Electronic Cigarettes Impact on Risk for Diseases: Implications for Oral Health Care

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Abstract

Background

E-cigarettes are battery powered devices that heat a liquid nicotine solution in a disposable cartridge and create a vapor that is inhaled. Vapor products can feature a liquid capsule that is inserted into cartridge. Vapors offer consumers a wider variety of flavors, including fruits and candy flavor is an important product characteristic in determining who is attracted to the product and the ability to get started on the product. Long term health effects of e-cigarettes are unknown, but compared with cigarettes; they are likely to be much less, if at all, harmful to users or bystanders.

Methods

The review consisted of an electronic search for peer-reviewed, published research articles from accredited sources. The search topics included E-cigarettes (a) safety, (b) toxicity, (c) potential harms, and (d) side effects.

Results

E-cigarettes are widely used among smokers attempting to quit, can help reduce the number of cigarettes smoked, and may be as effective for smoking cessation as the nicotine patch. However, there is a lack of longitudinal data concerning the safety and efficacy of e-cigarettes. To date, e-cigarettes have not been deemed as harmless. Additionally, available evidence showed no significant difference in adverse event rates between e-cigarettes and the nicotine patch.

Conclusion

Given the limited available evidence on the risks and benefits of e-cigarette use, longitudinal, randomized, controlled trials are urgently needed to definitively establish their potential for smoking cessation.

Review of the Literature

Background

E-cigarettes are a class of products intended to deliver nicotine-containing aerosol (vapor) to be used by heating a solution typically comprised of (a) propylene glycol/ or glycerol, (b) nicotine, and (c) flavoring agents [2]. To help an individual to quit smoking, E-cigarettes without nicotine are also available. The first of these devices that started the trend was invented by a Chinese pharmacist, Hon Lik, 2003[1]. E- Cigarette sales have risen rapidly since they entered the marketplace in 2007. These products are marketed as (a) healthier alternatives to tobacco smoking, (b) useful in quitting smoking and reducing cigarette consumption, and (c) a method of circumventing smoke free laws that enable users to smoke anywhere. Interest in the products has been increasing and an exponential rise in sales over the past 3 years has been due, at least in part, to widespread advertising via television, commercials, and print advertisement that often features celebrities; For the most popular brands; the big three manufacturers Lorillard Inc. (Blue Cigs), Philip Morris USA (Mark Ten) and Ryenolds American Inc. (Vuse)

Health Claims

These are marked as smoking cessation products, even though the FDA has not approved or recommended any e-cigarettes for smoking cessation option. In 2009, a study group on tobacco product regulation addressed the emerging regulatory issues pertaining to e-cigarettes; they noted that there was very little published scientific evidence on the health effects of e-cigarettes, or their efficacy for smoking cessation. Additionally, there was no sufficient evidence to support the cessation or health claims made by either the manufacturers, or those in the public health community who were advocating e-cigarettes a healthy alternative to tobacco cigarettes [13]. Furthermore, the e-cigarette aerosol has not been proven safe for inhalation by bystanders. The main concern with the product was lack of data on the safety of the main ingredient aerosol in the e-cigarette solution, especially the safety of repeated inhalation of a heated mixture of propylene glycol and other chemicals.

Methods

Initial searches were conducted using Pub Med electronic database using keywords to identify studies describing electronic cigarette (safety, toxicity, potential harms, and side effects). All articles were available electronically and were published within the last ten years to ensure the most current research was reviewed. A total of...
fourteen research articles were reviewed.

**Review of the Literature**

**Types of Electronic Cigarette**

E-cigarettes have many names, including electronic cigarettes, ENDS and e-hooka. The engineering on the e-cigarettes are evolving since the first one arrived in the global market in 2007. As of late 2013, there was wide variability in product engineering, including varying concentrations of nicotine in the solution that e-cigarette use to generate the aerosol, different volumes of solutions, different carrier compounds, a wide range of additives and flavors, and battery voltage. By January 2014 there were 466 brands (each with its own website) and 7764 unique flavors. In the 17 months between the searches, there was a net increase of 10.5 brands and 242 new flavors per month [6]. The product also comes in variety of nicotine strengths, including some without nicotine. The nicotine is usually expressed in mg/ml of solution or percent concentration. Some electronic cigarettes are made to be modified. Many types and designs continue to evolve rapidly. The first c-cig were cigarette-shaped, plastic or metal devices comprising three parts, a battery, a reservoir, for e-cigarette solution, and a fibrous material on which the solution is placed and which is used as a heating element which is attached to the battery and converts the liquid into an aerosol. More recent designs are larger models that are pen shaped and sized with customizers that often hold more nicotine solution to reduce the amount of times a user needs to refill thought the day. Some differ in kind, some electronic cigarettes are disposable, and some are rechargeable, consisting of a battery that connects to an atomizer.

**Potential risks to users**

Electronic cigarette devices are manufactured mainly in China. There have been many concerns about risks posed by e-cigarette and e-cigarette solution. Most of the packaging came with some instructions. Mostly provided information about the battery and how to connect it together, but did not come with a list of product ingredient, or health warning messages that most of the products leaked when handled and cartridges came with fluid leaked on them, creating a potential for dermal nicotine exposure and potential nicotine positioning. Propylene glycol and glycerin comprise the main base ingredients of the e-liquid and help to generate the aerosol used to deliver nicotine and other compounds to the user. This aerosol looks like smoke. There is concern about potential health effects of chronic inhalation of the vaporized base components of the e-liquid. A study was performed on the effects of e-cigarette liquid (e-liquid) on pro-inflammatory cytokine production, HRV infection and host defense molecules in primary human airway epithelial cell from young healthy non-smokers additionally, they study examined the role of SPLUNC1 in lung defense against HRV infection using SPLUNC1 knock out mouse model. The study found that that nicotine-free e-liquid promoted IL-6 production and HRV infection. Addition of nicotine into e-liquid further amplified the effects of nicotine-free e-liquid. Moreover, SPLUNC1 deficiency in mice significantly increased lung HRV loads51. 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 people4. When heated and vaporized, propylene glycol can from propylene oxide and glycerol forms acrolein, which can cause upper respiratory tract irritations. The recent data regarding electronic cigarette toxicity, impact on lung function, and efficacy in smoking reduction and cessation. Studies show that the vapor generated from electronic cigarettes has variable amounts of nicotine and potential harmful toxins53. Som examples of less serious adverse events include nausea, vomiting, and sore throat. If you smoke your e-cig as you smoke your cigarette you will find yourself with a sore throat, sore lungs, an incessant cough and irritation in your mouth and throat. Some cases have been reported where a person became seriously ill after drinking the e-liquid, other cases was reported that a young child died of nicotine poisoning from drinking her grandfather's e-cigarette solution. Also, due to the heat the e-cig could explode and catch fire causing serious injury. A man in Florida suffered severe burns and lost half of his tongue due to an e-cig battery exploding in his face. (CBS NEWS, February 16, 2012). These problems are common enough that it is advised on the packaging on the websites that the lithium batteries may explode or overheat.

**Biological Effects**

Vansickel conducted a study with 32 healthy smokers to examine nicotine absorption from e-cigarettes, cardiovascular effects on craving and withdrawal after using an e-cig. Participants with no prior e-cig use were asked to participate in each of 4 product use protocols, separated by 48 hours and after 12 hours of abstinence from tobacco smoking. The flavor of e-cig cartridge was match to the type of tobacco cigarette usually used by participant (menthol or non-menthol). Biological measures were blood plasma nicotine and expired air carbon monoxide; heart rate subjective measures of craving and withdrawal were also assessed. They found that 5 minutes of puffing Increase in ratings of direct effects of nicotine, and products were observed as well as decreases in abstinence symptoms [1]. User experience and/or device characteristics likely influence EC nicotine delivery and other effects. Systematic manipulation of these and other variables could elucidate conditions that produce intended effects [9].

**Second Hand Smoking**

Electronic cigarettes (e-cigarettes) are designed to generate inhalable nicotine aerosol (vapor). When an e-cigarette user takes a puff, the nicotine solution is heated and the vapor is taken into lungs. Although no side stream vapor is generated between puffs, some of the mainstream vapor is exhaled by e-cigarette user. A study was completed by measuring airborne markers of secondhand exposure: nicotine, aerosol particles, carbon monoxide and volatile organic compounds in an exposure chamber. The study also compared second hand exposure with e-cigarette vapor and tobacco smoke generated by 5 dual users. The study showed that e-cigarettes are a source of secondhand exposure to nicotine but not to combustion toxicants. The air concentrations of nicotine emitted by various
brands of e-cigarettes ranged from 0.82 to 6.23 μg/m (3). The average concentration of nicotine resulting from smoking tobacco cigarettes was 10 times higher than from e-cigarettes (31.606.91± vs. 3.322.49± μg/m (3), respectively; p = .0081). Using an e-cigarette in indoor environments may involuntarily expose nonusers to nicotine but not to toxic tobacco-specific combustion products [7]. An unexpected consequence of electronic cigarette use unforeseen risk. A study was conducted on the first comprehensive and standardized assessment of the acute impact of active and passive e-cigarette smoking on serum cotinine and lung function, as compared to active and passive tobacco cigarette smoking. E-Cigarettes and tobacco cigarettes generated similar (p > 0.001) effects on serum cotinine levelsafter active (60.6±34.3 versus 61.3±36.6 ng/ml) and passive (2.4±0.9 versus 2.6±0.6 ng/ml) smoking. Neither a brief session of active e-cigarette smoking (indicative: 3% reduction in FEV1/FVC) nor a 1 h passive e-cigarette smoking (indicative: 2.3% reduction in FEV1/FVC) significantly affected the lung function (p > 0.001) [12]. Regarding short-term usage, the studied e-cigarettes generate smaller changes in lung function but similar nicotinergic impact to tobacco cigarettes. Future research should target the health effects of long-term e-cigarette usage, including the effects of nicotine dosage.

**Health Effects**

A study was reported on a case of a serious adverse event deemed to be due to e-cigarette [10]. A 42 year old women who reported the following symptoms; fevers, dyspnea, and productive cough that had lasted for seven months, the patient was found to have exogenous lipoid pneumonia, a lung disease caused by the deposition of oil in the lung tissue. The symptoms coincided with when she began using e-cigarettes. Because no other behavior or exposure could explain her symptoms and because they resolved after she stopped using e-cigarettes, the patient was diagnosed with exogenous lipoid pneumonia due to e-cigarette use [2].

Another study was determining the health impact of electronic cigarettes, using an infodemiological approach. They collected information posted on three electronic cigarette forums: electronic cigarette forum, Vapor forum and vapor talk. There were 405 symptoms reported with majority negative. The majority of the symptoms affected the mouth and throat, and the respiratory system. Overall, examples of potentially serious negative health effects included: increase blood pressure and asthma attack. Some of the symptoms reported appeared opposite, such as increased and decreased blood pressure, including that users of the product may be differently affected or that these events are random occurrences and not related to e-cigarette use, as these are self-reported data with no formal analysis of causality [11].

**Clinical Information**

As a dental hygienist it is very important to us to learn about different kind of products that come out and that are inhaled through the mouth. When we see patients do internal exam, and oral cancer screening, it is important for us to understand what causes certain things in the mouth. After reviewing the literature there are many side effects to electronic cigarettes. Some of the reports have been nicotine poisoning. Nicotine poisoning could be deadly; the symptoms of nicotine poisoning are caused by excessive simulation of nicotinic cholinergic neurons. However, high doses can cause inhibitory effects leading to neuromuscular blockade. Some other reports have been less serious; some events included nausea, vomiting, and sore throat. As dental hygienist provider it is important to know when you vomit, the gastric acid from your stomach enters your mouth. Teeth are not designed to withstand gastric acids. When acid enters your mouth it erodes tooth enamel, which is the hard covering that protects your teeth from damage. When tooth enamel is worn out, your teeth become damaged. When doing internal exam it is important to understand that these electronic cigarette could cause burning to the tongue or other oral tissues, cases have been reported that the battery does heat up and it could blow up. The main thing to keep in mind when we do see patients in our chair that are using this product is that we do not have enough data to conclude what other damage they could cause. They have been advertise on television, magazines, and newspaper just like how regular cigarettes were In the 50’s and 60’s and many years later they discovered that cigarettes caused cancer, and periodontal diseases. Currently, the effects of long term exposure to electronic cigarettes are completely unknown and present a potential oral cancer and periodontal diseases risk for users, due to their higher exposure to the chemicals mixtures. Nicotine is vasoconstrictor compound, which means that is has the tendency to stimulate the contraction of the muscular wall of the blood vessels, resulting in reduced blood flow. The extended decrease of nutrient and oxygen to the gum increases the probability of periodontal disease development. Restriction of blood flow affects the mouth’s natural inhibitory functions of cleaning and fighting bacteria, as well as reduces the body’s innate ability to heal and generate new cells. The nicotine in these products can still cause gingivitis, periodontal disease, tooth decay, loss of teeth and cry mouth. Nicotine inhalation puts the dental health and overall-being of a person at risk.

**Gaps in the Literature**

Although there is a breadth of published and peer reviewed research surrounding the E-Cigarettes upon causing systemic diseases, it should be noted that there were some large gaps in the literature reviewed. The limitations that surrounds the E-Cigarette research is very limited, no long term study has ever been performed and there is not enough evidence as of now. There are several areas in which additional research would be useful for understanding the effects of e-cigarettes that could guide policymakers and health professionals, longitudinal studies to determine trajectories of use to obtain better data on patterns of imitation, Short- and long-term on the health effects of e-liquid aerosol in humans. Effects of short- and long- term exposure to particles by e-cigarette aerosol.

**Conclusion**

As of 2013, e-cigarette companies are marketing e-cigarettes using some of the same claims, tactics and media channels including
television and radio that were effective at marketing cigarettes to attract younger people and prevent smokers from quitting. Television and radio have been unavailable to the cigarette and other tobacco companies to market their products in the US since the 1950s. E-cigarette advertising on television and radio is mass marketing of an addictive nicotine product for use in a recreational manner to new generations who have never experienced such marketing. Awareness of and e-cigarette trial has at least doubled among both adults and adolescents, in the countries where data are available from 2008 to 2012. In the U.S., awareness is more prevalent among men, but trying e-cigarettes is more prevalent among women. Few if the population based studies reported on variables that could be related to self-selection to use e-cigarettes among smokers in the samples, such as dependence, motivation to quit, and previous use of smoking cessation therapies. In the end we have no longitudinal studies or research at this point to let us know what harm these E-cigarettes may cause.

References
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