Assessing oral cancer early detection: clarifying dentists' practices

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Abstract

Objective: This study explores new methods for assessing in greater detail what dentists do when they perform oral cancer early detection examinations. It clarifies practice behaviors and opens opportunities to identify factors that facilitate thorough early detection examinations by clinicians and to assess the relative effectiveness of different examination procedures.
Methods: A 38-item survey instrument was e-mailed to dentists in a western US, multistate dental practice group. Questionnaires were received by 241 dentists, and 102 responded. An Oral Cancer Knowledge scale (0 to 14) was generated from correct responses on oral cancer general knowledge. An Oral Cancer Examination Thoroughness scale was calculated from the two dimensions of reported usage and frequency of procedures in oral cancer examinations.
Results: Nearly all responding dentists were in general practice (90%), with a median year of graduation from dental school of 1994. The Oral Cancer Knowledge scores ranged from 5 to 14 with a mean of 10.4. The mean Thoroughness of Examination score was 11.34 (range 0 to 20). The two scales were not statistically correlated ($r = -0.015$, $P = 0.883$). Statistically, recency of continuing education was significantly associated with knowledge ($P = 0.0284$) and appears to be marginally associated with thoroughness ($P = 0.075$).
Conclusions: This study documents considerable variability in dentists' knowledge and thoroughness of examinations. The scales provide tools for future studies for improving understanding of early detection of oral cancer in clinical practice.

Introduction

The American Cancer Society projected 35,310 new oral cancer cases in the United States during 2008 and 7,590 oral cancer deaths (1). The US incidence and mortality rates for oral cancers have declined in recent years, though they have been rising in some population subgroups (2). Five-year survival rates began to show improvement in the mid-1990s, after being stable for two decades, but still remain poor (60 percent for 1996-2003) (3). Improved survival raises quality-of-life issues for patients who may undergo combinations of surgery, radiation, and chemotherapy (4). A 1999 review (5) on physical and psychosocial correlates of head and neck cancer showed that "many vital functions, such as mastication, swallowing, speaking, taste, smell, and appearance can be affected both before and after treatment." Facial disfigurement, tumor stage, gender, and social support are major variables in quality of life and psychosocial adjustment to these cancers (6).

Improved survival is associated with early detection. US five-year survival rates for 1996-2003 were 81.8 percent for localized tumors, 52.1 percent for regionally metastatic tumors, and 26.5 percent for distant metastases (3). Earlier diagnosis leads to less complex, debilitating, and costly

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treatment. Stage of disease at diagnosis and quality of life are strongly associated, and patients with advanced tumors report much poorer quality of life than patients whose tumors were detected at earlier stages of disease (7). Less invasive treatment enabled by early detection provides synergy between quality of life and survival (8).

Despite public health efforts, early detection rates have not improved. Healthy People 2010 Objective 21-6 is detection of 51 percent of all oral cancers at localized stage, but the Midcourse Review found the rate had moved away from its target (9). Diagnosis of localized disease had not improved.

Emphasis has been placed on early detection of oral cancers by dentists during routine examinations (10,11). Dentists' familiarity with and access to their patients' oral cavities make dentists particularly well suited to perform early detection examinations (10). Yet, studies of oral cancer early detection in dental offices have been discouraging (12-21). Assessments of dentists' knowledge of oral cancers have consistently found dentists not well prepared to perform early detection in their patients (12-15). While studies have investigated the frequency and periodicity of dentists' performance of "early detection examinations," they have not included details of specific procedures dentists perform (16-21). A few studies have inquired about palpation of cervical lymph nodes (17,18,21), but have not investigated the frequency with which dentists palpate other head and neck structures where tactile examination might reveal hidden abnormalities that could be signs of cancer. One study explicitly asked dentists whether they visually examine patients' tongues, but did not inquire about palpation (20).

Dentists report attending continuing education (CE) programs on oral cancer early detection which suggests that many perceive a need to update their knowledge and early detection skills (12-14,17,18,21). Studies do show associations between CE attendance and knowledge (12,13). However, while one study examined the impact of CE attendance on dental practice (18), and did find that CE attendance was associated with higher indexes for both screening examinations and risk assessment, the study's measure of screening was limited to whether dentists "examine" patients for oral cancer and whether they palpate lymph nodes.

For dentists to contribute fully to improvement of early detection, they must perform thorough examinations (11). Signs and symptoms of oral cancers are often neither obvious nor apparently threatening. Identification requires skill and care (22,23). This current study assesses methods for obtaining greater detail on what dentists report doing when they perform oral cancer early detection examinations. Building upon prior research (16-18,21), we expanded previously used questionnaires with the addition of questions on the dentists' performance of specific examination procedures and the frequency of performance. We used these questions to generate a scale measuring reported performance. This scale is a step toward further studies to clarify practice behaviors and to identify factors that facilitate thorough oral cancer early detection examinations. In addition, further specification of procedures used, as we have done, can facilitate future assessments of the cost effectiveness, sensitivity, and specificity of the various different procedures that clinicians use, potentially facilitating development of widely accepted practice standards that can be taught and practiced.

Methods

Sample

In the summer of 2007, a western US, multistate dental practice group contacted the authors to ask assistance in surveying their dentists regarding their oral cancer early detection practices with an existing instrument that had been used in prior research (21). Recognizing that prior surveys had not fully explored the various procedures that dentists might be using, we developed and fielded additional questions that probed more deeply into the report of practices than prior studies had done.

On November 6, 2007, the home office of the practice group forwarded by e-mail the revised, 38-item survey instrument to each of its practice sites across four states. The manager at each site was instructed to distribute the instrument to all dentists at that location and to ask each dentist to complete the form and return it to office management to be forwarded back to the home office. The cover on the instrument was clear that participation in the survey was voluntary, and that findings would be published. Informed consent was implied by participation. No personal identifying information was elicited by the questionnaire. The research team had no contact with the group's dentists. Three e-mail reminders were sent by the home office in weeks 2, 3, and 4 to encourage participation.

A total of 241 dentists received the questionnaire. After 4 weeks, 102 completed questionnaires had been returned, yielding a response rate of 42.3 percent. Data analysis was conducted using SPSS 15.0 (SPSS, Inc., Chicago, IL) and SAS 9.1 (SAS Institute, Inc., Cary, NC). This study had approval from the Institutional Review Board of the University of Illinois at Chicago (IRB2007-0897).

Data

The questionnaire captured basic background/demographic information on the dentists. It also reviewed knowledge of oral cancer, early detection practices, and information on the length of time since the respondent's most recent CE on oral cancer.

Following prior studies (12,13,15), a series of questions probed respondents' general knowledge about oral cancer,

the impact of early detection on patient survival, and the characteristics of lesions associated with smokeless tobacco. Each correct response was assigned one point. No points were assigned for incorrect responses or nonresponses. Points were summed equally across all items to create an "Oral Cancer Knowledge" scale measuring each dentist's general knowledge of oral cancer.

To assess the components of the oral cancer examinations reportedly performed by the dentists, a series of questions probed specific examination components and the frequency of performance. From these responses we created a scale which captured two dimensions of examinations: procedures used and frequency of use. For each procedure, points were assigned as follows: Always = 4; Usually = 3; Sometimes = 2; Rarely = 1; and Never = 0. We summed these scores across each procedure for each dentist to produce a "Thoroughness of Examination" scale which represents the likelihood that each of a dentist's patients will receive a thorough examination. The questions used to derive the scales are included in the Appendix S1.

We investigated whether there was a linear association between either the knowledge scale or the thoroughness scale and the time since last CE using a) the Mantel–Haenszel chi-square test (MH) for linear association; and b) differences of means testing using analysis of variance (ANOVA). The MH test treated the knowledge scale as an ordinal variable which was divided, as equally as possible, into four levels (5-8, 9-10, 11, ≥12). Time since last CE is also an ordinal variable: 1 (<1 year); 2 (1-2 years); 3 (>2 years); and 4 (never). In the ANOVA model, the knowledge scale was treated as a continuous variable. Because the distribution of the knowledge scores was not normal, we transformed them using the Box–Cox transformation (24) [$(Y^{1.75} - 1)/1.75$, where Y = knowledge score] prior to ANOVA. Because the thoroughness scores were normally distributed, no transformation was required; otherwise, the statistical methods for analysis were identical for both scales.

Results

All of the practice-group's 241 dentists received the survey. The response rate (42.3 percent) reflects a self-selected sample of 102 practice dentists. The sample consists of 74 males and 28 females (2.64:1), 90 percent being general dentists. The remainder are specialists in orthodontics (4), oral surgery (2) and endodontics, pediatrics, and prosthodontics (1 each). The year of graduation from dental school ranges from 1957 to 2007 (median 1994). At the time of the survey, more than 1/2 of the sample had been associated with the dental group for three or more years, some for as many as 30 years, and some for only a few months. They reported seeing an average of 200 patients per month, with some reporting as many as 900 monthly patient visits. Data provided by the home office confirm that the sample is representative of the total practice group in gender (2.64:1 male), years with the practice group (median = 2.5), and year of graduation (median = 1,989). However, sample dentists are more likely to be general dentists (cf. 55 percent for the whole group) and to report seeing more patients annually (group mean = 1,386).

Perceptions of oral cancer early detection training

All but one respondent agreed that dentists should be trained to examine patients for oral cancer, and 100 (98 percent) agreed that training should include palpation of cervical lymph nodes. More than one-third reported never having attended a CE course on oral cancer (Figure 1).

The dentists rated their training in oral cancer early detection generally, and in lymph-node palpation specifically, on scales of one to five. Few believed they were very well trained, and approximately one-fourth rated their training in the middle of the scale. Their assessment of their general oral cancer examination skills is consistently higher than their assessment of their palpation skills (Figure 2). The shapes of the two distributions are similar and highly correlated ($r = 0.766$, $P < 0.0001$). However, proportions were different (chi-square = 66.7, $P < 0.0001$). The mean value for general oral cancer exam training was higher than for training in palpation (3.83 and 3.58, respectively, pairwise t-test $P = 0.0006$).

Oral cancer knowledge and early detection practice

Possible scores on the "Oral Cancer Knowledge" scale ranged from zero to 14, and actual scores ranged from five (1 dentist)

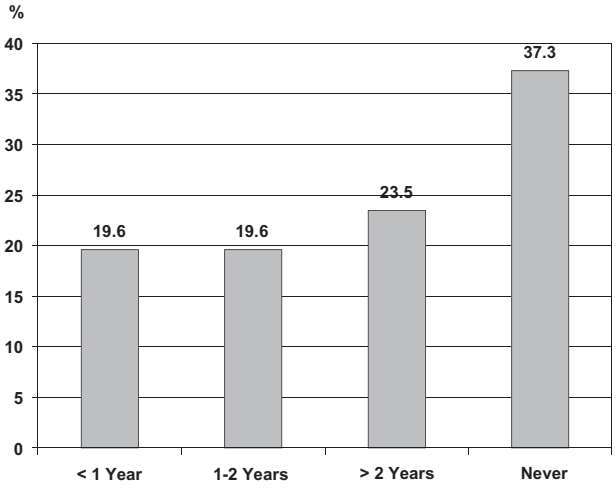

Figure 1 Percentage distribution of dentists' self-report of last time attended continuing education on oral cancer (n = 102).

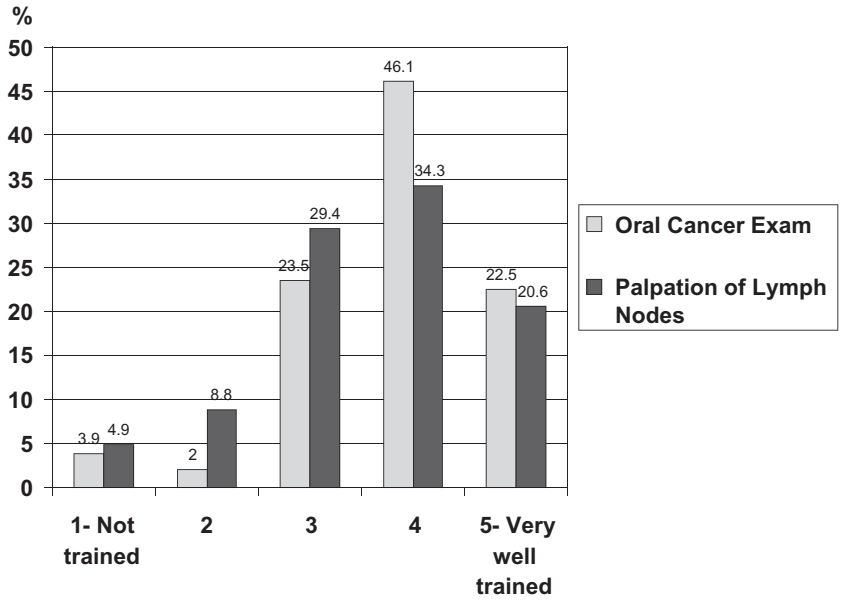

Figure 2 Percentage distributions of the perceptions of dentists about the status of their training on oral cancer examination and palpation of lymph nodes.

Table 1 The Frequency Dentists Self-Report Performing Specific Examination Procedures for Oral Cancer Early Detection

	Palpate cervical lymph nodes (%)	Palpate floor of mouth (%)	Palpate lateral borders of tongue (%)	Palpate dorsal borders of tongue (%)	Visualize dorsal borders of tongue (%)
Always	42	27	29	23	69
Usually	20	19	17	8	18
Sometimes	18	16	13	14	9
Rarely	4	3	1	3	0
Never	17	34	40	54	6

to 14 (3 dentists). The distribution of the scores was slightly skewed toward higher values: mean = 10.36; mode = 11. (The "Knowledge" values in subsequent tables represent transformed data.)

Ninety-one (89.2 percent) of the sample dentists reported that they provide oral cancer early detection examinations for asymptomatic patients. Most (70 percent) of those said they examine patients starting at less than 20 years of age. Just over one-third reported examining their patients at every nonemergency (recall) examination, while more than half (53.9 percent) report performing annual examinations.

The examinations the dentists reported giving their patients are not consistently thorough (Table 1). Although 42 percent indicated that they palpate the cervical lymph nodes every time they perform an oral cancer examination, nearly one-fifth said they rarely or never do so. Most other specific examination procedures are reportedly performed less often, with the exception of visualization of the dorsal borders of the tongue, which the vast majority reported doing regularly. More than half of the dentists said they never palpate the dorsal borders of the tongue.

Table 2 Results of Statistical Tests of Association between "Oral Cancer Knowledge" Scale (Transformed Data) and Dentists' Self-Report of Recency of Oral Cancer Continuing Education

CE group	Mean	95% confidence intervals
1 (<1 year)	39.93	(35.62, 44.23)
2 (1-2 years)	34.25	(29.95, 38.55)
3 (>2 years)	33.69	(29.76, 37.61)
4 (never)	31.71	(28.59, 34.84)

Test for Linear Association (Mantel–Haenszel test): chi-square statistic = 4.245 ($P = 0.0394$). Test for Different Means (ANOVA): F-statistic = 3.15 ($P = 0.0284$).

The "Thoroughness of Examination" scale was calculated from the data in Table 1. It is normally distributed (range 0 to 20; mean 11.34), and not correlated with the transformed "Oral Cancer Knowledge" scale ($r = -0.015$; $P = 0.883$).

We tested for linear associations between recency of CE and the two scales (Tables 2 and 3, respectively). The linear association between the recency of CE and the transformed knowledge scale is statistically significant (Mantel–Haenszel test: $P = 0.0394$). The more recent the last CE, the greater was the dentists' knowledge. ANOVA confirms that the four

Table 3 Results of Statistical Tests of Association between "Thoroughness of Examination" Scale and Dentists' Self-Report of Recency of Oral Cancer Continuing Education (CE)

CE group	Mean	95% confidence intervals
1 (<1 year)	13.95	(11.53, 16.38)
2 (1-2 years)	12.05	(9.63, 14.47)
3 (>2 years)	10.33	(8.12, 12.55)
4 (never)	10.24	(8.48, 11.99)

Test for Linear Association (Mantel–Haenszel test): chi-square statistic = 3.1694 ($P = 0.075$). Test for Different Means (ANOVA): F-statistic = 2.42 ($P = 0.070$).

groups are not all the same, thus we reject the null hypothesis that they are the same. The Bonferroni *t*-test showed that groups 1 and 4 are statistically different at alpha = 0.05.

The four CE groups and their group means for the "Thoroughness of Examination Scale" are presented in Table 3. The values of the means trend toward improvement on thoroughness with recency of CE, but this apparent association did not reach statistical significance in this small data set. ANOVA confirmed the null hypothesis that the four means are the same. However, the Bonferroni *t*-test showed a slight overlap in the confidence intervals for groups 1 and 4.

Discussion

This study expands a line of investigations of oral cancer early detection in dentistry (12-21) with new, more detailed inquiries about practice patterns. It uniquely contributes to this literature by examining in greater detail what a sample of dentists report doing when they perform early detection examinations. By eliciting more detail about examination conduct, this study shows that reported early detection examinations can be highly variable from one dentist to another, and from one patient to another, even when the same dentist performs the exam.

The scale used to measure dentists' knowledge about oral cancer is similar to indexing systems used in other studies (12,13,15). The scores were positively associated with recency of CE. This finding, which is consistent with prior studies (12,13), suggests that regular updating of oral cancer early detection training is needed to keep dentists well informed about oral cancer.

The need for CE is also increased by changes in scientific knowledge, advances in early detection, such as developing diagnostic adjuncts, and by changes in epidemiology that are primarily associated with changing risk behaviors in the population. Of particular note is an increasing proportion of women to men diagnosed with oral cancer (3), which is partly driven by shifting patterns of tobacco use. Increasing numbers of oral cancers associated with human papillomavirus (HPV) raise additional concerns (25,26). The rise of HPV as a risk factor is reflected in increasing oral cancer rates in younger people and is likely a consequence of changing sexual practices in the population (25). HPV-associated oral cancers have a different natural history from tobacco- and alcohol-related cancers, are more likely to be found in the oropharynx, and may not develop visible lesions in premalignant and in situ stages of disease (27,28).

Despite nearly unanimous agreement among our respondents that dentists should be trained in early detection, only about two-thirds of the sample had attended a CE program on the topic. Most who had attended training did so more than a year prior to the survey. Training among sample dentists is neither uniform nor routinely updated, and they largely recognize that they are not fully trained in early detection, as has been found in other surveys (17,18,21).

The sample dentists appear to emphasize visual over tactile examination procedures, and report less confidence in their palpation skills than in their visual examination skills. These findings are also consistent with prior studies (17,18,21). One reason dentists should perform early detection examinations is because of their familiarity with the normal appearance of the structures of the oral cavity (10). The skills required for palpation require additional experience and practice. For dentists to perform thorough examinations on their patients, they must acquire and practice palpation skills. Appropriate training opportunities would be required to meet that need.

Most of the sample (89.2 percent) reported routine performance of oral cancer examinations on asymptomatic patients, usually once or more per year, consistent with American Cancer Society recommendations for patients aged 40 and over (4). By comparison, a 2004 study of Illinois dentists found that 92.3 percent reported performing exams on asymptomatic patients, and 40.6 percent said they do so at least annually (21). In a 2001 study conducted in New York, 86 percent of dentists reported oral cancer examinations at initial examination and 80 percent at recall examinations (19). However, these studies, and others like them, do not make clear what precisely dentists actually mean when they report performing these examinations. The present study strongly suggests that further probing is required to ensure that survey results reflect practice more clearly.

The data reported here show that, while some of the sample dentists report performing thorough examinations most of the time, most do not. This finding is consistent with, but goes beyond, prior research (13,16-18,20,21). In particular, our sample dentists said they do not regularly palpate the neck, the floor of the mouth, or the tongue which are all critical in thorough examination. These deficiencies are troublesome because many oral cancers do not to present visually detectable signs or symptoms while in premalignant or localized stages when they are most treatable. Most oral cancers develop in the floor of the mouth or on the lateral borders of the tongue, and palpation of these structures is essential for a

thorough oral cancer early detection examination. Visualization of the base of the tongue and oropharynx are also essential, particularly with the growing incidence of HPV positive oropharynx cancers (27). These lesions are typically identified at advanced stages of disease because of neck mass or oropharyngeal mass, and associated symptoms including pain, dysphagia, and bleeding. Examination must therefore include thorough head and neck and lymph node palpation, and observation of the oropharyngeal region (29). Palpation of the posterior third and base of the tongue may be of value in detecting lesions in these sites (30).

The "Thoroughness of Examination" scale developed in this study is a new tool for summarizing what clinicians mean when they report performing oral cancer early detection examinations. It can be used to identify factors that contribute to the thoroughness of the examinations performed. Early detection CE, for example, can effect changes in clinical practice. The "Thoroughness of Examination" scale can be used in future investigations to identify additional factors that determine early detection practices.

Variability in dentists' clinical practice for early detection suggests a need for established practice standards that can be introduced and reinforced through training programs. Such standards should be based in part on the cost-effectiveness, and demonstrated sensitivity and specificity of examination procedures. However, as this study has shown, an examination may be more or less thorough. Future studies should take account of the different sets of procedures clinicians use in their exams.

Future investigations should not be restricted to dental practices either. Other health-care professions can also be trained and motivated to conduct early detection examinations in patients who may not have regular dental care (31).

This study seeks to advance our understanding of how best to promote early detection in clinical practice by first demonstrating that there appears to be previously uncovered variability in clinical practice. By taking that variability into account, a deeper understanding of both existing and preferred practice can be obtained and can inform a broader discussion of public policy concerning early detection.

Limitations

This study has several limitations to be considered when interpreting the findings. The sample is small and may be underpowered for detecting subtle associations among variables. The sample is from a single dental practice group located in the western United States, limiting the generalizability of the findings. Also, fewer than half of the group's dentists responded to the survey. This low response rate is not dramatically different from that achieved in many larger studies with reported rates from 40 to 52 percent (12,14,15,17,18). The low rate we achieved might reflect the timing of the survey which was fielded for only 4 weeks during November and early December. Other unmeasured factors might also have affected the rate, but we have limited information about nonrespondents and cannot fully assess whether there is any significant bias in the results because of limited participation. Notably, however, the dentists who did not respond were less likely to be general dentists.

This study is cross-sectional and relies on self-reports from respondents. The limitations of one-time surveys are acknowledged.

Notably, however, the data reported here on knowledge and practice are consistent with the findings of prior, larger surveys of dentists in different geographical regions. More importantly, the significance of this study lies less in the representativeness of the findings than in the demonstration that variation in services delivered to patients is substantial in this sample and may be similarly variable throughout the population of dentists. That is an important, empirical question that warrants thorough investigation.

Another limitation, which merits further research, is that we did not ask the dentists about their use of all possible diagnostic procedures. For example, we did not ask whether they palpate the buccal mucosa or visualize the oropharynx which, we have stated, is essential to a thorough examination.

Finally, we did not assess the validity and reliability of the scales used in this study. Comparisons could not be made with previously validated scales, and actual records were not accessible for documentation of actual performance and frequencies.

This study should be viewed as a pioneering, methodological study rather than a general survey of dental practice. We anticipate conducting a larger, validation study in the future which can further contribute toward development of clinical practice standards and interventions to improve oral cancer early detection.

Conclusions

The opportunity to conduct an assessment for a large multistate dental practice enabled further development of an innovative assessment tool for clinicians' report of oral cancer early detection examination procedures and frequencies. The data show that sample dentists recognize that they have an important role to play in reducing the burden of oral cancer in their patients. While most reported that they practice early detection, substantial variation in their early detection practices was identified.

Although most sample dentists indicated that they perform early detection examinations, as a group they do not do so consistently or thoroughly. Because these findings are consistent with previous studies, there appears to be a need to investigate the barriers that limit performance of thorough examinations for every patient at least annually and to take

steps to remove those barriers. It is possible that different barriers apply to different procedures, and studies of barriers should carefully account for each specific procedure and its associated barriers.

Improving dentists' early detection skills and their depth of knowledge about oral cancer are important steps that can be taken. The data reported here appear to reflect associations between CE and both knowledge and, to a lesser extent, thoroughness. Dental education institutions should establish and disseminate regular training opportunities for students and dentists to keep their knowledge and skills current, and to improve the quality of service they provide their patients.

This study is a preliminary exploration of improved methods for assessing actual practice more fully, and our methods enabled us to show significant variation in procedures and in the thoroughness of examinations performed in our sample. Future studies should investigate in detail the procedures dentists use, the frequency of their use, the role of adjuncts to clinical examination, and the specific barriers that may discourage thorough examinations on asymptomatic patients at all opportunities. Future research can also be directed toward establishing appropriate, clinical practice standards for early detection exams.

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References

1. Jemal A, Siegel R, Ward E, Hao Y, Xu J, Murray T, Thun MJ. Cancer statistics, 2008. *CA Cancer J Clin*. 2008;**58**(2):71-96.
2. Kingsley K, O'Malley S, Ditmyer M, Chino M. Analysis of oral cancer epidemiology in the US reveals state-specific trends: implications for oral cancer prevention. *BMC Public Health*. 2008;**8**:87. [WWW document]. URL http://www.biomedcentral.com/content/pdf/147-2458/8/87 [accessed on April 20, 2009].
3. Ries LAG, Melbert D, Krapcho M, Mariotto A, Miller BA, Feuer EJ, Clegg L, Horner MJ, Howlader N, Eisner MP, Reichman M, Edwards BK, editors. *SEER cancer statistics review, 1975-2004*. Bethesda, MD: National Cancer Institute; 2007. Based on November 2006 SEER data submission, posted to the SEER web site, 2007. [WWW document]. URL http://seer.cancer.gov/csr/1975_2004/ [accessed on April 20, 2009].
4. American Cancer Society. *American Cancer Society detailed guide: oral cancer*. [WWW document]. URL http://www.cancer.org/docroot/CRI/CRI_2_3x.asp?dt=60 [accessed on May 13, 2008].
5. De Boer MF, McCormick LK, Pruyn JF, Ruckman RM, van den Borne BW. Physical and psychological correlates of head and neck cancer: a review of the literature. *Otol Head Neck Surg*. 1999;**120**(3):427-36.
6. Jenewein J, Zwahlen RA, Zwahlen D, Drabe N, Moergeli H, Büchi S. Quality of life and dyadic adjustment in oral cancer patients and their female partners. *Eur J Cancer Care (Engl)*. 2008;**17**(2):127-35.
7. Hammerlid E, Bjordal K, Ahlner-Elmqvist M, Boysen M, Evensen JF, Biörklund A, Jannert M, Kaasa S, Sullivan M, Westin T. A prospective study of quality of life in head and neck cancer patients. Part I: at diagnosis. *Laryngoscope*. 2001;**111**(4 Pt 1):669-80.
8. Nordgren M, Hammerlid E, Bjordal K, Ahlner-Elmgvist M, Boysen M, Jannert M. Quality of life in oral carcinoma: a 5-year prospective study. *Head Neck*. 2008;**30**(4):461-70.
9. U.S. Department of Health and Human Services. *The healthy people 2010 midcourse review*. [WWW document]. URL http://www.healthypeople.gov/data/midcourse/ [accessed on May 12, 2008].
10. Mashberg A. Diagnosis of early oral and oropharyngeal squamous carcinoma: obstacles and their amelioration. *Oral Oncol*. 2000;**36**(3):253-5.
11. Silverman S. Controlling oral and pharyngeal cancer: can dental professionals make a difference? *J Am Dent Assoc*. 2005;**136**(5):576-7.
12. Yellowitz JA, Horowitz AM, Drury TF, Goodman HS. Survey of U.S. dentists' knowledge and opinions about oral pharyngeal cancer. *J Am Dent Assoc*. 2000;**131**:653-61.
13. Canto MT, Drury TF, Horowitz AM. Maryland dentists' knowledge of oral cancer risk factors and diagnostic procedures. *Health Promot Pract*. 2001;**2**(3):255-62.
14. Alonge OK, Narendran S. Opinions about oral cancer prevention and early detection among dentists practicing along the Texas-Mexico border. *Oral Dis*. 2003;**9**(1):41-5.
15. Patton LL, Elter JR, Southerland JH, Strauss RP. Knowledge of oral cancer risk factors and diagnostic concepts among North Carolina dentists. Implications for diagnosis and referral. *J Am Dent Assoc*. 2005;**136**(5):602-10.
16. Yellowitz JA, Goodman HS. Assessing physicians' and dentists' oral cancer knowledge, opinions and practices. *J Am Dent Assoc*. 1995;**126**(1):53-60.
17. Yellowitz JA, Horowitz AM, Goodman HS, Canto MT, Farooq NS. Knowledge, opinions and practices of general dentists regarding oral cancer: a pilot survey. *J Am Dent Assoc*. 1998;**129**(5):579-83.
18. Horowitz AM, Drury TF, Goodman HS, Yellowitz JA. Oral pharyngeal cancer prevention and early detection: dentists' opinions and practices. *J Am Dent Assoc*. 2000;**131**(4):453-62.
19. Cruz GD, Ostroff JS, Kumar JV, Gajendra S. Preventing and detecting oral cancer: oral health care providers' readiness to provide health behavior counseling and oral cancer examinations. *J Am Dent Assoc*. 2005;**136**(5):594-601.
20. Gajendra S, Cruz GD, Kumar JV. Oral cancer prevention and early detection: knowledge, practices, and opinions of oral health care providers in New York State. *J Cancer Educ*. 2006;**21**(3):157-62.

21. LeHew CW, Kaste LM. Oral cancer prevention and early detection knowledge and practices of Illinois dentists – a brief communication. *J Public Health Dent*. 2007;**67**(2):89-93.
22. Silverman S. Mucosal lesions in older adults. *J Am Dent Assoc*. 2007;**138** Suppl 1:41S-6.
23. Williams M, Elwood M, Hidlop G, MacAulay C, Poh C, Zhang L, Moorres M, Laronde D, MacKay H, Lobb P, Rosin M, Sutcliffe S, Sheehan B, Hay J, Gallagher R, Peacock S, Bottorf J, Hovan A, Zed C, Coldman A, O'Keefe J, Johanson J, Adams N, White M, Musa Z, Johnston K. *Guideline for the early detection of oral cancer in British Columbia*. Vancouver, BC: British Columbia Oral Cancer Prevention Program, BC Cancer Agency, College of Dental Surgeons of British Columbia; 2008. [WWW document]. URL http://www.cdsbc.org/pdf/OC_Guideline_Final_2008.pdf [accessed on July 20, 2009].
24. Box GEP, Cox DR. An analysis of transformation. *J R Stat Soc Series B Stat Methodol*. 1964;**26**:211-43.
25. Sturgis EM, Cinciripini PM. Trends in head and neck cancer incidence in relation to smoking prevalence: an emerging epidemic of human papillomavirus-associated cancers? *Cancer*. 2007;**110**(7):1429-35.
26. Gillison ML. Current topics in the epidemiology of oral cavity and oropharyngeal cancers. *Head Neck*. 2007;**29**(8):779-92.
27. Gillison ML, D'Souza G, Westra W, Sugar E, Xiao W, Begum S, Viscidi R. Distinct risk factor profiles for human papillomavirus type 16-positive and human papillomavirus type 16-negative head and neck cancers. *J Natl Cancer Inst*. 2008;**100**(6):407-20.
28. Gillison ML. Human papillomavirus and prognosis of oropharyngeal squamous cell carcinoma: implications for clinical research in head and neck cancers. *J Clin Oncol*. 2006;**24**(36):5623-5.
29. Ryerson AB, Peters ES, Coughlin SS, Chen VW, Gillison ML, Reichman ME, Wu X, Chaturvedi AK, Kawaoka K. Burden of potentially human papillomavirus-associated cancers of the oropharynx and oral cavity in the US, 1998-2003. *Cancer*. 2008;**113**(10 Suppl):2901-9.
30. Begum S, Gillison ML, Nocol TL, Westra WH. Detection of human papillomarirus-16 in fine-needle aspirates to determine tumor origin in patients with metastatic squamous cell carcinoma of the head and neck. *Clin Cancer Res*. 2007;**13**(4):1186-91.
31. LeHew CW, Epstein JB, Koerber A, Kaste LM. Pilot study of the impact of oral cancer prevention and early detection training on medical clinicians' perceptions and intentions. *Ear Nose Throat J*. 2009;**88**(1):748-53.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Questions included in the "Oral Cancer Knowledge" and "Thoroughness of Examination" scales.

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