Published in final edited form as:

J Adolesc Health. 2018 November ; 63(5): 587–593. doi:10.1016/j.jadohealth.2018.06.007.

Missed Opportunities for Detecting Alternative Nicotine Product Use in Youth: Data from the National Dental PBRN

Kimberley R. Isett,

Georgia Institute of Technology School of Public Policy

Simone Rosenblum,

Georgia Institute of Technology School of Public Policy

Julie Ann Barna,

Private Practice, Lewisberg, PA

Diana Hicks,

Georgia Institute of Technology School of Public Policy

Gregg H. Gilbert,

University of Alabama at Birmingham, School of Dentistry

Julia Melkers*

Georgia Institute of Technology School of Public Policy, and the National Dental PBRN Collaborative Group

Abstract

Purpose—With growing rates of youth e-cigarette and hookah use, and the fact that use of these products is difficult to detect, surveillance and early detection efforts need to be re-assessed. Physicians and pediatricians both report that their level of knowledge about these products is low. Given that over 80% of youth have had dental visits in the past year and that the effects of nicotine use are visible early in routine dental examinations, it is likely that dental professionals are well

*The National Dental PBRN Collaborative Group includes practitioner, faculty, and staff investigators who contributed to this activity. A list is available at <http://nationaldentalpbrn.org/collaborative-group.php>

corresponding author Kimberley R. Isett, Georgia Institute of Technology School of Public Policy.

Author statements:

Prof. Isett was the lead author on the paper and played a substantial role in the design of the study, guided the data analysis, wrote the first draft of the paper, and all subsequent versions.

Ms. Rosenblum was the lead in survey implementation and data analysis. She contributed to writing the paper and reviewing subsequent drafts.

Dr. Barna provided the initial idea for the paper and helped to shape its message and relevance to practicing dental professionals. She reviewed and contributed to the written paper.

Prof. Hicks contributed to the design of the study and the interpretation of the data. She reviewed and contributed to all written versions of the paper.

Dr. Gilbert contributed to conceptualization of study design, data acquisition, editing and revising the manuscript.

Prof. Melkers contributed to conceptualization and implementation of study design, data acquisition. She also provided editing and revising of the manuscript.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

positioned to play a critical role in detection. Currently, the knowledge about alternative nicotine among practicing dental clinicians is unknown.

Methods—1,722 dental professionals in community practice in the United States National Dental Practice-Based Research Network responded to a survey in the Summer/Fall of 2016. These data were supplemented with network membership enrollment data, and the American Community Survey, and were analyzed using descriptive statistics, measures of association, and logistic regression.

Results—Only 25%–36% of dental professionals feel knowledgeable about the most common types of alternative nicotine products, including e-cigarettes and hookahs. 38% of respondents reported not screening at all for e-cigarettes.

Conclusions—A substantial percentage of dental professionals do not have a working understanding of alternative nicotine products, nor are aware of their patients' use rates. Better access to information and training on alternative nicotine products could provide an opportunity to improve surveillance for early use of these products in youth populations.

The recent National Academies consensus report on e-cigarettes confirms much of what is known about e-cigarette use¹. Alternative nicotine products are a \$3.3b industry and are now the preferred nicotine product of youth populations^{2,3}. Despite the availability of nicotine-free varieties, 98% of e-cigarettes sold in 2015 contained nicotine⁴. Kasza and colleagues⁵ report that 1.6% of youth are daily users of tobacco, while Lanza et al.⁶ show that rates of e-cigarette use increase faster than combustibles in 13–16 year-olds. And while e-cigarettes are typically in the spotlight, use of other alternative nicotine products such as hookahs^a are also common -- 1 in 5 boys, and 1 in 6 girls had used hookahs in the past year⁷.

Unfortunately, adolescents using alternative nicotine products are new entrants to the tobacco market^{8,9}. The use of e-cigarettes in this population was associated with an elevated intention to smoke combustibles¹⁰ and the low cost of e-cigarettes is predictive of more days of nicotine use¹¹. Within youth populations, members of racial and sexual minorities have higher use^{5,12} -- with Hispanic youth^{6,13} and lesbian and bisexual girls¹⁴ having the greatest prevalence.

The bitterness of tobacco flavor has a negative effect on liking e-cigarettes¹⁵, so flavors are an especially salient inducement for youth^{16,17}. Flavoring in e-cigarettes is important for both initiation and continued use^{15,16,18}, and most users say their first and their "usual" e-cigarettes are flavored^{16,18}. About 61% of youth who had used e-cigarettes in the past 30 days used a flavored variety¹⁸.

Alarming, several studies illustrate that youth believe they are able to assess the relative harm of tobacco products. Seventy-three percent of youth believe e-cigarettes are less harmful than combustible cigarettes and 47% believed they were less addictive¹⁹. In another study, youth who had ever or were currently using e-cigarettes had greater odds than non-

^aHookahs are not a focus in this paper. However, as an important and prevalent secondary category of alternative nicotine delivery systems we include information and results about them for completeness and to begin to provide information about these products in the literature.

users of believing e-cigarettes were “not at all harmful” and “not at all addictive”²⁰. Youth also believed e-cigarettes were less harmful if they were flavored than if the aerosol tasted like tobacco^{17,20}. Perceived safety is correlated with increased use¹⁹.

E-cigarettes do offer some harm reduction benefits over traditional combustibles, at least in the short term¹. For example, e-cigarette aerosol is less cytotoxic²¹ and induces less oxidative stress than tobacco smoke²². However, danger lies in misinterpreting the evidence to suggest e-cigarettes are harmless. Laboratory studies have shown that e-cigarette aerosols are cytotoxic regardless of nicotine content and flavored aerosols increase the toxicity of the product overall, as well as the pathogenesis of oral disease^{23–25}. Additionally, emerging evidence suggests “passive” smokers are not without harm with alternative nicotine delivery products^{26,27}, as previously thought.

Early detection of alternative nicotine product use is particularly important to head off lifelong nicotine addiction and burden²⁸. Effects of smoking have been well documented and include coronary heart disease, stroke, cancer, and adverse pregnancy and birth outcomes^b. Unfortunately, many of the undesirable signs of combustible tobacco use are avoided with these products (e.g. stained fingers and teeth, odor of smoke) -suggesting a need to re-assess how detection and surveillance services are delivered, and a potential front line role for dental professionals. Given that 83 percent of youth ages 2–17 have had a dental visit in the previous year²⁹ and early signs of nicotine use such as inflammation, *Candida*, periodontitis, and dry socket³⁰ will be evident in oral examinations at the dentist’s office, oral screening may be effective in the early detection of alternative nicotine use. Dentists and hygienists have ready access to youths’ oral cavities and are well positioned to see the early signs of use and participate in the frontline of nicotine use surveillance.

Despite this potential, dental professionals do not have ready access to information on e-cigarettes. From January 1, 2014, until December 31, 2016^c, 245 journals indexed in the PubMed database published 762 original research articles on e-cigarettes. Of the 762 scientific articles appearing in PubMed, only six are in dental journals. Thus, to a large degree, information salient to the specifics of dentistry and e-cigarettes is limited, consistent with the documentation of the struggle of general physicians’ and pediatricians’ understanding these products^{31,32}.

With this in mind, we investigate dental professionals’ clinical engagement with and knowledge of alternative nicotine. This study identifies gaps in knowledge that if eliminated could improve surveillance and early detection efforts by dental professionals, potentially preventing long-term use of nicotine products and avoidance of the attendant negative health outcomes of smoking. This investigation also begins to answer the call for discussion of prevention of alternative tobacco product use outside of traditional tobacco control outlets³³.

^bFor an overview of the state of knowledge of the effect of smoking on health, refer to the CDC’s fact sheet, https://www.cdc.gov/tobacco/data_statistics/fact_sheets/health_effects/effects_cig_smoking/index.htm.

^cThis time period is used to correspond to the three years preceding the data presented in this paper.

Methods

Our analysis is based on two sources: primary data collected through surveys^d and related secondary data. An online survey approved by the eight applicable Institutional Review Boards was implemented in the Summer/Fall of 2016 with the members of the National Dental Practice-Based Research Network (PBRN), a consortium of dental practices and dental organizations focused on improving the scientific basis for clinical decision-making³⁴. The survey was designed to gather data about how dental professionals acquire practice-relevant evidence to incorporate into their patient care. The survey instrument underwent cognitive interview and pilot testing prior to launch to ensure the validity of the measures.

The sampling frame was all network members who were practicing dentists or hygienists, with some exclusions. First, professionals working at an academic institution were excluded. The broader study from where the data for this analysis came is centered on the translation of evidence from the peer-reviewed literature to use by professionals in clinical practice in communities. Given the educational, training, and research missions of universities, it is likely that dental professionals working in these settings have atypical access to empirical evidence and thus including them could have skewed our results. Second, guided by the study team's dental professionals, specialty types that were unlikely to treat a broad array of patient types including adults, young adults, and adolescents were also excluded. Specifically, orthodontists and pediatric dentists were excluded because their patient base is truncated. Then a stratified sampling strategy was employed with random sampling within strata and oversampling of underrepresented groups within the dental profession (i.e. female dentists and male hygienists, racial and ethnic minorities). Strata were based upon the six geographical regions of the network. Overall, 3106 practicing dentists and hygienists were surveyed and 1842 individuals responded. 120 respondents were ineligible and thus excluded from analysis. This resulted in a final adjusted response rate of 58% (N= 1,722). All data reported here were analyzed by the second author.

A representativeness analysis of the respondents to both the PBRN as a whole and to the population of dentists and hygienists in the U.S. was conducted. Using 2015 data from the Bureau of Labor Statistics (BLS) (number of dentists and hygienists by gender and race) and the American Dental Association (ADA) (population of dentists for age, gender, dental specialties, patient insurance coverage, and patient wait times), an independent sample t-test for comparison of means between the response group and the sub-population from which the sample was drawn (N= 4279) was performed using IBM SPSS statistical software v. 24. A test of given proportions which allows a test of the null hypothesis that the proportions of the response group are the same as the proportions of the population based on both the BLS (dentists and hygienists) and ADA (dentists only, no comparable hygienist data were available) data was run using R v. 3.4.0.

^dAll survey instruments used for this project are available at <http://nationaldentalpbrn.org/study-results/under> the study title listing "Rapid disruptions..."

On average, the study sample is representative of the PBRN with regard to age (sample age 50.2, PBRN age 50.8, n.s.) and proportion of generalists to specialists (see Table 1). The sample however, over represents the racial and ethnic categories that were explicitly oversampled, both in the PBRN population and with regard to the Bureau of Labor Statistics data. Given that the study was designed to represent the PBRN, but also to ensure that voices of underrepresented groups were included, these results are consistent with our goals.

The survey data were supplemented with other data sources. First, data from a detailed enrollment questionnaire that provided information about network members' race/ethnicity, educational background, and practice information were utilized. Second, data from the American Community Survey provided information about demographic and socioeconomic indicators in the ZIP code where each provider practices.

Survey Questions

The data analysis focuses on questions pertinent to patient use and clinician knowledge of a broad array of alternative nicotine products, with only the two most prominent kinds (e-cigarettes and hookahs) reported here. Throughout, survey responses related to alternative nicotine are compared with responses about traditional nicotine products like combustible cigarettes and smokeless tobacco to provide a cognitive anchor. In the survey, respondents were not required to answer any question. In cases of missing data, those individuals were excluded from the relevant analyses. Thus, in many cases the Ns reported in the results tables do not equal our sampled population.

Knowledge about alternative nicotine products—Survey respondents were asked to indicate how knowledgeable they were about an array of nicotine delivery products including traditional products like combustible cigarettes and smokeless tobacco. They were asked to indicate their knowledge about these products on a four point Likert-type scale with “not knowledgeable at all” as one anchor and “very knowledgeable” as the other. For the analyses the scale was collapsed to two categories representing “not knowledgeable” and “knowledgeable”.

Additionally, the extent to which dental providers perceived the relative harm of alternative nicotine products was assessed. They were asked to indicate “based on what you know today how harmful are the following to oral health compared to traditional cigarettes?” Here, the categories were “less harmful”, “about the same”, “more harmful”, and “not sure”.

To analyze the responses, correlation matrices and chi-square statistics were run in SPSS v. 24 to look at the strength of the relationships between product knowledge and different sociodemographic characteristics of the provider population from the PBRN, and patient population using data from the ACS. Logistic regression models with sample weights were also run to test the association among different socioeconomic and demographic variables, and the knowledge level of the professionals using Stata v.14.2.

Patient use and detection—To understand how dental professionals interact with patients about their nicotine use, two questions were asked. In the first, respondents indicated all the strategies they employ to identify nicotine users. These include screening

forms, asking patients, patient or family member volunteering information, intraoral examination, or do not screen. Clinicians then indicated the extent to which they see patients in their practices who use each of the products in a typical month. Response options were never, one or two patients, fewer than ten patients, ten or more patients, or not sure. These results are reported descriptively.

Information search on alternative nicotine—To understand the extent to which there was engagement with clinical knowledge about alternative nicotine products, respondents were asked if they had searched for information on these products, why they searched for that information, and where they searched. To make the search information more concrete, we asked that they focus on e-cigarettes within this series of questions. For dental professionals who did not do a search, they were asked to walk through a hypothetical search on e-cigarettes (e.g., where would you go first?).

To analyze these responses, descriptive statistics are reported illustrating the relationship among professionals and their search strategies. We also further looked at whether there was a relationship between initial level of knowledge about alternative products and search strategies to understand if where you searched was dependent upon what you know, using a chi-square test run in SPSS v. 24.

Results

Knowledge about alternative nicotine products

Table 2 displays the responses given by dental professionals about their perceived knowledge of nicotine products. Focusing on the last column where the aggregate totals are listed, 90% (X^2 6.867, $\alpha < .05$) of dental professionals feel knowledgeable about smoking and 68% (X^2 7.914, $\alpha < .05$) feel knowledgeable about smokeless products, which are both significant statistically. However, reported knowledge about newer nicotine products is much less, with only 36% of respondents feeling knowledgeable about e-cigarettes and 25% about hookahs (X^2 n.s., both). The three columns that report the same information broken out by our main professional categories (hygienists, general dentists, and dental specialists), show that the percentages reporting being not knowledgeable and knowledgeable align very closely with the overall aggregate totals.

A correlation matrix and logistic regressions were run (results not shown in tabular format) to determine if data about nicotine product knowledge co-varied with other kinds of products, sociodemographic characteristics of the provider or patient population, and geographical region. Correlations among the perceived knowledge about alternative nicotine products and smokeless tobacco were positive and significant (smokeless and e-cigarettes .522, smokeless and hookah .431, e-cigarettes and hookah .66, all $\alpha < .05$), indicating that if respondents perceived themselves to be knowledgeable about one of these products, they felt knowledgeable about the others as well. However, no other correlations were significant. Logistic regression models were not significant and had limited explanatory power, indicating that knowledge about alternative nicotine products had little relationship with these kinds of general SES and demographic variables.

Results reported in Table 3 reveal that dental professionals disagree about the relative harm of alternative nicotine products compared to traditional cigarettes. Again, focusing on the fourth column representing the aggregate totals, about half of dental professionals reported that they believed e-cigarettes and hookahs to be as harmful to oral health as cigarettes, with another 42% (X^2 13.522, $\alpha < .01$) of professionals perceiving e-cigarettes to be less harmful. The remaining respondents on hookah's relative harm were split. Twenty-three percent perceived hookahs to be less harmful and an approximate equal proportion perceived them to be safer (X^2 n.s.). These data suggest there is uncertainty about these products within the profession. As with the information reported in Table 2 about knowledge about nicotine delivery products, the granularity of the data by professional category does not reveal much. One exception here is the difference between hygienists and specialists. For both smokeless tobacco and e-cigarettes, hygienists believe these products are more harmful than traditional combustible cigarettes at greater proportions than specialists.

Patient use and detection

Most dental professionals use a combination of methods to detect nicotine use including patient screening forms, asking patients, and intraoral examinations. Interestingly, the survey results (not shown in tabular form) show that a considerable percentage of dental professionals do not screen for e-cigarettes (38%) or hookahs (64%). Further, 43% report that they are unsure what percentage of their patients use e-cigarettes, and 66% hookahs – compared to only 2% of dental professionals who were unsure about traditional cigarette use.

Information search on alternative nicotine

Both professionals who searched for information and those who hypothesized about what their search would look like revealed the same preferences for finding information on e-cigarettes for their clinical practice. The first stop for about one-third of dental professionals was a general internet search. This involved a search engine or Wikipedia, not a professional database like PubMed (37% of real searchers and 35% of hypothetical searchers). Preference for the peer-reviewed literature (21% real, 27% hypothetical) and then other professional sources (e.g., associations, continuing education materials) (19% real, 18% hypothetical) followed. These preferences represent between 76% (real) and 79% (hypothetical) of respondents. Initial search choice was not associated with level of reported knowledge of alternative nicotine (X^2 n.s.).

Discussion

Many healthcare professionals, including dentists and hygienists, are struggling to understand the implications of alternative nicotine for health and patient care. Because use of e-cigarettes is growing faster than traditional combustible cigarettes, especially in youth populations, this is an important gap and can hinder effective prevention of nicotine addiction.

The results shown on perceived understanding of relative health harms of alternative nicotine products compared to combustible cigarettes illustrate the uncertainty dental professionals

have about these kinds of products. While the literature shows that some health harms are reduced at least in the short run^{1,21,22}, dental professionals seem unaware of this. Exacerbating this is that even less is known about the impacts of this class of nicotine products on oral health than overall health and addiction. With the majority of the professionals in this study reporting perceived equal or increased harm from alternative nicotine products, it is unclear why more providers are not taking additional steps to detect use. The gap between 2% of respondents being unsure about cigarette use in their practice compared to 43–66% being unsure of their patients' alternative nicotine use is important. This is a barrier to detection of product use.

Perhaps the gap between perceived danger and explicit attention to detection is related to the dearth of relevant clinical dental information. The dominant strategy of our respondents for finding information on e-cigarettes was a general internet search (e.g., Google) which is most likely to return general information packaged for a lay audience, with limited use for clinical intervention. However, the 20% of clinicians who report going to the peer-reviewed literature first may not obtain much better information than Google searchers. Of the six articles published in dental journals noted earlier, only one appears in any of the journals that dentists have identified as among the publications they read regularly^{35,36}. Even if these dentists then have access to and consult major publications in other disciplines –which is unlikely due to paywalls, the information contained would not be specific to oral health and thus the salience of that information for practicing dental professionals is questionable. So, despite the large volume of alternative nicotine research being published, dental professionals' needs are not being served. Systematic efforts to provide continuing dental education and engagement with tobacco prevention experts could aid in closing this gap.

Limitations

The data used in this study are self-reported; therefore we do not have objective assessments of dental professionals' knowledge of the products we asked about or their information search processes. However, professionals have been shown to accurately recall and report their "typical" operations and procedures in prior studies^{37–39} so we can reasonably expect their responses to be consistent with usual practice. Second, our sample of dental professionals comes from a practice-based research network, which is a subset of all dentists and hygienists in the United States. We identified specific characteristics in which our sample differs from both the network and the larger population of dental professionals and reported that transparently. While these differences serve our study purpose, we caution to interpret the findings herein with these caveats in mind.

Conclusion

The oral cavity is a microcosm of overall health⁴⁰, and many health problems, including the effects of nicotine, are evident in the mouth early. Thus, dental professionals are uniquely positioned to play a key role in surveillance and early detection of alternative nicotine use. Currently, the potential of dental professionals to fulfill an early detection role is unexploited. Clinical, public health, and tobacco control researchers should engage dental professionals in this conversation and enlist their help in surveillance of at-risk populations –

youth generally and specifically Hispanic and LGBTQIA youth, and detection population wide. Attentiveness to the diagnostic signs of nicotine use beyond the obvious indicators of traditional cigarettes could provide insight into oral problems presenting in unexpected populations. This effort could be an important tool to head off the long-term scourge of increased nicotine addiction and leverage a uniquely positioned professional population underutilized in health surveillance efforts.

Acknowledgments

This work was supported by NIH grant U19-DE-22516. An Internet site devoted to details about the nation's network is located at <http://NationalDentalPBRN.org>. We are grateful to our entire study team for their insight and contribution to this paper and the project (Eugenio Beltran, DMD, MPH, MS, DrPH, DABDPH, George Ford, DMD, Julie Frantsve-Hawley, RDH, PhD, Ellen Funkhouser, DrPH, Michael Melkers, DDS, FAGD and Dan Meyer, DDS), members of the PBRN that provided useful critique of the paper (David L. Cochran, DDS PhD Valeria V. Gordan, DDS, MS, MS-CL, Heather Weidener, RDH and Jeff Fellows, PhD), as well as the regional coordinators who were indispensable in the data collection and follow up process (Meredith Buchberg, MPH, Claudia Carcelen, MPH, Colleen Dolan, MPH, Stephanie Hodge, MA, Hanna Knopf, BA, Shermetria Massingale, MPH, CHES, Deborah McEdward, RDH, BS, CCRP, Christine O'Brien, RDH, Stephanie Reyes, BA, Tracy Shea, RDH, BSDH, and Ellen Sowell, BA). Opinions and assertions contained herein are those of the authors and are not to be construed as necessarily representing the views of the respective organizations or the National Institutes of Health. The informed consent of all human subjects who participated in this investigation was obtained after the nature of the procedures had been explained fully.

References

1. National Academies of Sciences E, and Medicine,. Public health consequences of e-cigarettes. Washington, DC: The National Academies Press; 2018.
2. Greenhill R, Dawkins L, Notley C, Finn MD, Turner JJD. Adolescent Awareness and Use of Electronic Cigarettes: A Review of Emerging Trends and Findings. *J Adolesc Health*. 2016;59(6):612–619. [PubMed: 27693128]
3. Gilreath TD, Leventhal A, Barrington-Trimis JL, et al. Patterns of Alternative Tobacco Product Use: Emergence of Hookah and E-cigarettes as Preferred Products Amongst Youth. *J Adolesc Health*. 2016;58(2):181–185. [PubMed: 26598059]
4. Marynak KL, Gammon DG, Rogers T, Coats EM, Singh T, King BA. Sales of Nicotine-Containing Electronic Cigarette Products: United States, 2015. *Am J Public Health*. 2017;107(5):702–705. [PubMed: 28323467]
5. Kasza KA, Ambrose BK, Conway KP, et al. Tobacco-Product Use by Adults and Youths in the United States in 2013 and 2014. *N Engl J Med*. 2017;376(4):342–353. [PubMed: 28121512]
6. Lanza ST, Russell MA, Braymiller JL. Emergence of electronic cigarette use in US adolescents and the link to traditional cigarette use. *Addict Behav*. 2017;67:38–43. [PubMed: 27988415]
7. U.S. Department of Health and Human Services. E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General In: U.S. Department of Health and Human Services CfDCAp, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, ed. Atlanta, GA2016.
8. Barrington-Trimis JL, Urman R, Berhane K, et al. E-Cigarettes and Future Cigarette Use. *Pediatrics*. 2016;138(1).
9. Dutra LM, Glantz SA. E-cigarettes and National Adolescent Cigarette Use: 2004–2014. *Pediatrics*. 2017;139(2).
10. Park JY, Seo DC, Lin HC. E-Cigarette Use and Intention to Initiate or Quit Smoking Among US Youths. *Am J Public Health*. 2016;106(4):672–678. [PubMed: 26794178]
11. Bold KW, Kong G, Cavallo DA, Camenga DR, Krishnan-Sarin S. Reasons for Trying E-cigarettes and Risk of Continued Use. *Pediatrics*. 2016;138(3).
12. Coulter RWS, Bersamin M, Russell ST, Mair C. The Effects of Gender- and Sexuality-Based Harassment on Lesbian, Gay, Bisexual, and Transgender Substance Use Disparities. *J Adolesc Health*. 2017.

13. El-Toukhy S, Sabado M, Choi K. Trends in Susceptibility to Smoking by Race and Ethnicity. *Pediatrics*. 2016;138(5).
14. Dai H Tobacco Product Use Among Lesbian, Gay, and Bisexual Adolescents. *Pediatrics*. 2017;139(4).
15. Kim H, Lim J, Buehler SS, et al. Role of sweet and other flavours in liking and disliking of electronic cigarettes. *Tob Control*. 2016;25(Suppl 2):ii55–ii61. [PubMed: 27708124]
16. Harrell MB, Weaver SR, Loukas A, et al. Flavored e-cigarette use: Characterizing youth, young adult, and adult users. *Prev Med Rep*. 2017;5:33–40. [PubMed: 27896041]
17. Pepper JK, Ribisl KM, Brewer NT. Adolescents' interest in trying flavoured e-cigarettes. *Tob Control*. 2016;25(Suppl 2):ii62–ii66. [PubMed: 27633762]
18. Dai H, Hao J. Flavored Electronic Cigarette Use and Smoking Among Youth. *Pediatrics*. 2016;138(6).
19. Amrock SM, Lee L, Weitzman M. Perceptions of e-Cigarettes and Noncigarette Tobacco Products Among US Youth. *Pediatrics*. 2016;138(5).
20. Cooper M, Harrell MB, Perez A, Delk J, Perry CL. Flavorings and Perceived Harm and Addictiveness of E-cigarettes among Youth. *Tob Regul Sci*. 2016;2(3):278–289. [PubMed: 27722185]
21. Azzopardi D, Patel K, Jaunky T, et al. Electronic cigarette aerosol induces significantly less cytotoxicity than tobacco smoke. *Toxicol Mech Methods*. 2016;26(6):477–491. [PubMed: 27690199]
22. Taylor M, Carr T, Oke O, et al. E-cigarette aerosols induce lower oxidative stress in vitro when compared to tobacco smoke. *Toxicol Mech Methods*. 2016;26(6):465–476. [PubMed: 27690198]
23. Leigh NJ, Lawton RI, Hershberger PA, Goniewicz ML. Flavours significantly affect inhalation toxicity of aerosol generated from electronic nicotine delivery systems (ENDS). *Tob Control*. 2016;25(Suppl 2):ii81–ii87. [PubMed: 27633767]
24. Sundar IK, Javed F, Romanos GE, Rahman I. E-cigarettes and flavorings induce inflammatory and pro-senescence responses in oral epithelial cells and periodontal fibroblasts. *Oncotarget*. 2016;7(47):77196–77204. [PubMed: 27791204]
25. Yu V, Rahimy M, Korrapati A, et al. Electronic cigarettes induce DNA strand breaks and cell death independently of nicotine in cell lines. *Oral Oncol*. 2016;52:58–65. [PubMed: 26547127]
26. Auer R, Concha-Lozano N, Jacot-Sadowski I, Cornuz J, Berthet A. Heat-Not-Burn Tobacco Cigarettes: Smoke by Any Other Name. *JAMA Intern Med*. 2017.
27. Huntington-Moskos L, Rayens MK, Hall LA, Hahn EJ. The Peer and Family Smoking Index: A Valid Measure of Secondhand Smoke Exposure in Adolescents. *J Adolesc Health*. 2016;58(4):446–450. [PubMed: 26856961]
28. Viner RM, Hargreaves DS, Motta J, Horta B, Mokdad AH, Patton G. Adolescence and Later Life Disease Burden: Quantifying the Contribution of Adolescent Tobacco Initiation From Longitudinal Cohorts. *J Adolesc Health*. 2017;61(2):171–178. [PubMed: 28734324]
29. National Center for Health Statistics. Health, United States 2015: With Special Feature on Racial and Ethnic Disparities. Hyattsville MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; 2016.
30. Munshi T, Heckman CJ, Darlow S. Association between tobacco waterpipe smoking and head and neck conditions: A systematic review. *J Am Dent Assoc*. 2015;146(10):760–766. [PubMed: 26409986]
31. Correa JB, Ariel I, Menzie NS, Brandon TH. Documenting the emergence of electronic nicotine delivery systems as a disruptive technology in nicotine and tobacco science. *Addict Behav*. 2017;65:179–184. [PubMed: 27816664]
32. Gorzkowski JA, Whitmore RM, Kaseeska KR, Brishke JK, Klein JD. Pediatrician Knowledge, Attitudes, and Practice Related to Electronic Cigarettes. *J Adolesc Health*. 2016;59(1):81–86. [PubMed: 27338665]
33. Milicic S, Leatherdale ST. The Associations Between E-Cigarettes and Binge Drinking, Marijuana Use, and Energy Drinks Mixed With Alcohol. *J Adolesc Health*. 2017;60(3):320–327. [PubMed: 28012834]

34. Gilbert GH, Williams OD, Korelitz JJ, et al. Purpose, structure, and function of the United States National Dental Practice-Based Research Network. *J Dent*. 2013;41(11):1051–1059. [PubMed: 23597500]
35. Funkhouser E, Agee BS, Gordan VV, et al. Use of online sources of information by dental practitioners: findings from The Dental Practice-Based Research Network. *J Public Health Dent*. 2014;74(1):71–79. [PubMed: 22994848]
36. Botello-Harbaum MT, Demko CA, Curro FA, et al. Information-seeking behaviors of dental practitioners in three practice-based research networks. *J Dent Educ*. 2013;77(2):152–160. [PubMed: 23382524]
37. Marsden PV. Network Data and Measurement. *Annu Rev Sociol*. 1990;16:435–463.
38. Heaven TJ, Gordan VV, Litaker MS, et al. Concordance between responses to questionnaire scenarios and actual treatment to repair or replace dental restorations in the National Dental PBRN. *J Dent*. 2015;43(11):1379–1384. [PubMed: 25998565]
39. Rindal DB, Gordan VV, Fellows JL, et al. Differences between reported and actual restored caries lesion depths: results from The Dental PBRN. *J Dent*. 2012;40(3):248–254. [PubMed: 22245444]
40. Casamassimo PS. Relationships between oral and systemic health. *Pediatr Clin North Am*. 2000;47(5):1149–1157. [PubMed: 11059353]

Implications and Contribution

The oral cavity provides an opportunity for early detection of alternative nicotine product use. This study illustrates a gap in knowledge of dental professionals about the alternative products themselves and patients' use. A missed opportunity for surveillance and early detection exists in dental offices.

Table 1.

Descriptive Statistics comparing study sample with PBRN sampling frame, and Bureau of Labor Statistics data (%)

	Sample	PBRN*	BLS**
N	1722	4279	373000***
Underrepresented Categories (all respondents)			
Gender (Female =1) ^b	48	50	59
Black/ African American ^{ab}	6	5	3
Latino ^{ab}	9	7	7
Asian ^{ab}	10	7	12
Age (all respondents)			
Under 35	10	11	
35 – 44 ^a	27	23	
45 – 54	24	24	
55 – 64	29	30	
65 and over	11	13	
Practice (dentists only; ADA data)			
N	1358	2907	
General	88	89	
Specialist	12	11	

* Data from sampling frame population from PBRN Enrollment Questionnaire (April, 2016)

** Data from Bureau of Labor Statistics (2015): <https://www.bls.gov/cps/aa2015/cpsaat11.htm>

*** BLS data do not provide information on specialties, so these data are not a direct comparison to our sampling frame

^a sample is different from network, $\alpha < .05$

^b sample is different from BLS population, $\alpha < .05$

Table 2.

Dental Professional Knowledge of Common Nicotine Delivery Products n (%)

	Hygienist	General Dentist	Dental Specialist	Total	Chi-Square
Traditional Cigarettes					
Not Knowledgeable	21 (6)	125 (11)	16 (10)	162 (10)	
Knowledgeable	332 (95)	1052 (89)	145 (90)	1529 (90)	
N = 1691					
Missing Cases = 31					$\chi^2 = 6.867^*$
Smokeless Tobacco					
Not Knowledgeable	90 (26)	393 (34)	52 (33)	535 (32)	
Knowledgeable	262 (74)	780 (66)	108 (67)	1150 (68)	
N = 1685					
Missing Cases = 37					$\chi^2 = 7.914^*$
E-Cigarettes					
Not Knowledgeable	223 (64)	747 (64)	105 (67)	1075 (64)	
Knowledgeable	126 (36)	424 (36)	53 (33)	603 (36)	
N = 1678					
Missing Cases = 44					$\chi^2 = 0.435$
Hookah					
Not Knowledgeable	261 (74)	880 (75)	114 (71)	1255 (75)	
Knowledgeable	90 (26)	291 (25)	46 (29)	427 (25)	
N = 1682					
Missing Cases = 40					$\chi^2 = 1.145$

*
 $\alpha < .05$

Table 3.

Dental Professional Assessment of Relative Harm of Alternative Nicotine Products Compared to Traditional Cigarettes (%)

	Hygienist	General Dental	Dentist Specialist	Total	Chi-Square
Smokeless Tobacco					
Less harmful	26 (8)	177 (16)	33 (21)	236 (15)	
About the same	109 (32)	403 (36)	61 (38)	573 (35)	
More harmful	207 (60)	549 (48)	65 (41)	821 (50)	
N = 1630					
Missing Cases = 92					$\chi^2 = 28.752^{**}$
E-Cigarettes					
Less harmful	99 (35)	403 (43)	64 (48)	566 (42)	
About the same	137 (48)	434 (46)	61 (45)	632 (46)	
More harmful	48 (17)	110 (11)	9 (7)	167 (12)	
N = 1365					
Missing Cases = 357					$\chi^2 = 13.522^{**}$
Hookah					
Less harmful	52 (22)	190 (23)	30 (26)	272 (23)	
About the same	124 (54)	414 (50)	59 (51)	597 (51)	
More harmful	55 (24)	219 (27)	26(23)	300 (26)	
N = 1169					
Missing Cases = 553					$\chi^2 = 1.880$

**
 $\alpha < .01$