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Oral cancer examinations and lesion discovery as reported by U.S. general dentists: Findings from the National Dental Practice-Based Research Network

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ABSTRACT

General dentists (GDs) have the opportunity to examine their patients for oral premalignancy/malignancy. We estimated the annualized per dentist number of oral lesions suspicious for premalignancy/malignancy discovered by United States (U.S.) general dentists and the annualized per dentist number of histologically-confirmed cancers subsequently diagnosed. Eligible participants were licensed, clinically-active U.S. GDs who were members of the U.S. National Dental Practice-Based Research Network. An a priori sample size of 900 was determined; 2000 GDs were invited to participate; 1,073 completed the study. Self-reported, cross-sectional data were obtained via an online questionnaire during 4/12/2017–8/31/2017 and analyzed. The reported numbers of suspicious oral lesions and histologically-confirmed oral cancer cases diagnosed over the previous six months were quantified. Potential outcome predictors were evaluated as covariates in multivariable analyses. Crude and adjusted statistics were produced by regressing each outcome on each independent variable while assuming a Poisson distribution, log link and utilizing robust standard errors. Eighty-seven percent of dentists reported discovering 1+ lesion suspicious for oral premalignancy/malignancy during the preceding six months. The mean number of suspicious lesions/dentist/year was 9.5; adjusted mean: 9.6. Fifteen percent of participants reported discovering 1+ lesion confirmed as cancer during the same period, 213 confirmed cancer cases/6 months or 426/year. Crude and adjusted mean numbers of histologically-confirmed oral cancers were both 0.4 cancers/dentist/year. Our findings suggest that many U.S. general dentists are actively identifying oral lesions suspicious for premalignancy/malignancy, thereby aiding in the discovery of oral malignancies and representing an important component in the frontline against cancer.

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1. Introduction

It is estimated that there will be 51,540 new cases of and 10,030 deaths attributable to cancer of the oral cavity and pharynx in the United States (U.S.) during 2018 (Siegel et al., 2018). Cancer incidence rates for sites within the oral cavity have generally shown a downward trend over recent decades in the U.S., while rates for oropharyngeal cancer increased since the early 2000s (Noone et al., 2018). The primary risk factors for cancer of the oral cavity are tobacco use and heavy alcohol consumption, while the human papillomavirus (HPV), particularly type 16, is important in the etiology of oropharyngeal cancer (Blot et al., 1988; D'Souza et al., 2007; Cleveland et al., 2011). One strategy for reducing or preventing cancers at these sites is to attenuate or eliminate exposures to these risk factors through education and lifestyle modification.

Early detection provides another approach in the battle against cancer by seeking to discover, among asymptomatic persons, early indications of disease, when the condition may be more amenable to treatment or cure. Cancers of the oral cavity are often discoverable at an early stage or in a premalignant state and referred to as an oral potentially malignant disorder (OPMD). An additional benefit of conducting oral cancer examinations is the potential periodic discovery of lesions or conditions other than cancers per se that could have gone undetected and could benefit from treatment or close follow-up.

Dental practitioners are in a unique position to opportunistically examine the oral cavity and, to a lesser extent, oropharynx during routine patient examinations and encounters. Moreover, their ability to evaluate the clinical state of oral tissues is enhanced by the ready availability of a dental armamentarium that includes mouth mirrors, gauze squares, and a focused, adjustable light source, as well as an educational background that includes knowledge of the normal and pathological presentation of oral subsites.

In the United States, approximately one-third of oral and pharyngeal cancers are diagnosed at a localized stage (Noone et al., 2018). Stage at diagnosis is significant for oral cavity subsites as 5-year relative survival rates tend to be higher among individuals whose oral cavity cancer was diagnosed at an early, relative to late, stage (Noone et al., 2018; Morse and Kerr, 2006). As an example, 5-year relative survival rates for floor of mouth cancer during the years 2007–2013 were 78.1%, 39.2% and 18.8%, for persons diagnosed with localized, regional, and distant disease, respectively (Noone et al., 2018).

In a small retrospective study of cancer detection patterns by practitioner type, Holmes et al. (2003) found that asymptomatic cases of squamous cell carcinoma of the oral cavity and oropharynx were more likely to have been detected in a dental office, rather than in a medical or oral and maxillofacial surgery (OMFS) care-setting, while physicians and oral surgeons were more likely to see symptomatic lesions, which were subsequently confirmed as malignant.

The overall purpose of the current investigation was to obtain a cross-sectional overview of how United States general dentists (GDs) participating in the National Dental Practice-Based Research Network ("Network") regard and utilize oral cancer examinations (OCEs) in their practices. In the present analysis, we sought to estimate the annualized per dentist number of oral lesions suspicious for premalignancy/malignancy discovered by U.S. GDs and the annualized per dentist number of histologically-confirmed cancers subsequently diagnosed.

2. Methods

A cross-sectional study was conducted between 4/12/2017 and 8/31/2017 by the National Dental Practice-Based Research Network (Network), a consortium of dental practices and organizations dedicated to increasing knowledge in topical areas relevant to dental practice. The Network's main funding source is the United States (U.S.) National Institute of Dental and Craniofacial Research. Individuals eligible to participate in the current study were all U.S. licensed GDs practicing in the U.S. and clinically-active Network members. Potentially eligible practitioners were identified for OCE study inclusion through their responses to the Network Enrollment Questionnaire. Additional details regarding the Network and the manner in which members join have been published previously (Gilbert et al., 2013). The Network's applicable Institutional Review Boards approved the study, and all participants provided informed consent before completing the questionnaire.

2.1. Sample size considerations

In order to address the specific aims of the current analysis, a series of sample size calculations was performed predicated on the need for precise, stratified prevalence estimates, but not to address statistical differences of any modeled covariance. Based on those calculations, an overall a priori sample size of 865 clinically active general dentists was judged to provide sufficient statistical power.

In order to ensure that the desired sample size was available for planned analyses, two thousand GDs were invited to join the study, with invitations being forwarded via e-mail. Each invitation included a link to an on-line questionnaire. For individuals who had not completed the questionnaire within two weeks of the initial e-mail, a follow-up invitation was e-mailed, and a third invitation was sent if the questionnaire had not been returned after two additional weeks. Following three unanswered invitations, Network Regional Coordinators personally contacted non-completers via e-mail, telephone, or postal mail.

2.2. Network Enrollment Questionnaire

As part of the initial Network enrollment process, practitioners completed an Enrollment Questionnaire that collected information on dentist demographics, their practices, and their patient populations. The questionnaire is publicly available at http://nationaldentalpbrn.org/tyfoon/site/fckeditor/Network-EnrollmentQuestionnaire-2013-07-15-V9%200.pdf

Questionnaire items, which had documented test/re-test reliability, were taken from previous work in a practice-based study of dental care (Gilbert et al., 2011, 2013; The Florida Dental Care Study [http://nersp.nerdc.ufl.edu/~gilbert/]).

2.3. On-line OCE questionnaire

The on-line, self-administered OCE questionnaire was developed specifically for the study with input from an expert panel comprised of senior oral medicine and pathology specialists, cancer and other chronic disease epidemiologists, dental clinicians, a research psychologist, and network faculty and staff experienced with online questionnaire administration to Network practitioners. The final questionnaire contained 25 introductory questions, many with follow-up sub-questions. All items were reviewed and evaluated by Westat Instrument Design, Evaluation, and Analysis (IDEA) Services, key members of the Network Coordinating Center, and ten Network dentists and hygienists who completed the instrument and were individually interviewed for their understanding of each question.

Questions relevant to the current project sought to determine, for specific time periods, the number of lesions suspicious (to the practitioner) for being premalignant/malignant that were biopsied or referred and the number of patients with lesions that were ultimately diagnosed histopathologically as carcinoma in situ or oral cancer. The specific questions used to form the core of the current analysis were as follows:

1. "In the past six (6) months, approximately how many biopsies did you personally perform on patients with oral lesions suspicious for premalignancy/malignancy?"
2. "Of the oral lesions suspicious for premalignancy/malignancy you

biopsied yourself in the past *six (6) months*, how many had a histopathologic diagnosis that was carcinoma *in situ* or a cancer?"
3. "In the past six (6) months, how many patients with oral lesions suspicious for premalignancy/malignancy did you refer for consultation/biopsy?"
4. "Of the patients with lesions suspicious for premalignancy/malignancy that you referred for consultation/biopsy in the past 6 months, how many had a histopathologic diagnosis that was a carcinoma *in situ* or a cancer?"

2.4. Questionnaire reliability

In order to assess the reliability of the questionnaire during study conduct, a sample of respondents who indicated a willingness to retake the questionnaire was invited to repeat the survey within two weeks of initially completing the instrument. The test-retest reliability study invitations were issued weekly until the a priori sample size (n = 70) of retest completers was achieved.

2.5. Analysis

Study data were cleaned and subsequently imported into SAS, Stata and SPSS for analysis. The primary outcomes in the current analysis included the dentist-estimated number of oral lesions suspicious for oral premalignancy/malignancy that were either personally biopsied by the practitioner or referred for consultation/biopsy during the preceding six-months (assuming one suspicious lesion/referred patient). Because we could not disentangle the number of referred patients (or suspicious lesions) that received a biopsy from those which did not (question #3), we refrained from estimating the total number of biopsies and the percentage of referred patients/suspicious lesions that received a biopsy. Based upon those suspicious lesions, the practitioners estimated the number of cancer diagnoses that were subsequently confirmed histolopathologically. Annualized projections were produced based upon the six-month practitioner estimates.

The expert panel reviewed frequency distributions and boxplots for each of the outcomes and unanimously concluded that cancer detection totals at or beyond 2.5 standard deviations above the mean, and representing twelve dentists, were unlikely to characterize patient pools of general dentists. Generally similar frequency distributions were observed for dentists as regards measures of "suspicious lesions." As a consequence, subsequent analyses involving these variables excluded dentists whose values were at or exceeded 2.5 standard deviations above the respective means.

In order to determine whether practitioners who responded to the study questionnaire were different than non-responders, we compared the two groups on responses to eight questions included in the Network Enrollment Questionnaire. The eight variables were dentist gender, geographic region, practice location type, decade of dental school graduation, percentage of patients in practice covered by public insurance, percentage of patients covered by private insurance, full- or part-time practice, and number of patients personally treated during a typical work week. Geographic region and location type were treated as dummy variables. The statistical comparisons utilized Fisher's Exact and nonparametric Kruskal-Wallis tests, with a post-hoc Bonferroni pairwise adjustment when applicable.

Ten potentially key indicators of the outcomes of interest were identified from the Enrollment Questionnaire and current study questionnaires and subsequently evaluated for possible use as covariates in the adjusted analyses. The ten variables were: hours practiced per week, percentage of patients aged 45–64, percentage of patients aged 65 and older, percentage of patients with public insurance, dentist age, years since dental school graduation (a computed variable based on year of graduation), completed a General Practice Residency (GPR) or an Advanced Education in General Dentistry residency (AEGD), dentist gender, practice location, and Network region. Descriptive statistics and bivariate associations were examined; variables statistically significant in the bivariate analyses were included in the adjusted models. Crude estimates and p-values were produced by regressing each outcome on each independent key variable, while assuming a Poisson distribution, log link and utilizing robust standard errors to aid in accounting for any overdispersion. Marginal means and robust standard errors were prepared for each variable and variable level. In order to produce adjusted statistics for each of the two outcome variables, a stepwise approach was used beginning with the inclusion of all six potential confounders as covariates. The Poisson distribution, log link and robust standard errors were utilized.

3. Results

Two-thousand general dentists were invited to participate in the current National Dental – Practice-Based Research Network study. Of the 2,000 invitees, 58 (2.9%) were later determined to be ineligible for reasons including no longer a Network member or no longer meeting study eligibility criteria, e.g., no longer clinically active. Among the 1942 eligible invitees, 1073 (55.3%) completed the OCE questionnaire.

3.1. Study participants vs. nonparticipants

Eight questions from the Network Enrollment Questionnaire were used to compare the GDs who completed the study questionnaire to those who did not (Table 1). The groups were generally similar, although statistically significant differences ($p \leq 0.05$) were found regarding two of the eight enrollment questions, i.e., Network region where practice located ($p = 0.0006$) and decade of dental school graduation ($p < 0.0039$) (Table 1).

3.2. Tests of core question reliability

The reliability of practitioner responses to the four core questions referenced above was evaluated by comparing test-retest response values for each question using Spearman rank correlation coefficients. A total of 70 practitioners completed a re-test questionnaire. For core questions #1 and #3, which relate to the number of oral lesions suspicious for premalignancy/malignancy that were either personally biopsied by the dentist respondent or referred for consultation/biopsy during the previous six months, Spearman rank correlation coefficients were 0.75 ($p = 0.0019$) and 0.80 ($p < 0.0001$), respectively, indicating strong correlations between the reported test and retest values. For core questions #2 and #4, which provide the reported number of confirmed carcinoma in situ or cancer cases, the coefficients were 0.40 ($p = 0.17$) and 0.71 ($p < 0.0001$), indicating moderate to strong correlations.

3.3. Possible outcome indicators

Table 2A presents selected categorical variables evaluated as possible indicators of the primary outcomes of interest. Having completed a GPR or AEGD residency (no/yes) was not a statistically significant indicator of the reported number of suspicious lesions referred or biopsied (9.4 vs. 9.7, $p = 0.14$) or for the number of histopathologically-confirmed cancers (0.40 vs. 0.41, $p = 0.97$). Female dentists reported, on average, a modestly higher number of suspicious lesions that were referred or biopsied than male practitioners (10.5 vs. 9.0, $p = 0.04$); however, there was little difference, by gender, in the mean number of microscopically-confirmed cancers diagnosed by dentist gender (0.41 vs. 0.38, $p = 0.67$).

When practice location type (i.e., inner city, urban, suburban, rural) was considered, there were no statistically significant differences in the reported number of patients who were referred or biopsied with suspicious lesions or who were later diagnosed with oral cancer; however, there were regional differences in the numbers of confirmed

Table 1
Comparison of OCE National Dental PBRN study participants to non-participants on selected characteristics, 2017.

Categorical characteristics	Study participants n (%)	Non-participants n (%)	p-Value
Sample size	1073 (54%)*	927 (46%)*	
Dentist gender			
Male	753 (70.5)	683 (74.2)	0.07[a]
Female	315 (29.5)	238 (25.8)	
Practice full or part-time			
Full-time (≥32 hours per week)	891 (84.1)	769 (83.9)	0.90[a]
Part-time (< 32 hours per week)	168 (15.9)	148 (16.1)	
Practice location type			
Inner city/urban area	117 (11.0)	132 (14.3)	0.09[a]
Urban (not inner city)	292 (27.4)	264 (28.7)	
Suburban	498 (46.8)	393 (42.7)	
Rural	157 (14.8)	132 (14.3)	
Network region where practice located			< 0.01[a]
Midwest	122 (11.4)	84 (9.1)	
Northeast	248 (23.1)	163 (17.6)	< 0.05[b]
South Atlantic	131 (12.2)	157 (16.9)	< 0.05[b]
South Central	215 (20.0)	211 (22.8)	
Southwest	189 (17.6)	182 (19.6)	
Western	168 (15.7)	130 (14.0)	
Decade of dental school graduation			< 0.01[a]
Pre-1980s	220 (23.9)	192 (17.9)	< 0.05[b]
1980s	256 (27.9)	349 (32.5)	< 0.05[b]
1990s	183 (19.9)	204 (19.0)	
≥2000s	260 (28.3)	328 (30.6)	

Continuous characteristics	Mean (SD)/median	Mean (SD)/median	p-Value
Approximate percentage of patients in practice covered by			
Private insurance for dental care	60.3 (24.6)/65.0	61.0 (23.7)/65.0	0.67[c]
Public program for dental care	16.0 (24.1)/5.0	14.4 (23.0)/3.0	0.08[c]
Number of patients personally treated in a typical work week	42.2 (24.6)/40.0	42.1 (21.9)/40.0	0.81[c]

N.B., The total n for each variable may not equal the total number of study participants/non-participants due to missing data (see Table 2A for the number of missing values by specific characteristic).
p-Values obtained from: [a]Fisher's exact test; [b]Bonferroni adjusted p-value for pairwise comparisons; [c]Kruskal-Wallis test.
* Rounded from 2 decimal places.

malignancies ($p < 0.01$). Based upon Bonferroni corrected p-values, the South Atlantic region had a higher mean number of confirmed cancers (0.69/year) than both the Western (0.29/year, $P_{Bonferroni} = 0.056$) and Southwestern (0.27/year, $P_{Bonferroni} = 0.02$) regions.

Table 2B presents results from the regression analysis in which we explored selected continuous variables as outcome indicators of interest. Neither the percentage of patients aged 45–64 years nor the percentage with public insurance were significant indicators of either outcome (at $p \leq 0.05$); however, with increasing practice hours per week, the mean numbers of each outcome increased. The number of histopathologically-confirmed malignant lesions rose as the percentage of patients aged 65 and older increased ($p < 0.01$). On the other hand, our regression analyses revealed that dentist age and number of years since dental school graduation were both inversely associated with the number of identified lesions suspicious for precancer/cancer ($p < 0.01$), but neither was statistically associated with number of microscopically confirmed cancers.

3.4. Suspicious oral lesions

As shown in Tables 3, 87% of the dentist participants (923/1,062) claimed to have discovered at least one oral lesion suspicious for oral premalignancy/malignancy that was referred or biopsied during the preceding six-month period. The corresponding mean number of identified suspicious lesions/dentist/year was 9.5 [95% Confidence Interval (95%CI), 9.31, 9.68], with an adjusted mean of 9.6 (95%CI, 8.93, 10.16) (Table 3). At percentile levels of 25, 50, 75 and 100%, the numbers of patients with suspicious lesions were 2, 6, 12, and 60, respectively.

3.5. Histologically confirmed oral cancers

One hundred sixty-three (163) dentists (15% of the 1061 participants) reported discovering at least one lesion that was subsequently confirmed as an oral cancer during the previous six months (Table 3). A total of 213 confirmed cancer cases were reported for the same time period, corresponding to 426 for the year. Among dentists included in the analysis, the mean number of oral cancer cases/dentist/year was 0.4015 (426 cases/1061 dentists/year), with an adjusted mean of 0.4 cases/dentist/year (95% CI, 0.338, 0.463) after controlling for age and region. The number of reported OC cases at the 25th, 50th, 75th, and 100th percentile levels was 0, 0, 0, and 6.

Of note, findings from our regression models were robust with estimates and p-values virtually identical across distributions (Poisson, negative binomial, and Gaussian, both linear and exponential).

4. Discussion

We are unaware of any previous U.S. studies that quantify the discovery of oral lesions suspicious for oral premalignancy/malignancy by general dentists.

Table 2A
Practice-related variables (categorical) in relation to the number of lesions suspicious for precancer/cancer and lesions histologically-confirmed as cancer; National Dental PBRN, 2017.

Practice related variables	n	Number of lesions suspicious for precancer or cancer		Number of histologically-confirmed cancers	
		Mean (95% CI)	p-Value	Mean (95% CI)	p-Value
Completed a GPR or AEGD[a] residency					
Yes	354	9.7 (8.7 10.9)	0.14	0.41 (0.29, 0.52)	0.97
No	716	9.4 (8.7, 10.1)		0.40 (0.33, 0.48)	
Missing	3	14		15	
Dentist gender					
Female	315	10.5 (9.3, 11.8)	0.04	0.38 (025, 0.50)	0.67
Male	753	9.0 (8.4, 9.8)		0.41 (0.33, 0.48)	
Missing	5	16		17	
Practice location type			0.44		0.94
Inner city/urban area	117	8.0 (6.1, 10.0)		0.40 (0.19, 0.61)	
Urban (not inner city)	292	9.5 (8.4, 10.7)		0.43 (0.31, 0.55)	
Suburban	498	9.6 (8.7,10.5)		0.38 (0.29, 0.47)	
Rural	157	10.2 (8.6, 11.9)		0.42 (0.26, 0.58)	
Missing	9	9		21	
Network region where practice located			0.44		< 0.01
Midwest	122	11.5 (9.5, 13.6)		0.33 (0.23, 0.43)	0.68
Southwest	189	8.5 (7.1, 9.9)		0.27 (0.2, 0.35)	0.86
South Central	215	8.9 (7.5, 10.2)		0.40 (0.31, 0.48)	0.30
South Atlantic	131	11.0 (9.0, 13.0)		0.69 (0.55, 0.84)	< 0.01
Northeast	248	9.9 (8.6, 11.2)		0.46 (0.38, 0.55)	0.10
Western	168	8.1 (6.8, 9.4)		0.29 (0.15, 0.43)	Referent
Missing	0	11		12	

Means, 95% CI and p-values obtained from Poisson regression modeling with robust standard errors.
[a] GPR: General Practice Residency; AEGD: Advanced Education in General Dentistry.

Our findings suggest that a large proportion of GDs in the National Dental Practice-Based Research Network are examining their patients for lesions suspicious for oral premalignancy/malignancy, with 87% reporting at least one suspicious oral lesion that was referred or biopsied during the previous six months, and a mean of 9.5 lesions/GP dentist/year.

Among the 1061 GD respondents included in the current analysis, 15.4% (163/1061) reported discovering at least one lesion that was subsequently confirmed as an oral cancer, with a mean of 0.4 (0.4015) discovered oral cancer cases per dentist per year. Applying that figure to the estimated total number of U.S. GDs in May 2017 (110,400) (USBLS, 2017), the crude estimate for oral cancer cases discovered by U.S. GDs during 2017 is 44,325 (0.4015 cases/GD *110,400 GPs).

However, the number of discovered cancer cases is not synonymous with *incident, invasive* oral cancer cases as generally reported by the National Cancer Institute's - Surveillance, Epidemiology, and End Results (SEER) Program (Noone et al., 2018). Our estimate likely includes cancers such as squamous cell carcinomas on the skin of the lip, some cancers that had recurred at or near the site of a previous oral cancer (i.e., recurrences), as well as cases of in situ carcinoma (which are not invasive), and as such, would not be included as incident, invasive oral cancers in the Cancer Statistics Review (Noone et al., 2018). Nevertheless, the discovery of any cancer has life-saving potential.

Our estimated number of oral cancer cases discovered by U.S. GDs could also be inflated if some study participants over-reported their case numbers. We addressed these concerns by excluding from our analysis those dentists whose reported number of OC cases was at or exceeded two and one-half standard deviations above the mean, with our action serving to dampen the effect such outliers would have had on the overall mean discovery rate. Further, although Network dentists have much in common with dentists at large (Makhija et al., 2009a, b), Network dentists may differ from non-PBRN dentists on traits that influence - positively or negatively - the numbers of cancers diagnosed, thereby introducing possible bias in the reported number of diagnosed cancers. Further, a sizable portion of Network dentists elected not to participate in the project; had those dentists joined the study, they may have reported fewer OC cases than did participating dentists, thereby reducing the mean number of cases/GD/year and estimated discovered cancers.

We cannot accurately determine the impact of any potential overestimation or bias on our case estimates; however, if one assumes that

Table 2B
Practice-related variables (continuous) in relation to the number of lesions suspicious for precancer/cancer and lesions histologically-confirmed as cancer; National Dental PBRN, 2017.

Practice related variables	Mean (95% CI)		Number of lesions suspicious for precancer or cancer		Number of histologically-confirmed cancers	
	n	or percentage	Mean (95% CI)	p-Value	Mean (95% CI)	p-valUe
Average number of hours practice clinically per week	1,071	32.7 (32.2, 33.2)	9.5 (8.9, 10.1)	< 0.01	0.4 (0.34, 0.46)	0.02
Percentage of patients who are 45–64 years old	1,058	33.9 (33.1, 34.6)	9.5 (8.9, 10.1)	0.47	0.4 (0.34, 0.46)	0.09
Percentage of patients who are 65 or older	1,054	20.3 (19.6, 20.9)	9.5 (9.3, 9.7)	0.17	0.4 (0.34, 0.46)	< 0.01
Percentage of patients who are covered by public insurance	898	15.9 (14.4, 17.5)	9.7 (8.9, 10.1)	0.53	0.4 (0.34, 0.48)	0.20
Dentist's age	1,069	53.1 (52.4, 53.8)	9.5 (8.9, 10.1)	< 0.01	0.4 (0.34, 0.46)	0.62
Years since graduation	1,073	25.6 (24.8, 26.3)	9.5 (8.9, 10.1)	< 0.01	0.4 (0.34, 0.46)	0.53

Means, 95% CI and p-values obtained from Poisson regression modeling with robust standard errors.
N.B., the n for each variable may not equal the total number of study participants due to missing data (see Table 2A).

Table 3
Oral lesions suspicious for precancer/cancer and lesions histologically-confirmed as cancer (annualized); National Dental PBRN, 2017.

Measure used	Lesions suspicious for precancer or cancer	Histologically-confirmed cancers
Proportion (95% CI)[a] of dentists discovering at least one oral lesion	87.2% (85.2, 89.2) 923/1,062[e]	15.4% (13.2, 17.5) 163/1,061[f]
Unadjusted mean number of outcomes (95% CI) (n)	9.5 (9.3, 9.7) 1,062	0.4 (0.36, 0.44) 1,061
Adjusted mean number of outcomes (95% CI)[b] (n)	9.6 (8.9, 10.2)[c] 1,015	0.4 (0.34, 0.46)[d] 1,039

[a] Poisson exact CI.
[b] All descriptive variables (Tables 2A, 2B) entered initially.
[c] Mean (95% CI) obtained from Poisson regression model adjusted for the percentage of patients who are 65 years old and older, South Atlantic region, Northeast region, Midwest region, average number of hours practice clinically per week, and dentist's age.
[d] Mean (95% CI) obtained from Poisson regression model adjusted for the percentage of patients who are 65 years old and older, Southeast region and Northeast region.
[e] Denominator of 1,062 excludes 11 GPs whose suspicious lesion detection totals were ≥2.5 SDs above the mean (i.e., 1073-11).
[f] Denominator of 1,061 excludes 12 GPs whose confirmed oral cancer detection totals were > 2.5 SDs above the mean (i.e., 1073-12).

even 40% to 50% of the estimated OC cases resulted from such errors, the estimated number of OC cases discovered by U.S. general dentists (i.e., 22,163 to 26,595) remains impressive. Similarly, if we reduce our rate estimates for suspicious lesions and histologically-confirmed cancer by 40%–50%, the respective rates would be reduced from 9.5 lesions/dentist/year to 4.8 or 5.7 for suspicious lesions, and from 0.4 to 0.2 to 0.24 for confirmed cancers.

A number of panels and task forces, including the US Preventive Services Task Force (2013) and the American Dental Association Council on Scientific Affairs Expert Panel on Screening for Oral Squamous Cell Carcinomas (Rethman et al., 2010) have reviewed the literature relevant to oral cancer screening and concluded that there is *insufficient or inadequate evidence* to make definitive statements regarding the risks and benefits of OCEs and the associated use of adjuncts (Rethman et al., 2010; Lingen et al., 2017a, b; USPS TF, 2013). The terms "*insufficient" and "inadequate" evidence* do not imply that the practice of opportunistic OC screening is ineffective, only that sufficient scientific studies have not provided clear, demonstrable proof of risk or benefit. Nevertheless, these reviews have tended to advise dental practitioners to remain vigilant by performing visual and tactile examinations, particularly with regard to patients in high-risk groups, namely smokers and drinkers (Rethman et al., 2010; USPSTF, 2004).

Our findings suggest that many participating GDs elect to opportunistically examine their patients. However, it is important to remember that the accuracy of designating an abnormal examination finding as a premalignancy/malignancy based on clinical signs and symptoms is not perfect, and false positive and false negative results may come with a price. False positive findings can manifest as unnecessary patient anxiety, as well as the monetary costs, discomfort, and possible side-effects of subsequent biopsies. False negative findings can give rise to a false sense of security and result in patients failing to pursue care should symptoms later arise.

The primary strengths of the current project include access to a large population of general dentists through the National Dental Practice-Based Research Network and our development and use of a questionnaire designed specifically to investigate how GDs regard and utilize oral cancer examinations. Potential limitations discussed above include the use of self-reports to obtain information on the number of suspicious lesions and histologically-confirmed oral cancers. While the results of correlation analyses generated during our test-retest allayed some concern regarding the reliability of responses, we elected to further limit the potential impact of bias by eliminating from our analyses those respondents whose number of outcome events exceeded 2.5 standard deviations of the mean. We also considered the impact of adjusting our crude estimate of discovered oral cancer cases down as much as 50% and found that the estimate remained high.

5. Conclusions

Our findings suggest that many U.S. general dentists are identifying oral lesions suspicious for premalignancy/malignancy, thereby leading to the discovery of oral cancers. Through their actions, general dentists appear to identify a considerable proportion of U.S. OC cases and to be an important frontline component in the battle against oral cancer.

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An Internet site devoted to details about the nation's network is located at http://NationalDentalPBRN.org.

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