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Patterns of Care in Older Patients with Squamous Cell Carcinoma of the Head and Neck: A Surveillance Epidemiology and End Results-Medicare Analysis

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Abstract

Background—There is growing evidence in the literature that older patients may not benefit from more intensive therapy for Head and Neck Squamous Cell Carcinoma (HNSCC). A growing number of patients with Head and Neck Squamous Cell Carcinoma (HNSCC) are age 65 and older; however, much of the evidence base informing treatment decisions is based on substantially younger and healthier clinical trial populations. The purpose of this study was to assess the patterns of care of older HNSCC patients to better understand how age is associated with treatment decision.

Methods—Using the Surveillance, Epidemiology, and End Results (SEER)-Medicare database (1992–2007), we identified non-metastatic HNSCC patients (n=10,867) and categorized them into treatment models: surgery vs. non-surgery, and chemoradiotherapy (CRT) vs. radiotherapy (RT). Multivariate logistic regression models were used to identify variables associated with the receipt of surgery and CRT.

Results—Increasing age was associated with decreased odds of receiving CRT (OR = 0.94; 95% CI 0.93–0.94) but not surgery (OR 1.00; 95% CI 0.99–1.00). Co-morbidity and race were not associated with receipt of either surgery or CRT. Utilization of CRT increased while surgery decreased between 1992 and 2007.

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Conclusion—Age may influence the receipt of CRT for older HNSCC patients. There has been an increasing trend in the receipt of CRT and a decrease in primary surgery.

Keywords

Head and Neck Cancer; Elderly; Surgery; Radiation; Chemotherapy

Introduction

Within the last decade two large meta-analyses of head and neck squamous cell carcinoma (HNSCC) patients demonstrated a survival benefit when increasing the intensity of radiation therapy either by hyperfractionating (smaller doses per fraction) the course of radiation(1) or by adding concurrent chemotherapy.(2) However, in both studies, intensity of treatment was not associated with a survival benefit for HNSCC patients older than 71 years of age.(1, 2)

An increasing number of HNSCC patients are 65 or more years of age. Between 1991 and 2009 the NCI Surveillance, Epidemiology and End Results (SEER) registries recorded 168,257 incident malignant head and neck cancer cases, 47% of which occurred in patients ≥ 65 years old.(3, 4) In addition, the incidence of head and neck cancer among older patients is expected to increase 34% over the next 10 years, and 64% over the next 20 years.(5)

The evidence base informing contemporary management of HNSCC was developed predominantly on patients younger and healthier than those in the general HNSCC population.(6–8) Often not included in clinical trials, older patients commonly have multiple real and perceived complicating factors such as medical comorbidities, decreased functional reserve, poorer performance status, decreased quality of life, and limited life expectancy.(9, 10) Despite growing numbers of older patients with HNSCC, the dearth of research in this population has meant that older patients and their doctors often must decide among multiple treatment modalities with limited evidence-based guidance. Indeed, they face a paradox in cancer care quality: some have argued that this patient population is undertreated as a result of unfounded bias and ageism(9), while others have argued that because of their increased competing mortality they are treated too aggressively.(11)

The goal of this large, population-based study is to establish a baseline understanding of prevalent treatment patterns experienced by older HNSCC patients. It is important to gain insight into factors associated with treatment choices for this older population as a preliminary step prior to characterizing the appropriateness of care. Accordingly, we used SEER-Medicare linked data to identify clinically distinct treatment cohorts, characterize the type of treatment modalities they received, and identify how patient and provider characteristics may be associated with receipt of care and different treatment trends over time.

Materials and Methods

Data Source

This study used data from the National Cancer Institute's SEER-Medicare program. Briefly, the SEER system of population-based cancer registries currently covers approximately 28% of the US cancer population. Administrative and claims data for those also enrolled in Medicare allow the examination of comorbid health conditions, treatment utilization, and select outcomes, as well as many characteristics of the treating providers. These data have been the basis of innumerous published research studies, and are described extensively elsewhere.(12)

Study Population

We identified patients diagnosed with HNSCC between 1992 and 2007. Tumor site was identified by SEER cancer site codes, and cancer cohorts were grouped as larynx/hypopharynx (SEER cancer site codes 09, 38), oral cavity (02, 04, 05, and 10), oropharynx (07 and 08), and other (01, 03, 06, and 37). To maintain cohort treatment eligibility comparability and sufficient data to characterize baseline comorbidity and first year treatment utilization, we included patients with non-metastatic HNSCC that was their first and only cancer among those aged 66 years or older with at least 1 year of Medicare enrollment. Patients were excluded if they were diagnosed at autopsy or on death certificate, had metastatic disease at diagnosis, had incomplete claims or less than one year of continuous claims, or were missing information on date of diagnosis, qualifying treatment codes, or other covariates. To assure data stability for examination of racial disparities, only those SEER registries with 5% or greater non-Caucasians were examined(13), including Greater California, Detroit, Hawaii, New Jersey and Connecticut, Louisiana, and Georgia.

Main Outcomes—Based in the claims data, Current Procedural Terminology (CPT)/Healthcare Common Procedure Coding System (HCPCS) and International Classification of Disease (ICD-9) codes for radiation, chemotherapy, and surgery were used to identify treatments (Table 1). Validated codes were used that were similar to previous SEER-Medicare studies.(14–16) Based on timing of treatment claims data patients were placed into 7 treatment cohorts (Table 1). These cohorts were used to create two treatment models; surgery versus non-surgery (cohorts 1–5 vs. 6 & 7) and chemoradiotherapy (CRT) versus radiotherapy (RT) (cohorts 4 & 7 vs. 2, 3, & 6) (Table 1). These clinically relevant models were analyzed to answer which variables influence the receipt of definitive surgery and which affect the addition of chemotherapy to radiation. Of note patients who received post-radiation neck dissections (codes 40.40, 40.41, 40.42, 38700, 38720, 38724) within 80 days of first radiation treatment were still considered to be in the CRT alone or RT alone groups.

Covariates—Age was defined by date of diagnosis from SEER files and was analyzed as a continuous variable. Race (Caucasian or non-Caucasian), gender, marital status, and SEER region were all determined from SEER files as well. Date of diagnosis was defined as month and year of diagnosis from the SEER file and Medicare Claims files and was analyzed by 5 year periods (1992–1996, 1997–2001, and 2002–2007). Stage was defined by SEER Historic Stage A and was assessed across all time periods and was used to control for stage in our models.(17) There is no available TNM staging for Head and Neck cancer throughout the time period that we analyzed. This is partly because the TNM system is different among the different sites of head and neck cancer, and partly because both the TNM staging system and the available staging information in the SEER database has changed significantly over time. Therefore we used the historic SEER A staging system. In this staging system distant stage is defined as patients with metastatic disease (SEER Extent of Disease (EOD) code 85) or patients with direct extension into ‘remote’ body parts (e.g. Base of tongue cancer with extension into the mandible). Therefore, even though we excluded patients with metastatic disease (SEER EOD code 85), there were still patients with ‘distant’ stage in our analysis. Therefore these ‘distant’ stage patients would have T4a or T4b disease according to current AJCC staging guidelines and were thus labeled as locally advanced.(18)

Comorbidity was measured based on a weighted Charlson Comorbidity Index (CCI) created from Medicare claims from one year prior to diagnosis until one month prior to diagnosis of HNSCC. This method of creating a weighted comorbidity score has previously been reported and used for both outcomes and patterns of care analyses.(19–21)

Socioeconomic status (SES) indicators were from SEER census tract data for education and Medicare files on eligibility for state-buy in for Medicaid. Additional indicator variables were used to determine the type of treatment facility. These variables included organization affiliation with NCI Cooperative Groups having head and neck cancer research portfolios (ACOSOG, ECOG, CALGB, SWOG, NCCTG, and RTOG), NCI cancer center designation, and medical school affiliation as determined by Medicare Hospital Files.

Statistical Analysis—Bivariate analyses were performed to test the independence of several of the covariates including census tract education, state buy-in, and organizational variables. Multivariate logistic regression modeling was performed to identify variables associated with the two treatment models (surgery vs. non-surgery, and CRT vs. RT). Based on *a priori* hypotheses, several interaction terms were tested in the models including: age with comorbidity, age with race, race with gender, race and SES indicators, and race with comorbidity. Of note, none of these interaction terms were found to be significant. Model fit was compared using 2-Log Likelihood. All analyses were performed using SAS v9.2. This study was approved by the Institutional Review Board at the University of North Carolina at Chapel Hill (study #10-1985).

Results

Patient and Treatment Characteristics

Median age of all patients was 75 (range 66–106). The majority of patients were Caucasian, male, married, not eligible for Medicaid, and had no comorbidities based on the CCI (Table 2). Oral cavity was the most common primary site in the surgery vs. non-surgery model (43%) and hypopharynx + larynx was the most common in the CRT vs. RT model (49%). Most patients were treated between 2002 and 2007 at cooperative group affiliated hospitals (Table 2). Fifty eight percent (n=6,347) were treated with definitive surgery and 20% (n=2,201) were treated with CRT, of which 30% (n=668) were treated postoperatively.

Surgery vs. Non-surgery Model

On multivariate logistic regression comparing patients who received surgery as their primary treatment to those who received non-surgical treatment (i.e. RT or CRT), we observed that non-oral cavity primary site, regional or unknown stage, and later era of diagnosis were significantly associated with decreased receipt of surgical treatment (Table 3). Female patients were more likely to receive surgery. Of interest, older age (Figure 1a), race, comorbidity, socioeconomic status, and hospital affiliation were not significantly associated with receipt of surgery.

Chemoradiotherapy vs. Radiotherapy Model

In this model older age (Figure 1b, Table 4), female gender, and hypopharynx/laryngeal cancers were significantly associated with decreased receipt of CRT. Non local stage and oropharyngeal site were significantly associated with receipt of CRT. Comorbidity status, race, marital status, socioeconomic status, and hospital affiliation correlates were not significantly associated with treatment.

Patterns of care over time

We observed a decrease in use of surgery and associated increase in non-surgical treatments (Figure 2a, Table 3) from 1992 to 2007, with the change in treatment trends occurring around the year 2003. In the year 2006 the number of patients treated with surgery and non-surgical treatment were similar (Figure 2a). Furthermore there was an increase in the use of chemotherapy with radiation over the same time period (Figure 2b, Table 4).

Discussion

The purpose of this study was to establish a baseline understanding of the patterns of care for older HNSCC patients and to gain insight into factors associated with receipt of CRT vs. RT and surgery vs. non surgery. Using our cohort of older patients treated in multiple different settings throughout the US, we found that age may be associated with decreased receipt of CRT: i.e. the older the patient, the less likely he/she will be treated with CRT (OR = 0.94; 95% CI 0.93–0.94). However, increasing age was not associated with receipt of surgery (OR 1.00; 95% CI 0.99–1.00). Similarly race and co-morbidity were not associated with receipt of treatment in either model. Not surprisingly, regional stage and non-oral cavity primary tumor site were associated with decreased likelihood of receiving surgery. We also observed that the rate of non-surgical treatment and CRT use has increased over time. The increased utilization is consistent with the publication of clinical trials in the 1990's and early 2000's supporting the use of "organ preserving" CRT instead of surgery and the use of concurrent chemotherapy with RT.(22–26) Thus it appears that advancements in treatment were adopted in older patients. Whether these advancements are appropriate in older patients is still under debate and was not meant to be addressed in this paper.

Other patterns of care publications (27–29) in older head and neck studies have shown age to be associated with less intense treatment, and possibly worse outcomes. Most of these results are based on small single institutional retrospective studies that are biased by institutional specific treatment policies. Furthermore, previous SEER-Medicare studies may have misidentified the type of treatments received.(30) Specifically, some studies defined cancer related surgery and radiation based on SEER codes, which have significantly changed both in 1998 and 2003 and are known to be not as accurate as Medicare claims. To our knowledge, we are the first claims based study to distinguish between the treatment modalities and the order in which the modalities were received. This makes our study both unique and more clinically relevant. We are also the first study to evaluate how treatment patterns for this population have changed over time.

One of the limitations of this study involves the analysis of comorbidities. The Charlson Comorbidity index has been used in multiple retrospective studies and has been shown to be a good predictor for outcomes in this population.(31) However, one of the commonly discussed limitations of the Charlson Index in a claims-based setting is that it is often an indicator of the number of comorbidities and not the severity of the comorbidities. Severity of comorbidity may be a better predictor for both outcomes and ability to tolerate treatment. Therefore it is possible that the lack of association between comorbidity and receipt of treatment is a function of the comorbidity data available in this claims based database. Similarly, patient functional status is not available in this database and should play an important role in treatment decision.

We also found stage of disease to be associated with receipt of care. However, stage in this study is based on the SEER historic A staging system. The SEER historic staging system relies on very simple parameters such as whether disease is local versus regional versus distant. The AJCC staging system which is used more often clinically and in prospective randomized trials was not possible to use in this study due to its unavailability in the SEER-Medicare database over the time periods and cancer sites assessed. Therefore, the staging variable, although associated with receipt of care, may not be as reliable at assessing the severity of the cancer as the AJCC staging system used by most clinicians today.

Additionally, only 8% (n=824) of our cohort was coded with primary site as oropharynx in the SEER database. Some may suggest this is due in part to misclassification; however, these results may accurately represent the older population of the SEER-Medicare database.

The increasing incidence of HPV-related oropharyngeal cancers has been previously shown to be occurring in cohorts of patients less than 65 years of age.(32) In addition, previous non-SEER patterns of care studies in older patients with HNSCC also demonstrated lower rates of oropharyngeal cancer compared to other primary sites in this population.(27, 28)

The use of different primary sites (oral cavity, larynx, and oropharynx) in this study may also confound some of our results. Primary site plays a major role in the initial treatment decision (surgery vs. radiation) for HNSCC patients. However, in the majority of previous epidemiologic studies as well as in previously mentioned meta-analyses these sites were analyzed together. Therefore we felt it was appropriate to assess the patterns of care of these sites as one larger cohort.

Building upon this study, our future work will extend this research into the context of appropriateness of treatment strategies, first by assessing which patients were candidates for multimodality therapy based on tumor location and stage. A likely consideration will be to restrict the study population to a single site for which the most detailed data on staging is available in the SEER-Medicare database – staging data were not adequately granular using the overall HNSCC population. This will allow an examination of guideline concordance, as well as the examination of treatment outcomes and toxicity. For these examinations, propensity-weighted models developed in the current study can be leveraged to adjust for potential selection bias among the different treatment modalities and combinations. This will extend our understanding of treatment selection and outcomes among older HNSCC patients, and may inform the selective inclusion of older patients in Phase III clinical trials to address questions not easily explored using observational data.

Conclusion

This large claims-based study of HNSCC patients demonstrates that increasing age is associated with decreased receipt of CRT while the national trend reflects an increase in receipt of CRT with a coinciding decrease in receipt of surgery over time. This change in trend may be associated with the publication of evidence supporting CRT in the general population. Despite evidence of increasing utilization of CRT in older patients, it is unlikely that an answer to the appropriateness of therapy for this population will be parsed out from a large retrospective cohort such as SEER-Medicare. There is a significant need for prospective data in this patient population for a better understanding of how older patients tolerate and respond to different treatment regimens. Ultimately physicians and their patients must make individual treatment decisions based on the best available data. However, given the current lack of data available in this particular patient population, this study provides rare and much needed insight into treatment decisions among older HNSCC patients.

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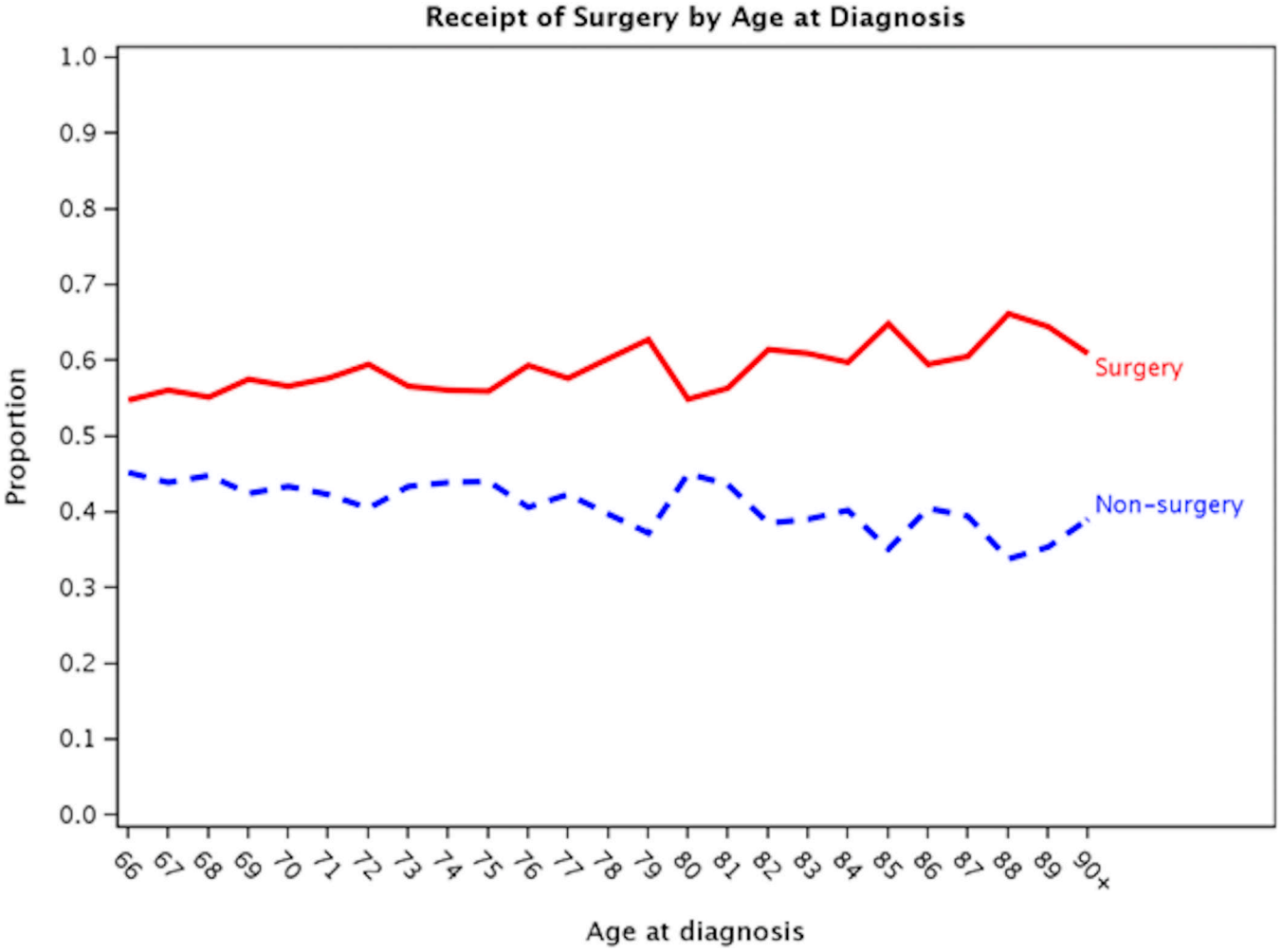
REFERENCES

1. Bourhis J, Overgaard J, Audry H, Ang KK, Saunders M, Bernier J, et al. Hyperfractionated or accelerated radiotherapy in head and neck cancer: a meta-analysis. Lancet. 2006 Sep 2; 368(9538): 843–854. [PubMed: 16950362]

2. Pignon JP, le Maitre A, Maillard E, Bourhis J. Meta-analysis of chemotherapy in head and neck cancer (MACH-NC): an update on 93 randomised trials and 17,346 patients. Radiother Oncol. 2009 Jul; 92(1):4–14. [PubMed: 19446902]
3. National Cancer Institute. Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence - SEER 18 Regs Research Data + Hurricane Katrina Impacted Louisiana Cases, Nov 2011 Sub (1973–2009 varying) - Linked To County Attributes - Total U.S., 1969–2010 Counties, National Cancer Institute, DCCPS, Surveillance Research Program, Surveillance Systems Branch, released April 2012, based on the November 2011 submission.
4. Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence - SEER 17 Regs Research Data + Hurricane Katrina Impacted Louisiana Cases, Nov 2010 Sub (1973–2008 varying) - Linked To County Attributes - Total U.S., 1969–2009 Counties, National Cancer Institute, DCCPS, Surveillance Research Program, Cancer Statistics Branch, released April 2011, based on the November 2010 submission.
5. Smith BD, Smith GL, Hurria A, Hortobagyi GN, Buchholz TA. Future of cancer incidence in the United States: burdens upon an aging, changing nation. J Clin Oncol. 2009 Jun 10; 27(17):2758–2765. [PubMed: 19403886]
6. Lin LL, Hahn SM. Combined modality therapy in the elderly population. Curr Treat Options Oncol. 2009 Aug; 10(3–4):195–204. [PubMed: 19507038]
7. Talarico L, Chen G, Pazdur R. Enrollment of elderly patients in clinical trials for cancer drug registration: a 7-year experience by the US Food and Drug Administration. J Clin Oncol. 2004 Nov 15; 22(22):4626–4631. [PubMed: 15542812]
8. Siddiqui F, Gwede CK. Head and neck cancer in the elderly population. Semin Radiat Oncol. 2012 Oct; 22(4):321–333. [PubMed: 22985815]
9. Fentiman IS, Tirelli U, Monfardini S, Schneider M, Festen J, Cognetti F, et al. Cancer in the elderly: why so badly treated? Lancet. 1990 Apr 28; 335(8696):1020–1022. [PubMed: 1970072]
10. Reid BC, Alberg AJ, Klassen AC, Samet JM, Rozier RG, Garcia I, et al. Comorbidity and survival of elderly head and neck carcinoma patients. Cancer. 2001 Oct 15; 92(8):2109–2116. [PubMed: 11596027]
11. Rose BS, Jeong JH, Nath SK, Lu SM, Mell LK. Population-based study of competing mortality in head and neck cancer. J Clin Oncol. 2011 Sep 10; 29(26):3503–3509. [PubMed: 21844503]
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 Aug.40(8 Suppl) IV-3-18.
13. Reeder-Hayes KE, Bainbridge J, Meyer AM, Amos KD, Weiner BJ, Godley PA, et al. Race and age disparities in receipt of sentinel lymph node biopsy for early-stage breast cancer. Breast Cancer Res Treat. 2011 Aug; 128(3):863–871. [PubMed: 21340480]
14. 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 Aug.40(8 Suppl) IV-55-61.
15. Virnig BA, Warren JL, Cooper GS, Klabunde CN, Schussler N, Freeman J. Studying radiation therapy using SEER-Medicare-linked data. Med Care. 2002 Aug.40(8 Suppl) IV-49-54.
16. Cooper GS, Virnig B, Klabunde CN, Schussler N, Freeman J, Warren JL. Use of SEER-Medicare data for measuring cancer surgery. Med Care. 2002 Aug.40(8 Suppl) IV-43-8.
17. National Cancer Institute, Division of Cancer Control and Population Sciences, Surveillance Research Program, Cancer Statistics Branch: Surveillance, Epidemiology, and End Results Program Limited-Use Data (1973–2004), released April 2007.; Available from: http://www.seer.cancer.gov.
18. Edge, SB. American Cancer Society. AJCC cancer staging handbook : from the AJCC cancer staging manual. 7th ed.. New York: Springer; 2010. American Joint Committee on Cancer.
19. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis. 1987; 40(5):373–383. [PubMed: 3558716]
20. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol. 1992 Jun; 45(6):613–619. [PubMed: 1607900]

21. Romano PS, Roos LL, Jollis JG. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: differing perspectives. J Clin Epidemiol. 1993 Oct; 46(10):1075–1079. discussion 81–90. [PubMed: 8410092]
22. Adelstein DJ, Li Y, Adams GL, Wagner H Jr. Kish JA, Ensley JF, et al. An intergroup phase III comparison of standard radiation therapy and two schedules of concurrent chemoradiotherapy in patients with unresectable squamous cell head and neck cancer. J Clin Oncol. 2003 Jan 1; 21(1): 92–98. [PubMed: 12506176]
23. Forastiere AA, Goepfert H, Maor M, Pajak TF, Weber R, Morrison W, et al. Concurrent chemotherapy and radiotherapy for organ preservation in advanced laryngeal cancer. N Engl J Med. 2003 Nov 27; 349(22):2091–2098. [PubMed: 14645636]
24. Bernier J, Domenge C, Ozsahin M, Matuszewska K, Lefebvre JL, Greiner RH, et al. Postoperative irradiation with or without concomitant chemotherapy for locally advanced head and neck cancer. N Engl J Med. 2004 May 6; 350(19):1945–1952. [PubMed: 15128894]
25. Cooper JS, Pajak TF, Forastiere AA, Jacobs J, Campbell BH, Saxman SB, et al. Postoperative concurrent radiotherapy and chemotherapy for high-risk squamous-cell carcinoma of the head and neck. N Engl J Med. 2004 May 6; 350(19):1937–1944. [PubMed: 15128893]
26. Denis F, Garaud P, Bardet E, Alfonsi M, Sire C, Germain T, et al. Final results of the 94-01 French Head and Neck Oncology and Radiotherapy Group randomized trial comparing radiotherapy alone with concomitant radiochemotherapy in advanced-stage oropharynx carcinoma. J Clin Oncol. 2004 Jan 1; 22(1):69–76. [PubMed: 14657228]
27. Kruse AL, Bredell M, Luebbers HT, Gratz KW. Head and neck cancer in the elderly: a retrospective study over 10 years (1999 – 2008). Head Neck Oncol. 2010; 2:25. [PubMed: 20923547]
28. Huang SH, O'Sullivan B, Waldron J, Lockwood G, Bayley A, Kim J, et al. Patterns of care in elderly head-and-neck cancer radiation oncology patients: a single-center cohort study. Int J Radiat Oncol Biol Phys. 2011 Jan 1; 79(1):46–51. [PubMed: 20395066]
29. Michal SA, Adelstein DJ, Rybicki LA, Rodriguez CP, Saxton JP, Wood BG, et al. Multi-agent concurrent chemoradiotherapy for locally advanced head and neck squamous cell cancer in the elderly. Head Neck. 2011 Oct 22.
30. Du XL, Liu CC. Racial/Ethnic disparities in socioeconomic status, diagnosis, treatment and survival among medicare-insured men and women with head and neck cancer. J Health Care Poor Underserved. 2010 Aug; 21(3):913–930. [PubMed: 20693735]
31. Piccirillo JF, Spitznagel EL Jr. Vermani N, Costas I, Schnitzler M. Comparison of comorbidity indices for patients with head and neck cancer. Med Care. 2004 May; 42(5):482–486. [PubMed: 15083109]
32. Gillison ML, Broutian T, Pickard RK, Tong ZY, Xiao W, Kahle L, et al. Prevalence of oral HPV infection in the United States, 2009–2010. JAMA. 2012 Feb 15; 307(7):693–703. [PubMed: 22282321]



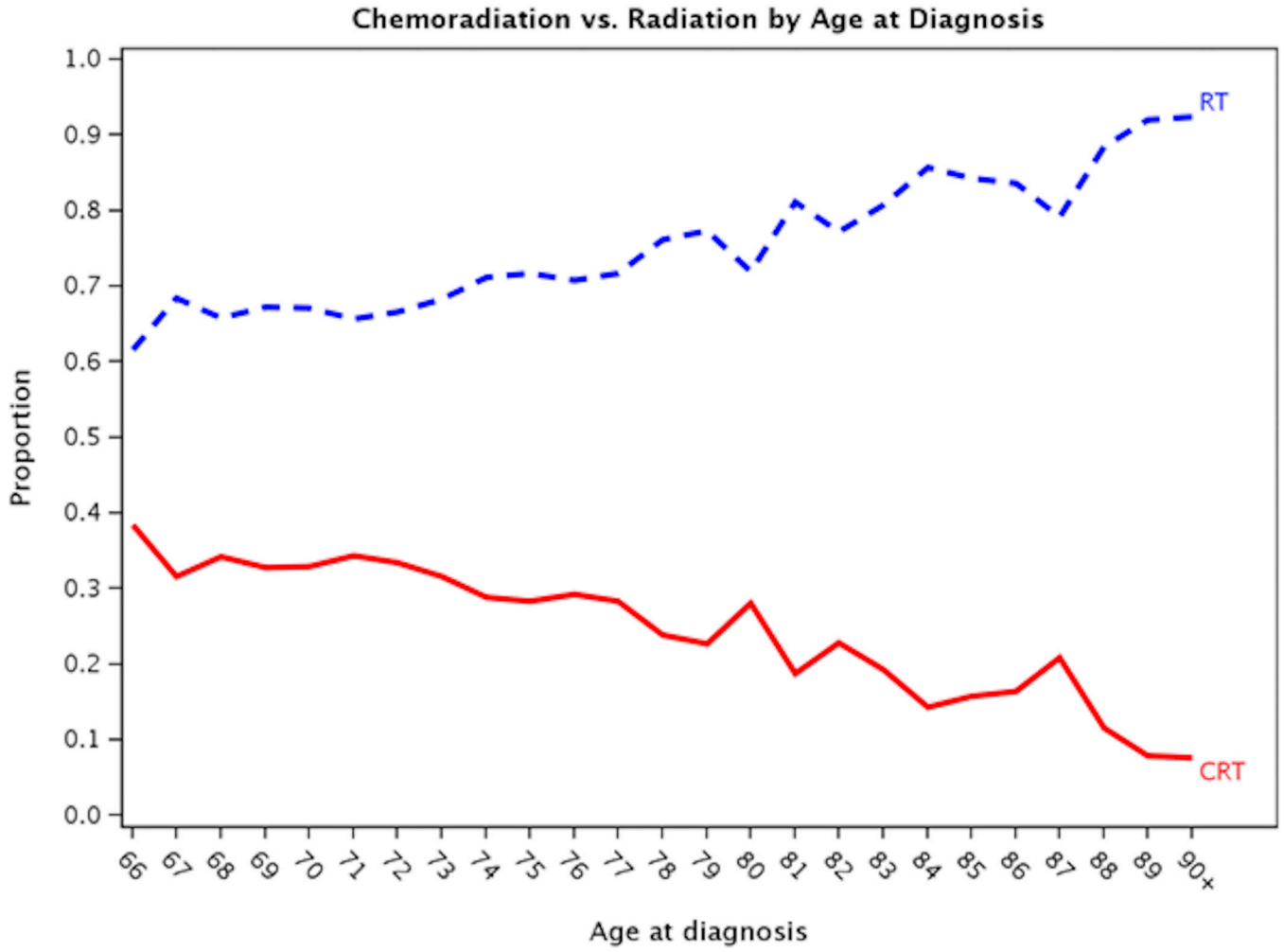
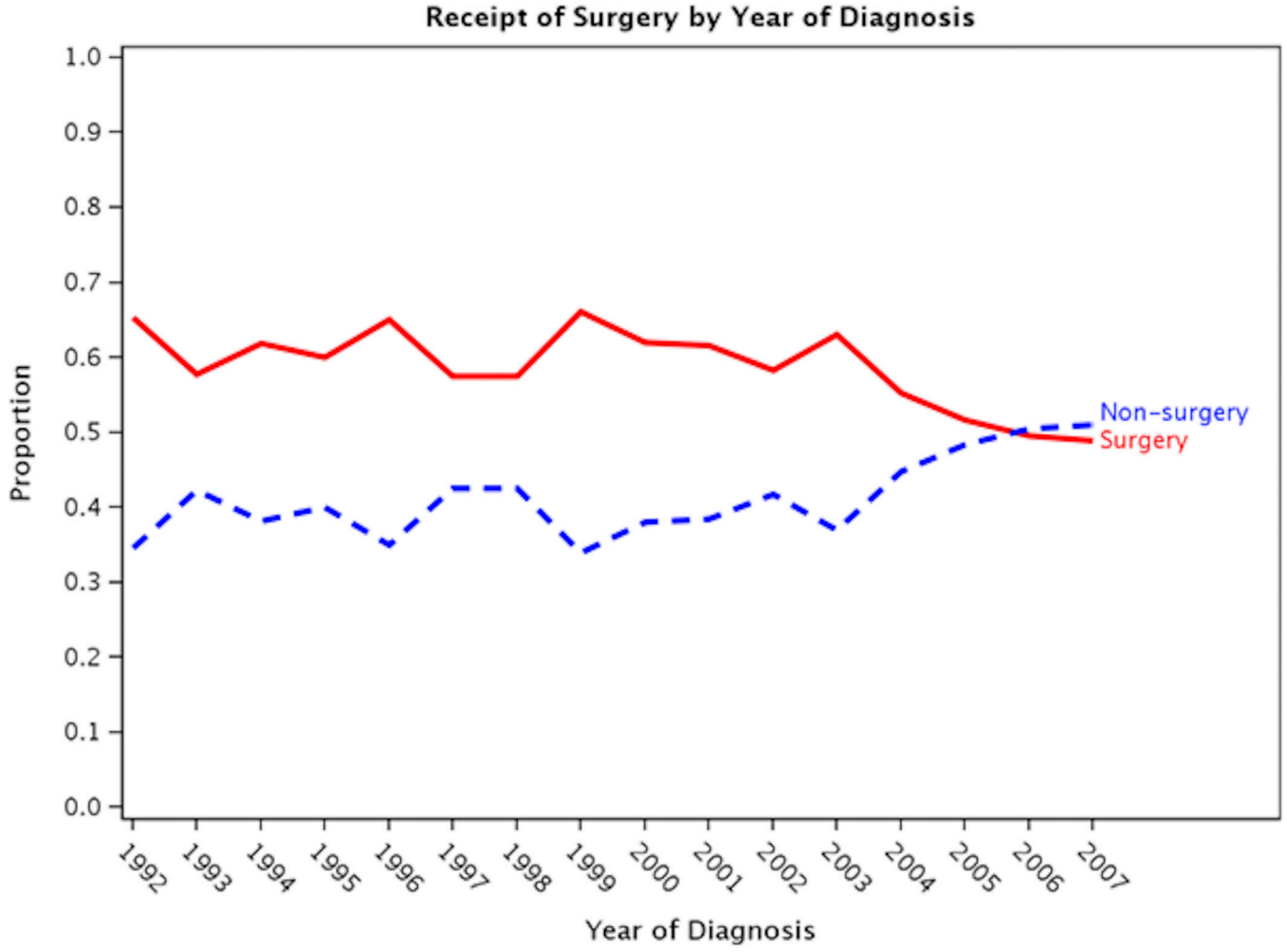


Figure 1.
a: Trend in surgery vs. non-surgery with increasing age
b: Trend in chemoradiation vs. radiation with increasing age



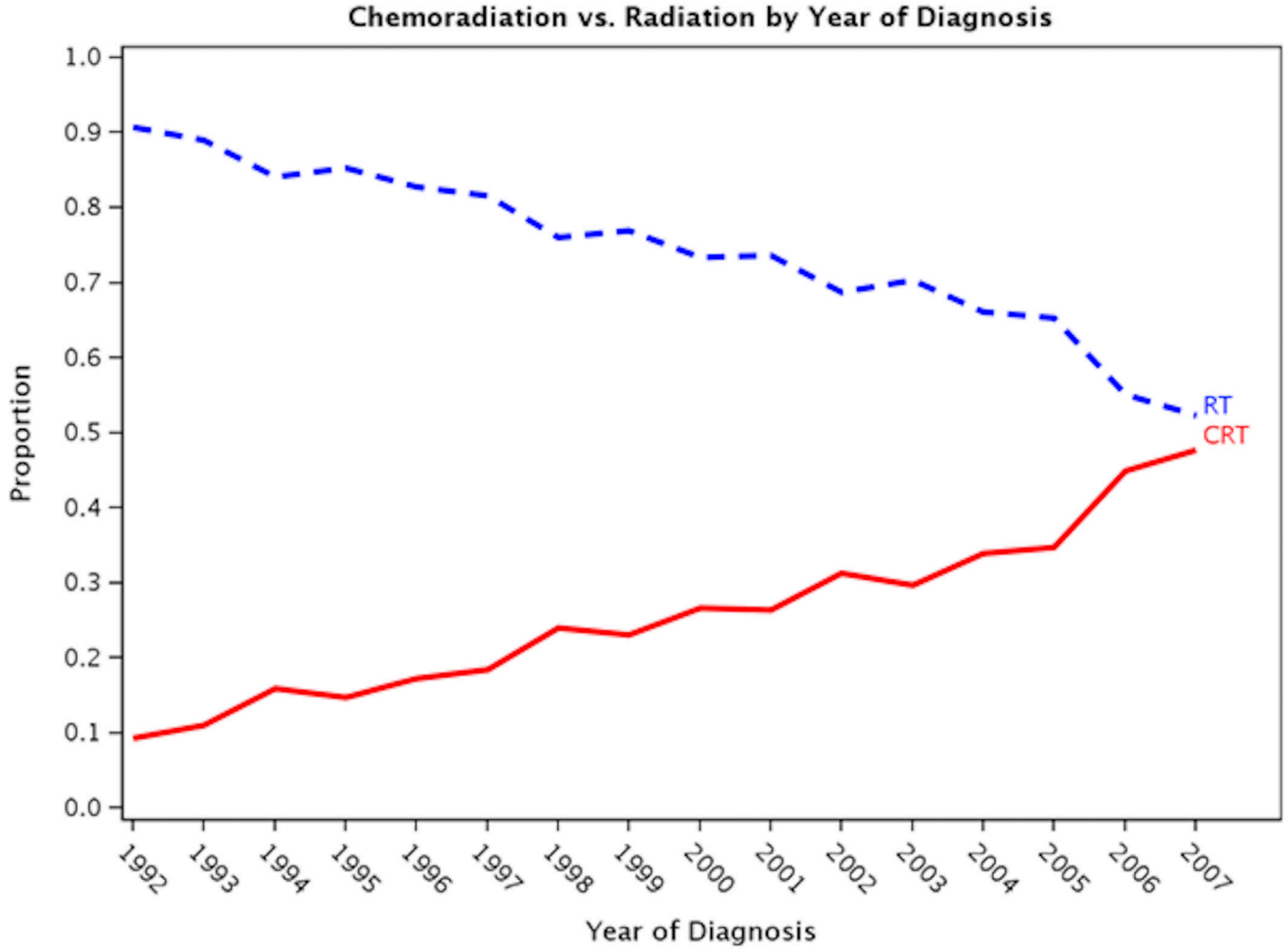


Figure 2.
a: Trend in surgery vs. non-surgery over time.
b: Trend in receipt of chemoradiation vs. radiation over time.

Table 1

Details of Treatment Cohorts

Treatment Cohort	Timing	ICD-9 Codes	CPT/HCPCS/Revenue Center/Category II/III codes	Number of Patients
Surgery Alone (cohort 1)	60 days prior to or 120 days from date of diagnosis and no radiation or chemotherapy codes within 120 days of first qualifying treatment code	21.5, 21.61, 21.69, 22.31, 22.42, 22.6, 22.60–22.64, 24.31, 25.1–25.4, 26.2, 26.29, 26.32, 27.3, 27.32, 27.4, 27.42, 27.43, 27.49, 27.55, 27.56, 27.72, 28.92, 29.33, 29.39, 30.0, 30.09, 30.1,30.2, 30.21, 30.22, 30.29, 30.3, 30.4, 31.1, 31.2, 31.29, 31.5, 40.40–40.42, 76.2, 76.31, 76.39, 76.41–76.45	CPT: 11620–11626, 11640–11646, 21044,21045, 21552–21558, 30117,30118, 30130–30150, 31200–31205, 31225–31299, 31300–31420, 38700–38724, 40810–40819, 41100–41155, 41599, 41825–41827, 42104–42140, 42410–42450, 42842–42894	2935
Preoperative Radiation then Surgery (cohort 2)	First qualifying treatment = radiation within 60 days prior to or 120 days from date of diagnosis followed by surgery within 80 days from start of radiation and no chemotherapy within 180 days of surgery	Radiation: 92.21–92.41, V58.0, V66.1, V67.1 Surgery: same as above, excluding 40.40, 40.41, 40.42 (neck dissection codes alone)	Radiation: CPT: 41019, 77401–77435, 77499, 77520–77525, 77750–77799 Category II: 4181F, 3318F, 0520F Category III: 0073T HCPCS: G0173, G0251, G0339, G0340, S8049 Revenue Center: 0330,0333 Surgery: same as above, excluding 38700, 38720, and 38724 (neck dissection alone codes)	181
Surgery and Postoperative Radiation Alone (cohort 3)	First qualifying treatment= surgery within 60 days prior to or 120 days from date of diagnosis, followed by radiation within 120 days after surgery and no chemotherapy within 180 days of surgery	Surgery: same as cohort 1 Radiation: same as cohort 2	Surgery: same as cohort 1 Radiation: same as cohort 2	2485
Surgery and Postoperative Chemoradiation (cohort 4)	First qualifying treatment= surgery within 60 days prior to or 120 days from date of diagnosis, followed by radiation and chemotherapy	Surgery: same as cohort 1 Radiation: same as cohort 2 Chemotherapy: 99.25, V58.1, V58.11, V58.12, V66.2, V67.2	Surgery: same as cohort 1 Radiation: same as cohort 2 Chemotherapy: CPT: 96400–96417, 96420–96425, 96440–96450, 96520–96530, 96542–96549, 99601–99602	668

Treatment Cohort	Timing	ICD-9 Codes	CPT/HCPCS/Revenue Center/Category II/III codes	Number of Patients
	within 120 days of surgery. (this cohort potentially includes patients who received neoadjuvant, concurrent, and adjuvant chemotherapy related to radiation)		Category II: 0519F, 3317F HCPCS: C1166–C1178, C9004–C9438, G0355–G0362, G9021-G9032, J8510-J999, Q0083-Q0085 Revenue Center: 0331,0332,0335	
Surgery followed by Chemotherapy alone (cohort 5)	First qualifying treatment= surgery within 60 days prior to 120 days from date of diagnosis, followed by chemotherapy within 120 days and no radiation within 180 days of surgery	Surgery: same as cohort 1 Chemotherapy: same as cohort 4	Surgery: same as cohort 1 Chemotherapy: same as cohort 4	49
Radiation Alone (cohort 6)	First qualifying treatment= radiation within 60 days prior to or 120 days from date of diagnosis and either no surgery codes, or neck dissection alone surgery codes within 80 days from first radiation and no chemotherapy codes within 60 days prior to or after first radiation code.	Radiation: same as cohort 2 Surgery: 40.40, 40.41, 40.42 (neck dissections allowed)	Radiation: same as cohort 2 Surgery: 38700, 38720, and 38724 (neck dissections allowed)	3016
Chemoradiation Alone (cohort 7)	First qualifying treatment either radiation or chemotherapy (as long as within 90 days between first chemotherapy and first radiation) and first code within 60 days prior to or 120 days following diagnosis. Either no surgery codes or neck dissection alone codes within 80 days of first qualifying treatment code. (this cohort potentially includes patients who received neoadjuvant, concurrent, and	Radiation: same as cohort 2 Chemotherapy: same as cohort 4 Surgery: 40.40, 40.41, 40.42 (neck dissections allowed)	Radiation: same as cohort 2 Chemotherapy: same as cohort 4 Surgery: 38700, 38720, and 38724 (neck dissections allowed)	1533

Treatment Cohort	Timing	ICD-9 Codes	CPT/HCPCS/Revenue Center/Category II/III codes	Number of Patients
	adjuvant chemotherapy related to radiation)			

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Table 2

Patient clinical and treatment characteristics

		Yes Surgery vs. No Surgery			Chemoradiation vs. Radiation		
Characteristic		**Total**	**Yes**	**No**	**Total**	**CRT**	**RT**
		(N=10,867)	**(N=6,318)**	**(N=4,549)**	**(N=7,883)**	**(N=2,201)**	**(N=5,682)**
SEER region	Detroit	1,742 (16%)	1,059 (17%)	683 (15%)	1,209 (15%)	412 (19%)	797 (14%)
	Hawaii	205 (2%)	122 (2%)	83 (2%)	151 (2%)	25 (1%)	126 (2%)
	Atlanta and Rural Georgia	681 (6%)	404 (6%)	277 (6%)	493 (6%)	105 (5%)	388 (7%)
	San Francisco, San Jose, LA and Greater California	4,406 (41%)	2,550 (40%)	1,856 (41%)	3,206 (41%)	837 (38%)	2,369 (42%)
	Louisiana	787 (7%)	400 (6%)	387 (9%)	604 (8%)	172 (8%)	432 (8%)
	Connecticut and New Jersey	3,046 (28%)	1,783 28%)	1,263 (28%)	2,220 (28%)	650 (30%)	1,570 (28%)
Cancer site	Oral Cavity	4,674 (43%)	3,467 (55%)	1,207 (27%)	2,460 (31%)	789 (36%)	1,671 1(29%)
	Hypopharynx + Larynx	4,403 (41%)	1,967 (31%)	2,436 (54%)	3,890 (49%)	805 (37%)	3,085 (54%)
	Tonsil + Oropharynx	824 (8%)	280 (4%)	544 (12%)	747 (9%)	353 (16%)	394 (7%)
	Salivary Gland, Nasopharynx + Middle Ear	966 (9%)	604 (10%)	362 (8%)	786 (10%)	254 (12%)	532 (9%)
Diagnosis era	2002–2007	5,295 (49%)	2,892 (46%)	2,403 (53%)	3,881 (49%)	1,432 (65%)	2,449 (43%)
	1997–2001	2,911 (27%)	1,778 (28%)	1,133 (25%)	2,084 (26%)	510 (23%)	1,574 (28%)
	1992–1996	2,661 (24%)	1,648 (26%)	1,013 (22%)	1,918 (24%)	259 (12%)	1,659 (29%)
Historic stage A	In Situ and localized	5,088 (47%)	3,106 (49%)	1,982 (44%)	3,171 (40%)	327 (15%)	2,844 (50%)
	Regional	4,464 (41%)	2,475 (39%)	1,989 (44%)	3,714 (47%)	1,470 (67%)	2,244 (39%)
	Locally advanced	703 (6%)	422 (7%)	281 (6%)	584 (7%)	296 (13%)	288 (5%)
	Unknown/Unstaged	612 (6%)	315 (5%)	297 (7%)	414 (5%)	108 (5%)	306 (5%)

Characteristic		Yes Surgery vs. No Surgery			Chemoradiation vs. Radiation		
		Total (N=10,867)	Yes (N=6,318)	No (N=4,549)	Total (N=7,883)	CRT (N=2,201)	RT (N=5,682)
Charlson comorbidity index	0	5,845 (54%)	3,453 (55%)	2,392 (53%)	4,193 (53%)	1,194 (54%)	2,999 (53%)
	1+	5,022 (46%)	2,865 (45%)	2,157 (47%)	3,690 (47%)	1,007 (46%)	2,683 (47%)
Gender	Male	6,947 (64%)	3,756 (59%)	3,191 (70%)	5,380 (68%)	1,558 (71%)	3,822 (67%)
	Female	3,920 (36%)	2,562 (41%)	1,358 (30%)	2,503 (32%)	643 (29%)	1,860 (33%)
Race	Caucasian American	9,512 (88%)	5,592 (89%)	3,920 (86%)	6,805 (86%)	1,864 (85%)	4,941 (87%)
	Non-Caucasian American	1,355 (12%)	726 (11%)	629 (14%)	1,078 (14%)	337 (15%)	741 (13%)
Age at diagnosis	N	10,867	6,318	4,549	7,883	2,201	5,682
	Mean (s.d.)	75.6 (6.8)	75.8 (6.8)	75.3 (6.7)	75.1 (6.5)	73.5 (5.6)	75.7 (6.8)
	Min, Max	66, 106	66, 103	66, 106	66, 106	66, 98	66, 106
	Median (Q1, Q3)	75 (70, 80)	75 (70, 80)	74 (70, 80)	74 (70, 79)	73 (69, 77)	75 (70, 80)
	10%, 90%	67, 85	67, 85	67, 85	67, 84	67, 81	67, 85
	66–69 yr	2,368 (22%)	1,324 (21%)	1,044 (23%)	1,858 (24%)	636 (29%)	1,222 (22%)
	70–74 yr	3,000 (28%)	1,718 (27%)	1,282 (28%)	2,254 (29%)	725 (33%)	1,529 (27%)
	75–79 yr	2,543 (23%)	1,501 (24%)	1,042 (23%)	1,840 (23%)	491 (22%)	1,349 (24%)
	80+ yr	2,956 (27%)	1,775 (28%)	1,181 (26%)	1,931 (24%)	349 (16%)	1,582 (28%)
Marital status	Unmarried or Unknown	5,116 (47%)	3,050 (48%)	2,066 (45%)	3,581 (45%)	976 (44%)	2,605 (46%)
	Married	5,751 (53%)	3,268 (52%)	2,483 (55%)	4,302 (55%)	1,225 (56%)	3,077 (54%)
Dual eligibility for Medicare/Medicaid	No	9,108 (84%)	5,345 (85%)	3,763 (83%)	6,537 (83%)	1,790 (81%)	4,747 (84%)
	Yes	1,759 (16%)	973 (15%)	786 (17%)	1,346 (17%)	411 (19%)	935 (16%)
Percent of high school graduate based on 2000	Quartile 1: >=75%	2,733 (25%)	1,602 (25%)	1,131 (25%)	1,944 (25%)	566 (26%)	1,378 (24%)

Characteristic		Yes Surgery vs. No Surgery			Chemoradiation vs. Radiation		
		Total (N=10,867)	Yes (N=6,318)	No (N=4,549)	Total (N=7,883)	CRT (N=2,201)	RT (N=5,682)
census data	Quartile 2: 50%–<75%	2,746 (25%)	1,619 (26%)	1,127 (25%)	1,971 (25%)	571 (26%)	1,400 (25%)
	Quartile 3: 25%–<50%	2,704 (25%)	1,577 (25%)	1,127 (25%)	1,962 (25%)	514 (23%)	1,448 (25%)
	Quartile 4: <25%	2,684 (25%)	1,520 (24%)	1,164 (26%)	2,006 (25%)	550 (25%)	1,456 (26%)
Cooperative group affiliated	No	4,044 (37%)	2,317 (37%)	1,727 (38%)	2,951 (37%)	811 (37%)	2,140 (38%)
	Yes	6,823 (63%)	4,001 (63%)	2,822 (62%)	4,932 (63%)	1,390 (63%)	3,542 (62%)
NCI cancer center designated	No	10,567 (97%)	6,131 (97%)	4,436 (98%)	7,673 (97%)	2,134 (97%)	5,539 (97%)
	Yes	300 (3%)	187 (3%)	113 (2%)	210 (3%)	67 (3%)	143 (3%)
Medical school affiliation	No	5,767 (53%)	3,340 (53%)	2,427 (53%)	4,186 (53%)	1,143 (52%)	3,043 (54%)
	Yes	5,100 (47%)	2,978 (47%)	2,122 (47%)	3,697 (47%)	1,058 (48%)	2,639 (46%)

Table 3

Multivariate analysis of surgery vs. non-surgery.

Patient Characteristics		OR	95% CI	p-value
SEER region (ref.= Connecticut and New Jersey)	Detroit	0.98	(0.86 – 1.11)	0.7116
	Hawaii	1.06	(0.77 – 1.45)	0.7178
	Atlanta and Rural Georgia	0.94	(0.78 – 1.12)	0.4739
	San Francisco, San Jose, LA and Greater California	0.86**	(0.77 – 0.95)	0.0046
	Louisiana	0.70**	(0.59 – 0.84)	<.0001
Cancer site (ref.= Oral Cavity)	Hypopharynx + Larynx	0.27**	(0.25 – 0.30)	<.0001
	Tonsil + Oropharynx	0.19**	(0.16 – 0.23)	<.0001
	Salivary Gland, Nasopharynx + Middle Ear	0.62**	(0.54 – 0.72)	<.0001
Diagnosis era (ref.= 2002–2007)	1997–2001	1.38**	(1.25 – 1.52)	<.0001
	1992–1996	1.40**	(1.26 – 1.56)	<.0001
Historic stage A (ref.= In Situ and localized)	Regional	0.73**	(0.67 – 0.80)	<.0001
	Locally advanced	0.99	(0.83 – 1.18)	0.9184
	Unknown/Unstaged	0.54**	(0.45 – 0.65)	<.0001
Charlson comorbidity index (ref.= 0)	1+	0.99	(0.91 – 1.08)	0.8588
Sex (ref.= Male)	Female	1.23**	(1.12 – 1.35)	<.0001
Race (ref.= Caucasian American)	Non-Caucasian American	0.93	(0.82 – 1.07)	0.3290
Age at diagnosis		1.00	(0.99 – 1.00)	0.3659
Marital status (ref.= Married)	Unmarried or Unknown	1.01	(0.93 – 1.10)	0.8038
Dual eligibility for Medicare/Medicaid (ref.= No)	Yes	0.96	(0.85 – 1.09)	0.5564
Percent of high school graduate based on 2000 census data (ref. = Quartile 4: <25%)	Quartile 1: >=75%	0.99	(0.87 – 1.12)	0.8343
	Quartile 2: 50%–<75%	1.01	(0.90 – 1.14)	0.8232
	Quartile 3: 25%–<50%	1.01	(0.90 – 1.13)	0.9015
Cooperative group affiliated		0.99	(0.90 – 1.08)	0.8188
NCI cancer center designated		1.25	(0.97 – 1.62)	0.0856
Medical school affiliation		0.95	(0.86 – 1.04)	0.2335

Table 4

Multivariate analysis of chemoradiation vs. radiation.

Patient Characteristics		OR	95% CI	p-value
SEER region (ref.= Connecticut and New Jersey)	Detroit	1.78**	(1.49 – 2.12)	<.0001
	Hawaii	0.38**	(0.23 – 0.62)	0.0001
	Atlanta and Rural Georgia	0.78	(0.60 – 1.02)	0.0707
	San Francisco, San Jose, LA and Greater California	0.83**	(0.71 – 0.95)	0.0095
	Louisiana	0.71**	(0.57 – 0.89)	0.0033
Cancer site (ref.= Oral Cavity)	Hypopharynx + Larynx	0.79**	(0.69 – 0.90)	0.0006
	Tonsil + Oropharynx	1.63**	(1.35 – 1.96)	<.0001
	Salivary Gland, Nasopharynx + Middle Ear	1.05	(0.87 – 1.28)	0.5875
Diagnosis era (ref.= 2002–2007)	1997–2001	0.47**	(0.41 – 0.54)	<.0001
	1992–1996	0.20**	(0.17 – 0.23)	<.0001
Historic stage A (ref.= In Situ and localized)	Regional	5.66**	(4.90 – 6.54)	<.0001
	Locally advanced	8.07**	(6.51 – 10.00)	<.0001
	Unknown/Unstaged	3.32**	(2.54 – 4.34)	<.0001
Charlson comorbidity index (ref.= 0)	1+	0.93	(0.83 – 1.04)	0.2035
Sex (ref.= Male)	Female	0.79**	(0.69 – 0.90)	0.0003
Race (ref.= Caucasian American)	Non-Caucasian American	1.09	(0.91 – 1.30)	0.3431
Age at diagnosis		0.94**	(0.93 – 0.94)	<.0001
Marital status (ref.= Married)	Unmarried or Unknown	0.95	(0.84 – 1.08)	0.4296
Dual eligibility for Medicare/Medicaid (ref.= No)	Yes	1.08	(0.92 – 1.28)	0.3375
Percent of high school graduate based on 2000 census data (ref. = Quartile 4: <25%)	Quartile 1: >=75%	1.05	(0.88 – 1.24)	0.5881
	Quartile 2: 50%–<75%	1.06	(0.90 – 1.25)	0.4816
	Quartile 3: 25%–<50%	0.97	(0.83 – 1.14)	0.7398
Cooperative group affiliated		0.99	(0.87 – 1.12)	0.8273
NCI cancer center designated		1.04	(0.74 – 1.47)	0.8162
Medical school affiliation		0.94	(0.82 – 1.06)	0.3107