Review Article

THE RISE OF VAPING AND IMPACT ON ORAL HEALTH

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Abstract
E cigarettes are being advocated as a healthier alternative to traditional smoked tobacco products i.e. cigarettes and are marketed as such. Their use as a smoking cessation treatment modality has also been extensively studied. Though studies indicate that there is a reduction in disease producing chemicals in the inhaled e cigarette vapor, the presence of nicotine and myriad flavoring agents added to the e cigarette liquid when inhaled lead to serious health issues. Nicotine addiction as well as oral and systemic health issues has been reported in various studies.

Keywords: E cigarette, Vaping, Nicotine addiction, Electronic Nicotine Delivery Systems

INTRODUCTION

Vaping[1] or the use of Electronic cigarettes (E-cigs) is on the rise. E Cigs are battery powered electronic devices that give a look and feel of a real cigarette. E cigarettes which can be refilled look structurally different (Figure1). With presence of multiple brands they are marketed as nicotine fix without the inherent dangers of cigarette smoking. It consists of a stainless steel shell housing a metal heating element connected to a cartridge containing the agent, an atomizer to vaporize the agent and a battery[2]. The heating element activated by the battery vaporizes a solution, present in the cartridge, containing a cocktail of chemicals including nicotine, base agents, propylene glycol, glycerin or glycerol, and hundreds of flavoring agents with fruity, candy and other flavors.[3] and other additives/humectants.(Figure 2)

Figure 1: Types of E-cigarettes
(Image courtesy www.fda.gov.us)

Chemical Composition

E cigarettes though marketed as a safer alternative to cigarettes, still have a considerable amount of chemicals in there aerosols. They contain high concentrations of nicotine (≥24) mg; aldehydes; heavy metals i.e. Ni, Cr, Cu, Ag etc; ultrafine particles, and tobacco specific nitrosamines.[4] Other flavoring chemicals are also found including ortho-vanilin (vanilla), maltol (malt), cinnamaldehyde and coumarin. During vaporization variable levels of carbonyls (around 380 µg /10 puffs) have been detected in e-cig aerosols. A general lack of oversight in manufacturing of the products and marketing of e-liquid or e juices is also observed.Therefore, significant concerns exist regarding the type and purity of the flavoring agents or additives used. Nicotine, which is the principle component of most e cigarettes, has been proven to be a contributor to periodontal disease.

Figure 2: Components of E-cigarette
(Image courtesy www.fda.gov.us)

Safety Issues

Most of the e cigarettes contain nicotine, which is highly addictive in nature. Stopping the use of cigarettes leads to nicotine withdrawal causing psychological as well as physiological symptoms ranging from tremors to depression and anxiety. Nicotine has also been shown to have adverse effects on the systemic health of not only the users but also the people around them being exposed to second hand smoke. E cigarettes even though marketed as a safer alternative to normal cigarettes generate toxic second hand smoke. Nicotine can cause cardiac problems in susceptible individuals and aggravate pre existing conditions. Arterial hardening has also been associated with nicotine and other chemicals present in e cigarette smoke. It also affects the CNS especially in children exposed to smoke and can cause developmental anomalies in kids affecting IQ, memory and attention[5]. Pregnant women using e cigarettes can cause damage to the unborn babies and it has been suggested that pregnant women shouldn't use nicotine at all.

Though e-cigarettes are in fashion and are being portrayed as a safer alternative to smoking and a way for smokers to give up smoking it is gathering more patronage in teenagers and young adults and is coming up in a big way as a for getting kids hooked on to a habit that is proven as a cause for diseases of the oral cavity, heart , lungs and cancer[6].

E- cigarettes just not contain nicotine alone nowadays as some brands also contain chemicals found in building materials and antifreeze that can be cancerous. Flavors incorporated into e cigarettes also raise great concerns for e.g. the use of a chemical called diacetyl, which is often added to foods to give a buttery taste to popcorns and other snacks. When diacetyl is inhaled, this harmful chemical, among other things, can cause a life threatening lung disorder is called popcorn lung as cited by the ALA.

E-cigarettes are thought be safer than normal cigarettes and as a result are having a farther reach especially among students. A survey by Wang et al in 2020 revealed that nearly 3.6 million of middle and high school students were e cig users and 81 percent cited the availability of appealing flavors as the reason[7]. (Figure 3)

Cigarette smoking kills almost 8 million people a year due to the chemicals that are emitted during burning and inhaled as smoke. As E-cigarettes don't produce smoke due to burning, so users are not exposed to those toxins. An expert review from Public Health, England in 2015 estimated that e-cigarettes are 95% less harmful than real cigarettes and ENDS, have surged in popularity but health organizations have been wary of them as a safer alternative to tobacco and various governments are introducing bills to regulate their use more strictly[8].

There are no definitive studies on the use of e cigarettes as an alternative and to help smokers quit smoking but this may be due to the diversity of the electronic products and low certainty among many studies. According to the FDA, no evidence has been found that e-cigarettes are a safe alternative and effective at helping smokers quit. The AHA advocates that e-cigarettes should only be used as a last resort by patients who have had no success with other treatment modalities.

A 2020 study in the journal of pediatrics concluded that teens using e-cigarettes had a higher predilection to use cigarettes compared to non user teens.[9] A study in JAMA in 2015 found a connection between e-cigarette users and increased predilection towards graduating to smoking. A study of 2,530 high school students who had never smoked cigarettes found that e-cigarette users had more chance to smoke or use other tobacco products over the next year than non-users. CDC statistics on teen smoking showed that while e-cigarettes use went up to 24% in 2015, cigarette smoking dropped to 11%.[10]

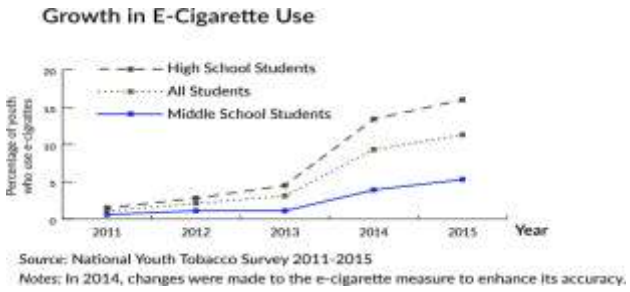

Figure 3: Rise in usage of E-cigarettes

REGULATIONS[11]

The FDA is regulating ENDS (electronic nicotine delivery systems) which include e-cigarettes as same as cigarettes and smokeless tobacco. The basic guidelines include:

- No sale to underage individual's whether online or in stores.
- Sellers have to check Identities of anyone less than 27 years of age.
- The ENDS cannot be sold from vending machines.
- Free samples or distributions are banned.
- Advertisements in any form for consumer sales are banned
- E-cigarettes available in the market after 2007 have to go through a stringent FDA safety and approval review to continue to be in the market.

What are the potential oral health side effects

A study in the University of Rochester in New York, gingiva of non smokers was exposed to e-cigarette vapor an inflammatory response was observed which aggravated stress and subsequent cellular damage. The findings were also duration and dose dependent. These findings contradict that the electronic devices are a healthier alternative to use of cigarettes. The research also observed that flavoring agents in e-cigarettes play a significant role in cellular damage.

A study has found that e-cigarette vapors may be as harmful to periodontal health as traditional cigarette smoke. The study, conducted by researchers at Université Laval in Quebec, Canada, involved an in vitro experiment whereby gingival epithelial cells were exposed to e-cigarette vapor in order to chart the effects.The negative effects of smoking traditional cigarettes have been well documented. Cigarette smoke has been linked to a number of diseases including cancer and bronchitis, as well as periodontal disease. Electronic cigarettes have been widely adopted by people who see them as a healthier alternative to regular cigarettes. This is because no combustion occurs while smoking, which eliminates the inhalation of harmful compounds such as tar and carbon monoxide. This study found the perception that they are healthier to be far from the reality.

For the experiment, researchers gathered gingival epithelial cells from the tissue of healthy non-smokers aged 18–25.

These cells were placed in a saliva-like liquid inside a custom-made smoke chamber. The cells were then exposed to e-cigarette vapor for 15 minutes a day in short bursts designed to mimic inhalations.When these cells were compared with the control sample, which had not been exposed to e-cigarette vapor, there was a stark contrast. The percentage of dead or dying cells was around 2% in the unexposed sample, whereas it was a remarkable 53% in the cells which had undergone three days of exposure.The authors suggested that this was due to the chemicals found in e-cigarette vapor. E-cigarettes work by vaporizing a liquid solution which typically contains glycerol, propylene glycol, nicotine and other flavorings. Studies have shown that after this solution is heated and turned into vapor it contains trace amounts of carcinogens and heavy metals, with a certain amount being converted into chemicals including formaldehyde.Continued exposure to traditional cigarette smoke can be a significant factor in tooth loss, and these findings suggest that electronic cigarettes also have potentially serious consequences for oral health, though further long-term research is required.[13]

The oral health effects of e-cigarettes are being studied extensively considering the effect of tobacco smoke with the oral environment. As several pathogenic processes in the oral cavity are attributed to smoking and use of nicotine, the contact of aerosols with the oral mucosa first when they are most concentrated and hot is also significant.

A systematic review in 2020 was done to establish if there was any evidence for effect of e cigarettes on oral health[12]. A few important studies were identified ranging from multiple user questionnaires/surveys that found the most reported side effect of e cigarettes was the recurring symptom of mouth and throat dryness and. Another study on growth of periodontal ligament fibroblasts exposed to additives demonstrated a decreased fibroblast proliferation rate with menthol additives.

On the other hand the cessation of smoking has shown to reduce tobacco related oral diseases, i.e. oral cancer and periodontal diseases. Smoking cessation is difficult for majority of users and one-year cessation rates of only 15 percent is achieved even while using intervention techniques and therapies. Therefore e-cigarettes may improve on the success rate and may be a particularly effective tool in the majority of patients who failed to quit.

Therefore the harmful effects of e-cigarette aerosol on the oral and periodontal tissues are to be considered and a balance sought with the benefit achieved by reducing exposure due to burning of tobacco.[14]

Despite the rising e-cigarette use insufficient studies are available to adjudge the toxicological effects of smoking on oral health. E cigarette aerosol mixtures added with flavors increase the oxidative stress and enhance the inflammatory cytokine release in human PDL fibers, gingival epithelial pooled cells (HGEPp), other gingival tissues.[12] E-cigarette derived chemicals cause increased oxidative stress and DNA damage, leading to dysregulated repair and impaired wound healing in smokers.

Nicotine has been found to impair leukocyte activity and delay healing due to inhibiting osteoblastic differentiation and neovascularization.[15] Studies have also found that smoking tobacco including e cigarettes is associated with an aggravated risk of failure of implants which could be due to impaired healing at the bone implant interface.. Berley et al. observed a decrease in level of osseo-integration in implants even after 4 weeks in rat femur which received nicotine subcutaneously[16]. Yamano et al. found in an animal study a down-regulated genetic expression of bone matrix genes in rats who received nicotine for 8 weeks which could be due to impairing of function of MSCs or stem cells by nicotine.[17]

Further studies have reported damage to lungs and alveoli with Lerner et al. reporting enhanced mitochondrial ROS, increased DNA nuclear fragmentation and reduced efficacy of electron transport chain complex in human lung fibroblasts when exposed to e-cigarette vapors and its end-products namely Cu nanoparticles[18]. Schweitzer et al. also reported that components of e-cigarettes namely propylene glycol, glycerol, and nicotine produced a loss of lung endothelial barrier function and caused an inflammatory response[19]. Gerloff et al observed that e-cigarettes and the various added agents can trigger a strong inflammatory response and cause dysfunction in the barrier membrane in the human lung epithelial cells[20].

Explosion: According to the FDA, 134 reports of serious injuries due to overheating e-cigarette batteries and catching fire, or exploding between 2009 and 2016. The FDA has instituted stringent guidelines to implement safety standards to prevent further occurrences.

Poisoning: Concentrated nicotine in liquid form is highly toxic with LD50 of 0.5/1.0 mg/kg in adults and 0.1 mg/kg in children. Therefore poisonings especially in children is on the rise. Guidelines advice keeping all e-cigarettes and their cartridges out of reach of children to prevent accidental poisoning. The most common effects of nicotine poisoning are nausea, headache, cough, and mouth/throat dryness and irritations, and death in extreme cases. The FDA has instituted regulations that will require the manufacturers to print warnings and manufacture child-resistant packaging for products.

CONCLUSION

E-cigarettes along with the various flavoring chemicals contribute to periodontal pathogenesis and affect general health via inflammation, cellular injury and delayed & dysregulated repair responses due to the effect on cellular proliferation and differentiation. This affects their ability in healing wounds by enhanced release of various pro-inflammatory compounds. E-cigarettes and their flavoring chemicals produce harmful effects in the oral mucosa, periodontal ligament cells and their precursor stem cells, and gingival fibroblasts. There is a need for a level headed and cautious approach to e-cigarettes as they are a double edged sword and judicious use is required for their use in the fight against tobacco. Further research, with long term studies, longitudinal and comparative studies, are required to have a better understanding of the impact of e-cigarettes on systemic and oral health. It is important and should be made mandatory for full disclosure by manufacturers about the materials and

chemicals used in manufacture of e-cigarettes so as to help the consumers understand the potential dangers.

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