

Center of Excellence in Regulatory Tobacco Science
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Effects of Electronic Nicotine Delivery Systems on the Oral Microbiome

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Abstract

One sixth of the world's population (or 1.1 billion individuals) smokes. In the U.S. alone, nearly 20% (45.3 million) of the population are current cigarette smokers; of these, nearly 80% (35.4 million) smoke every day¹. More alarmingly, the CDC reports that each day more 4,000 persons younger than 18 years of age smoke their first cigarette². These numbers suggest that despite numerous efforts in public policy and health education, smoking is still highly prevalent, especially among the younger age groups.

Though not as prevalent, the use of Electronic Nicotine Delivery Systems (electronic cigarettes or ENDS) is rapidly increasing among adolescents. The CDC reports that 6.8% of students between grades 6-12 (1.78 million children) have used ENDS². This uptake may be due in part to risk perceptions; 71% of smokers believe that ENDS are safer than conventional cigarettes and 28% considered them safer than nicotine replacement therapy³. However, these products vary widely in nicotine content, propylene glycol, glycerol, additives and flavorings; suggesting that these products – particularly if unregulated – may deliver toxins that interfere with a variety of bodily processes. Therefore, *there is an urgent need to develop biological metrics* for risk assessment that will facilitate science-based regulation.

Smokers present a high-at-risk cohort for three of the most common bacterially driven oral diseases — gingivitis, periodontitis and oral squamous cell carcinoma. For example, smoking presents a 6-27 fold higher risk for oral cancer⁴ and 5-15 fold risk for extensive and severe periodontal destruction⁵. It is known that smoking leads to changes not only in the human host but also in the oral microbiome⁶. We have previously demonstrated that smoking leads to pathogen-rich oral bacterial communities and a highly pro-inflammatory host response even in states of clinical oral health⁷. Importantly, our preliminary data provides compelling evidence that nicotine and cigarette smoke exert similarly deleterious effects on gene expression in oral biofilms, suggesting that nicotine itself may be a key catalyst for oral diseases, irrespective of the form of delivery. Based on these findings, we hypothesize that the risk-for-harm for bacterially driven oral diseases will be similar for ENDS and cigarettes. We propose to test this hypothesis using the specific aim below.

In summary, we propose much-needed studies in a severely under-explored area of research, namely, the impact of ENDS on oral health. By using high-throughput genomic research to compare the effects of tobacco smoke and ENDS on the oral microbiome, we will acquire baseline data that will enable us to design future, longitudinal studies to assess the short and long-term effects of ENDS on the oral cavity. The proposed studies will begin to establish a risk profile for ENDS in comparison to conventional cigarettes. Additional deliverables will include a panel of microbial markers for ENDS and cigarette exposure.

Aims

Aim 1: To assess the biological effects of ENDS on the oral environment by combining a five parallel group (nicotine free and high-nicotine ENDS, conventional cigarettes, dual use (ENDS and cigarettes) and non-smoking controls) cross-sectional study with shotgun sequencing, computational bioinformatics and comparative -genomics.