The use of electronic cigarettes and their implications for oral health
Electronic cigarettes, also called: Electronic Nicotine Delivery Systems (Ends), e-cigarettes, e-ciggy, ecigar, are mechanical-electronic devices activated by means of a lithium battery, whose function is to heat a liquid solution to high temperatures - which may contain nicotine, propylene glycol or, glycerol and additives - producing an aerosol that is inhaled by the user. The objective of the present study is to carry out a literature review on the impacts and repercussions of oral alterations resulting from the constituents of electronic cigarettes, as well as to discuss the role of related aspects for the correct diagnosis of these alterations and treatment mechanisms involved. Free articles, in Portuguese and / or English, and those in its full version, which apply to the theme proposed by the research, were included in the research in order to respond to the problems and objectives of the research. The study presented a current review of the implications that electronic cigarettes can have in the oral cavity. The constituents of these devices have proven genotoxic properties and have carcinogenic potential. More research is needed to understand the clinical results of long-term impacts on oral health.

**Keywords:** Electronic Cigarette, Nicotine, Oral Health.
INTRODUCTION

Electronic cigarettes, also called: Electronic Nicotine Delivery Systems (Ends), e-cigarettes, e-ciggy, e-cig, are mechanical-electronic devices activated by means of a lithium battery, whose function is to heat a liquid solution to high temperatures - which may contain nicotine, propylene glycol or, glycerol and additives - producing an aerosol that is inhaled by the user (BENOWITZ; FRAIMAN, 2017). The estimated temperature was 350°C, a condition in which chemical and physical reactions promote changes in these solutions, forming other potentially toxic substances (BESARATINIA, 2017).

The reality is that it has been observed that political changes regarding the use of electronic cigarettes have occurred worldwide (FARSALINOS, 2014). Several countries such as Brazil, Argentina and India have banned electronic cigarettes. In other countries such as Japan, South Africa and England, electronic cigarettes are allowed as a therapeutic means (FARSALINOS; STIMSON, 2014). The survey also showed that in the USA, in 2018, there was an increase of 1.5 million users, among these elementary and high school students. In countries such as Australia and the United Kingdom, the ban was restricted to the sale of nicotine used for this purpose; being strictly prohibited in Australia, and a limit quantity allowed for sales in the United Kingdom (BESARATINIA, 2017).

Studies that demonstrate the toxic effects of electronic cigarettes on oral health are still limited. Published evidence attempts to explain the effects of electronic cigarettes on periodontal health, including various pathophysiological events, such as oxidative stress, DNA damage, inflammation, cell senescence, unregulated repair and periodontal diseases. Results of in vitro research have shown a correlation between the aerosols of electronic cigarettes, with or without nicotine, and changes in the periodontal ligament, in stem cells and gingival fibroblasts due to the presence of aldehydes / carbonyls that lead to carbonylation of extracellular matrix proteins (FARSALINOS, 2014).

The objective of the present study is to carry out a literature review on the impacts and repercussions of oral alterations resulting from the constituents of electronic cigarettes, as well as to discuss the role of related aspects for the correct diagnosis of these alterations and treatment mechanisms involved, expanding the understanding about the subject.

MATERIAL AND METHODS

To carry out this literature review, the online database was used: National Center for Biotechnology Information- NCBI (PubMed), using the following terms and operators: “electronic cigarette” OR “e-cigarette” OR “electronic cigarettes” AND “oral health “. Free articles, in Portuguese and / or English, and those in its full version, which apply to the theme proposed
by the research, were included in the research in order to respond to the problems and objectives of the research. As exclusion criteria, non-systematic literature reviews, articles that did not refer strictly to the topic, and articles that had only the available abstract were excluded.

LITERATURE REVIEW AND DISCUSSION

In 2009, the National Health Surveillance Agency (Anvisa) issued Resolution RDC 46/2009, which prohibited the marketing and advertising of any type of electronic device for smoking with or without nicotine throughout the national territory until scientific studies and toxicological and clinical evaluations, aiming to identify its risks and supposed efficacy in smoking cessation (ANVISA, 2009). Anvisa considered in the ban the harmful potential of “purified” nicotine extracts to human health. Thus, Brazil was one of the first countries in the world to ban electronic smoking / electronic cigarette devices (GILLMAN, 2016).

Currently, it is observed that these products should be classified according to the harmful potential of nicotine and its ability to cause addiction, which becomes a great alert for the establishment of effective smoking control policies (GONIEWICZ, 2014). Studies report the emergence of electronic cigarettes in 2003 invented by Chinese pharmacist Hon Lik, however, years before large cigarette companies had already invested in the development of these devices (GILLMAN, 2016).

Currently, commercialized electronic cigarettes (Figure 1) differ in terms of the type of device, those classified as “first generation” resemble conventional cigarettes in appearance and can be refilled or discarded after use (GRANA, BENOWITZ; GLANTZ, 2014). These generally produce aerosol with a fixed duration of inhalation or frequency. Larger “second generation” devices are composed of a rechargeable cartridge, have a more powerful battery that allows the user to adjust the duration and frequency of puffs. The “third generation” tank type features a high-capacity battery, refillable cartridges and greater user control and personalization capacity, such as voltage or power adjustment, influencing the nicotine (and potential toxin) content present in the aerosol (GILLMAN, 2016; NIDES, 2014).
The composition of the liquids used in these devices may vary depending on the model used. Different concentrations of nicotine, water, flavorings and countless other additives can be found (Figure 2) (PUTZHAMMER, 2016). Propylene glycol is a substance considered harmless for oral ingestion, it can also be used as a humectant for cosmetics, industrial antifreeze and in theaters for the production of fog (SCHALLER, 2013). Research shows that this substance when heated and vaporized can form propylene oxide, which can have a carcinogenic action (SUTFIN, 2013).

Source: Putzhammer (2016).
Glycerol and glycerin are substances released for use in food and cosmetics. When heated, glycerol gives rise to acetaldehyde. Acetaldehyde is possibly classified as a carcinogen for humans (VORA, 2019). Ethylene glycol has been described in samples of electronic cigarettes labeled as nicotine free. Ethylene glycol is a skin and eye irritant. It is also used in antifreeze, detergents, paints, varnishes, pharmaceuticals, adhesives and cosmetics (SCHALLER, 2013).

As for the emission of metals, research shows that sodium, iron, aluminum and nickel may be present in higher concentrations in the vapors of electronic cigarettes than in regular cigarettes (GRANA, BENOWITZ; GLANTZ, 2014). Other elements such as copper, magnesium, lead, chromium and manganese were found in the same concentrations; and potassium and zinc in lower concentrations (SCHALLER, 2013).

Studies have associated electronic cigarettes with increased heart rate and endothelial cell toxicity (Figure 3). In some studies, cardiovascular changes were less pronounced with exposure to aerosol from electronic cigarettes compared to cigarette smoke (NIDES, 2014; PUTZHAMMER, 2016; BENOWITZ, Fraiman, 2017). Although it is known that lower levels of toxic substances are present in electronic cigarettes when compared to conventional ones, the values found are biologically relevant in their potential (WILLIAMS, 2013, GONIEWICZ, 2014).

**Figure 3.** Cytotoxicity mechanisms.

**Antibody-Dependent Cell-Mediated Cytotoxicity (ADCC)**

YE (2020), observed the effect of the use of electronic cigarettes on the biological profiles of saliva and crevicular gingival fluid (Figure 4), the profiles of users of conventional cigarettes, electronic cigarettes, users who used both types and non-users were evaluated and compared. Systemic inflammatory mediators between groups were also assessed.
The level of prostaglandin E2 was significantly higher for users of conventional cigarettes. For biomarkers of inflammatory mediators, a statistically significant difference was found between the groups that used electronic cigarettes and non-smokers; as well as between the group of users who used both types of cigarette and those who only used conventional cigarettes. The level of oxidative stress markers was significantly decreased in the groups of users of conventional cigarettes and users of electronic cigarettes, when compared to non-smokers (YE, 2020).

Few studies are published on the potential health consequences of electronic cigarettes and on its effectiveness as a strategic method in helping smoking cessation. Studies carried out with samples of the chemical vapors and liquid substances used in these devices, warned about the harmfulness of toxic and carcinogenic substances, similar to those found in conventional cigarette smoke (BESARATINIA, 2017).

The concentrations of most carcinogenic compounds present in the aerosols of electronic cigarettes are lower than those present in conventional cigarette smoke, however there is no “safe” level of exposure given the potential of carcinogens (Vora, 2019). The literature shows that reports of electronic systems associated with nicotine started in 1963, developed by tobacco companies.

Research carried out at the University of California, San Francisco, found that in 1990 Philip Morris began to develop a device that aerolized a nicotine solution, using technology
for pharmaceutical applications, as it was not known how such products would be designed by Food and Drug Administration. The widespread intention was to solve health problems and reduce the number of smokers, in a kind of nicotinic therapy by changing the form of consumption (Farsalinos & Stimson, 2014).

Research found that some models of electronic cigarettes marketed “without nicotine”, contained low levels of nicotine. The results also showed that half of the samples contained four tobacco-specific nitrosamines (NNN, NNK, NAB and NAT), the first two being classified as carcinogenic to humans (Sutfin, 2013). The acute use of electronic cigarettes can trigger oxidative stress and increase resistance to airflow, and cause changes in the secretion of proteins from the immune system in human airways. Pulmonary repercussions are important factors in observing the consequences caused by smoking (Besaratinia, 2017).

GANAPATHY (2017), examined the effects of aerosol exposure from electronic cigarettes on possible DNA damage in oral and lung epithelial cells. The results presented showed that exposure to aerosols from electronic cigarettes can cause significant levels of mutagenic DNA damage. Observation regarding the mechanisms that modulate DNA damage, identified an increase in reactive oxygen species, a decrease in total antioxidant capacity and a decrease in the expression of proteins essential for the repair of DNA damage; potentially increasing DNA damage and the risk of cancer.

YANG, SANDEEP E RODRIGUEZ (2020) in a systematic review gathered evidence from available research on the impact of electronic cigarette use on oral health. Reports of exposure to electronic cigarettes were associated with an increased risk of deteriorating periodontal, dental and gum health, as well as changes in the oral microbiota. It has also been reported that vapors generated by electronic cigarettes have cytotoxic, genotoxic and carcinogenic properties.

**CONCLUSION**

The study presented a current review of the implications that electronic cigarettes can have in the oral cavity. The constituents of these devices have proven genotoxic properties and have carcinogenic potential. More research is needed to understand the clinical results of long-term impacts on oral health.
REFERÊNCIAS


