are wary in recommending these products to their patients primarily because e-cigarettes have not been proven safe for long-term use.[23] Common complaints from e-cigarette users are headache, respiratory tract infection and changes in appetite. Upon initial investigation of e-cigarettes, they may appear to be a good alternative to traditional cigarettes. Most e-cigarette companies use the appealing platform of promising smoking cessation and harm reduction to attract consumers.However, without knowing the long-term health risks associated with e-cigarettes, it can be difficult for a healthcare professional to provide any recommendation of e-cigarettes to both tobacco and non-tobacco users.[24]

Farsalinos and colleagues performed a study to determine whether or not e-cigarettes are less harmful than tobacco cigarettes.[25] They measured and compared the cytotoxic potential of cigarette smoke and e-cigarette vapor extract on cultured myocardial cells. Additionally, they measured whether or not using a higher voltage (3.7 volts versus 4.7 volts) has an effect on cytotoxicity of e-cigarette agents. Electronic cigarette and cigarette smoke samples were tested in vapor form, as this is the form most used by consumers. Cytotoxicity was defined as viability less than 70 percent based on a specific protocol (ISO 10993-5). This was only done on low voltage e-cigarette samples due to an insufficient number of high voltage samples to demonstrate a significant difference.

The authors tested the vapor cytotoxicity of one cigarette smoke sample, 20 e-cigarette liquid samples and an e-cigarette base sample at five different concentrations: 100 percent, 50 percent, 25 percent, 12.5 percent and 6.25 percent.[25] Table 1 demonstrates the myocardial cell viability at low voltage of the cigarette smoke sample, base sample and the four e-cigarette vapor extracts that demonstrated a cytotoxic effect. Most tobacco producing samples exhibited the lowest survival rates. The base sample, containing 50 percent propylene glycol, 50 percent glycerol and no nicotine or flavoring, was considered non-cytotoxic at any extract concentration. Cigarette smoke was significantly more cytotoxic than e-cigarette samples with cytotoxicity exhibited at all concentrations above 6.25 percent. The most cytotoxic of the four samples was "El Toro Puros." Results of high voltage samples above 6.25 percent were not considered statistically significant due to the small amount of samples tested. The authors admitted the need to perform further studies, using more samples and more efficient atomizers, to determine the viability of e-cigarette use in higher voltage samples. Farsalinos and colleagues also suggested that flavoring, and the varying quantities of flavorings in liquids, may be a major contributor to e-cigarette cytotoxicity. Some flavorings are approved for use in food, but their effects when heated or evaporated are unknown.

A study by Romagna and colleagues also suggested flavoring as a cause of cytotoxicity in e-cigarettes liquid.[26] In the study, 21 e-cigarette liquids were tested, and only one out of the 21 liquids had cytotoxic properties when exposed to cultured mammalian fibroblasts. All samples were produced by the same manufacturer and had the same main ingredients (propylene glycol, glycerol and nicotine) in similar concentrations, leaving flavoring as the only contributor to varying cell viability.

Table 1. Myocardial Cell Viability in Cigarette Smoke and Electronic Cigarette Vapor Extracts at 3.7 volts (low voltage).[25]

	Dilutions				
Samples	100%	50%	25%	12.50%	6.25%
Cinnamon-Cookies	64.8± 2.5%	100.8±2.0%	97.2± 2.9%	99.3± 1.7%	99.2± 3.8%
El Toro Cigarillos-1	39.1±1.2%	52.5±1.8%	81.0± 2.0%	92.6± 0.4%	99.2± 1.0%
El Toro Cigarillos-2	22.3±4.0%	66.9± 6.2%	104.1± 5.8%	109.9±6.0%	112.0± 8.8%
El Toro Puros	2.2± 0.6%	7.4± 3.9%	84.5±6.5%	115.3±11.7%	111.9±7.4%
Base Sample	105.1± 1.2%	103.5± 1.9%	101.3± 4.2%	100.7± 3.4%	100.4± 2.3%
Cigarette smoke	3.9± 0.2%	5.2 ± 0.8%	3.1± 0.2%	38.2± 0.6%	76.9 ± 2.0%

Data comparing cytotoxicity between e-cigarettes and cigarette smoke was reported using mean ± standard deviation. Data comparing e-cigarette samples was reported using a paired t-test. Among e-cigarette samples, an independent t-test was used to assess whether nicotine levels played a role in viability. A two tailed p value < 0.05 was considered statistically significant. All samples, besides the base, had p values <0.001 and were considered statistically significant.

Studies evaluating the cytotoxicity of individual flavors in vapor form and the cytotoxicity of flavors at different concentrations may be essential in the production of safe e-cigarettes.[27] Bahl and colleagues completed a study using embryonic and adult cells to compare the cytotoxicity of various e-cigarette refill fluid flavors. They used three cell types: cells modeling the epiblast stage of human embryonic development (hESC), mouse neural stem cells (mNSC) isolated from the brain of a newborn and human pulmonary fibroblasts (hPF) representing adult cells from one of the initial points of contact of inhaled e-cigarette aerosol. Thirty-four refill fluid samples of varying doses, flavorings and nicotine concentrations were compared in all cell types, and found to differ significantly in potency. Refill fluids used were obtained from popular companies whose products are easily accessible to e-cigarette users online. Ninety-six well plates were filled with negative controls and refill solutions of various doses (0.001%, 0.01%, 0.03%, 0.1%, 0.3% and 1%). Table 2 shows the half maximal inhibitory concentration (IC_{50}) of the refill fluid product flavors that produced the most significant results and are the most common humectants used in refill fluid. Vegetable glycerin (VG) and propylene glycol (PG) are the two humectants most often used in refill solutions, and these were considered non-cytotoxic for both cell types. Menthol Artic (Freedom Smoke USA) and Caramel #40 (Global Smoke) demonstrated the strongest cytotoxic effects on hPF cells. Cinnamon Ceylon was found to be the most potent sample and the only one that produced strong cytotoxic effects on all three types of cells. The Bubblegum sample was tested and found to be non-cytotoxic. The authors warned that the cytotoxicity results achieved were potentially inaccurate. This is because the study used doses of vapor that were 100 times lower than the actual doses consumers would use. Therefore, a flavor demonstrating no toxicity at a 1 percent concentration, which was used in this study, may actually exhibit cytotoxicity when consumed at normal high doses such as 10 percent.

The study then used high pressure liquid chromatography spectra and found that products of the same flavor varied in flavor peaks and cytotoxicity.[27] For example, Butterscotch #30 and Butterscotch #29 had low toxicity and had fewer and shorter flavoring peaks (low chemical concentrations). In contrast, Butterscotch #20, which demonstrated cytotoxicity, had greater and higher flavor peaks (high chemical concentrations). These results demonstrate that companies are not always consistent with the contents of their products. Products of the same flavor from one manufacturer can vary in the amount of chemicals and, therefore, the levels of cytotoxicity. Additionally, stem cells from embryos and newborns were found to be more sensitive to refill solution than differentiated adult lung cells; consequently, it will be essential in future studies for e-cigarette cytotoxicity to be tested during pregnancy and in multiple cell types.

This study also examined the effects of nicotine on the cytotoxicity of e-cigarettes.[27] In Table 2, the nicotine levels of the refill fluids and humectants are shown. Samples containing nicotine concentrations ranging from 0 to 24 mg/mL were used. Propylene glycol, VG, Caramel #26, Butterscotch #30, Menthol Artic, Butterscotch #20, Cinnamon Ceylon and Caramel #21 contained 0 mg nicotine/mL; however, they differed in cytotoxicity. Propylene glycol, VG, Caramel #26, Butterscotch #30 and Menthol Artic were non-cytotoxic/low cytotoxicity while Butterscotch #20, Cinnamon Ceylon and Caramel #21 were considered toxic. Bubblegum and Butterfinger #19 were considered to have no cytotoxicity or low cytotoxicity but contained 24 mg nicotine/ml.

This study demonstrates that in order to truly confirm the cytotoxicity of e-cigarettes additional studies will need to be completed with great caution.[27] As this study only examined the end result of exposure, studies evaluating the reason for differences in cell survival may be beneficial. The results also demonstrate that high levels of nicotine do not correlate with high cytotoxicity in e-cigarettes, leaving the flavoring of e-cigarettes as the main cause of e-cigarette toxicity.

Aside from flavoring, there are several other toxic substances present in e-cigarette cartridges at low levels.[28] These substances include carbonyl compounds, volatile organic compounds, nitrosamines, ultrafine particulate matter and heavy metals. Performing studies on the cytotoxicity of these additional agents is important because they are known to contribute to various disease processes. Even the humectant propylene glycol, which is not cytotoxic in liquid form, has been found to contribute to allergic respiratory symptoms, and the safety of inhaling its vaporized form has not been tested in humans. By eliminating their cytotoxic flavors and other cytotoxic component, e-cigarettes may be able to contribute safely to tobacco reduction and cessation.

Table 2. Cytotoxic Levels and Nicotine Content of Various Refill Fluid Product Flavors.[27]

Refill fluid (Company)	Nicotine (mg/ml)	Cell Type		
		hESC[c]	mNSC[d]	hPF[e]
Propylene glycol (FS-USA)[a]		Low	Low	Low
Vegetable Glycerin (FS-USA)		Low	Low	Low
Bubblegum #18 (FS-USA)	24	Low	Low	Low
Butterscotch #30 (FS-USA)	0	Low	Low	Low
Butterscotch #29 (FS-USA)	6	Low	Low	Low
Caramel #26 (Freedom Smoke)	0	Low	Low	Low
Caramel #27 (Freedom Smoke)	6	Low	Low	Low
Caramel #28 (Freedom Smoke)	6	Low	Low	Low
Caramel #40 (Global Smoke)	18	Moderate	Low	Moderate
Butterfinger #19 (FS-USA)	24	Moderate	Low	Low
Menthol Arctic (Freedom Smoke)	0	Moderate	Low	Moderate
Vanilla Tahity (FS-USA)	0	Moderate	Moderate	Moderate
Pure nicotine (FS-USA)	100	Moderate	Moderate	Moderate
Caramel #21 (Freedom Smoke)	0	Moderate	Moderate	Moderate
Arctic Menthol (Johnson Creek)	18	High	Moderate	Low
Butterscotch #20 (FS-USA)	0	High	Moderate	Moderate
Cinnamon Ceylon (FS-USA)	0	High	High	High
Butterscotch #41 (Freedom Smoke)[b]	0	----	Moderate	Moderate

Refill products were considered to be non-cytotoxic or have low cytotoxicity if IC_{50}>1%, moderate toxicity if IC_{50} was 0.1-1%, and high cytotoxicity if IC50<0.1%.

[a]Freedom Smoke USA

[b]Butterscotch #41 was only tested in mNSC and hPF because it was ordered and arrived from the manufacturer later in the experiment.

[c]Cells modeling the epiblast stage of human embryonic development

[d]Mouse neural stem cells isolated from the brain of a newborn

[e]Human pulmonary fibroblasts

Electronic Cigarettes: Examining Utility for Smoking Cessation Therapy

In a prospective proof of concept six-month pilot study, Polosa and colleagues examined the effect of e-cigarettes on smoking reduction and cessation.[29] Forty regular smokers (unwilling to quit) were invited to attend five study visits (baseline, week 4, week 8, week 12 and week 24) and follow-up appointments at each visit. Adverse events and participants' opinions and acceptance of the product were also monitored. Smokers ranged from 18 to 60 years of age, smoked greater than or equal to 15 factory made cigarettes per day for at least the past 10 years and were not currently trying to quit smoking or hoping to do so in the next 30 days. At the baseline visit, participants were given a free e-cigarette kit and were instructed on how to use, charge and activate the e-cigarette. A four-week supply of 7.4 mg nicotine cartridges was also provided, and participants were trained on how to load them into the e-cigarette atomizer. Participants were allowed to use the e-cigarette at their own convenience throughout the day up to a maximum of four cartridges per day as recommended by the manufacturer. They were also instructed to complete a four-week study diary to record their use, the number tobacco cigarettes smoked and any adverse events. Subjects were invited to subsequent visits to receive more free supplies of cartridges and study diaries, to record their exhaled carbon monoxide (eCO) levels and to give back completed study diaries and unused products. At the final follow-up visit, participants reported product usage (cartridges/day), number of tobacco cigarettes, and eCO levels and rated the degree of usefulness of the product.

The product ratings of satisfaction, helpfulness in keeping them from smoking and whether they would recommend to a friend who wants to quit or reduce smoking were measured using a visual analogue scale (0 = completely unsatisfied, 10 = fully satisfied). Patients who spontaneously asked for assistance in quitting were provided with smoking cessation services but were excluded from the study. The majority (67.5%) of participants were able to adhere to the program and returned for the final follow-up visit with an overall quit rate of 22.5 percent. There was at least a 50 percent reduction in cigarette smoking in 32.5 percent of participants.

Overall 55 percent of participants exhibited reduction or smoking cessation.[29] The study suggested that the positive effect of e-cigarettes could have been due to their ability to replace some of the rituals associated with smoking (e.g., hand-to-mouth action of smoking). E-cigarette use was not found to produce increased CO levels. Serious adverse events or events causing unscheduled visits to a healthcare provider did not occur. The most frequent adverse events were mouth irritation (20.6%), throat irritation (32.4%) and dry cough (32.4%) possibly due to the low toxicity of propylene glycol. However, these adverse events subsided with time, and participants were satisfied with the product. Side effects such as depression, anxiety, insomnia, irritability, hunger and constipation that are normally present in smoking cessation trials with drugs for nicotine dependence were absent.

The authors admitted that the study was small and uncontrolled; therefore, the results could have been due to chance and should be interpreted with caution.[29] Additionally, the study's design should not be considered as an ordinary cessation study because the design included smokers who were unwilling to quit and used e-cigarettes. Based on this study, e-cigarettes should not be compared to other smoking cessation products, and the absence of withdrawal symptoms and adverse effects should be considered with caution, given that the authors did not study these variables rigorously.

Conclusion from Selected Studies on Electronic Cigarettes

These five studies demonstrate that the use of e-cigarettes is not yet safe and healthy for the public.[25-29] There are still many factors including toxicity and efficacy in smoking cessation that need to be studied further. An article by Simon Chapman, professor of public health at the University of Sydney, stresses many mistakes have been made with the way tobacco has been sold and marketed.[23] In order to avoid the same mistakes with e-cigarettes, early caution should be taken. Chapman suggests scheduling e-cigarettes and creating access through pharmacies with a permit or prescription as a way for them to be overseen for quality and safety. This tighter control would allow e-cigarettes to be carefully monitored through research, and their availability to be relaxed or tightened as evidence of benefits and/or harms develop.

Clinical Applications and the Role of the Pharmacist

As of now the FDA has not completely studied and evaluated e-cigarettes and cannot state if there is any therapeutic benefit from the use of these products. Currently, only e-cigarettes that are marketed for or claim a therapeutic purpose such as smoking cessation are being regulated.[30] The FDA issued a proposition that would allow the agency's tobacco authority to cover additional products that meet the legal definition of a tobacco product, such as e-cigarettes and any other products containing tobacco derivatives such as nicotine.[30,19]

Before initiating any form of smoking cessation, pharmacists should consider using the "5As" approach. This involves **asking** the patient about his or her current tobacco use, **advising** them on the importance of quitting and the health benefits that come with smoking cessation, and **assessing** if the patient is willing and ready to quit. Once the patient is ready, the pharmacist should **assist** the patient in selecting and beginning smoking cessation therapy and **arranging** follow-up sessions to help monitor and encourage the patient's progress. A first-line treatment to smoking cessation for most patients is nicotine replacement therapy (NRT).[31] Other first-line treatments include prescription products such as varenicline and bupropion SR. On the market, there are a number of NRT products designed to help patients end their need for nicotine. Available NRT products include gums, lozenges, nasal sprays, inhalers and patches. Each of these products have advantages and disadvantages which the patient should discuss with a pharmacist in order to determine which product is right for them.[32] As of now, e-cigarettes have not been formally classified as a NRT product, but there is continuing research to determine if e-cigarettes would qualify.[19]

From the presented studies and evidence, the use of e-cigarettes can be toxic to the health of patients, and without regulation to standardize e-cigarettes, it may be difficult to discern which products are safe.[30] Although, there are no official counseling guidelines for e-cigarettes, it is still important that pharmacists use available knowledge to inform patients on the effects of e-cigarettes. Most e-cigarettes do not contain a tamper resistant mechanism, which has resulted in children overdosing on nicotine by consuming the concentrated nicotine liquid. Likewise, various liquids cause damage to cells, and certain e-cigarette devices, especially ones that are higher in voltage, can contribute additional harm.[25] In comparison to traditional tobacco based cigarettes, it is not accurate to say that e-cigarettes are better or worse. This is because e-cigarettes are not being formally regulated in the same way.[19] Patients who are looking to switch from traditional tobacco cigarettes to e-cigarettes as a form of NRT should be informed about the consequences of using e-cigarettes and their effects on health; an example being that certain nicotine liquids and e-cigarettes can cause more cytotoxicity when compared to other brands of e-cigarettes.[27,30,32] If a patient wants to quit smoking cigarettes, pharmacists should make recommendations on safer established methods, such as NRT products, before suggesting e-cigarettes. Patients already using e-cigarettes as a form of smoking cessation should be encouraged to switch to established methods or, at a minimum, invest in products that progressively contain less and less nicotine, eventually seceding from all nicotine and tobacco containing products.[25,30,31] Utilizing the above counseling points, regulated forms of NRT, or referral to a physician who can prescribe a prescription based smoking cessation therapy, would all be safer options than using an e-cigarette.[27,30]

Conclusion

Presently, there have been studies to show that certain e-cigarette and nicotine liquid brands are safer than the traditional e-cigarette, but that does not mean e-cigarettes in general are completely safe. The FDA has listed a number of adverse effects that have been attributed to the chronic use of e-cigarettes including, but not limited to, chronic heart failure, pneumonia and seizures. Additional studies, the creation of standards and regulating e-cigarettes like tobacco are important next steps. Unfortunately, the FDA has not instituted such regulations but is currently working on extending the e-cigarette classification to be in the same category as traditional tobacco products. If a standard and safe e-cigarette is created, this could add another potentially safer NRT option for smoking cessation.

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