Published in final edited form as:

Oral Oncol. 2014 October ; 50(10): 976–982. doi:10.1016/j.oraloncology.2014.07.008.

Age and Stage as Determinants of Treatment for Oral Cavity and Oropharyngeal Cancers in the Elderly

David Goldenberg, MD, FACS¹, Heath Mackley, MD², Wayne Koch, MD³, Darrin V Bann, PhD¹, Eric W. Schaefer, MS⁴, and Christopher S. Hollenbeak, PhD^{1,4}

¹Department of Surgery, The Pennsylvania State University, College of Medicine, Hershey PA

²Department of Radiology, The Pennsylvania State University, College of Medicine, Hershey, PA

³Department of Otolaryngology-Head & Neck Surgery, Johns Hopkins University, Baltimore, MD

⁴Department of Public Health Sciences, The Pennsylvania State University, College of Medicine, Hershey, PA

Abstract

Background—We investigate treatment selection for oral cavity and oropharyngeal (OC&OP) cancers to understand factors that influence treatment selection.

Methods—We studied 7,023 patients, 66 years, diagnosed with a first primary OC&OP cancer using SEER-Medicare data. Multinomial logistic regression was to model treatment selection, controlling for other factors.

Results—Most patients with OC cancer were treated with surgery alone (56.5%); most patients with OP cancer were treated with chemotherapy and radiation (28.9%). Age, stage and site were the most important predictors of treatment selection. As age increased from 70 to 81 (the interquartile range), treatment shifted toward surgery alone (OR=1.26; CI: 1.08-1.46) and no treatment (OR=1.5, 95% CI: 1.25-1.80), and away from combined surgery, radiation and treatments involving chemotherapy.

Conclusions—Age, stage, and site are the most important determinants of treatment selection for patients with OC&OP cancers. Increasing age and stage drive treatment toward non-surgical options and no treatment at all.

© 2014 Published by Elsevier Ltd.

Corresponding Author: David Goldenberg, MD The Pennsylvania State University College of Medicine Department of Surgery Division of Otolaryngology – Head & Neck Surgery 500 University Drive, H091 Tel #: 717-531-8945 Fax #: 717-531-6160 dgoldenberg@hmc.psu.edu.

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

Presented at the 8th International Conference on Head and Neck Cancer, July 21-25, 2012, Toronto, Canada

Conflict of Interest Statement
None declared.

Keywords

Oral cancer; oropharyngeal cancer; head and neck cancer; surgery; radiation chemotherapy; elderly age

Introduction

The increasing prevalence of human papilloma virus (HPV) infection has led to a rapid increase in cancers of the oral cavity and oropharynx (OC&OP) among people aged 40-59 [1]. However, OC&OP cancers are most concentrated among older patients, with a median age at diagnosis of 62 years [2]. Additionally, more than half of the approximately 7,890 OC&OP cancer deaths in 2012 occurred in patients 65 years of age and older [2].

As with most malignant neoplasms, the prognosis for patients with cancers of the OC&OP is based primarily on the extent of the tumor and specific subsite at the time of presentation as well as the presence of regional or distant metastasis. Five-year survival rates range widely, from 73% for localized tumors of the lip to only 12% for metastatic tumors of the oropharynx [3]. It has been shown that cancers of the OC&OP carry a different prognosis despite similar morphologic stage [3-7]. Furthermore, recent evidence indicates that age >65 years is independently associated with poor prognosis among patients with OP cancer [8].

The treatment paradigm for OC differs from that of OP cancer. OC cancer is typically treated with surgery, while radiation is reserved for adjuvant therapy to enhance loco-regional control, primary treatment in patients unable to tolerate or unsuited for surgery, or salvage treatment of recurrent or persistent disease [9]. In contrast, until recently chemotherapy and radiation was used primarily for all but the smallest OP tumors, in part because of the potential morbidity of OP resections. Moreover, surgery, chemotherapy, and radiotherapy may be frequently complicated by locoregional disease persistence and significant long-term functional deficits in speech and swallowing [10,11]. While the treatment options for OC&OP are well-known, treatment choice has not been systematically studied, particularly in the elderly population. In this study we use data from the combined Surveillance Epidemiology and End Results (SEER) and Medicare data to systematically study factors that affect choice of treatment for OC&OP cancers to better understand which treatments patients receive and what variables influence the treatment selection.

Methods

Data

Data for this study were obtained from the SEER-Medicare linked database, which combines tumor registry data from the National Cancer Institute's (NCI) SEER program for patients who are covered by Medicare with their Medicare billing records [12]. The SEER-Medicare data contain tumor registry data on 54,955 patients who were diagnosed with a first primary tumor of the OC (lip, tongue, floor of mouth, gum, and other mouth) or OP (tonsil and oropharynx) between 1973 and 2005. Claims data are only available beginning in 1986 and are only available for certain types of services since 1994. We therefore limited our sample to patients who were diagnosed with a first primary tumor of the OC or

oropharynx between 1995 and 2005. We further restricted cases to patients aged 66 and older and excluded patients for whom the diagnosis of cancer was obtained on autopsy or from a death certificate only. In addition, patients enrolled in a health maintenance organization (HMO) at or after the cancer diagnosis were excluded since these patients do not have any Medicare billing records. The final sample contained 7,023 patients. The human subjects protocol and procedures were reviewed and approved by The Pennsylvania State University Institutional Review Board.

Outcomes and covariates

Our aim was to identify factors associated with treatment choice for patients with OC&OP cancers. The dependent variables for these analyses were treatment indicators. Treatment indicators were mutually exclusive for surgery alone, radiation alone, a combination of surgery and radiation, chemotherapy in combination with radiation (regardless of surgery), chemotherapy without radiation (regardless of surgery), and absence of any treatment. Radiation and surgery were defined according to the SEER tumor registry data. Chemotherapy was determined from Medicare billing records. Specifically, all Medicare claims files were searched for any record with a Healthcare Common Procedure Coding System (HCPCS) code of 964.xx, 965.xx, or Q0083-Q0085, an ICD-9 diagnosis code of V58.1, V66.2, V67.2, or an ICD-9 procedure code of 99.25 [13]. Patients with at least one of these claims in the window ranging from 1-month prior to diagnosis up to 4 months after diagnosis were classified as having received chemotherapy. Patients in which a chemotherapy claim was made at least 2 months prior to diagnosis were excluded from the analysis. Claims prior to diagnosis were included because there can be lags in reporting. There were only 2 patients in the final data set who had chemotherapy listed prior to diagnosis; the remaining patients had chemotherapy beginning on the date of diagnosis or later (within 4 months).

We distinguished between OC cancer, which included tumors of the lip, oral tongue, floor of mouth, and gum & other mouth, and tumors of the OP, which included tumors of the base of tongue, tonsils, and oropharynx. Our analyses controlled for demographic characteristics, disease characteristics, and comorbidities. Demographic variables included patient age at diagnosis, gender, race/ethnicity (black, white, other), year of diagnosis, marital status, and geographic location. Disease variables included cancer site and morphologic extent of malignant disease defined using the SEER historic stage (local, regional, distant metastasis, unstaged) [14]. We controlled for comorbidities using the sum of the number of Agency for Health Care Research and Quality (AHRQ) comorbidities for each patient up to one year prior to diagnosis [15,16].

Statistical methods

The statistical analysis was designed to model the relationship between treatment choice, age, stage, and site of disease, controlling for demographic characteristics and comorbidities. We first presented descriptive statistics to summarize the sample. We used chi-squared tests to test whether the distribution of disease variables across treatment types was significantly different.

We used multinomial logistic regression, which is a generalization of logistic regression to outcomes with more than two categories, to model the probability of treatment choice by age, site, stage and other patient characteristics. First, we tested several models of probability of treatment choice as a function of age and site. The best fitting model was a quadratic function of age (i.e. age and age squared) with no interaction term. Next, we added stage to the model as a categorical effect with localized and in situ stages combined and specified as the reference group. Again several model specifications were tested, but the best fitting model was the one with no interactions, a quadratic effect for the log odds of age, and main effects for site and stage. Lastly, we included all other demographics and patient characteristics in the model, to determine whether the associations we observed among age, site and stage remained significant after adjusting for other factors.

Results

The characteristics of patients with OC&OP cancers are summarized in Table 1. The average age is almost 76 years, and patients were predominantly male (58.8%), white (85.9%) and living in a metropolitan area. Most patients had no comorbidities (82.8%), however, among those who did the most common were hypertension (10.5%) and chronic pulmonary disease (5.9%).

Among patients with OC disease, the primary treatment was surgery alone (56.5%), followed by combined surgery and radiation (16.8%) or single modality radiation therapy (11.8%) (Table 2). Patients with OP cancer were primarily treated with chemotherapy and radiation (28.9%) or with single modality radiation therapy (27.9%), followed by surgery plus radiation (17.1%). Nearly 8.1% of patients with OC cancers and 12.4% of patients with OP cancers received no treatment at all.

Site and stage of disease were strongly associated with treatment choice. Single modality surgery was the primary treatment for patients with disease of the lip (87.4%), oral tongue (54.5%), floor of mouth (44.4%) and gum & other mouth (43.0%) (Table 2). Treatment choice for the OC was also largely driven by stage of disease. Single modality surgery was the most common treatment for all stages but other treatments were also used.

The most frequent treatments for OP cancers were radiation alone or in combination with chemotherapy. Increasing stage was associated with lower likelihood of radiation alone, and greater likelihood of chemotherapy plus radiation. Approximately 12.4% of patients with disease of the oropharynx (across all stages) received no treatment; of patients with distant disease of the oropharynx, 20.2% received no treatment at all.

Figure 1A presents the trends in treatment between 1995 and 2005. Among patients with OC cancers, treatment choice has remained largely stable, with most patients receiving surgery alone. Patients with OP cancers, however, were more likely to be treated with chemotherapy and radiation, and less likely to be treated with surgery and radiation as time progressed.

The predicted probabilities of treatment choice from the multinomial regression model that included age and site as predictors are shown for OC diseases in Figure 1B. For OC cancers, as age increased a patient's probability of receiving surgery alone was relatively unchanged.

However, the probability the patient was treated with combined surgery and radiation decreased and the probability of receiving single modality radiation therapy or no treatment increased. Chemotherapy was rarely used and the probability of chemotherapy treatment remained essentially constant as age increased.

The predicted probabilities of treatment choice from the multinomial regression for OP diseases are shown in Figure 1C. For OP cancers, the probability of receiving surgery alone was relatively low and remained essentially unchanged as age increased. The probability a patient received surgery and radiation decreased as age increased, as did the probability that a patient received chemotherapy with radiation. The probability that a patient received no treatment increased with age.

The predicted probabilities of treatment choice from the multinomial regression model controlling for age, site and stage are shown in Figure 2. For OC cancers, the probability of receiving surgery alone for localized/in situ patients remained near 80% across all ages. For regional diseases and earlier ages, surgery and surgery with radiation comprised just fewer than 80% of the treatments. As stage increased to distant metastases, treatment shifted to single modality radiation and no treatment. For OP cancers, surgery was the most prevalent treatment option for localized/in situ patients, but was rarely used for patients with regional or distant disease. Instead, chemotherapy with radiation was the most prevalent treatment for earlier ages for regional and distant disease.

Odds ratios (ORs) and 95% confidence intervals for the multinomial regression model that controlled for age, site, stage and all other demographics and patient characteristics are shown in Table 3. Age, site and stage remained significantly associated with treatment choice in this model. We reported ORs for the interquartile range of age 81 versus age 70 since the odds were not constant across ages due to the quadratic fit used. The OR=1.26 for radiation only (95% CI: 1.08-1.46) and OR=1.50 for no treatment (95% CI: 1.25-1.80) indicated that these treatments increased faster relative to surgery as age increased. Similarly, the odds ratios for radiation and surgery, chemotherapy with radiation, and chemotherapy without radiation were less than one, suggesting that these treatments decreased faster relative to surgery as age increased. Patients with OP cancer, with regional disease, or with distant disease had higher odds of receiving any non-surgical treatment compared to surgery alone.

Discussion

These results suggest that age and stage are the primary drivers of treatment choice for OC&OP cancers. Patients with OC cancers were predominantly treated with surgery alone. Treatment shifted toward radiation and combined surgery and radiation with increasing age and stage. Patients with OP tumors were predominantly treated with chemotherapy and radiation. Treatment shifted to radiation alone with increasing age and stage. It is likely that the decrease in surgery and radiation in OC cancer and the decrease in combined chemoradiation in OP cancer represented a shift toward more palliative treatment with advancing age.

Previous studies have suggested that elderly patients, even when healthy, may be less likely to receive standard treatment than younger patients [17]. Other studies have found that older patients with head and neck cancer are less likely to receive potentially curative treatment than younger patients despite observations that elderly patients may benefit from aggressive treatment [18-22]. Although the reason behind this phenomenon is not completely clear, there is some evidence that associated comorbidities are only part of the explanation [18,23]. Furthermore, Gourin et al., however, found that co-morbidities were not significantly associated with treatment selection in patients with head and neck cancer [24].

Another explanation for why elderly patients may not receive standard treatment for head and neck cancer is that patients or their families may refuse recommended treatment [25]. In our data, no treatment was a common treatment choice for the oldest patients. Up to 12.4% of patients received no treatment at all for their cancer, most of which were older patients with advanced stage. It is not clear whether this was a deliberate treatment strategy, a patient choice issue, or an artifact of the disease. It is possible that treating physicians felt that the risk due to comorbidities outweighed the potential benefits of attempts at curative treatment, or that patients or their families refused treatment. Alternatively, many elderly patients with distant disease did not survive long enough to receive planned curative or palliative treatment, and therefore were categorized as having received no treatment *de facto*. The data do not allow us to distinguish between these explanations. The fact that 48% of patients who were unstaged and 20.7% of patients with distant metastases received no treatment favors the latter explanation.

In our multinomial logistic regression model, African American patients had twice the odds of receiving no treatment relative to surgery compared to white patients. This is not likely to be explained by access to care issues since all patients were covered by Medicare. It may, however, be explained by other socioeconomic issues. Black patients were less likely to be married, and we also found that married patients were more likely to receive surgical treatment. Additional research is needed to better understand the relationship between marriage, treatment selection, and outcomes for patients with OC&OP cancer.

We recognize the limitations in our study that arise from the observational nature of the data set. First, we cannot generalize these findings to younger patients. Second, the SEER registry does at present not allow us to identify HPV as the source of cancer, so we were unable to explore the relevance of HPV for treatment decisions. Also, our measures of comorbidities were derived from billing data and so may be underestimated. Most billing systems provide a limit to the number of diagnosis codes, and the priority of most billing coders is to optimize reimbursement rather than to most accurately depict concomitant conditions. Furthermore, there may be substantial variation in coding and billing practices between institutions. Another limitation is that AJCC staging is preferred to SEER historic stage but these are not available for cases diagnosed prior to 2004. Finally, as mentioned earlier, we were unable to know the underlying reason for the 12% of patients who received no treatment. This was more common among patients with distant metastases and who were unstaged, which suggests that they may have expired before treatment could be carried out.

In clinical practice the optimal therapeutic choice for OC&OP tumors is made based on a careful review of each individual case, with specific attention paid to the site and stage of disease, the general physical and emotional condition of the patient, and the available treatment facilities. Still, even among elderly patients, increasing age and increasing stage appear to be the most at the forefront of factors that determine treatment selection for OC&OP cancer, and other factors such as race and marital status contribute to treatment choice.

Acknowledgments

Funding Sources: This study was supported by a grant (5 R03 DE000019511) from the National Institutes of Health/National Institute of Dental and Craniofacial Research (NIH/NIDCR).

Disclaimer: This study used the linked SEER-Medicare database. The interpretation and reporting of these data are the sole responsibility of the authors. The authors acknowledge the efforts of the Applied Research Program, NCI; the Office of Research, Development and Information, CMS; Information Management Services (IMS), Inc.; and the Surveillance, Epidemiology, and End Results (SEER) Program tumor registries in the creation of the SEER-Medicare database.

References

1. Pytynia KB, Dahlstrom KR, Sturgis EM. Epidemiology of HPV-associated oropharyngeal cancer. *Oral Oncol.* Jan 21.2014 [Epub ahead of print].
2. Howlader, N.; Noone, AM.; Krapcho, M.; Garshell, J.; Neyman, N.; Altekruse, SF., et al., editors. Based on November 2012 SEER data submission, posted to the SEER web site. National Cancer Institute; Bethesda, MD: Apr. 2013 SEER Cancer Statistics Review, 1975-2010. http://seer.cancer.gov/csr/1975_2010
3. Sanabria A, Carvalho AL, Vartanian JG, Magrin J, Ikeda MK, Kowalski LP. Comorbidity is a prognostic factor in elderly patients with head and neck cancer. *Ann Surg Oncol.* 2007; 14:1449–1457. [PubMed: 17235712]
4. Lacy PD, Kennedy JT, Piccirillo JF. Validation of the composite laryngeal recurrence staging system. *Cancer.* 2004; 101:761–767. [PubMed: 15305407]
5. Piccirillo JF. Inclusion of comorbidity in a staging system for head and neck cancer. *Oncology.* 1995; 9:831–836. discussion 841, 845-838. [PubMed: 8562325]
6. Hu M, Ampil F, Clark C, Sonavane K, Caldito G, Nathan CA. Comorbid predictors of poor response to chemoradiotherapy for laryngeal squamous cell carcinoma. *Laryngoscope.* 2012; 122:565–571. [PubMed: 22252981]
7. Paleri V, Wight RG, Silver CE, Haigentz M Jr, Takes RP, Bradley PJ, et al. Comorbidity in head and neck cancer: a critical appraisal and recommendations for practice. *Oral Oncol.* 2010; 46:712–719. [PubMed: 20850371]
8. Ryan Camilon P, Stokes WA, Nguyen SA, Lentsch EJ. The prognostic significance of age in oropharyngeal squamous cell carcinoma. *Oral Oncol.* Feb 20.2014 pii: S1368-8375(13)00801-4. [Epub ahead of print].
9. Huang SH, O'Sullivan B. Oral cancer: current role of radiotherapy and chemotherapy. *Med Oral Patol Oral Cir Bucal.* 2013; 18:e233–240. [PubMed: 23385513]
10. Sciubba JJ, Goldenberg D. Oral complications of radiotherapy. *Lancet Oncol.* 2006; 7:175–183. [PubMed: 16455482]
11. Forastiere A, Koch W, Trotti A, Sidransky D. Head and neck cancer. *N Engl J Med.* 2001; 345:1890–1900. [PubMed: 11756581]
12. Warren JL, Klabunde CN, Schrag D, Bach PB, Riley GF. Overview of the SEER-Medicare data: content, research applications, and generalizability to the United States elderly population. *Med Care.* 2002; 40:IV–3-18.
13. Warren JL, Harlan LC, Fahey A, Virnig BA, Freeman JL, Klabunde CN, et al. Utility of the SEER-Medicare data to identify chemotherapy use. *Med Care.* 2002; 40:IV–55-61.

14. Young, J., Jr; Roffers, S.; Ries, LAG.; Fritz, A.; Hurlbut, A. SEER summary staging manual -2000: codes and coding instructions. Nancer Institute; Bethesda, MD: 2001. NIH Pub. No. 01-4969
15. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care.* 1998; 36:8–27. [PubMed: 9431328]
16. HCUP Comorbidity Software. [October 10, 2013] Healthcare Cost and Utilization Project (HCUP). Sep. 2013 www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp.
17. Samet J, Hunt WC, Key C, Humble CG, Goodwin JS. Choice of cancer therapy varies with age of patient. *JAMA.* 1986; 255:3385–3390. [PubMed: 3712698]
18. Derks W, de Leeuw JR, Hordijk GJ, Winnubst JA. Reasons for non-standard treatment in elderly patients with advanced head and neck cancer. *Eur Arch Otorhinolaryngol.* 2005; 262:21–26. [PubMed: 15014947]
19. Hirano M, Mori K. Management of cancer in the elderly: therapeutic dilemmas. *Otolaryngol Head Neck Surg.* 1998; 118:110–114. [PubMed: 9450840]
20. Jones AS, Beasley N, Houghton D, Husband DJ. The effects of age on survival and other parameters in squamous cell carcinoma of the oral cavity, pharynx and larynx. *Clin Otolaryngol Allied Sci.* 1998; 23:51–56. [PubMed: 9563666]
21. Sarini J, Fournier C, Lefebvre JL, Bonafos G, Van JT, Coche-Dequeant B. Head and neck squamous cell carcinoma in elderly patients: a long-term retrospective review of 273 cases. *Arch Otolaryngol Head Neck Surg.* 2001; 127:1089–1092. [PubMed: 11556858]
22. Camilon PR, Stokes WA, Nguyen SA, Lentsch EJ. Are the elderly with oropharyngeal carcinoma undertreated? *Laryngoscope.* Mar 3.2014 [Epub ahead of print].
23. Italiano A, Ortholan C, Dassonville O, Poissonnet G, Thariat J, Benezery K, et al. Head and neck squamous cell carcinoma in patients aged > or = 80 years: patterns of care and survival. *Cancer.* 2008; 113:3160–3168. [PubMed: 18932260]
24. Gourin CG, McAfee WJ, Neyman KM, Howington JW, Podolsky RH, Terris DJ. Effect of comorbidity on quality of life and treatment selection in patients with squamous cell carcinoma of the head and neck. *Laryngoscope.* 2005; 115:1371–1375. [PubMed: 16094107]
25. Genden EM, Rinaldo A, Shaha AR, Clayman GL, Werner JA, Suárez C, et al. Treatment considerations for head and neck cancer in the elderly. *J Laryngol Otol.* 2005; 119:169–174. [PubMed: 15845185]

Figure 1. (A) Trends in treatment for oral and OP cancer, 1995-2005, (B) For OC cancers, predicted probabilities of treatment choice by age from multinomial regression model (solid lines), with raw (unadjusted) probabilities also plotted (dotted lines), (C) For oropharynx cancers, predicted probabilities of treatment choice by age from multinomial regression model (solid lines), with raw (unadjusted) estimates also plotted (dotted lines).

Figure 2.
Predicted probabilities of treatment choice from multinomial model across age, by site and stage combinations.

Table 1

Characteristics of Medicare patients with oral and oropharyngeal cancers

Variable	Oral cavity (N = 4831)	Oropharyngeal (N = 2192)	Total (N = 7023)	p-value
Age at diagnosis				<0.001
Mean (SD)	76.7 (7.28)	73.6 (6.20)	75.8 (7.11)	
Sex				<0.001
Male	2611 (54%)	1521 (69.4%)	4132 (58.8%)	
Female	2220 (46%)	671 (30.6%)	2891 (41.2%)	
Race				<0.001
White	4241 (87.8%)	1795 (81.9%)	6036 (85.9%)	
Black	234 (4.8%)	228 (10.4%)	462 (6.6%)	
Asian	171 (3.5%)	77 (3.5%)	248 (3.5%)	
Hispanic	77 (1.6%)	45 (2.1%)	122 (1.7%)	
Other / unknown	108 (2.2%)	47 (2.1%)	155 (2.2%)	
Marital status				<0.001
Single	437 (9%)	245 (11.2%)	682 (9.7%)	
Married	2235 (46.3%)	1076 (49.1%)	3311 (47.1%)	
Separated	39 (0.8%)	25 (1.1%)	64 (0.9%)	
Divorced	324 (6.7%)	251 (11.5%)	575 (8.2%)	
Widowed	1361 (28.2%)	510 (23.3%)	1871 (26.6%)	
Unknown	435 (9%)	85 (3.9%)	520 (7.4%)	
Urban / rural				<0.001
Big Metro	2515 (52.1%)	1310 (59.8%)	3825 (54.5%)	
Metro	1338 (27.7%)	597 (27.2%)	1935 (27.6%)	
Urban	329 (6.8%)	129 (5.9%)	458 (6.5%)	
Less urban	523 (10.8%)	129 (5.9%)	652 (9.3%)	
Rural / missing	126 (2.6%)	27 (1.2%)	152 (2.2%)	
Comorbidities				0.429
0	4013 (83.1%)	1804 (82.3%)	5817 (82.8%)	
1+	818 (16.9%)	388 (17.7%)	1206 (17.2%)	

Table 2

Characteristics of patients with oral and oropharyngeal tumors stratified by type of treatment Percent are for rows.

	Surgery Only (N = 2,917)		No Treatment (N = 660)		Radiation Only (N = 1,182)		Surgery + Radiation (N = 1,189)		Chemo + Radiation (N = 870)		Chemo w/o Radiation (N = 205)	
	N	%	N	%	N	%	N	%	N	%	N	%
Site												
Lip / oral tongue	1,665	70.05%	155	6.52%	180	7.57%	261	10.98%	84	3.53%	32	1.35%
Floor of mouth	288	44.40%	63	9.70%	93	14.40%	137	21.10%	46	7.10%	21	3.20%
Gum & other mouth	776	43.00%	171	9.50%	298	16.50%	416	23.00%	106	5.90%	39	2.20%
Oral Cavity (N = 4,831)												
Stage												
In situ / localized	2,033	77.54%	143	5.45%	166	6.33%	229	8.73%	35	1.33%	16	0.61%
Regional	626	33.20%	177	9.40%	335	17.80%	529	28.10%	161	8.50%	56	3.00%
Distant	70	21.50%	69	21.20%	70	21.50%	56	17.20%	40	12.30%	20	6.20%
Site												
Base of tongue	89	8.30%	128	12.00%	285	26.70%	179	16.80%	321	30.10%		
Tonsil	77	9.10%	81	9.60%	249	29.40%	162	19.10%	240	28.40%		Some cells < 11
Oropharynx	22	7.90%	62	22.30%	77	27.70%	34	12.20%	73	26.30%		
Oropharyngeal (N = 2,192)												
Stage												
In situ / localized	81	26.21%		13.92%	80	25.89%	59	19.09%	37	11.97%		Some cells < 11
Regional	89	6.00%	147	9.90%	432	29.10%	270	18.20%	464	31.30%		Some cells < 11
Distant	18	4.50%	81	20.20%	99	24.70%	46	11.50%	133	33.20%		

Table 3

Estimated odds ratios and 95% confidence intervals from multinomial regression model of treatment choice with surgery as the reference group

Variable	Radiation only	Radiation and Surgery	Chemo with Radiation	Chemo without Radiation	No treatment
Age					
81 vs. 70	1.26 (1.08-1.46) *	0.66 (0.57-0.76) *	0.69 (0.58-0.83) *	0.67 (0.50-0.90) *	1.50 (1.25-1.80) *
Site					
Oral cavity	Reference	-	-	-	-
Oropharyngeal	10.3 (8.40-12.6) *	3.67 (2.98-4.50) *	18.5 (14.7-23.2) *	9.15 (6.55-12.8) *	7.38 (5.83-9.34) *
Stage					
Localized / in situ	Reference	-	-	-	-
Regional	6.04 (5.06-7.22) *	6.62 (5.61-7.81) *	14.4 (10.9-18.9) *	11.1 (7.12 - 17.4) *	3.95 (3.19-4.89) *
Distant	9.61 (7.07-13.1) *	6.19 (4.50-8.52) *	26.1 (18.0-38.0) *	25.5 (14.6-44.4) *	14.1 (10.2-19.5) *
Sex					
Female	Reference	-	-	-	-
Male	1.10 (0.92-1.31)	1.00 (0.85-1.18)	1.07 (0.87-1.31)	0.87 (0.63-1.21)	1.46 (1.19-1.80) *
Race					
White	Reference	-	-	-	-
Black	2.04 (1.45-2.86) *	1.50 (1.06-2.12) *	1.87 (1.29-2.71) *	1.68 (0.97-2.92) *	2.40 (1.66-3.48) *
Other	1.46 (1.09-1.96) *	1.49 (1.13-1.96) *	1.42 (1.00-2.01) *	1.72 (1.03-2.88) *	1.44 (1.01-2.05) *
Marital status					
Married	Reference	-	-	-	-
Single	1.13 (0.85-1.50)	0.73 (0.55-0.97) *	1.08 (0.79-1.49)	1.22 (0.75-1.99)	2.03 (1.48-2.79) *
Separated / divorced	2.04 (1.53-2.71) *	1.34 (1.01-1.76) *	1.45 (1.05-2.01) *	1.25 (0.71-2.17)	2.98 (2.14-4.16) *
Widowed	1.25 (1.01-1.53) *	1.02 (0.84-1.25)	1.14 (0.89-1.46)	1.14 (0.76-1.72)	1.51 (1.17-1.95) *
Unknown	0.98 (0.69-1.39)	0.54 (0.37-0.77) *	0.92 (0.59-1.44)	2.38 (1.38-4.13) *	3.86 (2.82-5.28) *
Urban / rural code					
Big metro	1.50 (1.15-1.97) *	1.65 (1.26-2.14) *	1.63 (1.17-2.27) *	2.73 (1.46-5.09) *	1.43 (1.05-1.95) *

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Variable	Radiation only	Radiation and Surgery	Chemo with Radiation	Chemo without Radiation	No treatment
Metro	1.37 (1.03-1.83) *	1.54 (1.17-2.04) *	1.27 (0.89-1.82)	1.17 (0.59-2.33)	1.08 (0.77-1.51)
Urban	1.29 (0.87-1.92)	1.59 (1.10-2.31) *	1.25 (0.77-2.02)	1.47 (0.61-3.55)	1.48 (0.95-2.30)
Less Urban / rural	Reference	-	-	-	-
Comorbidities, increase of 1	1.17 (1.11-1.24) *	0.99 (0.93-1.06)	1.08 (1.01-1.16) *	1.06 (0.94-1.19)	1.26 (1.18-1.34) *
Year of diagnosis, 1 year increase	1.00 (0.97-1.02) ***	0.98 (0.96-1.00)	1.10 (1.07-1.13) *	1.07 (1.01-1.12) *	1.05 (1.02-1.08) *

* p-value <0.05

** Age was modeled as a quadratic effect; the odds ratio is reported for the 75th vs. 25th quantile.

*** The number of comorbidities and year of diagnosis were modeled as linear effects; the odds ratio is reported for a 1-unit increase.