Curriculum Vitae

Dr. Shashank Joshi – BDS, MBA, MS E mail- drshashankj@gmail.com

EDUCATION

Univ. Of Maryland School of Dentistry, MD June 2018
Masters in Periodontics

W. P. Carey School of Business at Arizona State University, AZ May 2012
Master of Business Administration

Veritas Healthcare Solutions, NY Sept 2012
Clinical Research Associate Certification

M.G.V's Dental College & Hospital, INDIA Aug 2004
Bachelor of Dental Surgery

SUMMARY OF SKILLS

- Plastic Periodontal surgery
- Perio-Ortho Treatment planning
- Implant Dentistry
- Perio-Prosth Treatment planning
- Interdisciplinary Treatment planning
- Digital Treatment planning
- Microsurgery
- Sinus Augmentation

MASTERS THESIS

- "Knowledge, Awareness and Perceptions regarding E-cigarettes among dental practitioners"

CONFERENCE/WORKING PAPERS PRESENTED

- Research Project "Single-flap Guided tissue regeneration: a retrospective cohort study"
- Presentation on "Perio-Prosth considerations in Treatment planning"
- Presentation on "Anterior Esthetics: Periodontal and Orthodontic Considerations"
- Presentation on "Digital Smile Design"

- Presentation on “Periodontally Assisted Osteogenic Orthodontics – Wilckodontics”
- Presentation on “Alveolar ridge preservation – Socket grafting”
- “Perceptions, Attitudes, Knowledge and General Questions regarding E-cigarettes” – Research in progress
- “Measurement of Maxillary Arch Tooth Movement in 3-Dimension” Robyn Silberstein PhD, Hajwa Kim, MS; Shashank Joshi, BDS, MS; Linping Zhao, PhD– Paper submitted for publication in Journal of Dentistry
- “Trans-Alveolar Extractions-Surgical Extractions” Review prepared with 5 case studies and presented at MGV's Dental College and Hospital in August 2005.

ORGANIZATIONS/AFFILIATIONS

- AMERICAN ACADEMY OF PERIODONTOLOGY - AAP
- AMERICAN DENTAL ASSOCIATION – ADA
- INTERNATIONAL ASSOCIATION FOR DENTAL RESEARCH - IADR

PROFESSIONAL EXPERIENCE

UNIVERSITY Of MARYLAND SCHOOL Of DENTISTRY, July 2015- Present
Periodontics and Implantology Resident

- Diagnosing and treating comprehensive periodontal disease cases with conventional periodontal surgeries.
- Treatment planning of multiple and single implant cases.
- Operating periodontal plastic surgery procedures using autogenous and allografts using principles of microsurgery. We are the only program in the country using microscopes for surgeries and videography. Majority of my cases are treated using microscopes.
- Using Dynamic navigation system(X-Guide system) to place implants, remove teeth, biopsy lesions etc.
- Operating complex surgery cases including sinus augmentation procedures, Guided bone regeneration cases, surgical management of Peri-implantitis cases.
- Treatment planning and surgical management of interdisciplinary cases with Orthodontics using Wilckodontics technique with bone augmentation, surgical exposures, soft tissue grafting etc.
- Treatment planning of interdisciplinary cases with Endodontics including root resorption lesions, intentional re-implantation cases, flaps for Apicoectomy etc.
- Treatment planning and surgical management of interdisciplinary cases with Prosthodontics including esthetic crown lengthening, functional crown lengthening cases, implant surgeries with immediate provisionalizations, Guided surgeries including All-on-4TM / All-on-6 cases etc.

TRANQUIL DENTAL, Chicago, IL May 2013-Aug 2014
Manager

- Planning and Implementing strategies to meet the financial, production and quality of treatment goals of the dental center
- Designing variety of quality metrics and data capture methods to improve quality of services provided and increase patient satisfaction
- Using lean tools such as Visual management, 5S and Two bin system for Inventory management
- Designing and Implementing new methods of cross checking claims submission and approvals thereby decreasing accounts receivable days by 2 weeks
- Implementing methods to increase claims collection rate to 95%-98%
- Designing new social media marketing strategy for community outreach and marketing efforts
- Training, mentoring, motivating and nurturing up to 4 staff members to achieve daily and weekly goals of the clinic.

SAINT BERNARD HOSPITAL DENTAL CENTER, Chicago, IL July 2012-May 2013
Manager of Clinic Effectiveness at St. Bernard Hospital's Dental Center

- Planning and Implementing strategies to meet the financial, production and quality of treatment goals of the dental center
- Involved with supervision, quality control of a critical care clinic at Walmart.
- Designing variety of quality metrics and data capture methods to improve quality of services provided and increase patient satisfaction
- Using lean tools such as Visual management, 5S and Two bin system for Inventory management at the dental center
- Designing and Implementing new methods of cross checking claims submission and approvals thereby decreasing accounts receivable days by 2 weeks
- Implementing methods to increase claims collection rate to 95%-98%
- Designing new social media marketing strategy for the expansion of special needs kids program.
- Training, mentoring, motivating and nurturing up to 11 staff members to achieve daily and weekly goals of the clinic.
- Organized and Implemented free dental screening as part of hospital wide effort "Heatlh Fair-2012"
- Created and managed a new database which allowed for the more efficient data analysis of research study, increasing efficiency by 30%.
- Analyzed existing processes, functions and work flow of the research study and recommending new ways to reduce expenses and improve efficiency by 15%.
- Trained new recruits which ensured a low employee turnover.

DR SHASHANK JOSHI'S DENTAL CLINIC, India August 2005 -August 2010
Managing Director and Dental Surgeon of Two Dental Practices

- Managed and operated two dental clinics with 8 employees in the most competitive environment of Mumbai, India for more than 5 years, serving varied demography of population, mainly underprivileged and economically backward society.
- Provided varied aspects of general dentistry and specialty treatment procedures to meet the demands of the community.
- Developed and implemented free dental and medical screening camps in schools and non profit centers
- Developed and organized "Anti-tobacco" rallies, "Oral Cancer" awareness drives and vaccination camps in association with Colgate Inc., Warren - Indigo, Elan Pharma and FDC ltd.
- Built strong relationships with physicians and other healthcare providers to provide services improving overall health of the population.
- Organized and provided Hepatitis-B, Polio,TB and other vaccines in collaboration with physicians and non-profits at subsidized rates to the community.
- Built strong relationships with vendors and supplier groups to collaborate in improving community dental health

CERTIFICATIONS

- Clinical Research Associate certification
- CPR-Pro certified including AED for Professional Rescuer
- First Aid and Emergency care certified
- EKG and ACLS certification

“Knowledge, Perceptions and Behavior regarding E-cigarettes among Dental Practitioners”

Shashank Joshi, Master of Science, 2018
Thesis Directed by - Dr Thomas Oates

ABSTRACT

Background

The increased use of e-cigarettes represents an emerging concern for dental practitioners with the potential to impact clinical care. The concerns for, and effects of, e-cigarettes remain poorly understood, especially with long-term use. Given current limits to our understanding of the effects of e-cigarette use, the goal of this study was to assess the level of concern among dental practitioners and the effects of these concerns on the care provided for patients using e-cigarettes.

Methods

Dental practitioners (n=187) in Maryland completed a 28-item survey of e-cigarette knowledge, perception and their current clinical practices for patients using e-cigarettes. A knowledge score was computed, and associations between participant demographic characteristics and knowledge survey items, perception survey items and knowledge score levels, and behavior survey items and knowledge score levels were explored.

Results

Most practitioners do not see or do not ask patients about E-cigarette use (33%), switching from conventional cigarette to E-cigarette use (38%) or dual use (55%). Majority of practitioners classified as medium to high knowledge 75% (141/187), felt

they were well-informed and have up to date knowledge about E-cigarettes compared to 25% classified as low knowledge (46/187). Practice behaviors were not significantly different across knowledge score groupings. High knowledge groups modified their practice behavior positively in all the categories, except high knowledge group did not feel concerned with recommending dental implants in e-cigarette smokers (mode=5). Low knowledge group consistently had negative practice behavior except more positive response within the group for recommending stopping of E-cigarettes before invasive procedures was observed (mode = 5).

Conclusions

The evidence and knowledge about e-cigarette risks on oral health is lacking and is not yet fully influencing practice behaviors. This study reinforces the value of disseminating and translating this evidence to dental practitioners through early inclusion of this topic in dental and hygiene training programs and through continuing education courses.

Knowledge, Perceptions and Behavior regarding E-cigarettes among Dental Practitioners

by
Shashank Joshi

Thesis submitted to the Faculty of the Graduate School of the
University of Maryland, Baltimore in partial fulfillment
of the requirements for the degree of
Master of Science
2018

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Introduction

Electronic cigarettes (E-cigs) or Electronic Nicotine Delivery Systems (ENDS) have gained considerable attention since their introduction into European and American markets in 2006 and 2007, respectively (Noel, Rees, and Connolly 2011). Practitioners should be concerned becausee-cigarette users refer themselves as “vapers” and when asked about tobacco use, e-cigarette users may not refer to their use of e-cigarettes as “smoking,” or themselves as “smokers.” On May 10, 2016, the US Food and Drug Administration (FDA) finalized a rule extending the agency’s authority to regulate e-cigarettes manufacturing, labeling, advertising, sales etc.(“Deeming Tobacco Products To Be Subject to the Federal Food, Drug, and Cosmetic Act, as Amended by the Family Smoking Prevention and Tobacco Control Act; Restrictions on the Sale and Distribution of Tobacco Products and Required Warning Statements for Tobacco Products” 2016).

E-cigarettes are used as an entry drug by adolescent children and young adults. CDC and the Food and Drug Administration (FDA) analyzed data from the 2011-2016 National Youth Tobacco Surveys (NYTS) to identify patterns of current (in the last 30 days) use of seven tobacco product types among U.S. middle and high school students. They concluded that for 2016, 47.2% of high school students and 42.4% of middle school students currently used more than 2 tobacco products, and e-cigarettes were the most commonly used tobacco product among high (11.3%) and middle (4.3%) school students. Researchers have blamed the rapid rise in use of e-cigarettes among young adults on aggressive marketing strategies used by manufacturers. (Yang et al. 2017) conducted a nationally (US) representative longitudinal phone survey

of 13–25 year olds from June 2014 to September 2016, with 2,413 respondents who completed a baseline and follow-up survey six months later. The authors concluded that information seeking predicted higher likelihood of vaping six months later even after controlling for baseline smoking and vaping status, intention to vape, and demographics, The second conclusion was that information seeking partially mediated the relationship between intention to vape and subsequent vaping behavior (Yang et al. 2017).

The e-liquid usually has three main components- nicotine, propylene glycol and vegetable or aqueous glycerin, usually as a mixture of 80% propylene glycol and 20% glycerin. New generation of tank-style devices are highly diverse in voltage and coil composition, as they can be assembled and manipulated by the user, thus varying levels of heating of e-liquid leading to chemical reactions that could result in the formation of new compounds. Hence, chemical composition of aerosol could be different from the composition contained in e-liquid (S.J. Huang, Xu, and Lau 2017). A few studies have detected toxic metals such as chromium, nickel, and lead in e-liquid and in the aerosol produced by E-cigarettes(Williams et al. 2013; Saffari et al. 2014; Maciej Lukasz Goniewicz et al. 2014; Hess et al. 2017). Serious health effects of metals are published in the literature including neurotoxicity (Garza, Vega, and Soto 2006) and cardiovascular disease (Navas-Acien et al. 2007) with lead, and respiratory disease and lung cancer for chromium and nickel (Jaishankar et al. 2014).Olmedo et al, made comparisons between metal concentrations in e-liquid from the refilling dispenser (before contact with the device and the heating coil), e-liquid in the device itself (in contact with the heating coil), and the generated aerosol (inhaled by the user). The high correlation between detected Arsenic levels in the dispenser and those found in the aerosol and tank samples supports

that when Arsenic is present in the dispenser e-liquid it gets transferred to the aerosol("Environmental Health Perspectives – Metal Concentrations in E-cigarette Liquid and Aerosol Samples: The Contribution of Metallic Coils" n.d.)

To date, no investigators have reported the oral health effects of e-cigarettes(Wellman and O'Loughlin 2016). Risks of e-cigarettes on dental diseases like caries and periodontal disease are not yet reported in the literature. NHANES III data correlating passive conventional cigarette smoke exposure and caries risk is reported to be 27% for decayed and 14% for filled tooth surfaces (Aligne et al. 2003). Oxidative/carbonyl stress via protein carbonylation seems to be an important factor in causing inflammation and DNA damage resulting in stress-induced premature senescence (a state of irreversible growth arrest which re-enforces chronic inflammation) in gingival epithelium, which may contribute to the pathogenesis of oral diseases. Sundar et al shows that e-cigarettes with flavorings cause increased oxidative/carbonyl stress and inflammatory cytokine release in human periodontal ligament fibroblasts, Human Gingival Epithelium Progenitors pooled (HGEPp), and epigingival 3D epithelium. Further, e-cigarettes cause DNA damage along with histone deacetylase 2 (HDAC2) reduction via RAGE-dependent mechanisms in gingival epithelium. Effects of the e-liquids on human gingival fibroblasts (HGFs), increased apoptosis as measured by BAX gene expression and Reactive Oxygen Species production suggest a role for e-cigarette fluids in the pathogenesis of periodontitis (Sancilio et al. 2016)

Despite limited objective data, evidence suggests e-cigarettes may induce some of the same physiologic changes as traditional cigarettes, with or without nicotine present, and may have a significant deleterious effect on wound healing (Fracol et al. 2017). Several

studies have proven deleterious effects of conventional cigarette smoking on healing and surgical outcomes. Systematic review by Kotsakis et al revealed a reduction in pocket depths ranged from 0.76mm to 2.05mm in smokers compared to 1.27mm to 2.40mm in non-smokers, and gain in clinical attachment level in smokers was 0.09- 1.2 mm compared to 0.29- 1.6 mm in non smokers(Kotsakis et al. 2015). A meta-analysis by Chatzopoulos 2016, demonstrated a highly significant difference for the reduction of pocket depths of 0.39 mm and 0.35 mm more attachment gain in non-smokers compared to smokers(Chatzopoulos 2016). In animal models, it has been shown that nicotine inhibits the expression of genes related to osteogenic activity [BMPs, TGF-b, alkaline phosphatase (ALP), platelet-derived growth factor (PDGF), vascular endothelial growth factor (VEGF), receptor activator of nuclear factor kappa-B ligand (RANKL), and osteoprotegerin (OPG)], especially in high doses (Truntzer et al. 2015, L. S. Wong et al. 2004; Ma et al. 2011; Fang et al. 1991).A meta-analysis that included seven studies, recognized an inflection point for improved outcomes around 3–4 weeks of smoking cessation prior to surgery and reported a relative risk (RR=0.74) for wound complications than cessation within 3 weeks of surgery (J. Wong et al. 2012). Another meta-analysis by Mills et al, demonstrated a similar risk reduction associated with preoperative cessation across a variety of systems (wound, pulmonary), with a compounding increase in the magnitude of effect of 19 % for each week of cessation prior to surgery (Mills et al. 2011). Sorensen et al. in a study on wound healing showed that following 20 days of abstinence from smoking, neutrophil oxidative burst returned to the level of non-smokers, and monocyte oxidative burst increased by 50 %(Lars Tue Sørensen et al. 2004). Another

study showed that collagen synthesis directly related to bone turnover was impacted after 6 weeks of smoking cessation (Oncken et al. 2002).

The public is exposed to significant amounts of misinformation, promotional material in the disguise of unbiased advice, and that marketing has greatly outpaced the science. Differences in the labeled and true nicotine levels in e-liquid solutions, the mode of heating and converting e-liquid into an aerosol create extensive variability in nicotine levels and other chemicals delivered to users, posing challenges when examining health effects. Adverse event reports suggest that E-cigarettes may increase the risk of adverse health effects including seizure, tachycardia, disorientation, airway resistance, congestive heart failure, pneumonia, and second-degree burns from faulty devices. Lerner et al observed that mitochondria are sensitive to both e-cigarette aerosols and aerosol containing copper nanoparticles when exposed to human lung fibroblasts (HFL-1) evident by elevated levels of mitochondrial ROS (mtROS). This increased mtROS after aerosol exposure is associated with reduced stability of OxPhos electron transport chain (ETC) complex IV subunit and nuclear DNA fragmentation. Increased levels of IL-8 and IL-6 in HFL-1 were also observed. These findings reveal both mitochondrial genotoxic and inflammatory stresses when exposed to e-cigarette aerosols which are ensued by inflammatory duress, raising a concern on deleterious effect of vaping (Lerner et al. 2016). In vitro experiments performed by Yu et al in 2016, on normal epithelial cells as well as head and neck squamous cell carcinoma (HNSCC) cell lines, exposed to nicotine-containing and nicotine-free vapor extract from two popular e-cigarette brands for 48 hours to 8 weeks. E-cigarette-exposed cells showed significantly reduced cell viability and clonogenic survival, along with increased rates of apoptosis and necrosis, regardless

of e-cigarette vapor nicotine content (Yu et al. 2016). The authors also demonstrated increased DNA strand breaks in the exposed cells but could not conclude that this can lead to mutations and ultimately result in cancer.

In 2015, the US Preventive Services Task Force concluded that evidence was insufficient to recommend e-cigarettes for tobacco cessation in adults because of conflicting and limited evidence available at the time (Siu and U.S. Preventive Services Task Force 2015). Soneji et al in 2018 used the Monte Carlo Stochastic simulation model and estimated that 2,070 additional current cigarette smoking adults (95% CI: -42,900 to 46,200) who currently used e-cigarettes in 2014 would quit smoking in 2015. They would gain (-3,000) years of life (95% CI: -351,000 to 325,000), and remain continually abstinent from smoking for ≥7 years using e-cigarettes, compared to those who did not currently use e-cigarettes(S. S. Soneji et al. 2018). The model also estimated that an additional 168,000 never-cigarette smoking adolescents and young adults in 2014 (95% CI: 114,000 to 229,000) who had ever used e-cigarettes would initiate cigarette smoking in 2015 and eventually become daily cigarette smokers at age 35±39 and will lose 1,510,000 years of life (95% CI: 1,030,000 to 2,060,000, compared to those who had never used e-cigarettes(S. S. Soneji et al. 2018). A 2016 meta-analysis of 38 studies found that smokers who also used e-cigarettes were 28 % less likely to quit than nonusers (Kalkhoran and Glantz 2016).

Goniewicz et al evaluated the effects of e-cigarettes on nicotine delivery and exposure to selected carcinogens and toxicants. Participants reported significant improvements of symptoms such as chest tightness, visual disturbances, daytime cough, difficulty concentrating, irritability and presence of phlegm over the course of 2 weeks. This is the

first study to demonstrate that e-cigarettes can be potentially used as harm reduction devices. They concluded that levels of total nicotine and some polycyclic aromatic hydrocarbon metabolites did not change after switching from tobacco to e-cigarettes. Dual use of combustible and e-cigarettes is common, although whether dual users decrease their consumption of combustibles when using e-cigarettes is unclear. Along with e-cigarette use binge drinking and other risky behaviors are similar as seen with conventional cigarette smoking.

Aggressive e-cigarette marketing affects judgment in both never and current users. Vulnerable age groups especially adolescents and young adults perceive that fruit flavors available with e-cigarettes are less harmful and appealing. E-cigarette use may encourage use of combustible tobacco by both adolescent and adult never smokers. Public beliefs that e-cigarettes can be used as a smoking cessation aid are not backed by evidence. Authors of a recent review(Drummond and Upson 2014), reached three conclusions: (1) there are no data showing that e-cigarettes are a healthier alternative to conventional cigarettes in the long term; (2) some smokers may reduce the number of cigarettes they consume by substituting with e-cigarettes, but most continue to smoke cigarettes daily; and (3)e-cigarettes do not aid in smoking cessation.

It is important for the dental community to be aware of grave threat that e-cigarette pose to our patients' health. Identifying and recognizing e-cigarettes as a risk would be first steps towards creating an action plan in tackling this emerging crisis. Currently, there is limited research evaluating how knowledge and awareness of e-cigarettes influences practice patterns of dentists. Therefore, the primary objective of this study is to assess the knowledge and perceptions of practicing dentists related to e-cigarette smoking risk

and how their knowledge and perceptions influence decision making when developing treatment plans.

Materials & Methods

At present, there is no known literature concerning dentists' perceptions and subsequent clinical practice related to electronic cigarettes (e-cigarettes). Based on an extensive literature review, we designed a survey to assess the knowledge, perceptions, and practice behavior of dental practitioners in relation to e-cigarettes and oral health. The final 28-item survey was prepared in English and made available to dental practitioners through an online survey system (RedCap). Background data for each practitioner were collected, including their title/role (dentist, hygienist, or other), dental specialty (general, periodontics, endodontics, pediatric dentistry, orthodontics, oral/maxillofacial surgery, prosthodontics, or other), and year in which the highest level of dental training was completed (1995 or earlier 1996 – 2015, 2015 – 2018). The participants' knowledge, perception and behavior of e-cigarettes were assessed on the basis of their responses to survey questions concerning the risk of e-cigarettes on oral health, use of e-cigarettes as cessation device/therapy and the practitioner's current practices for patients using e-cigarettes. A total of 28 questions (6 demographic-based, 10 knowledge based, 4 perception based and 8 behavior based) were evaluated. Demographic questions could be answered with top-of-the-head estimate about frequency of patient using e-cigarettes with answers of either None, Rarely (less than 1 per week), occasionally (1 per week to 1 per day), Often (more than 1 per day), and Don't Know options. Knowledge, perception and behavior questions could be answered, with either strongly agree/agree/neutral or don't know/disagree/strongly disagree or always/sometimes/rarely/never/doesn't apply. Knowledge score was calculated based upon correct answers to the 10 knowledge-based

questions. Correct answers were those deemed most supported by current literature. Knowledge questions for which limited or inconclusive information was available were viewed as correctly answered by the less definitive responses of agree/neutral/disagree. A knowledge score equal to the sum of correct answers was constructed. Participants were classified as having a high knowledge score (8-10 questions answered correctly), medium knowledge score (6-7 questions answered correctly) or a low knowledge score (0-5 questions answered correctly). Strongly agree, agree, always, and sometimes were interpreted as positive survey responses; strongly disagree, disagree, rarely, and never were viewed as negative responses. Contingency tables of knowledge score category versus each survey item response and reported positive or negative responses (in %) were constructed.

Statistical analysis

Descriptive statistics were used to summarize each of the survey questions, and knowledge score mode, mean, median, and interquartile range was computed. Specialty categories were collapsed into 3 groups: General Dentistry (general and pediatric), Surgical (endodontics, periodontics, and oral surgeons), and Nonsurgical (orthodontics, prosthodontics, other). Correlation between completion of training year and encounters with E-cigarette users, completion of training year and knowledge score and Pearson's rho (correlation coefficient) was calculated for overall knowledge score and individual behavior questions.

Results

Dental practitioners (n=187) completedthe 28-item survey. The majority of practitioners surveyed were dentists 158 (85%) and 27 (15%) were hygienist. Out of the total respondents (Figure 1),64% reported being in General Dentistry Practice (General dentist and pediatric dentist), 20% in surgical specialties (Endodontics, Periodontics, and Oral, Maxillo-facial surgery) and 16% in Non-surgical fields (Orthodontics, Prosthodontics and other). Of the 27 hygienist that responded to our survey, 72% were in General Dentistry practice. Most of the respondents 110 (61%) completed their training before 1995 and 69 (39%) completed their highest level of training in 1996-2018 (Figure2).

Figure 1 – Distribution of practitioners according to specialty

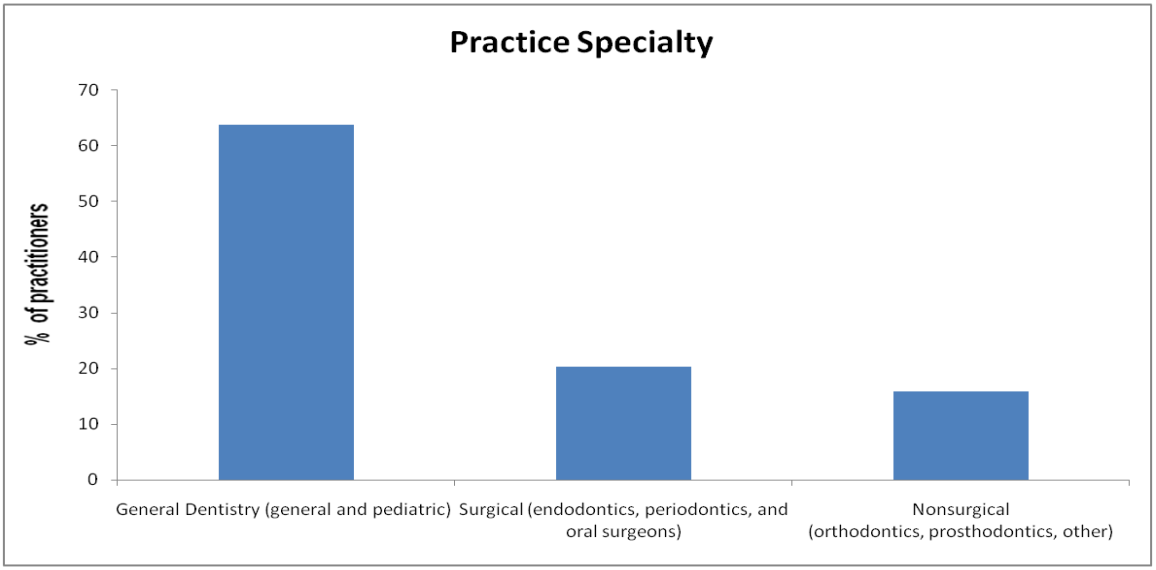
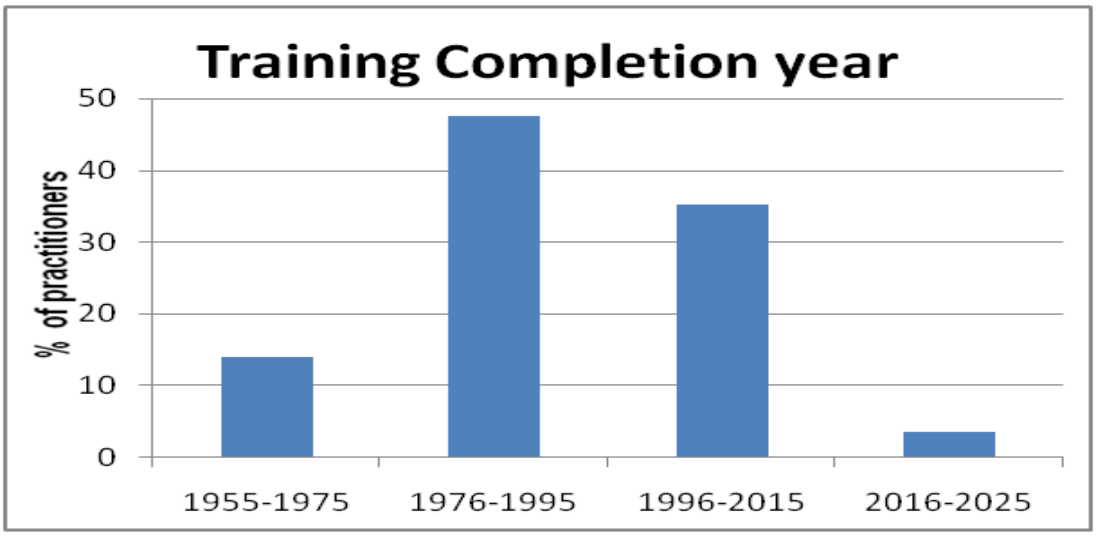


Figure 2 – Distribution of completion of training year



The majority of practitioners(62%) estimated they encounterpatients who use e-cigarettes occasionally or rarely, with 10% seeing no patients using e-cigarettes. Only 5% of practitioners reported seeing e-cigarette users daily, and 23% did not know how often they saw e-cigarette users as patients. A similar percentage of practitioners (6%)reported seeing e-cigarette users as patients at least once per week (Figure 4) who were former conventional cigarette users and (6%) who were dual conventional and e-cigarette users (Figure 5).Practitioners (9-19%) reported seeing no e-cigarette users, and 23-35% of practitioners reported that they didn't know how often they saw e-cigarette users as patients.

Figure 3 – Frequency of Encounters with E-cig users

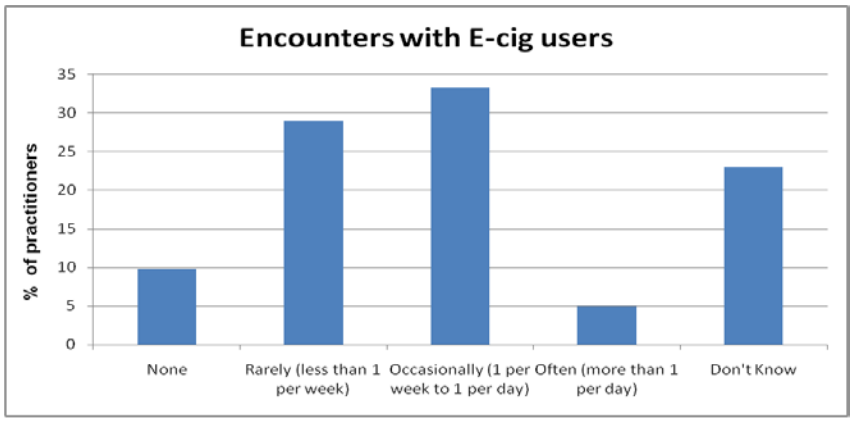


Figure 4 – Frequency of Encounters with switch users

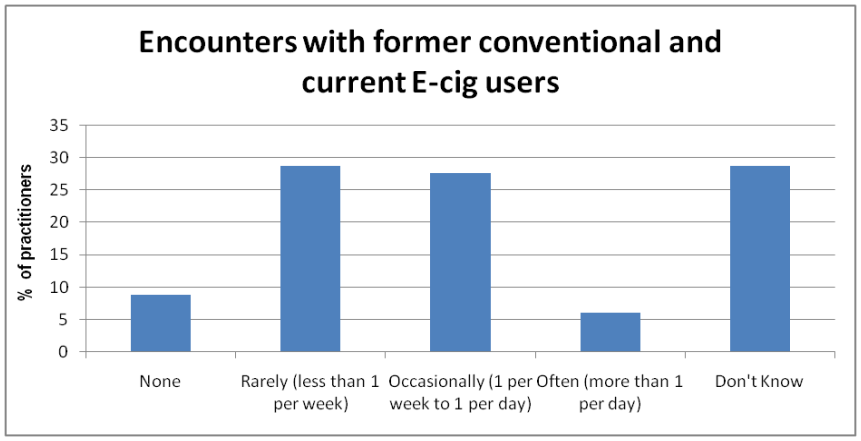
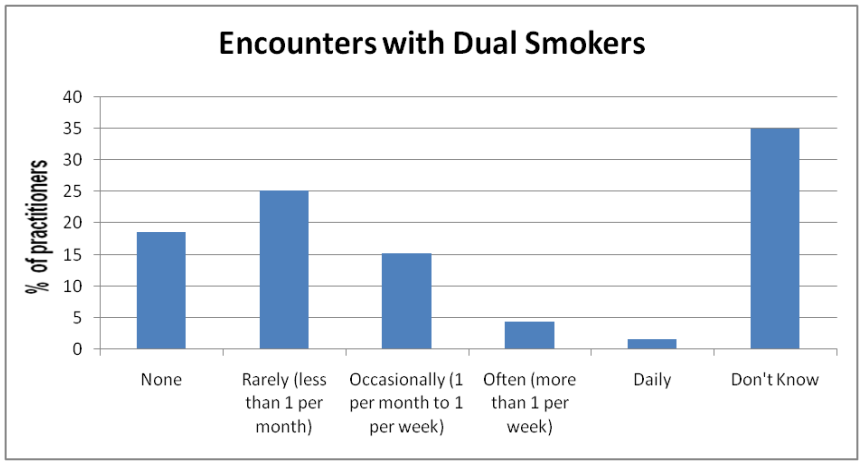


Figure 5 – Frequency of Encounters with Dual users



Overall, 29% of practitioners reported not knowing the frequency with which their patients were e-cigarette users. Comparison ofthe two categories based on year of completion of training showed significant differences ($p<0.01$) with the older training group reporting “Don’t Know” at an 11% higher frequency than the younger training group (Table 1). Additionally, 31% of all practitioners reported seeing E-cigarette users“occasionally to often” in their practices that is at least on a monthly basis, with no difference between training groups.

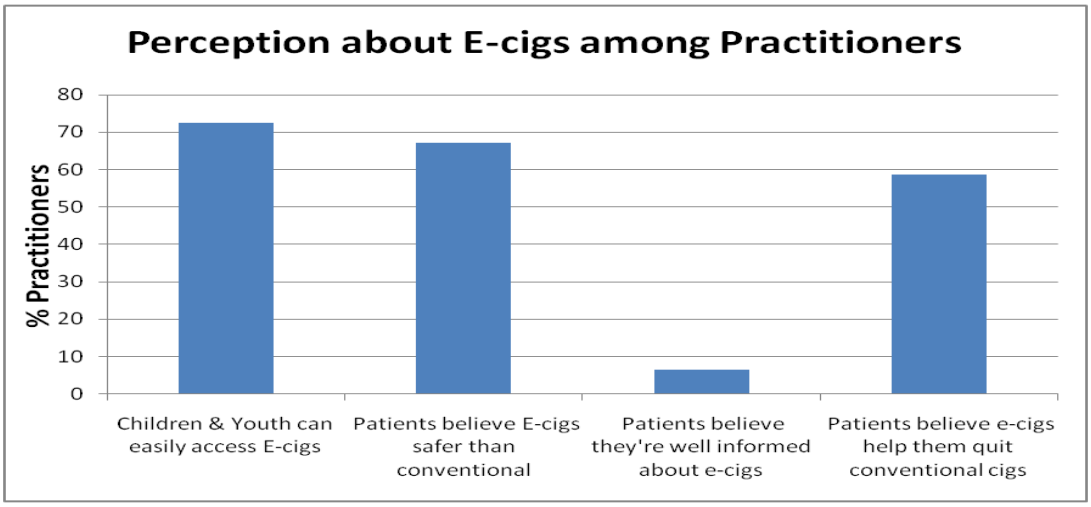
Table 1– Frequency of Encounters and training completion year

		Occasionally – Often	Rarely - Never	Don't Know	P value
0-Overall e-cigarette encounters	1995 & earlier	101 (31%)	113 (35%)	109 (34%)	0.004 *
[sum of 3 questions below]	1996 - 2018	64 (29%)	104 (48%)	49 (23%)	
1-Encounters with E-cigarette Users	1995 & earlier	39 (36%)	38 (35%)	31 (29%)	0.521
	1996 - 2018	30 (41%)	32 (44%)	11 (15%)	
2-Encounters with Former Conventional and current E - Cigarette Users	1995 & earlier	36 (34%)	36 (34%)	35 (33%)	0.187
	1996 - 2018	24 (33%)	32 (44%)	17 (23%)	
3-Encounters with Dual Users	1995 &earlier	26 (25%)	39 (36%)	43 (39%)	0.025
	1996 - 2018	10 (16%)	40 (55%)	21 (29%)	

Differences between Training cohorts:
0-The chi-square statistic is 11.0744. The p-value is .003938. The result is significant at $p < .01$.
1-The chi-square statistic is 1.3056. The p-value is .520585. The result is not significant at $p < .01$.
2-The chi-square statistic is 3.3482. The p-value is .187477. The result is not significant at $p < .01$.
3-The chi-square statistic is 7.3524. The p-value is .025319. The result is not significant at $p < .01$.
P<0.01 significance determined with Bonferroni correction.

We asked about practitioners' perceptions about e-cigarettes and patient attitude towards e-cigarettes (Figure 6). Of the total practitioner that responded, 73% (132 of 182 practitioners) believed that children and youth have easy access to e-cigarettes. The majority of practitioners did feel that e-cigarettes offered some benefit with 67% (122 of 182) reporting that their patients believed that e-cigarettes were safer than conventional cigarettes, 59% (106 of 181) reported that their patients believed that e-cigarette is helping them quit conventional cigarettes, but only 7% (12 of 181) considered their patients to be well informed about the risks and benefits of e-cigarettes.

Figure 6 – Perceptions about E-cigs among Practitioners



We asked respondents 10 questions to assess their knowledge based on published evidence regarding e-cigarettes. When asked about their knowledge about risks of e-cigarettes 53% (96 of 183) of respondents felt that they are well informed. Similar number of practitioners, 53% (97 of 183) correctly reported that they feel e-cigarettes are not safer than conventional cigarettes. When asked about oral cancer risks, dry mouth/caries risks, periodontal disease risk and risks with dental implant failures, 55% (101 of 183), 79% (143 of 182), 75% (136 of 182), and 78% (142 of 183), respectively,

of practitioners reported as being concerned with e-cigarettes. When asked about concerns regarding wound healing with e-cigarette use 74% (135 of 182) practitioners reported that they were concerned. Oral and general health risks is high according to 84 % (153 of 183) practitioners in e-cigarette smokers and about 92% (168 of 182) practitioners are worried about the harmful effects of unknown chemicals and constituents in the e-cigarettes. Only 29% responded correctly that e-cigarettes are not beneficial for conventional cigarette smoking cessation.

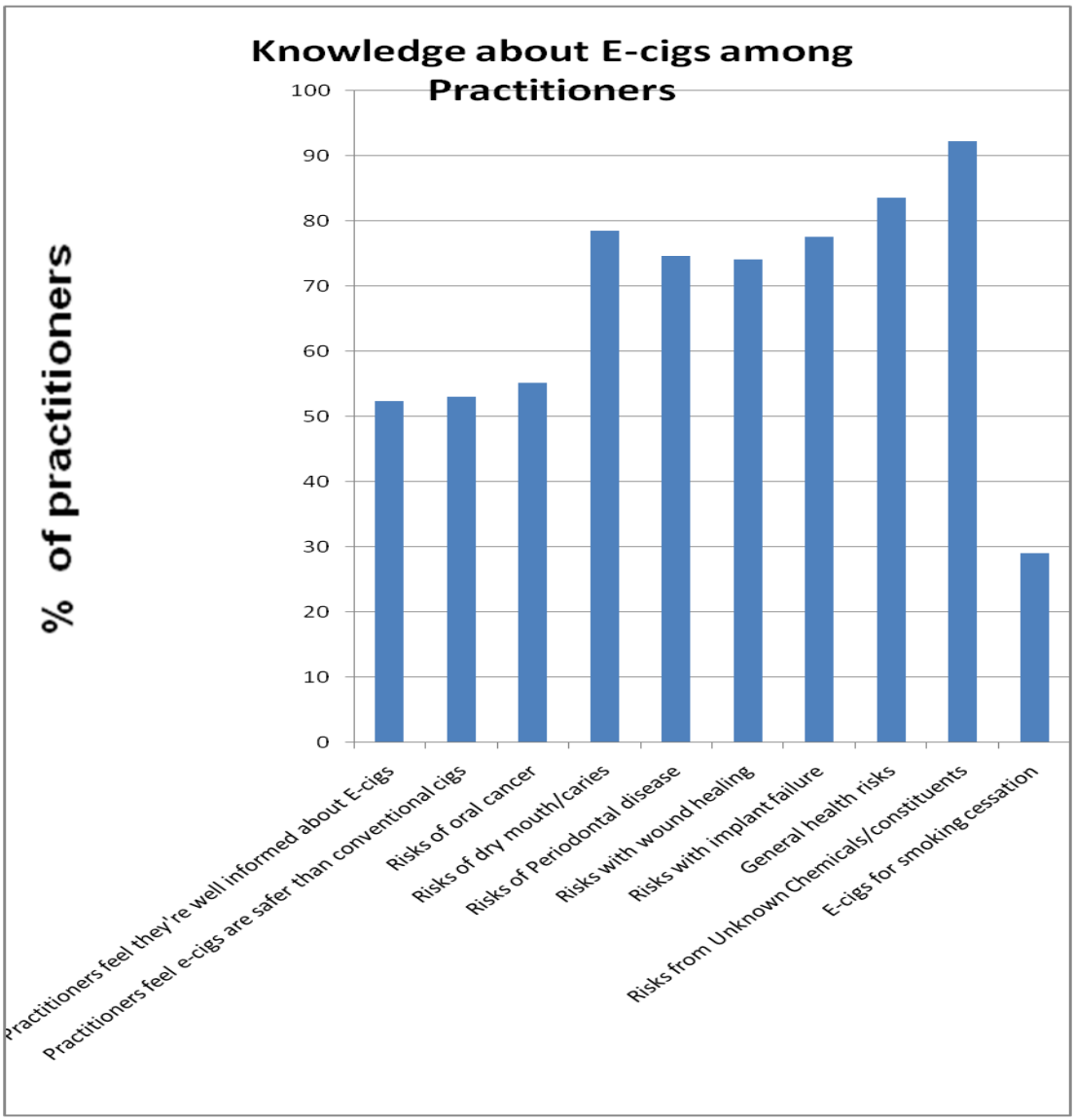
Table 2 - Key to answers and observed responses to "Knowledge Score" questions

Response percentage (n)						
Questions	**Correct answer**	**Strongly Agree**	**Agree**	**Neutral/Don't know**	**Disagree**	**Strongly Disagree**
1.I am well informed about th risks of E-cigarettes	Strongly Agree/Agree	15%(27)	38%(69)	22%(40)	21%(38)	5%(9)
		Total	53%			
2.In my opinion, E-cigarettes are overall safer than conventional cigarettes	Disagree/ Strongly Disagree	2%(4)	22%(41)	22%(41)	33%(61)	20%(36)
					Total	53%
3.E-cigarette use increases the risks for oral cancer	Strongly Agree/Agree	19%(35)	36%(66)	38%(70)	6%(11)	0.5%(1)
		Total	55%			
4.E-cigarette use can cause dry mouth and/or increases the risk of caries	Agree/Neutral/Disagree	21%(39)	49%(89)	28%(51)	1.6%(3)	0(0)
			Total		78%	
5.E-cigarette use increases risk of susceptibility to periodontal disease	Agree/Neutral/Disagree	25%(46)	44%(80)	29%(52)	2%(4)	0(0)
			Total		75%	

Table 2 contd.- Key to answers and observed responses to “Knowledge Score” questions

6.E-cigarette use negatively affects oral wound healing	Agree/Neutral/Disagree	26%(47)	47%(86)	26%(47)	1%(2)	0(0)
			Total		74%	
7.E-cigarette use increases risk of implant failure	Agree/Neutral/Disagree	22%(41)	37%(68)	40%(73)	0.5%(1)	0(0)
			Total		77%	
8.Oral and general health risks associated with E-cigarette use increases with duration and dose.	Strongly Agree/Agree	26%(48)	57%(105)	16%(30)	0(0)	0(0)
		Total	83%			
9.I am concerned about the unknown constituents/chemicals in E-cigarettes and their effects on general and oral health	Strongly Agree/Agree	59%(108)	33%(60)	6%(11)	2%(3)	0(0)
		Total	92%			
10.E-cigarettesare helpful to patients who want to quit smoking cigarettes	Disagree/ Strongly Disagree	3%(6)	32%(58)	35%(63)	20%(35)	9%(17)
					Total	29%

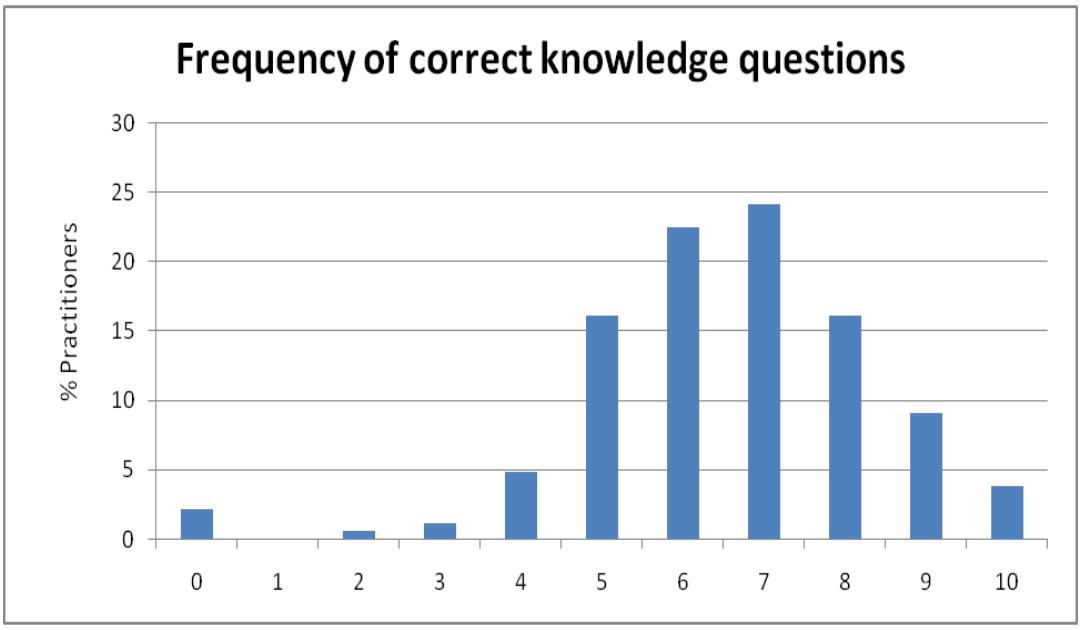
Figure 7 – Distribution of Knowledge about E-cigs among Practitioners



The distribution of survey responses observed for the ten questions contributing to the knowledge score are presented in Table 2. Knowledge score was computed based on number of correct answers out of 10 questions. High knowledge group was considered as practitioners those answered 8-10 correct answers, medium knowledge group 6-7 correct answers and low knowledge group as 0-5 correct answers (Fig 8). The overall observed knowledge score range was 0 to 10 [median (IQR, interquartile range) = 7.0 (2)]. In the

high knowledge category 54 practitioners (29%) [median score (IQR) = 8 (7,8)] were classified, while 87 practitioners (47%) were classified into medium knowledge category [median score (IQR) = 7 (6,7)] and 46 practitioners (25%) were classified into the low knowledge category [median score (IQR) = 5 (4,5)] and. 8 of the 10 knowledge questions were answered correctly by only 29% of all the practitioners.

Figure 8 – Frequency of correct knowledge questions



Responses to individual behavior questions revealed some interesting observations such as only 7% of practitioners include risks about e-cigarettes in their informed consent and only 21% practitioners ask about specific e-cigarette use on their medical history form compared to 86% ask about conventional cigarette use on medical history forms. 69% practitioners discuss risks of e-cigarette adverse effect on oral health, 64% discuss risks with treatment outcomes. More than half, 57% modify treatment recommendations for e-cigarette smokers, less than half 48% recommend stopping e-cigarette before invasive

treatment. 52% practitioners are concerned placing dental implants in e-cigarette smokers whereas 74% are concerned about healing after extractions and surgical procedures in e-cigarette user.

Table 3 - Key to answers and observed responses to Behavior questions

Response percentage (n)						
Questions	**Correct answer**	**Always**	**Sometimes**	**Rarely**	**Never**	**Doesn't apply**
1.Information about the risk from E-cigarettesuse is include in my patient consent forms	Always/Sometimes	4%(7)	3%(6)	17%(30)	76%(138)	0(0)
2. My medical history forms ask my patients about the use of E-cigarettes	Always	21%(39)			79%(148)	
3. My medical history forms ask my patients about the use of Conventional cigarettes	Always	86%(160)			14%(27)	
4. My medical history forms ask my patients about the use of Other nicotine products	Always	12%(23)			88%(164)	
5. I (would) modify my treatment recommendations if a patient reports smoking E-cigarettes	Always/Sometimes	13%(24) Total	44%(81) 57%	23%(43)	9%(17)	10%(18)

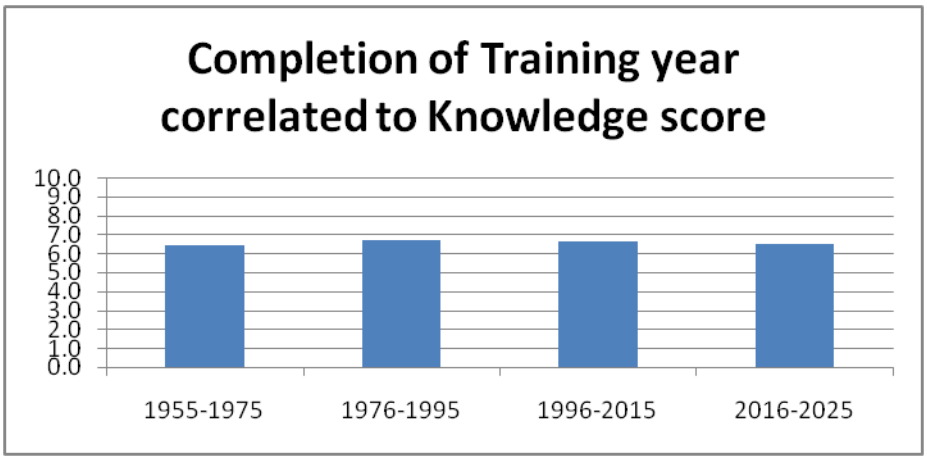
Table 3 contd. - Key to answers and observed responses to Behavior questions

6. If my patients use E-cigarettes, I discuss the risks of adverse effect on oral health	Always/Sometimes	41%(75)	28%(52)	12%(22)	9%(17)	9%(17)
		Total	69%			
7. If my patients use E-cigarettes, I discuss the risks of adverse outcomes of treatment with him or her	Always/Sometimes	39%(71)	25%(45)	14%(26)	11%(21)	10%(18)
		Total	64%			
8. I have advised patients who require invasive dental treatment to stop using E-cigarettesbefore a procedure	Always/Sometimes	32%(58)	16%(30)	10%(19)	19%(35)	22%(40)
		Total	48%			
9. I have concerns with offering dental implants to patients who use E-cigarettes	Always/Sometimes	28%(51)	24%(44)	11%(19)	7%(13)	29%(53)
		Total	52%			
10. I worry about healing after extractions and surgical procedures for patients who use E-cigarettes	Always/Sometimes	49%(89)	25%(45)	8%(15)	4%(7)	15%(27)
		Total	74%			

Correlation between training year and Knowledge score –

When stratified for training year we did not find any correlation to level of knowledge score. All groups of practitioners had similar means for knowledge score, the data is presented in Fig 8

Figure 9 – Correlation of completion year to knowledge score



Correlation between knowledge level and individual behavior questions –

When level of knowledge score was correlated with mean scores for individual behavior questions we did not find any difference between high, medium and low knowledge groups. Most of the behavior questions had correct responses across all knowledge levels (Figures 10-17). Ninety-three percent (168) and 79% (148) practitioners irrespective of their knowledge level did not include E-cigarettes in their informed consent or medical forms, respectively.

We saw a general direct correlation between knowledge levels and specific behavior. As presented in Fig 10-17 below the higher the mean score the less likely practitioners were adopting certain behaviors. Low knowledge level practitioners consistently were less likely to modify treatment options, recommend stopping E-cigarette before invasive procedures, discuss risks of E-cigarettes on oral and general health, and discuss risk with treatment outcomes and healing post extraction or surgeries. Concerns about offering dental implants to E-cigarette smokers was the only category in which high knowledge group demonstrated less concern than low knowledge group practitioners.

Figure 10 – Correlation of Informed consent to knowledge score

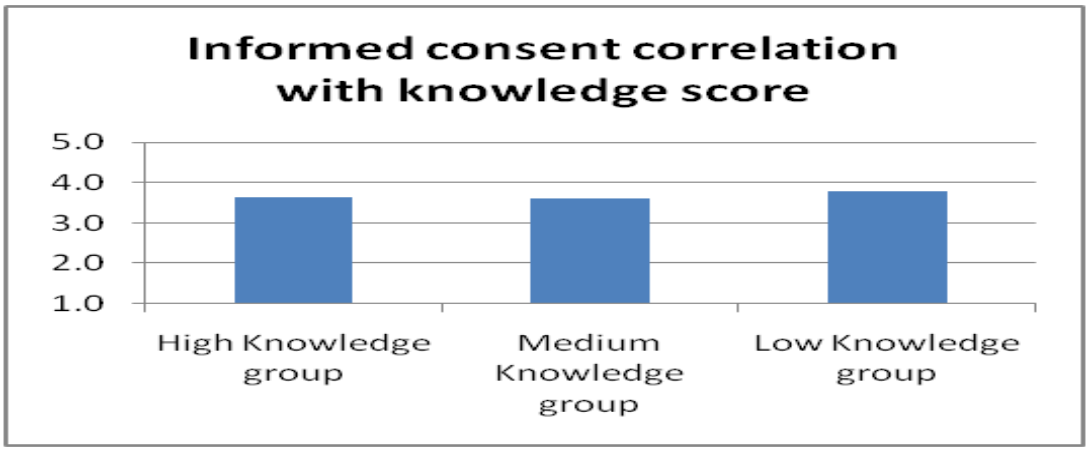


Figure 11 - Correlation of Medical History to knowledge score

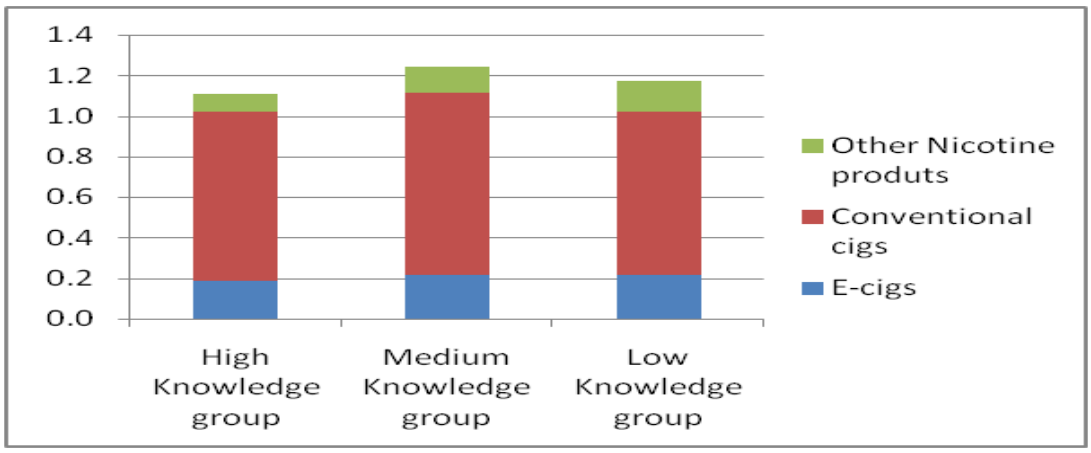


Figure 12 - Correlation of recommendation of treatment modification to knowledge score

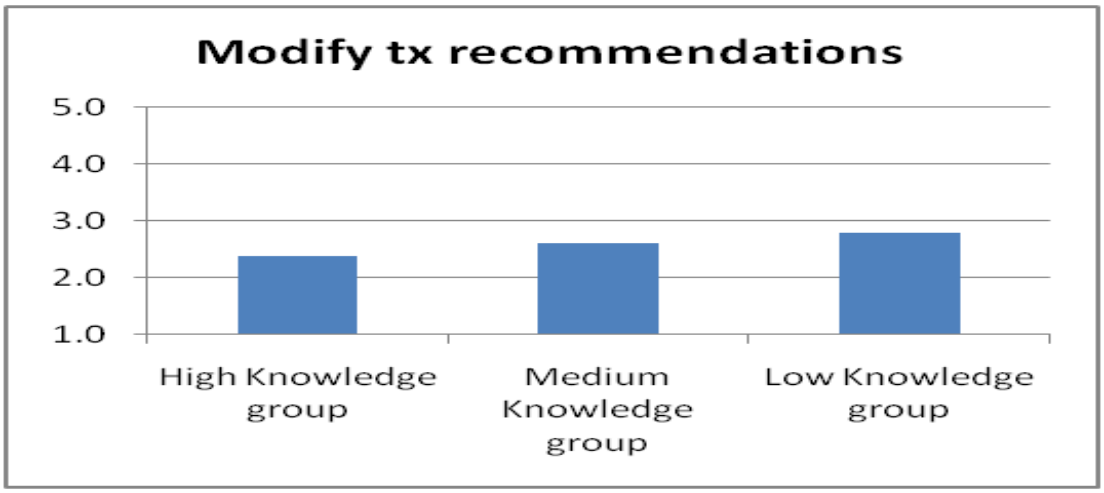


Figure 13 - Correlation of discussion of risk on oral health to knowledge score

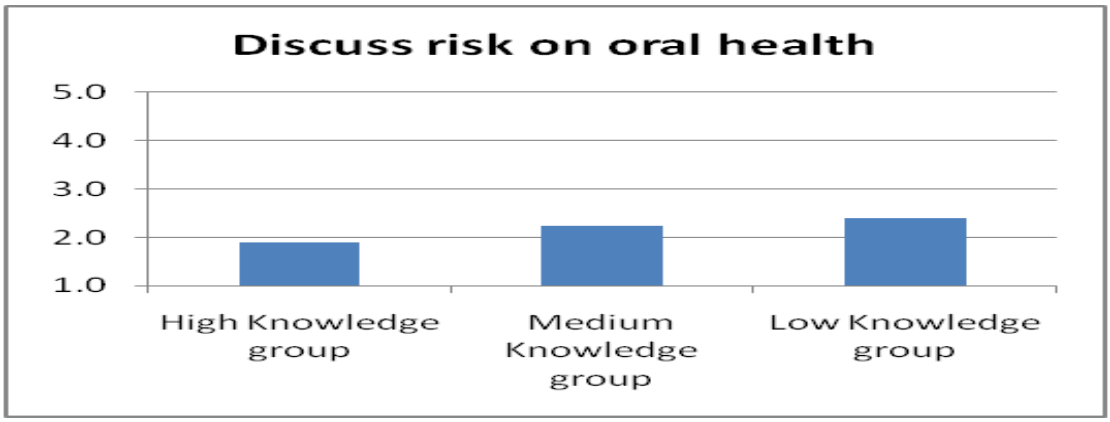


Figure 14 - Correlation of discussion of risks with treatment outcomes to knowledge score

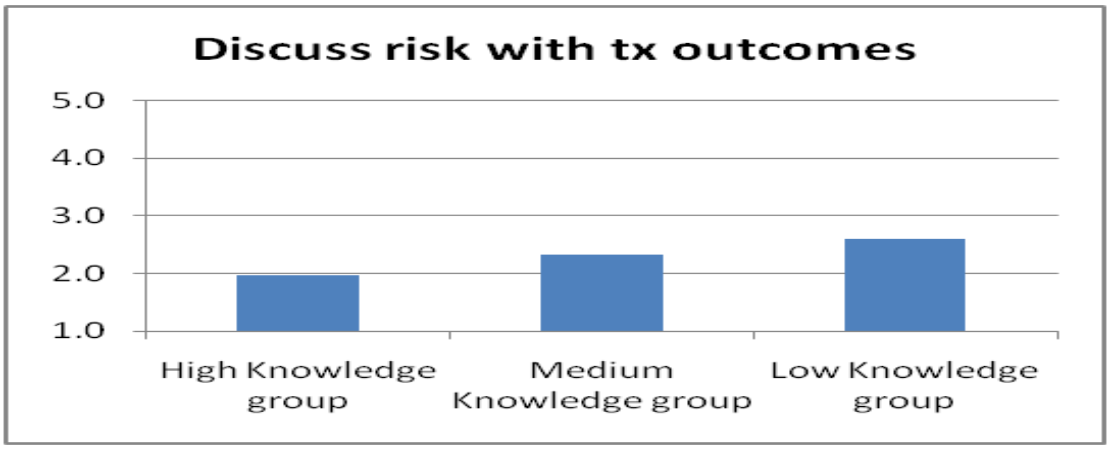


Figure 15 - Correlation of smoking cessation for invasive procedure to knowledge score

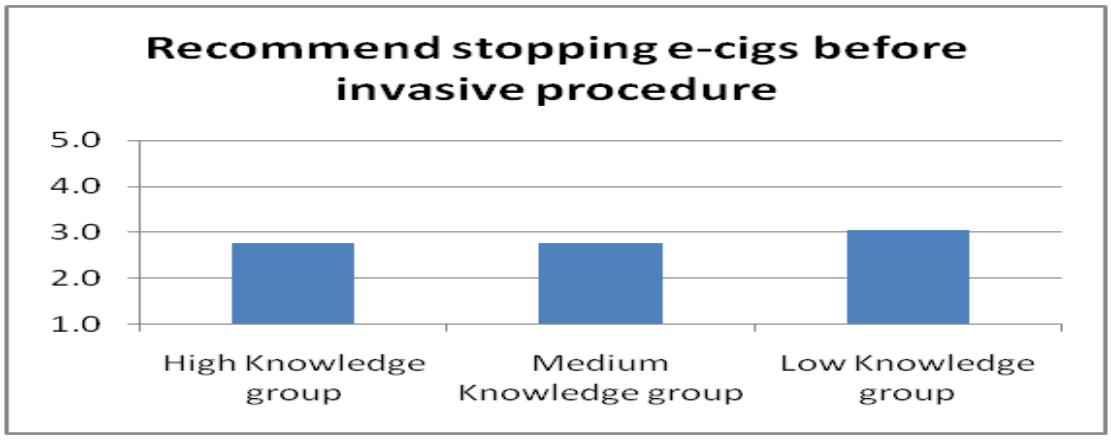


Figure 16 - Correlation of offering dental implants to knowledge score

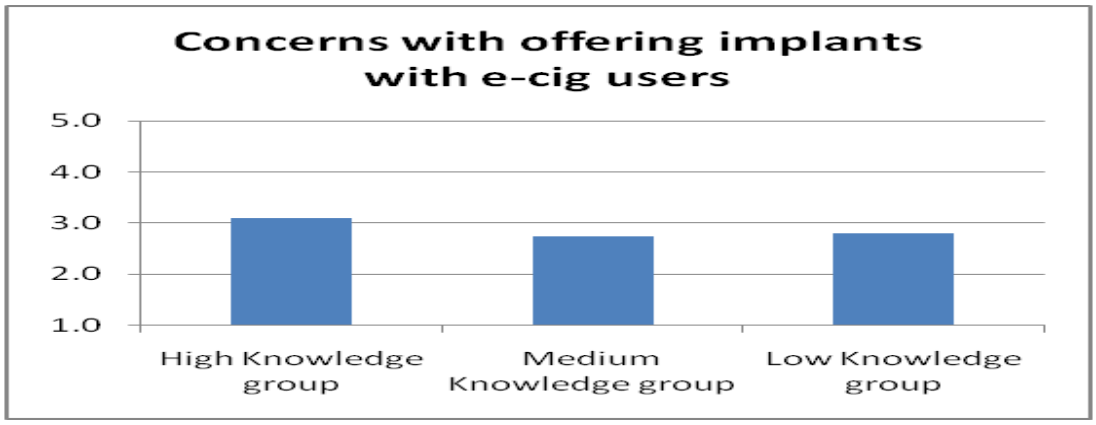
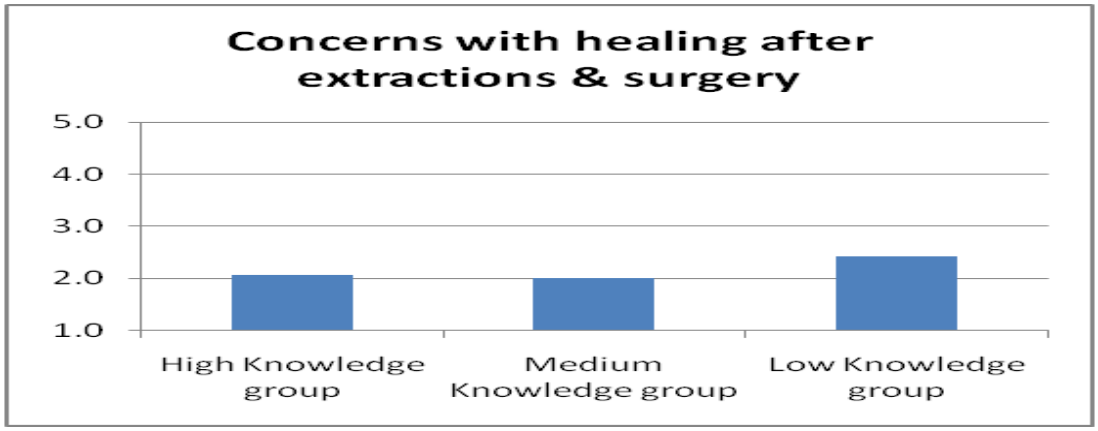


Figure 17 - Correlation of concerns with healing to knowledge score



When looking closely within the low, medium and high knowledge group's responses to individual behavior questions we found that for Low knowledge group practitioners responded more commonly (mode = 5) against recommending stopping E-cigarette before invasive procedure compared to medium and high knowledge groups. The high knowledge group responded more commonly (mode = 5) indicating no concern with recommending dental implants for E-cigarette users compared to medium and low knowledge groups. For all other behavior questions the common responses across low, medium and high knowledge groups were the same. This shows that knowledge level is a subtle predictor for practice behavior regarding E-cigarettes.

Correlation between knowledge score and individual behavior score was computed using Pearson's r (correlation coefficient) test, we found for this group of practitioners higher knowledge score had very low correlation, r = 0.08, with obtaining information about E-cigarette on informed consent form. Similarly a low correlation, r = 0.005 for E-cigarette use, r = 0.12 for conventional cigarette use and, r = 0.03 for other nicotine products use on the medical history form was noted. Modification of treatment procedures and discussion of risk on oral and general health was found to have 16% (r = 0.16) correlation

with knowledge score. A 20% (r = 0.195) correlation was found between knowledge score and discussion of risks with treatment outcomes and E-cigarette use. Low correlation between knowledge score and recommendation of stopping E-cigarette before invasive treatment (r = 0.04), low correlation (r = 0.03) was also noted with recommendation of dental implants in E-cigarette users and a low correlation (r = 0.10) with knowledge score and concerns about healing after extractions and surgeries.

Table 4 - Correlation of knowledge levels to individual behavior questions

Questions		**Low Knowledge level**	**Medium Knowledge level**	**High Knowledge level**
1.Information about the risk from E-cigarettesuse is include in my patient consent forms	Mode	4	4	4
	Median	4	4	4
	Mean	3.79	3.6	3.63
2. My medical history forms ask my patients about the use of E-cigarettes	Mode	0	0	0
	Median	0	0	0
	Mean	0.22	0.22	0.19
3. My medical history forms ask my patients about the use of Conventional cigarettes	Mode	1	1	1
	Median	1	1	1
	Mean	0.8	0.9	0.83
4. My medical history forms ask my patients about the use of Other nicotine products	Mode	0	0	0
	Median	0	0	0
	Mean	0.15	0.13	0.09

Table 4 contd. - Correlation of knowledge levels to individual behavior questions

5. I (would) modify my treatment recommendations if a patient reports smoking E-cigarettes	Mode	2	2	2
	Median	2	2	2
	Mean	2.79	2.79	2.38
6. If my patients use E-cigarettes, I discuss the risks of adverse effect on oral health	Mode	1	1	1
	Median	2	2	2
	Mean	2.4	2.23	1.91
7. If my patients use E-cigarettes, I discuss the risks of adverse outcomes of treatment with him or her	Mode	1	1	1
	Median	2	2	2
	Mean	2.6	2.33	1.96
8. I have advised patients who require invasive dental treatment to stop using E-cigarettesbefore a procedure	Mode	5	1	1
	Median	3	2	2
	Mean	3.05	2.76	2.77
9. I have concerns with offering dental implants to patients who use E-cigarettes	Mode	1	1	5
	Median	2	2	3
	Mean	2.79	2.73	3.10
10. I worry about healing after extractions and surgical procedures for patients who use E-cigarettes	Mode	1	1	1
	Median	2	2	1
	Mean	2.42	2.0	1.51

Discussion

The results from this study show that overall practitioner knowledge of E-cigarette risk does not influence practice behaviors among those surveyed. This may be due to lack of data specifically regarding E-cigarettes risk and oral health. The prevalence of patients reporting E-cigarette use within the patient population of our surveyed practitioners is high in accordance with other national level data reported by Merianos et al 2017, CDC & FDA 2011-2016 National Youth Tobacco Surveys (NYTS). In a National Youth Tobacco survey, Merianos et al found that from 2013-2015, youth were at nearly 5 times the risk of reporting ever use of E-cigarettes and 4 times the risk of reporting current use compared to 2013 (Merianos et al. 2017). This is concerning given research suggests that E-cigarette use may be predictive of initiation of conventional cigarette use due to low perceived harm and the potential of renormalization and social acceptance of smoking behavior among this population (Barrington-Trimis et al. 2015; Zhong et al. 2016; Leventhal et al. 2015) As seen by our survey, 38% practitioners see e- cigarette users more than once per day to one per week in their practices. 34% practitioners are noting increase in switch to E-cigarette and 20% see dual use among their patients consistent with other reports of poly product use. Merianos et al found that exposure to vapor from E-cigarettes in public places significantly increased the risk of dual and poly use. Patients exposed to E-cigarette were 10.4 times (95% CI, 7.8-13.8) more likely to report current poly use (Merianos et al. 2017). In 2014, a study of adolescents and young adults found that among active tobacco users, 25% reported using at least 2 tobacco products, and 21% reported using more than 2 tobacco products (S. Soneji, Sargent, and Tanski 2016).

Our results suggest that a third of surveyed practitioners do not know or did not collect information from their patients about E-cigarette use. Also a third of practitioners surveyed who completed their training year 1995 or earlier did not know or did not collect information from their patients about E-cigarette use. Similarly, 38% and 55% of practitioners did not know or did not collect information from their patients about former conventional cigarette and current E-cigarette use or dual use, respectively. 33% and 39% of practitioners graduating 1995 or earlier did not know or did not collect data regarding former conventional cigarette and current E-cigarette or dual use, respectively. Statistically significant difference between training groups could be explained by the emergence of new evidence linking risks in overall health and conventional smoking and the incorporation of this body of literature into medical and dental training programs. This practitioner behavior can be explained by a lack of knowledge and evidence regarding e-cigarettes and oral health. This canalso be explained by the neighborhood or part of state they practice where patients might not use e-cigarette and use other tobacco products. This phenomenon was observed by (Hartwell et al. 2016) that concluded that certain sociodemographic characteristics such as younger age, male sex, higher educational attainment appear to be patterned with E-cigarette awareness, 'ever use' and current use. Although significant downward trends in conventional cigarette smoking have been seen among high school students, there have been upward trends in the use of nonconventional tobacco and nicotine delivery products such as hookah and E-cigarettes; resulting in no overall change in nicotine product use over time (Kann et al. 2016; Singh et al. 2016).

Dual use of cigarettes and E-cigarettes has been linked to health risk behaviors including low daily physical activity, poor dietary behavior, alcohol and other drug use, physical fighting, and suicide attempts (Demissie et al. 2017). Negative consequences specifically associated with polyproduct use include elevated risk of becoming nicotine dependent,(Apelberg et al. 2014; Harrell et al. 2017) lower intentions to quit smoking,(Tworek et al. 2014) increased use of alcohol and illicit drugs,(Bombard et al. 2009) and elevated rates of substance use disorders (Cavazos-Rehg et al. 2014). These results possibly suggest a need for more awareness about newer tobacco products and information about their harmful effects on oral health care to be dissipated to private practitioners through continuing education courses and other training avenues.

Access to E-cigarettes has been reported by many studies as unregulated and marketing strategies are targeting young vulnerable population. Several studies elude to the fact that exposure to E-cigarette advertising and lower harm perception is associated with a higher likelihood of use (Choi and Forster 2014). In 2013-2014, 81% of current youth e-cigarette users cited the availability of appealing flavors as the primary reason for use (Villanti et al. 2017) . A study monitoring Google search queries from January 2009 to January 2015 reported rapidly increasing levels of E-cigarette web searches in every U.S. state indicating that people actively seek information about E-cigarettes(Ayers et al. 2016). Our survey results also suggest that more than 70% practitioners surveyed perceive that children and youth have easy access to these harmful products.Youth who exclusively use E-cigarettes also reported significantly greater intention to use (Bunnell et al. 2015) and eventual initiation (Wills et al. 2017) of combustible cigarette use than never E-cigarette users.

In our study 60% - 70% practitioners surveyed believe that their patients think E-cigarettes are harmless compared to conventional cigarette and would help with quitting cigarettes. Only 7% of practitioners believe that their patient base is well informed about the risks of E-cigarettes. A 2015 report from Public Health England stated that E-cigarettes are 95% less harmful than cigarettes; however, the studies used to support this finding have been scrutinized for having conflicts of interest and weak methodology (Polosa 2015). In addition, many of the expert panelists who generated the "95% safer" claim were later shown to have connections to the tobacco industry and are established champions of E-cigarettes as "harm reduction" devices; a strategy readily embraced by the tobacco industry (Gornall 2015). Studies about constituents of e-liquid and aerosol produced by the e-cigarette reveal that there are many similarities with conventional cigarette in terms of the various carcinogens, heavy metals and other unknown toxins. These have damaging effects on several organ systems, cellular and biologic components such as DNA, mitochondria, electron chain transport etc.. Genotoxic, and inflammatory stresses are features of direct cell exposure to E-cigarette aerosols which are ensued by inflammatory duress, raising a concern on deleterious effect of vaping (Lerner et al. 2016). Uchiyama et al demonstrated that 70% of examined E-cigarette brands contained or generated carbonyl compounds such as formaldehyde, acetaldehyde, acrolein, crotonaldehyde and methylglyoxal (Bekki et al. 2014; Flora et al. 2017; Gillman et al. 2016; Han et al. 2016; Ogunwale et al. 2017; Uchiyama et al. 2013). Volatile organic compounds (VOCs) such as benzene, crylonitrile, ethylbenzene, styrene and toluene were found in E-cigarette aerosol as well (Bouza et al. 2017; Y.-H. Kim and Kim 2015; Lee et

al. 2017; Lim and Shin 2017; Marco and Grimalt 2015; Pankow et al. 2017; Pulvers et al. 2016; Shahab et al. 2017)

Many of the carcinogens are similar between conventional and E-cigarettes such as Tobacco-specific nitrosamines (TSNAs), N'-nitrosonornicotine (NNN), 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone (NNK), N'-nitrosoanabasine (NAB), and N'- nitrosoanatabine (NAT) (Farsalinos et al. 2015, H.J. Kim and Shin 2013, Orr 2014, Wu et al. 2013). Menthol a common masking agent used in conventional cigarettes is now available as flavoring agent in e-liquids. Reports suggest that one third of diagnosed esophageal cancers in 1998 in the US, were in females (Brooks-Brunn 2000) and about a third of female smokers preferred menthol cigarettes (Giovino et al. 2004). Menthol increases the flux of the known carcinogens like nitrosamine and nitrosonornicotine across porcine esophagus (Azzi et al. 2006). DIY (Do-it-yourself) e-liquids are particularly dangerous in which the user can mix disproportionate amount of nicotine and other addictive chemicals. Several reports of marijuana extract oil and other recreational drugs mixed into e-liquids for additive effects are common. Ease of access, minimal regulation on product availability, DIY e-liquids and unkown effects on health is creating a major public health crisis.

Knowledge score distribution among the surveyed practitioners categorized more than $2/3^{rd}$ of the respondents into medium to high knowledge level groups. Given the paucity of data regarding effects of E-cigarettes on oral/dental health, it seems that the dental community is drawing parallels in knowledge with conventional cigarettes and newer tobacco products. As a major branch of healthcare we are better off expecting similar harm profile for e-cigarettes as the conventional tobacco cigarette. This strategy would

prepare us to protect our patients and our practices as we learn more from upcoming evidence suggesting the worse.

High, medium and low knowledge levels when correlated with specific behaviors in practice, the results revealed some interesting observations. 93% of practitioners surveyed did not protect themselves and their practices with specific inclusions about E-cigarettes in their informed consent forms. Informed consent is critical piece of legal document used in defense of liability and negligence claims against practitioners. More than a third of practitioners (80%) surveyed also did not ask about E-cigarette use on their medical history forms compared to only 14% of practitioners that do not ask about conventional cigarette and even less than 12% ask about other nicotine products. This was true across all knowledge level. E-cigarettes perception as being less harmful and perhaps lack of evidence and coverage in oral health journals is the reason that screening of E-cigarette users has not reached to the level of conventional cigarettes and alcohol consumption. Training level when correlated with encounters with e-cigarette users, users that switch to e-cigarettes and dual users suggest that recent graduates (1995-2018) are more likely to collect information about use of these products from their patients. Curriculum in dental and hygiene program lacks information about recommending smoking cessation therapies and working closely with physician and other allied providers. E-cigarettes have been in the market for more than a decade but information and risks about them progresses slowly into academic books and training programs.

Furthermore, the level of knowledge relates directly to the practitioner's self-perception of understanding, that is, the high knowledge group better recognized their higher level of understanding, while the low knowledge group was less accurate in identifying their level

of understanding. This result is consistent with previous studies suggesting greater accuracy for self-perceptions of understanding in relation to true knowledge base. A direct correlation was observed between knowledge level and positive behaviors regarding modifying treatment recommendation for E-cigarette users, recommending stopping E-cigarettes before invasive procedures, discussing risks of E-cigarettes on treatment outcomes and discussing risks with healing post-extraction or surgeries in E-cigarette users. High and medium knowledge level groups consistently responded positively than low knowledge group for the above mentioned behaviors. Interesting observation was that low knowledge level group, as expected, strongly responding (mode = 5) to not stopping E-cigarette before invasive procedure. A meta-analysis by Mills et al, demonstrated risk reduction associated with preoperative cessation across a variety of organ systems with a compounding increase in the magnitude of effect of 19 % for each week of cessation prior to surgery (Mills et al. 2011). Mills et al, included 6 randomized trials in their meta-analysis and demonstrated a relative risk reduction of 41% (95% confidence interval [CI], 15-59, P = .01) for prevention of postoperative complications. Trials of at least 4 weeks smoking cessation had a significantly larger treatment effect than shorter periods of cessation. Observational studies examining duration of cessation demonstrated that longer periods of cessation (>4weeks), compared with shorter periods(<4weeks), had an average reduction in total complications of 20% (RR 0.80, 95% CI, 3-33, P = .02, I^2 = 68%) (Mills et al. 2011). Sorenson et al noted, in a meta-analysis, that preoperative smoking cessation for at least 4 weeks reduced the frequency of surgical site infections (Lars Tue Sørensen 2012).The mechanism was believed to be related to increased vitamin C levels and increased procollagen I N-propeptide (PINP)

levels observed in the abstained smokers, both of which promote collagen synthesis and wound contraction (Lars T. Sørensen et al. 2006). However, no studies were found directly related to cigars or electric cigarettes. Oxidative stress is linked to a number of impaired healing processes. Both wound and bone healing share many physiological pathways impacted by cigarette smoking that we predict will lead to similar clinical outcomes. Such shared pathways include cellular hypoxia, arteriolar vasoconstriction, and delayed revascularization (Hoogendoorn et al. 2002).

Direct correlation with discussing risks of E-cigarettes on oral health and knowledge level was also observed in our study. Although data linking E-cigarettes and oral or dental health is not available, some in vitro studies point out that there is a possibility that effects might be similar to conventional cigarettes. Sundar et al show that E-cigarettes with flavorings cause increased oxidative/carbonyl stress and inflammatory cytokine release in human periodontal ligament fibroblasts, Human Gingival Epithelium Progenitors and gingival epithelium. They also note an increased levels of prostaglandin-E2 and cycloxygenase-2 are associated with upregulation of the receptor for advanced glycation end products (RAGE) by E-cigarette exposure-mediated carbonyl stress in gingival epithelium/tissue. Sancilio et al found that apoptosis as measured by BAX gene expression and Reactive Oxygen Species production suggest a role for E-cigarette fluids in the pathogenesis of oral diseases, such as periodontitis (Sancilio et al. 2016). No data regarding E-cigarette use and dry mouth/caries risk is published till date. In an Iowa Fluoride Study by Shenkin et al, collected 637 children's socioeconomic information, parents also completed at least three questionnaires during the first year of life of the child, and had a primary dentition exam at age 4-7 years. Conventional smoking

information in the households was asked in the questionnaires. Socioeconomic status (SES) was divided into three groups (low, middle, and high) based on family income and mother's education. The authors found that children residing in regularly smoking homes had a higher prevalence of caries. For the middle SES group and overall, the children from smoking homes had a significantly higher prevalence of caries compared to nonregular/nonsmoking homes 52% vs 24% (P=.05)and 44% vs 25%, (P=.002) respectively. After adjusting for age, socioeconomic status, toothbrushing frequency, total ingested fluoride, and combined intake of soda pop and powdered drink beverages, the relationship of smoking and caries still remained significant (odds ratio [OR]=3.38; P=.001) (Shenkin et al. 2004)

Unlike the other behavior questions opposite trend was observed with recommendation of dental implants in E-cigarette user and knowledge level. High knowledge level group reported strongly (mode = 5) of having no concerns compared to low knowledge level group in recommending dental implants to E-cigarette smokers. This observation was contradictory to evidence regarding conventional cigarette smoking and implant complications. A meta-analysis by Moraschini et al concluded that more marginal bone loss occurred with smoking group (standardized mean difference - SMD 0.49, 95% CI 0.07-0.90; P=0.02) and more marginal bone loss in the maxilla than mandible (SMD 0.40, 95% CI 0.24-0.55; P<0.00001). A statistically significant difference in implant failure in favor of the non-smoking group was also observed (OR 1.96, 95% CI 1.68-2.30; P<0.00001) (Moraschini and Barboza 2016). Another meta analysis by Chrcanovic et al included studies with total of 19,836 implants placed in smokers, with 1259 failures (6.35%), and 60,464 implants placed in non-smokers, with 1923 failures

(3.18%). Smoking significantly affected the failure rates, the risk of postoperative infections as well as the marginal bone loss. The results should be interpreted with caution due to the presence of uncontrolled confounding factors in the included studies (Chrcanovic, Albrektsson, and Wennerberg 2015). Bain and Moy, 1993 reviewed the outcome of 2,194 Brånemark implants placed in 540 patients over a 6-year period. The overall failure rate of 5.92% they found was consistent with other studies. A significantly greater percentage of failures occurred in smokers (11.28%) than in nonsmokers (4.76%) ($P < .001$) (Bain and Moy 1993). Schwartz-Arad, compared implant failures and complication rates between 3 groups: non-smokers, mild smokers (up to 10 cigarettes per day) and heavy smokers (more than 10 cigarettes per day). Smokers were further divided into 2 subgroups according to duration of smoking (less or more than 10 years). The overall failure rate was 2% for non-smokers and 4% for all smokers. Minor and major complications were also found in higher percentages (46%) in the smoking groups than in the non-smoking group (31%) (Schwartz-Arad et al. 2002)

Intended as a pilot project for assessing knowledge, perceptions and practice behavior of dental practitioners regarding e-cigarettes, our study population consisted of a sample of dental practitioners in the Maryland. The findings of this study could potentially be biased, as those who replied to the survey were all alumni of University of Maryland School of Dentistry and might have had similar content of instruction. Conducting a similar survey with a larger sample of practitioners may yield results that are more generalizable. Future studies should evaluate physicians' knowledge and perceptions related to E-cigarettes will be instrumental in determining if physicians are aware of the risk of e-cigarettes, if physicians are discussing these risks with their patients, and if they

are referring patients to dentists or vice versa in order improve collaborations between physicians and dental practitioners when managing patients using e-cigarettes.

Conclusions

- The results from this study show that overall practitioner knowledge of E-cigarette risk does not influence practice behaviors among those surveyed. This may be due to lack of data specifically regarding E-cigarettes risk on oral health.

- The results of this survey demonstrate the importance for a dental practitioner to identify and understand risks of electronic cigarettes and communicate these risks to patients and how this knowledge can affect their treatment recommendations and other behaviors.

- While much remains unknown regarding the risk of E-cigarettes, evidence from different fields is emerging regarding safety, risks and benefits of E-cigarettes. This study reinforces the value of disseminating and translating this evidence to dental practitioners through early inclusion in training programs and continuing education courses.

- This study also urges professional dental organizations eg. American Dental Association, American Academy of Periodontology and others to review the evidence and provide guidelines and best practices to manage patients using e-cigarettes.

Clinical Implications

- This study did identify differences in certain practice behaviors based on subject knowledge and demonstrates a need for translation of information into clinical practice guiding dental care for patients smoking e-cigarettes. This study also urges professional dental organizations e.g. American Dental Association, American Academy of Periodontology and others to review the evidence and provide guidelines and best practices for its members to effectively manage patients using e-cigarettes.

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