



Review article

E-cigarettes: Considerations for the otolaryngologist[☆]Sneh Biyani^{a,*}, Craig S. Derkay^{a,b}^a Department of Otolaryngology-Head and Neck Surgery, Eastern Virginia Medical School, Norfolk, VA, USA^b Children's Hospital of the King's Daughters, Norfolk, VA, USA

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ABSTRACT

Purpose: To review the literature regarding electronic cigarettes and discuss potential implications and need for advocacy for the pediatric otolaryngologist.

Background: Electronic cigarettes (e-cigarettes) are battery-operated devices that deliver nicotine-containing vapors via inhalation. Research on the health related consequences of e-cigarettes is ongoing and safety has yet to be established. E-cigarettes are not presently under the regulation of any national governing body with wide accessibility to minors. Use of these products has substantially increased since arrival to the market, particularly within the adolescent population. These products are marketed via various platforms including television, Internet and social media. Hundreds of flavors are offered and e-cigarettes are packaged in various colors. Not only are the ill health effects and addictive quality of nicotine concerning, these products have the potential to serve as a gateway for minors to tobacco use.

Applications: The relationship between tobacco use, secondhand smoke exposure and otolaryngology specific diseases has well been defined. As use of electronic cigarettes increases, pediatric otolaryngologists should be aware of the ongoing literature regarding these products and to be prepared to counsel families accordingly.

Conclusions: The use of e-cigarettes among teenagers, potential implications of secondhand vapor exposure from parents and friends, and concerns this may encourage adolescents to utilize conventional tobacco products needs to be considered.

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1. Introduction

Electronic cigarettes (“e-cigarettes” or “e-cigs”), otherwise known as electronic nicotine delivery systems (ENDS), are

battery-operated devices that deliver nicotine-containing vapors to the lungs via inhalation. These products were first introduced into the United States market in 2007. They resemble traditional tobacco containing cigarettes in both their appearance and their method of nicotine delivery. The appeal lies in the delivery of high concentrations of nicotine without risk of the fumes associated with combustion of tobacco. At the same time, use of electronic cigarettes satisfies the oral urge associated with the act of smoking. A typical e-cigarette is composed of three parts: (1) a rechargeable battery (2) a cartridge containing a nicotine solution and (3) an “atomizing

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device” which aerosolizes the solution. Proponents argue e-cigarettes have enormous potential in aiding smokers in tobacco cessation. However, e-cigarettes are becoming an increasingly controversial topic as use increases while long-term data regarding the health effects of the product are unknown.

2. Regulation

Despite being available in the US market for several years, e-cigarettes are not under any body of federal regulation. Presently, the US Food and Drug Administration (FDA) regulates cigarettes and other tobacco products under the Tobacco Control Act of 2009 [1]. Only those products specifically marketed as therapeutic nicotine delivery devices are subject to regulation by the FDA. Electronic cigarettes are not distributed as such, leaving them ungoverned by any national body.

Use and regulation of e-cigarettes is therefore subject to a patchwork of state and local laws. As of December of 2014, 40 states have enacted legislation that prohibits sale and use of e-cigarettes in minors. This still leaves ten states in addition to the District of Columbia without such restrictions, allowing more than 16 million minors the ability to purchase e-cigarettes legally [2]. State and local policies regarding clean air and relation to vapor exposure from e-cigs are variable and often met with resistance due to the inconsistencies and limitations in knowledge regarding secondhand vapor exposure [3]. Twenty-six states and the District of Columbia have comprehensive smoke free laws including electronic cigarettes; however only 3 states (New Jersey, North Dakota and Utah) also include restrictions of indoor e-cig use [2]. Comprehensive bans do additionally exist at a municipal level, including influential cities New York City, Chicago, Boston, San Francisco and Los Angeles [3].

In April of 2014, the FDA proposed rules to regulate these devices on a national level. Proposed regulations include restriction of sales to minors (<18 years), requirement of ID for purchase, disclosure of product ingredients and safety data to FDA and requirement of warning labels on the product packaging [1]. It may be several more months to years before these rules are to be implemented. While this is certainly a step in the right direction, are these rules adequate? Topics such as vapor exposure, product flavoring, standardization of packing, and advertisement tactics are not included within this proposed legislation.

3. Health effects and risks

Electronic cigarettes do not require combustion, nor do they contain many of the carcinogens found in traditional cigarettes; therefore both active use and secondhand exposure are expected to be less toxic. However, given the recent introduction of these products into the market, long-term health effects are unknown and investigations are ongoing.

E-cigarette liquid is aerosolized to produce a vapor, which is then inhaled. The liquid most commonly contains nicotine, propylene glycol, glycerin, water and frequently flavorings [4]. Multiple studies have demonstrated that content of this liquid is variable [4–6]. The nicotine content within these devices and contents of the resultant vapor varies between brands and even within the brands themselves. Product labeling has also been an issue. Some studies have demonstrated inconsistencies between the nicotine content described on labels and actual content; in fact, some products marketed as nicotine-free have even been shown to contain nicotine, and some of these in significant concentrations [6]. Inhalation of electronic cigarettes introduces another factor to consider, as aerosolization and nicotine delivery are inconsistent during use [4].

Both content of the vapor and particle size within the vapor are being researched. How these affect the air within the environment is unclear [3–6]. Some studies demonstrate both fine and ultrafine particulate matter within electronic cigarette vapor resulting in variable lung inhalation with active and passive exposure [7,8]. Content of particulate matter emissions from e-cigs is also being studied. Pellegrino et al. demonstrated that while particulate matter emissions from e-cigs did exceed guidelines from the World Health Organization slightly, emissions were 15 times lower than after use of conventional cigarettes [7]. Tobacco-specific nitrosamines (TSNA) are known carcinogens found in traditional tobacco [6]. These have also been detected within vapor of most e-cigs at varying concentrations, though levels have been demonstrated to be 9–450 times lower than in traditional cigarette smoke [9]. Similarly carbonyls, other potential carcinogens, have been detected in vapors of electronic cigarettes at concentrations ranging from ‘below the limit of detection’ to levels comparable to standard cigarette smoke [6].

Propylene glycol and glycerol vapor are major components within the cartridges of electronic cigarettes and are known upper airway irritants. Little is known about the long-term health implications of repeated inhalation of these chemicals [5,6,10].

Flavorings are another additive commonly found in electronic cigarettes, many of which are derived from flavorings used in food. The Flavor and Extract Manufacturers Association regulates safety of chemicals used in food flavorings, however these safety regulations are for ingestion. Hence, they cannot be applied to the inhalation of such chemicals. Aerosolized flavorings specifically contain diacetyl, a chemical that has the potential for adverse respiratory implications [11]. Early studies have specifically identified cinnamon flavoring as having cytotoxic potential [12]. This introduces yet another unknown variable in the health and safety of these products, in which more research and studies are needed.

Nicotine itself is highly addictive with known deleterious effects including adverse cognitive behavioral outcomes in children and negative stresses imposed on the cardiovascular systems [13]. Medicinal nicotine has been demonstrated to be safe when administered in non-toxic levels [14]. However, as levels of nicotine in electronic cigarettes are not yet regulated, the safety profile is unknown. Toxicity from nicotine can result from ingestion, inhalation, or absorption through skin and mucous membranes. Acute toxicities related to nicotine are a real concern given the high nicotine content within the cartridges of electronic cigarettes. The United States Poison Control Center has reported a significant rise in the amount of accidental exposures, in both children and adults onward from 2010. In September of 2010, the number of calls related to e-cigs was on average one per month. This number has dramatically increased to 215 calls per month as of February of 2014 [15]. Most commonly, adverse effects related to toxicity include nausea, vomiting and eye irritation. However, case reports have documented attempted suicide attempts by either oral or intravenous nicotine found in electronic cigarette liquid cartridges, including one successful suicide via intravenous nicotine [16]. Tragically, two children to date have died from unintentional liquid nicotine poisoning: the first in Israel in May of 2013, and more recently a one year old died in December 2014 in the United States [17].

A recent systematic review published by Pisinger et al. comprehensively reviews existing literature on health consequences of vaping associated with electronic cigarettes, in turn demonstrating the deficiencies in present research. In the absence of a standardized product without sufficient regulation, no hard conclusions can be drawn regarding the safety profile of these products [6]. The Cochrane review published a meta-analysis regarding the efficacy of electronic cigarettes in assisting with

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