Patterns of Hospital Utilization for Head and Neck Cancer Care
Changing Demographics

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Importance
The care of patients with head and neck cancer (HNCA) is becoming increasingly regionalized to high-volume, more effective centers. However, it remains uncertain whether such care is equally distributed. Increasing our understanding of how HNCA treatment is utilized among different sectors should improve strategy designs aimed at ensuring optimized quality of care.

Objective
To determine which patient- or treatment-associated factors may account for increased regionalization of HNCA care.

Design, Setting, and Participants
Secondary analysis of all inpatient records of hospital admissions with a primary HNCA diagnosis contained within the Nationwide Inpatient Sample during the calendar years 2000, 2005, and 2010.

Main Outcomes and Measures
Influence of comorbidities, payer, radiation therapy, and case complexity on regionalization of HNCA care to teaching institutions.

Results
In the years 2000, 2005, and 2010, there were an estimated mean (SE) 28,862 (2,067), 33,517 (3,080), and 37,354 (4,194) inpatient hospital HNCA stays, respectively, in the United States. Over time, the respective Charlson comorbidity index (CCI) scores (4.4 and 4.0) and Van Walraven scores (10.0 and 8.9) for nonteaching and teaching institutions were increasingly higher (P < .001). Payer status (private insurance vs Medicaid) did not change for teaching institutions (35.4% vs 33.3%) (P = .63), but the proportion of Medicaid patients did increase over time for nonteaching institutions (10.2% vs 15.8%) (P = .002). Both teaching and nonteaching institutions saw an increase in proportion of prior irradiated cases (7.6% and 4.6% vs 3.4% and 1.9%, respectively) (P < .02). The proportion of major ablative procedures was stable for teaching institutions over time (46.5% vs 43.3%) (P = .57) but decreased for nonteaching institutions (27.2% vs 32.6%) (P = .01). The proportion of flap reconstruction procedures increased over time for teaching institutions (8.6% vs 4.1%) (P < .001) but not for nonteaching institutions (2.7% vs 2.4%) (P = .21).

Conclusions and Relevance
Despite the demonstrated link between excellence and outcomes and specialized resource-intensive care, the regionalization of head and neck oncologic treatment is becoming increasingly divergent, and the neediest, sickest patient groups are receiving less than optimal care.

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In a previous publication, we reported that care of patients with complex cases of head and neck cancer (HNCA) is increasingly being regionalized to academic teaching institutions, with increasingly fewer such cases being treated at nonteaching hospitals. This may be an appropriate transition, if it results in improved care and patient outcomes, but the driving forces for this regionalization remain unclear.

The reasons for the regionalization of HNCA care are manifold and may involve patient factors (eg, patient preferences, increasing patient comorbidities where complexities such as prior radiation therapy require tertiary care), institutional factors (eg, decreasing or limited services offered at nonteaching institutions), and payer factors (eg, regionalization occurring along the lines of private pay vs Medicaid payer status), among others. Furthermore, there may be a selective shift in HNCA case distribution with only more complex head and neck procedures being performed at teaching hospitals while less complex procedures are shifted to nonteaching hospitals. All of these factors may evolve over time, adding an additional time component variable.

To clarify this issue, we further examined a national, all-payer, inpatient hospital database to ascertain the potential influence of several of these factors on HNCA care regionalization.

**Methods**

This study was reviewed by the institutional review boards of Harvard Medical School and David Geffen School of Medicine, University of California, and deemed exempt from review; participant written informed consent was also waived.

**Data Extraction**

We reanalyzed the Nationwide Inpatient Sample (NIS) for the calendar years 2000, 2005, and 2010. For each of these calendar years, records of all admissions with a primary diagnosis of HNCA were extracted according to the diagnosis clinical classification software code for head neck cancer (group 11, “cancer of the head and neck”). Admissions could be for surgical and/or nonsurgical services. The data were then imported into SPSS software, version 22.0 (IBM Corporation) for analysis. For each admission, extracted data included *International Classification of Diseases, Ninth Revision (ICD-9)* codes, hospital number of beds, hospital teaching status, and primary expected payer for the hospital stay. In the NIS, the primary expected payer field options are Medicare, Medicaid, private insurance, or other. The data were then sequentially analyzed. Statistical comparisons were conducted with a general linear model for point score variables and with $\chi^2$ for proportional variables; statistical significance was set at $P = .05$. The complex samples procedures in SPSS were used to incorporate stratification and clustering and weighting parameters contained within the NIS.

**Hypothesis Testing**

Several hypotheses regarding the causes of regionalization of HNCA care were tested using the NIS data: (1) increasing patient comorbidities over time, causing a shift in care to teaching institutions that would theoretically be better equipped to handle such increased comorbidities; (2) shifting of payer status; (3) increased proportion of prior radiation therapy; and (4) a higher fraction of more complex procedures being referred and performed at teaching institutions.

The first hypothesis concerned whether regionalization of HNCA care was owing to increasing patient comorbidities over time, causing a shift in care to teaching institutions that would theoretically be better equipped to handle such increased comorbidities. This was tested by examining and comparing comorbidity scores between cases treated by teaching and nonteaching institutions over time (2005-2010) as follows: 2 comorbidity measures were calculated for each patient with HNCA: the D’Hoore modification of the Charlson comorbidity index (CCI) and the van Walraven point score for the Elixhauser comorbidity index. The comorbidity scores were graphically compared for teaching vs nonteaching institutions for 2000, 2005, and 2010. The difference in comorbidity scores between teaching and nonteaching institutions was statistically compared for 2010, the year in which the greatest percentage shift of HNCA admissions to teaching institutions was evident.

The second hypothesis posited that regionalization of HNCA care was owing to shifting of payer status. This hypothesis was tested by examining and comparing trends in the proportions of the different payers (private insurance, Medicare, Medicaid, and other) for HNCA admissions to teaching and nonteaching institutions over time (2000-2010).

Next, we examined whether the regionalization of HNCA care was possibly owing to an increased proportion of prior radiation therapy. We examined the proportion of admissions with a history of radiation therapy as determined by the presence of the *ICD-9* code V153 (“history radiation therapy”) among the extracted diagnosis codes. The proportion of admissions with prior radiation therapy was compared over time for teaching and nonteaching institutions.
Finally, we examined the hypothesis that regionalization of HNCA care was owing to a higher fraction of more complex procedures being referred and performed at teaching institutions. All HNCA admissions were examined according to procedure codes 1 through 15. If the admission included 1 of the ablative procedures as listed in Table 1, the admission was categorized as a major ablative procedure admission. If the admission included any of the flap reconstruction codes as listed in Table 1, the admission was categorized as having a major flap reconstruction procedure. The proportion of cases undergoing a major head and neck ablative procedure and the proportion of cases undergoing a major flap reconstructive procedure were compared between teaching and nonteaching institutions over time.

Results
There were an estimated mean (SE) 28,862 (2,067), 33,517 (3,080), and 37,354 (4,194) inpatient hospital HNCA stays in the United States in 2000, 2005, and 2010, respectively (unweighted N [raw sample size], 5,869, 6,759 and 7,371, respectively). Figure 1 presents the relative distribution of inpatient admissions over the 3 sampled calendar years according to hospital teaching status.

Hypothesis 1
Figure 2 and presents the CCI scores and van Walraven point scores for admissions to teaching and nonteaching institutions for each of the sampled years. Over time, the relative comorbidity scores actually were higher for nonteaching institutions. The difference in mean (SE) CCI scores ultimately in 2010 for teaching institutions (4.04 [0.05]) vs nonteaching institutions (4.36 [0.08]) was statistically significant (P = .001). Similarly, the difference in van Walraven morbidity point score for teaching institutions (CCI, 8.86 [0.19]) vs nonteaching institutions (10.01 [0.19]) was statistically significant (P < .001). Thus, by 2010, nonteaching institutions actually had slightly higher mean comorbidity scores than teaching institutions for their inpatient admissions.

Discussion
This study reveals several key factors about the demographics of HNCA treatment. During the review period, inpatient admissions for HNCA increased by nearly 30%. This may, in part, be attributable to the increase in the population aged 55 to 64 years (baby boomers) by 47.3% and the 13.5% increase in the population 65 years or older. This increase also reflects the rise of human papillomavirus–related HNCA. It is likely that this rate will continue to rise as the population further ages.4,5

Over time, patients admitted with HNCA at nonteaching institutions had slightly but significantly higher comorbidity scores than those admitted to academic institutions.
This is somewhat surprising because it would be expected that academic institutions, with more experienced, focused teams of specialists, would attract sicker patients. One possible explanation for this seemingly contradictory trend is that sicker patients with higher comorbidity scores are unable to be regionalized because they are in fact “too sick” or unwilling to travel to a regional teaching medical center. Given the potential relative mismatch between likely available resources to care for patients with higher comorbidity scores at teaching institutions and academic centers, and this observed trend toward higher comorbidity scores in nonteaching institutions, a rigorous surveillance of outcomes, particularly in nonteaching institutions, must be maintained. Clinical outcomes are demonstrably affected by complex interactions between patient comorbidities and the teaching status of the hospital where care is given. For example, for patients with HNCA, Genther and Gourin have reported that safety-net hospitals, which are more likely to be teaching facilities, treat patients with advanced comorbidities requiring more extensive procedures. Despite this, no association between safety-net status and hospital mortality was observed. However, if care is rendered at low-volume hospitals, which generally are nonteaching facilities, worse outcomes are seen. This is also true for complex cancer operations of the esophagus, lung, and pancreas.

In examining the influence of comorbidity index per se, researchers have found that higher indices are associated with higher rates of hospitalization and in-hospital deaths for several types of tumors, including breast carcinoma and several types of HNCA. Habbous et al found that increased comorbidity scores were independently associated with poorer overall survival in oropharyngeal, nasopharyngeal, and early-stage laryngeal cancers. They suggest that comorbidity scores may be a partial surrogate measure for age and social habits, since higher scores were associated with increasing age, smoking, and drinking patterns. They further suggest that, at least for laryngeal and oral cancers, comorbidity index scores should be considered as part of the TNM staging system to design proper treatment. In contrast, for oropharyngeal tumors, such scores may not be uniformly predictive due to biologic (human papillomavirus status) or environmental factors.

In a study from Denmark, remarkable for its analysis of a relatively closed medical system where there is a high degree of treatment uniformity, Boje et al found that comorbidity had a negative impact on survival in HNCA, imparting significantly higher overall but not cancer-specific mortality rates.

Thus, based on our data and those of others, nonteaching hospitals may be expected to shoulder an increasing burden of sicker patients who come for treatment, and with that increasing burden they may observe worse inpatient clinical outcomes than high-volume academic institutions. This underscores the early and prescient observation of Piccirillo that comorbidity per se is likely an important prognostic indicator in HNCA care outcomes.

As summarized in Table 3, in concert with higher comorbidity index scores in patients admitted to nonteaching hospitals, several factors are associated with regionalization of HNCA treatment. These factors include payer status, prior radiation therapy, and procedural complexity. The table shows the percentage of admissions and standard errors for 2000, 2005, and 2010, along with the p-values for the comparison between years.

### Table 2. Factors in Teaching Institutions Potentially Associated With Regionalization of HNCA Treatment

<table>
<thead>
<tr>
<th>Factor</th>
<th>Admissions, % (SE)</th>
<th>P Value 2000 2005 2010</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>35.4 (2.1)</td>
<td>35.5 (2.4)</td>
<td>33.3 (2.4)</td>
</tr>
<tr>
<td>Medicare</td>
<td>38.9 (1.7)</td>
<td>37.2 (2.0)</td>
<td>39.5 (1.4)</td>
</tr>
<tr>
<td>Medicaid</td>
<td>16.6 (2.1)</td>
<td>15.3 (1.5)</td>
<td>17.3 (2.2)</td>
</tr>
<tr>
<td>Other</td>
<td>8.9 (2.0)</td>
<td>11.9 (3.2)</td>
<td>9.7 (1.5)</td>
</tr>
<tr>
<td>Prior radiation therapy</td>
<td>3.4 (1.1)</td>
<td>5.0 (1.0)</td>
<td>7.6 (1.1)</td>
</tr>
<tr>
<td>Procedural complexity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major ablative procedure</td>
<td>43.3 (2.2)</td>
<td>44.9 (2.7)</td>
<td>46.5 (2.2)</td>
</tr>
<tr>
<td>Flap reconstruction</td>
<td>4.1 (0.6)</td>
<td>6.2 (0.8)</td>
<td>8.6 (1.0)</td>
</tr>
</tbody>
</table>

Abbreviation: HNCA, head and neck cancer.

### Table 3. Factors in Nonteaching Institutions Potentially Associated With Regionalization of HNCA Treatment

<table>
<thead>
<tr>
<th>Factor</th>
<th>Admissions, % (SE)</th>
<th>P Value 2000 2005 2010</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private insurance</td>
<td>32.3 (1.6)</td>
<td>30.6 (1.5)</td>
<td>28.6 (1.7)</td>
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<tr>
<td>Medicare</td>
<td>51.1 (1.5)</td>
<td>49.5 (1.2)</td>
<td>46.1 (1.4)</td>
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<tr>
<td>Medicaid</td>
<td>10.2 (1.1)</td>
<td>14.0 (1.1)</td>
<td>15.8 (1.2)</td>
</tr>
<tr>
<td>Other</td>
<td>5.3 (0.8)</td>
<td>5.9 (0.6)</td>
<td>8.8 (1.0)</td>
</tr>
<tr>
<td>Prior radiation therapy</td>
<td>1.9 (0.3)</td>
<td>2.8 (0.6)</td>
<td>4.6 (0.6)</td>
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<tr>
<td>Procedural complexity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major ablative procedure</td>
<td>32.6 (2.1)</td>
<td>24.3 (1.8)</td>
<td>27.2 (2.5)</td>
</tr>
<tr>
<td>Flap reconstruction</td>
<td>2.4 (0.4)</td>
<td>1.6 (0.3)</td>
<td>2.7 (0.7)</td>
</tr>
</tbody>
</table>

Abbreviation: HNCA, head and neck cancer.
ing institutions, we found that the proportion of Medicaid patients admitted to nonteaching hospitals significantly increased from 10.2% in 2000 to 15.8% in 2010 ($P = .002$) compared with teaching institutions where the Medicaid coverage was not significantly changed. This finding parallels that of Al-Refaie et al, who found a similar shift toward more Medicaid patients receiving cancer surgery care (for tumors of the lung, esophagus, and pancreas) at low-volume hospitals. Similarly, for nonteaching hospitals, the percentage of patients with no insurance or other payer status significantly increased from 5.3% to 8.8% during the study period. Interestingly, payer status across all payers remained relatively constant for teaching hospitals (Tables 2 and 3). The observed rise in the Medicaid and other payer population in nonteaching hospitals compared with teaching institutions (Tables 2 and 3) should also be expected to negatively influence clinical outcomes. Subramanian and Chen reported that for Medicaid patients with HNCA in Georgia or California, less than one-third are diagnosed at an early stage, and roughly one-third die within 12 months of diagnosis. In a smaller study from Pittsburgh, Pennsylvania, Kwock et al found that overall survival in patients with HNCA was significantly affected by the type of insurance coverage they had, even after controlling for age, sex, race, smoking, cancer stage, treatment, or alcohol use. Whether this insurance-associated effect on clinical outcome acts in isolation or in concert with higher comorbidity indices remains to be determined.

Over the 10 years of our study, the proportion of irradiated patients nearly doubled in both teaching and nonteaching hospitals (Tables 2 and 3), whereas the proportion of ablative cases significantly decreased only in nonteaching hospitals. The proportion of patients receiving a flap rose significantly only in the academic hospitals (Table 2). This trend of decreased surgery at nonacademic institutions appears to be continuing beyond 2010. In the prospective Longitudinal Oncology Registry of Head and Neck Carcinoma (LORHAN) study, it was observed that in community hospitals, patients were likely to be treated with radiation alone plus or minus chemotherapy or biologic therapy. Thus our observed decreased rates of ablative surgery in nonteaching hospitals may partly reflect an increase in such hospitals with the expertise to treat HNCA as well as a rise in the number of regional community cancer centers, both of which eliminate the need to travel to distant teaching hospitals.

Such institutional changes are expected to influence outcomes as well. George et al described a group of patients with HNCA who were surgically treated at an academic medical center and underwent radiation therapy locally or at a nonacademic center. On univariate analysis, the researchers found that patients treated at the academic center had improved overall and disease-free survival compared with those treated in nonacademic centers. However, on multivariate analysis, they found that treatment at an academic center did not prove to be an independent predictor of survival, suggesting that factors other than irradiation may have contributed to the observed cancer outcome. Other studies have also demonstrated improved HNCA survival at academic centers, especially for tumors of the larynx and other mucosal sites.

Whether differences in surgical treatment rates, in addition to higher comorbidity index in nonacademic hospitals, may further contribute to poorer outcomes remains to be determined. However, the lower rate of flap reconstruction we observed in nonacademic institutions (Table 2) no doubt plays a factor in this scenario, since arguably, reconstructive microvascular flap reconstruction has been reported to improve not only functional but oncologic outcomes.

Conclusions

In summary, our findings reveal that populations in greatest need of specialized care, care in institutions where systems are integrated and demonstrably linked to improved outcomes, are least likely to obtain it. To paraphrase Dimick et al, HNCA care is separate but not equal. Our study adds to the growing literature that documents a disturbing national divergence in the type of care rendered to patients with HNCA. Patients who are sicker fall into lower socioeconomic groups and minority groups and are least likely to obtain care at academic centers where links between volume, quality, and positive outcomes are clearly documented. The mechanisms for this are manifold. What is clear is that health care policies that focus on measuring outcomes alone—in quality or quantity—without guaranteeing an equitable distribution of care are falling short of their stated goal of improving outcomes for all.

**REFERENCES**


