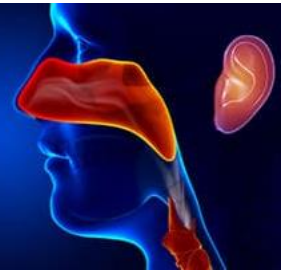


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E-cigarette adverse effects in Otolaryngology: A comprehensive review

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Abstract

Electronic cigarettes (e-cigarettes) have gained widespread popularity as an alternative to traditional tobacco smoking. Despite their perceived safety compared to conventional cigarettes, emerging evidence suggests potential adverse effects, particularly within the realm of otolaryngology. This review paper aims to comprehensively summarize the current literature on the adverse effects of e-cigarettes on the ear, nose, and throat (ENT) region. Through a systematic review of relevant studies, we highlight the various detrimental impacts of e-cigarette use on the structures and functions of the ENT system. Additionally, we discuss the underlying mechanisms implicated in these adverse effects and offer insights into the clinical implications for otolaryngologists. This review underscores the importance of continued research and heightened awareness among healthcare professionals and the general public regarding the potential otolaryngological consequences of e-cigarette use.

Keywords: Electronic cigarettes, vaping, side effects, adverse effects, otolaryngology

Introduction

Electronic cigarettes, also known as E-cigs or electronic nicotine delivery systems (ENDSs), are classified as noncombustible tobacco products. E-cigarettes are often promoted as a means to quit smoking due to their capacity to quickly deliver nicotine and replicate the appearance, sensation, and flavor of a conventional cigarette^[1]. Consisting of a power supply and heating element, these devices convert a solvent into an aerosol, which is then inhaled by the user. Propylene glycol and glycerin are often found in solvents and help to enhance vapor generation. The liquid moreover comprises flavorings, nicotine, and other ingredients that differ amid different items.

Electronic cigarettes, often known as e-cigarettes, have become a widely used substitute for conventional tobacco products, with a global user base numbering in the millions. E-cigarettes are promoted as a less hazardous alternative to smoking^[2]. They release nicotine and other substances in the form of a fine mist, frequently with added flavors to cater to various customer tastes. Nevertheless, there is an increasing apprehension about the safety and possible negative impacts on health, especially in the field of otolaryngology. This review seeks to synthesize current research about the detrimental impacts of e-cigarettes on the ear, nose, and throat (ENT) area, providing insights into the consequences for both clinical practice and public health. Gaining knowledge about the structure and mechanism of e-cigarettes is essential for understanding their possible impact on the ear, nose, and throat^[3, 4]. E-cigarettes generally include a device powered by a battery, an atomizer as a heating element, a cartridge carrying e-liquid (which commonly contains nicotine, flavorings, and solvents), and a mouthpiece. When the atomizer is activated, it turns the e-liquid into vapor, which the user then inhales as an aerosol. Nicotine, the main mind-altering ingredient in e-cigarettes, produces its effects by stimulating nicotinic acetylcholine receptors^[5, 6]. Meanwhile, other substances like propylene glycol and glycerol may also add to the overall harmfulness and negative consequences.

E-cigarettes have been advocated to assist existing cigarette users in achieving cessation. When used with behavioral assistance, E-cigarettes have shown superior effectiveness compared to nicotine replacement therapy in aiding smoking cessation. Nicotine-containing items inside E-cigs have shown greater efficacy for smoking cessation compared to nicotine-

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free E-cigs. However, among American adolescents, electronic cigarettes may indeed promote the use of traditional cigarettes. There is apprehension that E-cigarettes may serve as a "gateway drug," which refers to a substance that is addictive and might potentially lead to the use of more potent and habit-forming narcotics. The prevalence of E-cig use, also known as vaping, has been seen to be rising among both adults and adolescents, including those who have never smoked traditional cigarettes. Moreover, there has been a correlation between first E-cigarette usage and subsequent transition to conventional cigarette smoking [7, 8, 8]. While the adverse effects of conventional cigarettes are well known, the study of the negative effects of electronic nicotine delivery systems (ENDSs) is still an emerging area of research. Furthermore, the extensive assortment of vaping products, flavorings, and nicotine levels results in a wide spectrum of potential negative effects that might vary across different brands. As the number of adverse effects caused by E-cigarette use has risen, the majority of investigations have focused on the field of pulmonary medicine. Furthermore, the diversity in E-custodies poses a difficulty in determining the immediate and prolonged negative consequences associated with vaping. At our organization, we have seen a growing number of individuals who use E-cigarettes seeking medical attention for symptoms related to the field of otolaryngology [10, 11]. The aim for this scoping review aimed to examine the inadvertent otolaryngology-related adverse consequences linked to any degree of E-cigarette use in both adolescents and adults [12, 13, 14].

Otolaryngological Adverse Effects of E-cigarettes

Nasal Effects

E-cigarette use has been associated with various nasal adverse effects, including nasal congestion, rhinorrhea, and sinonasal irritation. Studies have reported alterations in nasal mucociliary clearance and increased pro-inflammatory cytokine levels among e-cigarette users, suggesting a potential role in exacerbating rhinologic conditions such as rhinitis and sinusitis.

Pharyngeal and Laryngeal Effects

Chronic exposure to e-cigarette aerosols may elicit pharyngeal and laryngeal irritation, leading to symptoms such as sore throat, cough, and hoarseness. Histopathological analyses have revealed epithelial changes and inflammatory responses in the pharyngeal and laryngeal mucosa of e-cigarette users, raising concerns regarding their long-term impact on voice quality and airway function.

Otologic Effects

The auditory system is not immune to the adverse effects of e-cigarette use. Studies have implicated e-cigarettes in the development or exacerbation of otologic conditions such as tinnitus and sensorineural hearing loss. The ototoxicity of nicotine and its metabolites, coupled with the potential for oxidative stress and vascular dysfunction, underscores the need for further investigation into their otologic consequences.

Pathogenesis and Fundamental Processes

There are a number of potential pathophysiological pathways that contribute to the otolaryngological side effects of electronic cigarettes, including inflammation, endothelial dysfunction, direct tissue damage, and oxidative

stress. Vapors from electronic cigarettes include nicotine, volatile chemical compounds, and reactive oxygen species, all of which may harm the mucosal epithelium and cause mucociliary clearance to be hindered or even destroyed.

Essential Results

Adverse events, or side effects, are defined by the US Food and Drug Administration as "unwanted or unexpected events or reactions," and they may range from very small issues to serious health risks. The government oversees electronic cigarette usage and promotes the use of an official website for the reporting of adverse effects. Examining potential otolaryngology-related adverse effects after vaping at any dosage was the main idea of the research. Any pathologic diagnosis or symptom affecting anatomic regions routinely treated by otolaryngologists was considered an otolaryngology-related side effect [15]. The research by Phulka *et al.* on the otolaryngology-related adverse consequences of cannabis usage provided the basis for this definition. For this investigation, we consulted their list of potential adverse effects associated with otolaryngology procedures [16]. Not limited to the following were the side effects that were taken into account: vertigo, hearing loss, cancer, sinusitis, anosmia, infections of the sinuses and oral cavities, hoarseness, dysfunction of the vocal cords, paralysis of the vocal cords, dyspnea, respiratory arrest requiring intubation, sleep apnea, enlarged or diseased lymph nodes in the head and neck, oral lesions/ulcers, cough, irritation of the mouth and throat, epistaxis, dry mouth, epistaxis, and change or loss of taste [17, 18].

Synthesis by Subspecialty

Participants in this scoping review came from a range of subspecialties within otolaryngology. The findings and themes that were found are grouped according to the specialism.

Otolaryngology in general

With 26 publications, general otolaryngology was the most common specialty. The majority of research found various adverse effects associated with vaping. Cough, along with irritation of the mouth or throat, dry mouth or throat, or painful throat, was reported in seventeen studies as an adverse effect of vaping. Of these investigations, two mentioned dyspnea and four mentioned a dry cough. Only a few of studies (n = 6) tracked users over time to document how these adverse effects developed. At 3- to 12-month follow-up, five studies found that mouth/throat discomfort, sore throat, and cough had resolved, in whole or in part [19, 20, 21]. The irritation of the mouth and throat, dry cough, and dry mouth were still present at the 24-month follow-up in one research. Eight individuals hospitalized with acute respiratory failure after vaping were described in a case series. But items derived from marijuana made up the bulk of the vaping devices.

Otology

The correlation between vaping and hearing loss (n = 1) and vestibular dysfunction (n = 8) was examined in nine studies. Two studies found no correlation between vaping and vertigo or dizziness, whereas six found a favorable link. The effects of vaping on the vestibular system could not be definitively determined since the majority of research did not distinguish between vertiginous and non-vertiginous

vertigo ^[21]. There were no major adverse effects necessitating follow-up at 24 months, although one research noted the consequences of vestibular dysfunction and described how these spontaneously resolved.

Head & Neck

Oral mucosal diseases, including nicotine stomatitis, hairy tongue, and hyperplastic candidiasis, were linked to vaping in four trials. On the other hand, no vape users reported oral lesions in any of the two investigations. In a study it is found that vape users had a much greater frequency of *Candida albicans* carriage compared to never smokers. Nonetheless, the incidence of oral yeast carriage did not change significantly between nicotine doses ^[22].

Rhinology

Two research in pediatric populations have shown that vaping increases the risk of allergic rhinitis, and one study in adults has looked at the link between vaping and sinusitis. In their study of children, Lee *et al.* found no correlation with allergic rhinitis. It has been found comparable outcomes in a pediatric group of E-cig users who used them alone, but they did note that using both E-cigs and traditional cigarettes at the same time increased the risk of allergic rhinitis compared to using just conventional cigarettes. Vaping negatively affects mucociliary clearance and subjective sinonasal symptoms as evaluated by the SNOT-22 ^[23].

Laryngology

Two research looked at how vaping affected the voice. Subjective and objective voice analysis indicated that, in comparison to traditional cigarettes, the effects of vaping were minimal. When comparing vape users to controls, another research likewise found no significant change on the VHI-10. The VHI-10, on the other hand, was significantly greater in the group that smoked traditional cigarettes as opposed to the E-cig or control groups. People who used e-cigarettes reported that their voices were harsher ^[24].

Discussion

Over time, e-cigarette use has skyrocketed, particularly among younger generations. In 2018, the US General Surgeon proclaimed the dramatic increase in vaping among adolescents as an epidemic ^[25]. The CDC has reported that the spike has undone the gains achieved in reducing cigarette smoking among this demographic. Electronic cigarettes were the subject of a policy statement by the American Academy of Otolaryngology-Head & Neck Surgery, which included specific guidelines for both adults and adolescents. It prompted doctors to warn teenagers about the risks of electronic cigarette usage and the high risk of addiction among this demographic, as many users are unaware that these products contain nicotine, which may lead to serious health problems. In addition, it called for a nationwide ban on ENDS product sales to minors, a restriction on marketing to those under the age of 18, and the elimination of youth-targeted advertising ^[26]. Lastly, it proposed that adults should only be able to purchase E-cigs with a high nicotine content via a prescription system. Similarly, a policy statement was recently issued by the Canadian Society of Otolaryngology-Head and Neck Surgery, which vehemently supports the prohibition of flavored electronic cigarettes and the increase of the

minimum legal age for their purchase. Our goal in doing this scoping review was to compile all of the relevant clinical data on otolaryngology-related unexpected side effects into one convenient place. Fifteen of the thirty-two studies set out to do just that—look into the potential negative consequences of electronic cigarettes. The majority of adverse effects were associated with otolaryngology in general and included symptoms including coughing, dry mouth/throat, painful throat, and irritation of the mouth and throat. But most of the studies didn't even figure out when the adverse effects started or how long they lasted, much alone how severe they were. In five out of six trials that tracked patients over time, the majority of adverse effects became better or disappeared altogether. Concomitant conventional cigarette smoking was a confounding factor in 1 trial, yet patients still reported prolonged mouth/throat discomfort. Compared to those who smoked cigarettes in the past, electronic cigarette users had a much greater incidence of nicotine stomatitis, hairy tongue, and angular cheilitis. On the other hand, the incidence of oral mucosal ulcers was similar across the categories. Patients in the study had to have used electronic cigarettes for at least six months, and the researchers didn't specify how long the subjects had been vaping, but they did find no signs of cancer. Despite the fact that most research were conducted at the basic science level, a comprehensive assessment found that the evidence linking E-cigs to the development of head and neck malignancies was of poor quality. Even though population-based research are necessary to draw a judgment, a comparable study on the risk of head and neck cancers found some evidence supporting the carcinogenic effect of E-cigs. It is too early to tell what impact E-cigs will have in the long run because to the small amount of time they have been available and the usual period to carcinogenesis. According to a research, the impact of electronic cigarettes on one's voice is less severe than that of regular cigarettes. But all of the males who volunteered were completely symptom-free when it came to their voices ^[24]. One of the adverse effects mentioned in the data retrieved from forum postings on the health impacts of E-cig usage was harsh voice, however the length and intensity of this effect were not specified. In order to determine the subjective and objective degree of hoarseness in current E-cig users and to detect any upper aero digestive tract disorders using physical examination or nasal endoscopy, future research should evaluate this population. Many people who now smoke traditional cigarettes have found that using electronic cigarettes in conjunction with behavioral assistance helps they quit even more effectively than nicotine replacement treatment alone. However, the E-cig group has reported a higher incidence of otolaryngology side effects, such as irritation of the mouth and throat. Although ^[15] could not comment on the long-term safety of this modality, they did find low-quality evidence on the benefit of E-cigs for smoking cessation in a Cochrane study. Electronic cigarette users were less likely to stop smoking traditional cigarettes among head and neck cancer patients. Doctors should warn their patients about using electronic cigarettes in addition to regular cigarettes in a position statement from the American Academy of Otolaryngology-Head and Neck Surgery. This is because using both types of cigarettes makes quitting less probable and makes addiction worse. The otolaryngologist's role is to advise patients seeking help to quit smoking to be aware that there is little high-quality information about the

effectiveness of smoking cessation therapies and to warn them about the risks connected with electronic cigarettes. There has been a meteoric growth in the number of people using electronic cigarettes, even those who have never smoked a cigarette before. This is despite the fact that these devices may play a role in helping people stop traditional cigarettes. There is substantial data to show that young people and adolescents who use electronic cigarettes now are more likely to start smoking and continue smoking [27]. In spite of the fact that a patient may have smoked for many years before they get cancer, cigarette smoking is a major risk factor for head and neck malignancies. It may be some time before we witness the potentially harmful long-term impacts of this method, given the rapid and ongoing growth of ENDSs. Hence, it is necessary to implement public health measures to educate young adults and teenagers about how electronic cigarettes can be a gateway drug to traditional cigarettes. This will help mitigate the negative effects of e-cigarettes while simultaneously preventing the well-known and devastating outcomes of developing a nicotine addiction. It is more common for those who are highly dependent on nicotine to use both traditional cigarettes and electronic cigarettes. In addition, despite claims to the contrary, some electronic cigarettes really contain nicotine [28]. This might lead to a stronger reliance on nicotine and an increased risk of developing an aversion to the negative effects of both forms of nicotine delivery. A nicotine inhaler was pitted against two electronic cigarettes—one containing nicotine and the other lacking [29]. The nicotine-containing ENDSs did cause higher mouth and throat discomfort, but that was after just one hour of usage, and the people in the research were already smoking cigarettes. Therefore, given such a limited time period, it is challenging to extract the ENDSs' short- and long-term impacts. Some research failed to disclose the nicotine content, while others used other metrics to quantify vaping usage, such as puffs per session or frequency. We cannot conclude that nicotine in electronic cigarettes directly correlates to the user's unexpected adverse effects due to the study heterogeneity and lack of tangible proof [30].

Clinical Implications and Future Directions

When it comes to identifying and treating the otolaryngological consequences of e-cigarette usage, otolaryngologists are indispensable. Patients presenting with sinonasal, pharyngeal, laryngeal, or otologic symptoms should raise a red flag for potential e-cigarette-related side effects. In addition, further studies are needed to determine the long-term impacts of electronic cigarettes on the otolaryngological tract and to develop evidence-based protocols for advising patients and helping them quit smoking.

Conclusion

The use of electronic cigarettes is on the rise among both adults and young people. Finally, a wide range of negative consequences on the nasal, pharyngeal, laryngeal, and otologic structures are associated with e-cigarette usage, making it a major otolaryngological danger. Healthcare providers should keep a close eye on these side effects and take appropriate action, while lawmakers and public health activists should make regulating e-cigarettes a top priority. The growing public health issue caused by e-cigarette usage may be better managed and the health of present and future

generations protected by encouraging multidisciplinary cooperation and research in this area. Unexpected otolaryngology-related adverse effects with E-cig usage of any length have never been reported before in an otolaryngology scoping review. Coughing was the second most prevalent adverse effect, after irritation of the mouth and throat. Due to the novelty of electronic cigarettes, the long-term effects on otolaryngology are uncertain. To learn about the short- and long-term safety characteristics of E-cigs, further prospective studies are necessary.

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