Original Article

# Comparison of surgical margins and adjuvant therapy for head and neck cancer by hospital type

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**Background:** Differences in patient populations and outcomes by hospital type are becoming increasingly relevant as health care systems shift to value-based care models. There is a paucity of literature on patient-level and hospital-level differences for patients with head and neck squamous cell carcinoma (HNSCC). The objective of this study was to examine differences in patient characteristics, surgical margins, and adjuvant therapy patterns for surgically treated HNSCC across different hospital types.

**Methods:** A statewide retrospective cohort study was conducted to examine differences in surgically treated patients with HNSCC by hospital type.

**Results:** A total of 579 surgically treated HNSCC patients with a mean age of 58.5 [standard deviation (SD) 10.7] years were included. There were 152 patients (26%) treated at academic hospitals, 205 (35%) at community cancer centers, and 222 (38%) at community hospitals. Patients at academic hospitals were more likely to travel farther for surgery (mean distance 43.6 miles for academic centers *vs.* 12.7 miles for community cancer centers *vs.* 12.6 miles for community hospitals; P<0.001) and have advanced T stage (T3–T4) at diagnosis (38% academic, 26% community cancer center, 26% community hospital; P=0.003). There was no significant difference in the positive surgical margin rate by hospital type (32.0% for academic hospitals, 32.1% for community cancer centers, and 35.0% for community hospitals; P=0.79). However, patients at academic hospitals were more likely to receive adjuvant chemoradiation even after adjusting for tumor stage and site [odds ratio (OR) 2.4, 95% confidence interval (CI): 1.2–5.0].

**Conclusions:** There are important patient-level and hospital-level differences for head and neck cancer management in academic versus community hospitals.

**Keywords:** Head and neck neoplasms; margins of excision; hospitals; practice guidelines; quality indicators

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## Introduction

Head and neck squamous cell carcinoma (HNSCC) contributes to a significant burden of disease in the United States, accounting for approximately 66,470 new cases and 15,050 deaths in 2022 (1,2). Prognosis for HNSCC is relatively poor with 5-year overall survival (OS) estimates ranging from 50% to 66% based on large population studies (3,4). Recent studies have found that HNSCC patients treated at teaching hospitals have better OS (5,6) compared to those treated at non-teaching hospitals. Potential mechanisms underlying this association remain speculative, but could include differences in patient characteristics, rate of positive surgical margins, and adjuvant therapy patterns.

Presence of positive surgical margins is an established negative prognostic factor for HNSCC (7-9). Several studies have shown that hospitals with higher surgical volumes have lower rates of positive margins for HNSCC (10,11), which has been attributed to greater surgeon experience. However, there is limited evidence regarding how the positive surgical margin rate for HNSCC may vary by hospital type.

Adherence to national treatment guidelines is another prognostic factor for HNSCC. It has been associated with better survival outcomes across a variety of cancers, including breast (12,13), endometrial (14), colorectal (15), esophageal cancer (16), and HNSCC (17). Studies have found that adherence to the National Comprehensive Cancer Network (NCCN) guidelines for laryngeal cancer is associated with improved survival, lower costs, and reduced treatment morbidity (18-20). Despite this, few studies have compared treatment patterns for HNSCC across different types of hospitals.

As the health care system in the United States continues to adopt value-based care models, it becomes increasingly important to identify modifiable factors at the hospital-level to improve quality of care. Furthermore, it is important to identify potential differences in patient populations between hospitals to help guide fair risk adjustment models. To this end, our aim was to examine differences in patient characteristics, surgical margins, and adjuvant therapy in HNSCC patients receiving surgery at academic and community institutions using the Carolina Head and Neck Cancer Epidemiology (CHANCE) study. We present this article in accordance with the STROBE reporting checklist (available at https://tcr.amegroups.com/article/view/10.21037/tcr-23-2047/rc).

**Highlight box**

**Key findings**

- Patients at academic hospitals traveled significantly farther for surgery and were more likely to have advanced T stage.
- There were no significant differences in the rate of positive surgical margins by hospital type.
- Patients at academic hospitals had significantly higher odds of receiving adjuvant chemoradiation compared to community hospitals.

**What is known and what is new?**

- Facility type is commonly affecting surgical outcomes and treatment selection.
- There are important differences at both the patient and hospital level for head and neck cancer care in academic versus community hospitals.

**What is the implication, and what should change now?**

- These findings can help guide future research, development of value-based care models, and dissemination of treatment guidelines.

## Methods

### *Patient population*

The patient population consisted of participants in CHANCE, a statewide population-based study which identified cases through the North Carolina Central Cancer Registry (21,22). Patients were eligible if they had been diagnosed with a first primary squamous cell carcinoma of the oral cavity, pharynx, or larynx between January 1, 2002, and February 28, 2006, were ages 20 to 80 years at diagnosis, and resided in a 46-county region in central North Carolina. Patient characteristics were assessed and recorded by trained nurse-interviewers using a structured questionnaire during an in-home visit. Clinical information such as tumor site, tumor stage, surgical margin, and treatment were abstracted from participants' medical records and reviewed independently by a pathologist and a head neck cancer surgeon. Tumors were classified by site according to International Classification of Diseases for Oncology, third edition (ICD-O-3) (23). American Joint Committee on Cancer (AJCC) 7$^{th}$ edition staging guidelines were used. p16 immunohistochemistry was performed retrospectively using a previously described protocol (24,25). Surgical margins were determined as positive if at least one of the margins were described as macroscopically or microscopically positive in the pathology report. All CHANCE patients who received primary surgery (n=579) with or without adjuvant therapy were eligible for the present study. The study was conducted in accordance with the Declaration of Helsinki. The Institutional Review Board of the University of North Carolina at Chapel Hill approved this retrospective analysis (Approval ID: 17–1220). All study participants provided written informed consent at the time of enrolling in CHANCE.

### *Treatment center designation*

We categorized surgical treatment centers as academic hospitals, community cancer centers, and community hospitals based on National Cancer Institute (NCI) designations. Veterans Affairs (VA) hospitals affiliated with an academic institution were categorized as academic centers. Hospitals without an NCI designation or academic affiliation were categorized as community hospitals. Of 39 surgical sites, there were a total of 5 academic centers, 9 community cancer centers, and 25 community hospitals.

### *Statistical analysis*

We used chi-square testing to examine baseline associations between all categorical variables. For chi-square testing, we defined both community cancer centers and community hospitals as community hospitals to create a dichotomous variable. We then used univariate and multivariable logistic regression models to estimate the odds ratio (OR) and 95% confidence interval (CI) for the likelihood of having surgery at an academic hospital, having positive surgical margins, and receiving adjuvant therapy with respect to demographic, socioeconomic, and clinical variables. The adjustment set included: age, sex, race, tobacco use, alcohol use, tumor site, T stage, nodal metastases, education, household income, insurance status, and household location. We found no evidence of multicollinearity on variance inflation factor testing, except between military/VA insurance and academic hospitals. To address this, we excluded military/VA insurance from the logistic regression models containing collinear variables. We stratified the surgical margin analysis by overall stage because stage is a known confounder. We used a significance level of P<0.05 for all testing. We used STATA 16.0 software (Stata Corporation, College Station, TX, USA) for all analyses.

## Results

### *Baseline characteristics*

There were 579 patients with HNSCC that met the inclusion criteria for this study, with a mean age of 58.5 years (SD 10.7). Seventy-six percent of patients were white and approximately three quarters (72%) were male. Within the sample, 255 patients had oral cavity cancer (44%), 170 had laryngeal cancer (29%), 144 had oropharyngeal cancer (25%), and 10 had hypopharyngeal cancer (2%). A total of 408 patients had stage T1 to T2 cancer (70.5%) and 171 patients had stage T3 to T4 cancer at diagnosis (29.5%). All patients received primary surgical treatment and an additional 323 of patients received adjuvant therapy with radiation (aRT) or chemoradiation (aCRT) (56.0%).

We compared patient demographics, tumor characteristics, and treatment for academic versus community hospitals (*Table 1*). There were 152 patients treated at academic hospitals (26%), 205 at community cancer centers (35%), and 222 at community hospitals (38%). There were no significant differences in age, sex, race, tobacco use, alcohol use, tumor site, or nodal metastases by facility type. Patients receiving surgery at academic hospitals were more likely to have advanced T stage (T3–T4) at diagnosis compared to patients at community hospitals (38% academic, 26% community cancer center, 26% community hospital; P=0.003). Patients receiving surgery at academic hospitals were also more likely to receive aCRT compared to patients at community hospitals (29% academic, 15% community cancer center, 15% community hospital; P<0.001). Patients at academic hospitals were less likely to have p16-positive tumors (27% of patients at academic hospitals *vs.* 46% and 38% of patients at community cancer centers and community hospitals were p16-positive, respectively; P=0.02).

In a comparison of patient socioeconomic status across hospital types, we found no significant differences in level of education, household income, or not having health insurance (*Table 2*). Patients receiving surgery at academic hospitals were more likely to have VA/military insurance (P=0.002) and less likely to have private insurance (P=0.001) than patients at community hospitals. There were no significant differences in metropolitan *vs.* rural household location by hospital type, but patients treated at academic hospitals were more likely to travel at least 25 miles to get surgery (60% academic hospital, 14% community cancer center, 16% community hospital; P<0.001). The mean

 

**Table 1** Demographic and tumor characteristics by hospital type

| Variables | Academic Hospital (n=152) | Community Cancer Center (n=205) | Community Hospital (n=222) | P value* |
|---|---|---|---|---|
| Age (years) | | | | 0.71 |
| <50 (n=136) | 35 (23%) | 44 (21%) | 57 (26%) | |
| 50–65 (n=270) | 75 (49%) | 100 (49%) | 95 (43%) | |
| >65 (n=173) | 42 (28%) | 61 (30%) | 70 (32%) | |
| Sex | | | | 0.67 |
| Male (n=419) | 112 (74%) | 151 (74%) | 156 (70%) | |
| Female (n=160) | 40 (26%) | 54 (26%) | 66 (30%) | |
| Race | | | | 0.47 |
| White (n=441) | 119 (78%) | 154 (75%) | 168 (76%) | |
| Black (n=138) | 33 (22%) | 51 (25%) | 54 (24%) | |
| Smoking status | | | | 0.66 |
| ≤10 years (n=141) | 35 (23%) | 56 (27%) | 50 (23%) | |
| >10 years (n=438) | 117 (77%) | 149 (73%) | 172 (77%) | |
| Alcohol use | | | | 0.18 |
| ≤1 drink/week (n=98) | 31 (20%) | 33 (16%) | 34 (15%) | |
| >1 drink/week (n=481) | 121 (80%) | 172 (84%) | 188 (85%) | |
| p16 status | | | | 0.02 |
| Negative (n=178) | 52 (73%) | 52 (54%) | 74 (62%) | |
| Positive (n=110) | 19 (27%) | 45 (46%) | 46 (38%) | |
| Site | | | | 0.35 |
| Hypopharynx (n=10) | 2 (1%) | 2 (1%) | 6 (3%) | |
| Larynx (n=170) | 49 (32%) | 47 (23%) | 74 (33%) | |
| Oral cavity (n=255) | 71 (47%) | 100 (49%) | 84 (38%) | |
| Oropharynx (n=144) | 30 (20%) | 56 (27%) | 58 (26%) | |
| T stage | | | | 0.003** |
| T1 (n=218) | 48 (32%) | 83 (40%) | 87 (39%) | |
| T2 (n=190) | 45 (30%) | 69 (34%) | 76 (34%) | |
| T3 (n=74) | 22 (14%) | 29 (14%) | 23 (10%) | |
| T4 (n=97) | 37 (24%) | 24 (12%) | 36 (16%) | |
| N stage | | | | 0.11*** |
| N0 (n=337) | 80 (53%) | 118 (58%) | 139 (63%) | |
| N1 (n=83) | 22 (14%) | 33 (16%) | 28 (13%) | |
| N2 (n=142) | 41 (27%) | 50 (24%) | 51 (23%) | |
| N3 (n=17) | 9 (6%) | 4 (2%) | 4 (2%) | |

**Table 1** *(continued)*

**Table 1** *(continued)*

| Variables | Academic Hospital (n=152) | Community Cancer Center (n=205) | Community Hospital (n=222) | P value* |
|---|---|---|---|---|
| Treatment category | | | | <0.001 |
| Surgery only (n=255) | 60 (39%) | 99 (48%) | 96 (43%) | |
| Surgery + chemoradiation (n=107) | 44 (29%) | 30 (15%) | 33 (15%) | |
| Surgery + radiation (n=216) | 47 (31%) | 76 (37%) | 93 (42%) | |

*, P value for comparison of academic hospitals *vs.* non-academic hospitals (community hospitals and community cancer centers); **, P value for early *vs.* advanced T stage; ***, P value for presence *vs.* absence of nodal metastasis.

**Table 2** Patient socioeconomic characteristics by hospital type

| Variables | Academic Hospital (n=152) | Community Cancer Center (n=205) | Community Hospital (n=222) | P value* |
|---|---|---|---|---|
| Education | | | | 0.92 |
| Less than high school (n=187) | 51 (34%) | 63 (31%) | 73 (33%) | |
| High school grad (n=162) | 41 (27%) | 51 (25%) | 70 (32%) | |
| Greater than high School (n=230) | 60 (39%) | 91 (44%) | 79 (36%) | |
| Income | | | | 0.39 |
| Income >$50,000 (n=181) | 41 (27%) | 78 (38%) | 62 (28%) | |
| Income $20,000–$50,000 (n=192) | 55 (36%) | 58 (28%) | 79 (36%) | |
| Income <$20,000 (n=206) | 56 (37%) | 69 (34%) | 81 (36%) | |
| Health insurance type | | | | |
| Medicare (part A or B) (n=215) | 59 (39%) | 71 (35%) | 85 (38%) | 0.62 |
| TRICARE (n=37) | 14 (9%) | 15 (7%) | 8 (4%) | 0.10 |
| Military/VA (n=30) | 15 (10%) | 7 (3%) | 8 (4%) | 0.002 |
| Medicaid (n=88) | 28 (18%) | 29 (14%) | 31 (14%) | 0.20 |
| Private (n=302) | 62 (41%) | 110 (54%) | 130 (59%) | 0.001 |
| Unknown (n=2) | 0 (0%) | 1 (0.5%) | 1 (0.5%) | 0.40 |
| Uninsured (n=62) | 19 (12%) | 23 (11%) | 20 (9%) | |
| Area of residence | | | | 0.08** |
| Metropolitan area (n=442) | 103 (75%) | 172 (86%) | 167 (78%) | |
| Micropolitan area (10,000–49,999) (n=79) | 23 (17%) | 18 (9%) | 38 (18%) | |
| Rural or small town (<10,000) (n=29) | 11 (8%) | 9 (5%) | 9 (4%) | |
| Distance traveled to reach surgery (miles) | | | | <0.001 |
| 0–5 (n=157) | 13 (9%) | 66 (33%) | 78 (36%) | |
| >5–10 (n=112) | 5 (4%) | 47 (24%) | 60 (28%) | |
| >10–25 (n=137) | 37 (27%) | 59 (30%) | 41 (19%) | |
| >25 (n=144) | 82 (60%) | 27 (14%) | 35 (16%) | |

*, P value for comparison of academic hospitals *vs.* non-academic hospitals (community hospitals and community cancer centers); **, P value for metropolitan area *vs.* less populated area. VA, Veterans Affairs.

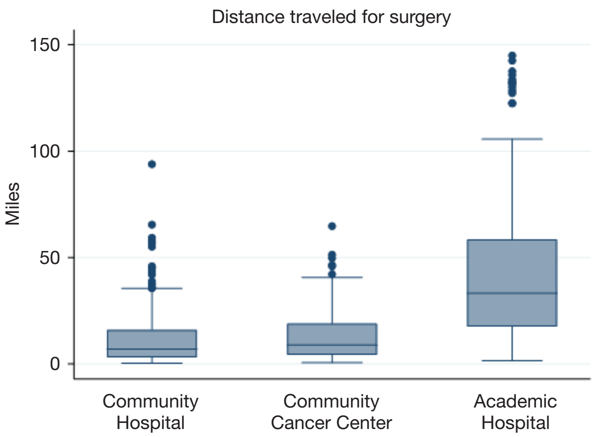


**Figure 1** Distance travelled for surgery (miles), by facility type.

distances traveled for surgery were 43.6 miles for academic hospitals, 12.7 miles for community cancer centers, and 12.6 miles for community hospitals (*Figure 1*).

### *Factors associated with receiving surgery at an academic hospital*

We used univariate and multivariable logistic regression models to assess patient characteristics that may be associated with receiving surgery at an academic versus community hospital (*Table 3*). In the univariate analysis, advanced T stage at diagnosis (OR 1.8, 95% CI: 1.2–2.6) and VA/military insurance (OR 3.0, 95% CI: 1.4–6.3) were significantly associated with receiving surgery at an academic hospital. Patients with p16-positive oropharyngeal cancer (OR 0.4, 95% CI: 0.2–0.9) and patients with private insurance (OR 0.5, 95% CI: 0.4–0.8) were significantly less likely to receive surgery at an academic hospital.

In the fully adjusted multivariable analysis, patients with advanced T stage at diagnosis (OR 2.2, 95% CI: 1.3–3.6), nodal metastases (OR 1.7, 95% CI: 1.1–2.8), and military/VA health insurance (OR 3.6, 95% CI: 1.5–8.6) were more likely to have surgery at an academic hospital (*Table 3*). Patients who were older than 65 (OR 0.4, 95% CI: 0.1–0.9), identified as black race (OR 0.6, 95% CI: 0.3–1.0; P=0.043), had p16-positive oropharyngeal cancer (OR 0.4, 95% CI: 0.2–1.0; P=0.04), and had private insurance (OR 0.3, 95% CI: 0.2–0.7) were less likely to have surgery at an academic hospital.

### *Positive surgical margins*

We next examined the rate of positive surgical margins by facility type and used logistic regression models to examine for variables associated with positive surgical margins (*Table 4*). There were no significant differences in the positive surgical margin rates of academic and community hospitals (32.0% for academic hospitals, 32.1% for community cancer centers, and 35.0% for community hospitals; P=0.79). In a subset analysis stratified by surgical volume, hospitals in the top third by volume had a lower rate of positive margins (28.8%) compared to middle third (36.8%) and bottom third (34.4%), although this effect did not reach statistical significance (P=0.48).

In the unadjusted analysis, neither academic hospitals (OR 0.9, 95% CI: 0.6–1.4) nor community cancer centers (OR 0.9, 95% CI: 0.6–1.3) were associated with positive surgical margins relative to community hospitals (*Table 4*). The only significant association of positive margin status in the fully adjusted model was p16-positive oropharyngeal cancer (OR 2.4, 95% CI: 1.2–4.7). Patients with advanced T-stage (OR 0.6, 95% CI: 0.4–1.0; P=0.043), oral cavity cancer (OR 0.3, 95% CI: 0.2–0.5), and female sex (OR 0.5, 95% CI: 0.3–0.8) were significantly less likely to have positive margins when adjusting for in the fully adjusted model. The fully adjusted model included age, sex, race, tobacco use, alcohol use, tumor site, T stage, nodal metastases, education, household income, insurance status, and facility type.

We performed a secondary analysis to assess the association between facility type and positive margin status when stratified by early (I or II) and advanced (III or IV) overall stage. Among early-stage patients, neither academic hospitals (OR 0.7, 95% CI: 0.3–1.4) nor community cancer centers (OR 0.7, 95% CI: 0.4–1.2) were associated with positive surgical margins relative to community hospitals. Among advanced stage patients, neither academic hospitals (OR 1.1, 95% CI: 0.6–2.0) nor community cancer centers (OR 1.2, 95% CI: 0.7–2.0) were associated with positive surgical margins relative to community hospitals.

### *Adjuvant therapy patterns*

We next used logistic regression models to examine associations of (I) aRT after surgery relative to no adjuvant therapy and (II) aCRT after surgery relative to single-modality adjuvant therapy (*Tables 5,6*).

In the unadjusted analysis for odds of aRT after surgery relative to no adjuvant therapy, there was no association with hospital type (P=0.47 and P=0.30 for academic hospitals and community cancer centers, respectively)

 

**Table 3** Logistic regression model for odds of surgery at an academic hospital

| Variables | Unadjusted model | | | Adjusted for tumor characteristics | | | Adjusted for tumor and patient characteristics | | |
|---|---|---|---|---|---|---|---|---|---|
| | OR | 95% CI | P | OR | 95% CI | P | OR | 95% CI | P |
| Advanced T stage | 1.8 | 1.2–2.6 | 0.004 | 1.5 | 1.0–2.3 | 0.048 | 2.2 | 1.3–3.6 | 0.002 |
| Nodal metastasis | 1.4 | 0.9–2.0 | 0.11 | 1.4 | 1.0–2.2 | 0.084 | 1.7 | 1.1–2.8 | 0.03 |
| Site (relative to larynx/hypopharynx) | | | | | | | | | |
| Oral cavity | 1.0 | 0.6–1.5 | 0.91 | 1.1 | 0.7–1.6 | 0.805 | 1.1 | 0.7–1.8 | 0.70 |
| Oropharynx (p16–) | 0.9 | 0.5–1.7 | 0.83 | 0.9 | 0.5–1.7 | 0.740 | 1.0 | 0.5–2.0 | 0.94 |
| Oropharynx (p16+) | 0.4 | 0.2–0.9 | 0.02 | 0.4 | 0.2–0.9 | 0.024 | 0.4 | 0.2–1.0 | 0.04 |
| Black (*vs.* white) | 0.9 | 0.5–1.3 | 0.48 | | | | 0.6 | 0.3–1.0 | 0.043 |
| Age category (relative to <50 years) | | | | | | | | | |
| 50–65 | 1.1 | 0.7–1.8 | 0.66 | | | | 1.0 | 0.6–1.7 | 0.99 |
| >65 | 0.9 | 0.6–1.6 | 0.77 | | | | 0.4 | 0.1–0.9 | 0.03 |
| Female sex (relative to male) | 0.9 | 0.6–1.4 | 0.67 | | | | 0.9 | 0.5–1.5 | 0.66 |
| Smoking (>10 pack-years) | 1.1 | 0.7–1.7 | 0.66 | | | | 1.0 | 0.6–1.7 | 0.92 |
| Alcohol use (>1 drink/week) | 0.7 | 0.5–1.2 | 0.19 | | | | 0.5 | 0.3–1.0 | 0.051 |
| Education (relative to less than high school) | | | | | | | | | |
| High school graduate | 0.9 | 0.6–1.5 | 0.68 | | | | 0.9 | 0.5–1.7 | 0.85 |
| Additional education past high school | 0.9 | 0.6–1.5 | 0.79 | | | | 1.0 | 0.5–1.7 | 0.88 |
| Household location (relative to metropolitan area) | | | | | | | | | |
| Micropolitan area | 1.4 | 0.8–2.3 | 0.27 | | | | 1.5 | 0.8–2.7 | 0.17 |
| Rural area | 2 | 0.9–4.4 | 0.08 | | | | 2.1 | 0.9–4.8 | 0.10 |
| Health insurance (relative to other types) | | | | | | | | | |
| Medicare | 1.1 | 0.8–1.6 | 0.62 | | | | 1.7 | 0.7–3.7 | 0.22 |
| TRICARE | 1.8 | 0.9–3.6 | 0.10 | | | | 1.9 | 0.8–4.3 | 0.13 |
| Military health care/VA | 3 | 1.4–6.3 | 0.004 | | | | 3.6 | 1.5–8.6 | 0.003 |
| Medicaid | 1.4 | 0.8–2.3 | 0.20 | | | | 1.2 | 0.5–2.5 | 0.72 |
| Private | 0.5 | 0.4–0.8 | 0.001 | | | | 0.3 | 0.2–0.7 | 0.002 |
| No insurance | 0.8 | 0.4–1.4 | 0.41 | | | | 1.0 | 0.4–2.4 | 0.95 |
| Income (relative to >50,000) | | | | | | | | | |
| $20,000–$50,000 | 1.4 | 0.9–2.2 | 0.19 | | | | 1.3 | 0.7–2.3 | 0.35 |
| <$20,000 | 1.3 | 0.8–2.0 | 0.31 | | | | 0.5 | 0.3–1.2 | 0.13 |

OR, odds ratio; CI, confidence interval; VA, Veterans Affairs.

(*Table 5*). In the fully adjusted model, advanced T stage (OR 1.9, 95% CI: 1.2–3.1), nodal metastases (OR 8.7, 95% CI: 5.4–14.2), and p16-positive oropharyngeal cancer (OR 2.7, 95% CI: 1.0–7.1; P=0.042) were significantly associated with receiving aRT after surgery. In contrast, oral cavity tumor site was associated with lower odds of receiving aRT after surgery (OR 0.2, 95% CI: 0.1–0.4).

In the unadjusted analysis for (II) odds of aCRT after

 

**Table 4** Logistic regression model for variable associations with positive surgical margins

| Variables | Unadjusted model | | | Adjusted for tumor characteristics | | | Adjusted for tumor and patient characteristics | | |
|---|---|---|---|---|---|---|---|---|---|
| | OR | 95% CI | P | OR | 95% CI | P | OR | 95% CI | P |
| Hospital type (relative to community hospital) | | | | | | | | | |
| Community Cancer Center | 0.9 | 0.6–1.3 | 0.55 | 1.0 | 0.6–1.6 | 0.96 | 1.0 | 0.6–1.6 | 0.98 |
| Academic Hospital | 0.9 | 0.6–1.4 | 0.56 | 1.1 | 0.7–1.7 | 0.75 | 1.1 | 0.7–1.8 | 0.76 |
| Advanced T stage | | | | 0.6 | 0.4–1.0 | 0.043 | 0.6 | 0.4–1.0 | 0.043 |
| Nodal metastasis | | | | 0.9 | 0.6–1.4 | 0.71 | 0.9 | 0.6–1.4 | 0.65 |
| Site (Relative to larynx/hypopharynx) | | | | | | | | | |
| Oral cavity | | | | 0.3 | 0.2–0.5 | <0.001 | 0.3 | 0.2–0.5 | <0.001 |
| Oropharynx (p16–) | | | | 0.8 | 0.4–1.4 | 0.37 | 0.8 | 0.4–1.5 | 0.50 |
| Oropharynx (p16+) | | | | 2.1 | 1.1–4.0 | 0.02 | 2.4 | 1.2–4.7 | 0.02 |
| Black (*vs.* white) | | | | | | | 1.1 | 0.6–1.8 | 0.83 |
| Age category (relative to <50 years) | | | | | | | | | |
| 50–65 | | | | | | | 0.9 | 0.5–1.5 | 0.70 |
| >65 | | | | | | | 1.1 | 0.5–2.6 | 0.81 |
| Female sex (relative to male) | | | | | | | 0.5 | 0.3–0.8 | 0.008 |
| Smoking (>10 pack-years) | | | | | | | 1.0 | 0.6–1.7 | 0.98 |
| Alcohol use (>1 drink/week) | | | | | | | 0.8 | 0.4–1.5 | 0.49 |
| Education (relative to less than high school) | | | | | | | | | |
| High school graduate | | | | | | | 0.9 | 0.6–1.6 | 0.82 |
| Additional education past high school | | | | | | | 0.8 | 0.5–1.3 | 0.31 |
| Health insurance (relative to other types) | | | | | | | | | |
| Medicare | | | | | | | 1.2 | 0.6–2.6 | 0.63 |
| TRICARE | | | | | | | 1.1 | 0.5–2.6 | 0.78 |
| Medicaid | | | | | | | 0.9 | 0.5–1.9 | 0.86 |
| Private | | | | | | | 1.1 | 0.6–2.1 | 0.69 |
| No insurance | | | | | | | 0.9 | 0.4–2.2 | 0.85 |
| Income (relative to >50 K) | | | | | | | | | |
| $20,000–$50,000 | | | | | | | 1.1 | 0.7–1.9 | 0.70 |
| <$20,000 | | | | | | | 1.0 | 0.5–2.0 | 0.99 |

OR, odds ratio; CI, confidence interval.

surgery relative to single-modality aRT alone, there was a significantly higher odds with academic hospital affiliation (OR 2.6, 95% CI: 1.5–4.6) (*Table 6*). This effect persisted for academic hospitals when adjusting for T stage, nodal metastases, and tumor site (OR 2.7, 95% CI: 1.4–5.1). In the fully adjusted model, academic hospital affiliation (OR 2.4, 95% CI: 1.2–5.0), advanced T stage, nodal metastases, and any tumor site relative to the larynx/hypopharynx were

**Table 5** Logistic regression model for variable associations with adjuvant therapy following surgery relative to no adjuvant therapy

| Variables | Unadjusted model | | | Adjusted for tumor characteristic | | | Adjusted for tumor and patient characteristics | | |
|---|---|---|---|---|---|---|---|---|---|
| | OR | 95% CI | P | OR | 95% CI | P | OR | 95% CI | P |
| Hospital type (relative to community hospital) | | | | | | | | | |
| Community Cancer Center | 0.8 | 0.6–1.2 | 0.30 | 0.8 | 0.5–1.3 | 0.32 | 0.8 | 0.5–1.3 | 0.42 |
| Academic Hospital | 1.2 | 0.8–1.8 | 0.47 | 1.1 | 0.7–1.9 | 0.62 | 1.2 | 0.7–2.0 | 0.52 |
| Advanced T stage | | | | 1.8 | 1.1–2.8 | 0.02 | 1.9 | 1.2–3.1 | 0.008 |
| Nodal metastasis | | | | 8.3 | 5.2–13.2 | <0.001 | 8.7 | 5.4–14.2 | <0.001 |
| Site (relative to larynx/hypopharynx) | | | | | | | | | |
| Oral cavity | | | | 0.2 | 0.1–0.4 | <0.001 | 0.2 | 0.1–0.4 | <0.001 |
| Oropharynx (p16–) | | | | 0.5 | 0.3–1.0 | 0.052 | 0.5 | 0.2–1.0 | 0.054 |
| Oropharynx (p16+) | | | | 2.5 | 1.0–6.3 | 0.05 | 2.7 | 1.0–7.1 | 0.042 |
| Black (*vs.* white) | | | | | | | 1.4 | 0.8–2.5 | 0.20 |
| Age category (relative to <50 years) | | | | | | | | | |
| 50–65 | | | | | | | 1.1 | 0.6–1.9 | 0.74 |
| >65 | | | | | | | 0.9 | 0.3–2.1 | 0.73 |
| Female sex (relative to male) | | | | | | | 1.0 | 0.6–1.7 | 0.88 |
| Smoking (>10 pack-years) | | | | | | | 1.3 | 0.7–2.2 | 0.41 |
| Alcohol use (>1 drink/week) | | | | | | | 0.7 | 0.3–1.2 | 0.20 |
| Education (relative to less than high school) | | | | | | | 1.1 | 0.7–2.0 | 0.65 |
| High school graduate | | | | | | | 1.2 | 0.7–2.2 | 0.45 |
| Additional education past high school | | | | | | | | | |
| Health insurance (relative to other types) | | | | | | | | | |
| Medicare | | | | | | | 1.4 | 0.6–3.2 | 0.38 |
| TRICARE | | | | | | | 0.9 | 0.4–2.1 | 0.74 |
| Medicaid | | | | | | | 0.8 | 0.4–1.8 | 0.68 |
| Private | | | | | | | 1.6 | 0.8–3.1 | 0.17 |
| No insurance | | | | | | | 0.9 | 0.3–2.2 | 0.78 |
| Income (relative to >50 K) | | | | | | | 0.9 | 0.5–1.7 | 0.87 |
| $20,000–$50,000 | | | | | | | 1.9 | 1.1–3.3 | 0.03 |
| <$20,000 | | | | | | | 1.7 | 0.8–3.7 | 0.15 |

significantly associated with higher odds of aCRT after surgery (*Table 6* and *Figure 2*).

## Discussion

Our study highlights several important patient-level and hospital-level differences for HNSCC surgery at academic and community hospitals. First, academic hospitals had a significantly higher proportion of surgical HNSCC patients with advanced stage cancer. Second, HNSCC patients receiving surgery at academic hospitals traveled significantly farther distances for surgery compared to patients at

**Table 6** Logistic regression model for variable associations of adjuvant chemoradiation therapy following surgery relative to single-modality adjuvant therapy

| Variables | Unadjusted model | | | Adjusted for tumor characteristic | | | Adjusted for tumor and patient characteristics | | |
|---|---|---|---|---|---|---|---|---|---|
| | OR | 95% CI | P | OR | 95% CI | P | OR | 95% CI | P |
| Hospital type (relative to community hospital) | | | | | | | | | |
| Community Cancer Center | 1.1 | 0.6–2.0 | 0.72 | 0.9 | 0.4–1.6 | 0.64 | 0.8 | 0.4–1.6 | 0.53 |
| Academic Hospital | 2.6 | 1.5–4.6 | 0.001 | 2.7 | 1.4–5.1 | 0.004 | 2.4 | 1.2–5.0 | 0.02 |
| Advanced T stage | | | | 2.2 | 1.2–4.1 | 0.01 | 2.0 | 1.1–3.9 | 0.03 |
| Nodal metastasis | | | | 3.6 | 1.9–6.9 | 0.000 | 3.7 | 1.9–7.4 | <0.001 |
| Site (relative to larynx/hypopharynx) | | | | | | | | | |
| Oral cavity | | | | 2.9 | 1.4–6.2 | 0.005 | 2.9 | 1.3–6.2 | 0.009 |
| Oropharynx (p16–) | | | | 7.5 | 3.1–18.4 | <0.001 | 7.6 | 3.0–19.4 | <0.001 |
| Oropharynx (p16+) | | | | 8.8 | 3.6–21.3 | <0.001 | 6.4 | 2.5–16.6 | <0.001 |
| Black (*vs.* white) | | | | | | | 0.5 | 0.2–1.1 | 0.11 |
| Age category (relative to <50 years) | | | | | | | | | |
| 50–65 | | | | | | | 0.7 | 0.4–1.4 | 0.28 |
| >65 | | | | | | | 0.8 | 0.2–2.8 | 0.68 |
| Female sex (relative to male) | | | | | | | 0.7 | 0.3–1.3 | 0.25 |
| Smoking (>10 pack-years) | | | | | | | 1.0 | 0.5–2.0 | 0.95 |
| Alcohol use (>1 drink/week) | | | | | | | 0.7 | 0.3–1.8 | 0.51 |
| Education (relative to less than high school) | | | | | | | | | |
| High school graduate | | | | | | | 1.3 | 0.6–2.7 | 0.54 |
| Additional education past high school | | | | | | | 1.1 | 0.5–2.5 | 0.75 |
| Health insurance (relative to other types) | | | | | | | | | |
| Medicare | | | | | | | 0.7 | 0.2–2.2 | 0.58 |
| TRICARE | | | | | | | 1.5 | 0.4–5.4 | 0.57 |
| Medicaid | | | | | | | 0.7 | 0.2–2.3 | 0.61 |
| Private | | | | | | | 1.3 | 0.5–3.5 | 0.59 |
| No insurance | | | | | | | 1.0 | 0.3–3.6 | 0.99 |
| Income (relative to >50,000) | | | | | | | 0.6 | 0.3–1.4 | 0.24 |
| $20,000–$50,000 | | | | | | | 0.7 | 0.3–1.5 | 0.37 |
| <$20,000 | | | | | | | 1.3 | 0.5–3.3 | 0.65 |

OR, odds ratio; CI, confidence interval.

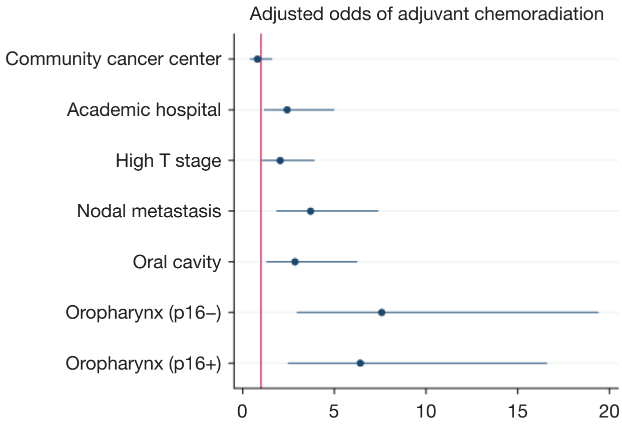


**Figure 2** Adjusted odds ratios for adjuvant chemoradiation.

community hospitals. Third, we found no significant differences in the rate of positive surgical margins between academic and community hospitals. Finally, we found that HNSCC patients treated at academic hospitals were significantly more likely to receive aCRT even after adjusting for tumor site and stage.

These findings are supported by several other studies in current literature. Among radiotherapy recipients with advanced HNSCC, academic centers and facilities with high-volume of cases have been reported to achieve better survival outcomes (26). A recent analysis of the National Cancer Database (NCDB) found that HNSCC patients treated at academic institutions were more likely to live in higher income areas (5). Coupled with our finding that patients treated at academic hospitals travel significantly farther to receive surgery, these data suggest that some patients with the financial means may choose to go to academic hospitals for surgery even if it is less geographically convenient. To our knowledge, this finding has not been previously reported for HNSCC, and there is no evidence in current literature that provides insight into HNSCC patient preferences or expectations regarding hospital type.

Similar to our study, other studies have also reported that that HNSCC patients treated at academic hospitals are more likely to have advanced stage cancer at diagnosis compared to community hospitals (6,27). This may be secondary to referral patterns given the increased capacity for many academic hospitals to care for complex, advanced stage patients with multidisciplinary treatment teams. Since advanced stage at diagnosis a well-established predictor of poor survival in HNSCC, and these patients appear to be over-represented at academic hospitals, cancer stage an important variable to adjust for in any value-based payment models.

Our finding that the rate of positive surgical margins did not differ by hospital type is an important negative result. Other studies using the NCDB have found that high-volume facilities and academic hospitals are more likely to have lower rates of positive surgical margins for HNSCC (11,28). The discrepancy between these findings highlights the importance of hospital-level data, which is a unique strength of the CHANCE study. Although academic hospitals may have an overall superior positive margin rate on the national level, this may not translate into significant differences at the state level, which may be a relevant distinction for hospital-level quality metrics. Of note, hospitals in the top third by surgical volume in our sample had a lower rate of positive surgical margins, however this association was not statistically significant. This finding may be driven by a select few of the high-volume, non-academic hospitals in North Carolina.

Finally, it is important to note that HNSCC patients at academic hospitals in our study were significantly more likely to receive aCRT following surgery, even when controlling for tumor stage and site. To our knowledge, there is a limited number of studies that have directly examined adherence to treatment guidelines for cancer management across different types of hospitals. While in other types of cancer superior guideline adherence has been reported at teaching hospitals (29), treatment of oral cavity cancer at academic hospitals has been associated with better adherence to adjuvant chemotherapy when needed, and a greater risk for missing therapy, probably due to increased travel distance for patients (30). In contrast, one NCDB study found that HNSCC patients treated at academic hospitals were less likely to receive postoperative radiation within the recommended 6-week timeframe (31). A different study found that academic hospitals had less delays in starting adjuvant radiation therapy for HNSCC patients and were more likely to administer the full, intended radiation course (32). Our study helps address this gap in literature by identifying important stage-independent treatment differences between academic and community hospitals.

Our study has several unique strengths. The CHANCE study contains patient information collected from in-home interviews that is not routinely available in national cancer registries, such as individual-level socioeconomic status and geographic distance to surgery. It also contains hospital-level data from a state cancer registry with 39 hospitals which allows for unique comparisons by hospital type. Finally, it has complete information on adjuvant treatment patterns by hospital type, which helps fill a significant gap in current literature.

However, there are several limitations to our study as well. The CHANCE study enrolled patients at a time when p16 status was not routinely tested, so we cannot accurately interpret the inverse association we found between p16-positive oropharyngeal cancer and surgery at an academic hospital. However, it is possible that because these tumors are difficult to treat surgically, they may be more likely to receive chemoradiation in the community setting. While the role of HPV is well demonstrated in the oropharynx, its causal association with non-oropharyngeal sites is unclear (33,34). Since p16 testing was available for a limited subset of non-oropharyngeal patients, the p16 variable was only used when analyzing oropharyngeal cancer patients. It is also worth noting that the association between p16-positive oropharyngeal cancer and positive margin status may be skewed by the time period of investigation. Furthermore, variables such as extracapsular extension and depth-of-invasion were not routinely included in pathological reports during the study period, so we were limited to using AJCC 7$^{th}$ edition staging guidelines. In addition, we were unable to directly measure treatment guideline compliance at the time of data collection, so we used stage- and site-adjusted treatment differences as an indirect proxy to estimate potential differences by hospital type. Another limitation of the present study has to do with the initial data collection dates-final CHANCE patients enrolled 17 years ago. Given the significant changes in surgical approaches (e.g., Transoral robotic surgery), systemic therapy and access to healthcare, this cohort is not necessarily reflective of the present. Also, the high degree of heterogeneity of the patient population could limit the practical interpretation of our findings. However, the heterogenous nature of the population could potentially make the study more generalizable to the head and neck cancer population of the United States. Since head and neck cancer patients continue to be treated at a range of hospitals, including many community hospitals with small volumes (and sometimes without fellowship-trained head and neck surgeons), this study may reflect the head and neck cancer population encountered in US hospitals more accurately than head and neck cancer studies that focus on high-volume academic centers. Finally, our study uses a population-based sample restricted to a single state, so it may have limited generalizability to the United States as a whole.

Despite these limitations, we believe that our study provides important information about patient characteristics, positive surgical margin rates, and adjuvant treatment patterns in academic versus community hospitals. These findings can inform future research into HNSCC patient preferences and behaviors, such as traveling farther distances to receive surgery at an academic hospital. They can also help guide research into developing useful quality metrics and risk-adjustment models for value-based care. Finally, they can help inform strategies for the development and dissemination of HNSCC treatment guidelines to the head and neck cancer professional workforce.

## Conclusions

Patients receiving HNSCC surgery at academic hospitals tend to have more advanced cancer stage and travel farther for surgery. The rate of positive surgical margins does not differ by hospital type in this statewide study, but patients treated at academic hospitals were more likely to receive aCRT, independent of tumor site and stage. This study highlights important differences between academic and community hospitals that can be used to guide future research and quality improvement for HNSCC.

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*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki. The Institutional Review Board of the University of North Carolina at Chapel Hill approved this retrospective analysis (Approval ID: 17–1220). All study participants provided written informed consent at the time of enrolling in CHANCE.



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