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AMERICAN ACADEMY OF OTOLARYNGOLOGY–HEAD AND NECK SURGERY FOUNDATION

Original Research—Laryngology and Neurolaryngology

Otolaryngology–Head and Neck Surgery
147(1) 85–90
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DOI: 10.1177/0194599812438170
http://otojournal.org
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Trends in Total Laryngectomy in the Era of Organ Preservation: A Population-Based Study

Patrick Tate Maddox, MD[1], and Louise Davies, MD, MS[1–3]

No sponsorships or competing interests have been disclosed for this article.

Abstract

Objective. To describe time trends in total laryngectomy health services utilization across the United States, such as rates of surgery, cost, length of stay, and insurance payer, and to compare this to important milestones in recommendations for laryngeal cancer treatment.

Study Design. Population-based cohort study

Setting. Healthcare Cost and Utilization Project-Nationwide Inpatient Sample (HCUP-NIS) 1997-2008: stratified sample of all US hospital discharges.

Subjects and Methods. All patients with the principal procedure of complete laryngectomy. The unit of analysis was the discharge.

Results. Between 1997 and 2008, the number of laryngectomies done in the United States decreased by 48%. New cases of laryngeal cancer decreased 33% during the same time. The proportion of patients older than 65 years decreased from 48% to 43%. Mortality for the procedure was 1.4% in 1997 and 1.1% in 2008. Mean length of stay over the study period increased from 13 days to 14 days. Mean hospital charges rose from $58,000 in 1997 to $109,000 in 2008, consistent with the overall rise in US health care costs. Medicare was the dominant insurer throughout. Home health was ordered in 50% of 2008 discharges but only 32% in 1997.

Conclusions. The rate of total laryngectomy has dropped more than the incidence of laryngeal cancer has dropped, consistent with the trend toward nonsurgical treatment. Lower surgical volumes and/or salvage laryngectomy surgeries are hypothesized to play a role in longer length of stay, stable mortality rates despite younger patient age, and increased need for home services after discharge.

Keywords

laryngeal neoplasm, health services research, surgery, radiation, chemotherapy

Received October 20, 2011; revised December 28, 2011; accepted January 17, 2012.

It is estimated that 12,720 men and women (10,110 men and 2,610 women) were diagnosed with cancer of the larynx in 2010.[1] While the larynx is the most common subsite affected in the head and neck, it is still an uncommon disease compared with others such as breast cancer (207,090 cases in 2010). Thus, many head and neck surgeons work in relative isolation in their area of subspecialty. Furthermore, nonsurgical treatment of laryngeal cancer has become more common since the publication of the findings of the VA laryngeal cancer study group in 1991: they demonstrated that nonsurgical therapy (induction chemotherapy followed by radiotherapy) is a viable alternative to primary surgery for advanced laryngeal tumors.[2]

While the trend away from primary surgical management of advanced laryngeal tumors has been described by others,[3] and changing patterns of survival have been documented,[3,4] little has been done to describe the effect of changing rates of surgical intervention for laryngeal squamous cell carcinoma on cost, length of hospital stay, type and size of hospital performing these surgeries, and resource utilization after discharge.

Using the HCUP-NIS database,[5] we describe rates of total laryngectomy across time and across different parts of the country. Furthermore, we describe the rates of total laryngectomy surgery undertaken at teaching and nonteaching hospitals in terms of length of stay, cost, size of hospital, insurance coverage, and outcomes. By evaluating these factors, we illustrate previously unreported or underrecognized effects of changing trends in the management of laryngeal cancer.

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This article was presented at the 2011 AAO-HNSF Annual Meeting & OTO EXPO; September 11-14, 2011; San Francisco, California.

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Table 1. Definition of Terms

Medicare: includes fee-for-service and managed-care Medicare patients
Medicaid: includes fee-for-service and managed-care Medicaid patients
Private insurance: includes Blue Cross, commercial carriers, and private health maintenance organizations and preferred provider organizations
Uninsured: includes an insurance status of "self-pay" and "no charge"
Other: includes Worker's Compensation, TRICARE/CHAMPUS, CHAMPVA, Title V Maternal and Child Health Services Block Grants, and other government programs
Northeast: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont
Midwest: Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Michigan, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin
South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Maryland, Mississippi, Louisiana, Tennessee, North Carolina, Oklahoma, South Carolina, Texas, Virginia, West Virginia
West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming

Methods

This is a cross-sectional, longitudinal, population-based study of hospital discharges in the United States between 1997 and 2008. The primary data source was the Nationwide Inpatient Sample (NIS). It was developed in 1988 as part of the Healthcare Cost and Utilization Project (HCUP), a government-maintained database run by the Agency for Health Care Research and Quality with input from the states. The HCUP-NIS is a 20% stratified sample of discharges from community hospitals. It is the largest all-payer, inpatient care database in the United States, representing approximately 8 million hospital stays per year. Not all states participate in HCUP, so not all states are present in HCUP data. In 1997, 22 states contributed their data; in 2008, 42 states contributed data (not contributing in 2008 were Alabama; Alaska; Delaware; Washington, DC; Idaho; Mississippi; Montana; and North Dakota; however, not all states contribute all years). HCUP creates the stratified sample each year from the data available, and participating states are weighted so that the data are representative of the entire United States. Our study is limited to 1997 and later because HCUP recommends that data prior to 1997 not be analyzed longitudinally. Prior to 1997, only 8 states participated in the database, making population estimates less reliable.

Inclusion Criteria

All cases in which the principal procedure was ICD-09 code 30.3 (complete laryngectomy) or ICD-09 code 30.4 (radical laryngectomy; *International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9CM]) were eligible for inclusion. Patients with principal procedure codes for partial laryngectomy, pharyngectomy, or esophagectomy were excluded.

Data Sources

The HCUP-NIS online software program was used for analysis. The following variables were included: type of payer (ie, insurance status), total hospital charges, census region where surgery was performed, length of hospital stay, age category of the patient at the time of surgery, teaching/non-teaching status of the hospital performing the surgery, and bed size of the facility. The unit of analysis was the discharge. US census data were accessed to obtain the following variables: US population older than 18 years and national health expenditure rates. The Surveillance, Epidemiology, and End Results (SEER) database, maintained by the National Institutes of Health National Cancer Institute, was accessed for calculations related to larynx cancer rates and laryngectomy rates.

Definitions

Key definitions for interpreting the data are outlined below and in **Table 1**.

Principal procedure is the procedure that is performed for definitive treatment, not one that is performed for diagnostic or exploratory purposes or that is necessary to take care of a complication.

Mortality is defined as death during the hospital stay, without regard for the length of the hospital stay. Deaths outside the hospital are not included. For example, if a patient dies shortly after discharge from the hospital, they are not included as a death in this data set.

Payer is the expected payer for the hospital stay. When more than 1 payer is listed for a patient's hospital discharge, the first-listed (primary) payer is used.

Hospital charges are the amount the hospital charged for the entire hospital stay. It does not include professional (MD) fees, but it does include both the technical fee and the hospital charge. Charges are not necessarily how much was reimbursed and so cannot represent actual health care expenditures; however, total charges are commonly used as a surrogate for overall resource utilization. In this article, all charges were converted to 2008 dollars to allow for fair comparison across the study period.

Region is defined by the Bureau of the Census: Northeast, Midwest, South, and West (see **Table 1**).

Length of stay is the number of nights the patient remained in the hospital. A patient admitted and discharged on the same day has a length of stay = 0.

Table 2. General Characteristics of the Selected HCUP-NIS Cases

	1997	2008
Incidence rate of laryngeal cancer (per million)[a]	38.2	28.7
Number of total laryngectomies	5038	3414
Sex, % male	78	79
Mean hospital charges, 2008 dollars	$58,245	$109,342
Mean length of stay, days	13	14
% in hospital deaths (n)	1.4 (71)	1.1 (39)
% at teaching hospitals (n)	72 (3609)	83 (2841)
% at large hospital (n)	56 (2796)	75 (2556)
% Medicare (n)	46 (2299)	44 (1502)
% uninsured (n)	5 (235)	5 (155)

[a]Data are from the Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence-SEER 13 Regs Research Data, Nov 2010 Sub (1992-2008) <Single Ages to 85+, Katrina/Rita Population Adjustment> - 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.

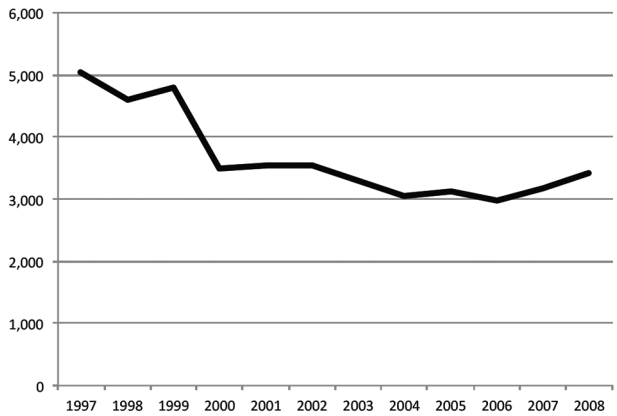

Figure 1. Trend in total number of laryngectomies done over the study period.

Teaching status indicates a teaching or a nonteaching hospital. A hospital is considered to be a teaching hospital if the American Hospital Association (AHA) Annual Survey indicates it has an American Medical Association–approved residency program, is a member of the Council of Teaching Hospitals, or has a ratio of full-time equivalent interns and residents to beds of 0.25 or higher.

Bed size indicates the size of the hospital based on the number of short-term, acute care beds. The size criteria vary by US census region as well as by teaching and nonteaching status (supplemental appendix available at otojournal.org).

Human Subjects Protections

The HCUP-NIS data are publicly available, deidentified, administrative data and thus are exempt from review as designated by the Dartmouth College Committee for the Protection of Human Subjects. The data are not available without signing a data use agreement with HCUP-NIS. Both authors signed this data use agreement to gain permission to use the data.

The data use agreement specifies that no attempt shall be made to identify or attempt to identify any individual. Thus, no cells of tabulated data less than or equal to 10 are released. Otherwise, all available data were used for this analysis.

Results

Patient Characteristics

The rate of laryngectomy fell 48% over the study period. The estimated number of total laryngectomies performed in 1997 was 5038. This number dropped steadily to a low of 2966 in 2006 and then rose slightly in 2008 to 3414 (**Table 2**; **Figure 1**). In contrast, the incidence rate of larynx cancer over the same period decreased by only 33%, from 38.2/1,000,000 people to 28.7/1,000,000 people.

The mortality rate for laryngectomy decreased over the study period. The overall estimated mortality rate of laryngectomy as a percentage of total cases performed at all sampled hospitals in 1997 was 1.4% (71 deaths). In 2008, the rate was 1.1% (39 deaths). Among census regions, the highest mortality rate in 1997 was in the West at 1.7%; the lowest mortality rate was <0.05%, in the Midwest. In 2008, the census region with the highest rate was the Northeast at 2.1%; the lowest mortality rate was not calculable because of the small number of deaths overall.

More patients were admitted from the emergency department for their cancer surgery at the end of the study period than at the beginning. In 1997, 7.5% of patients undergoing laryngectomy (n = 378) were admitted from the emergency department. In 2006, the most recent year for which data were available, 8.4% of patients undergoing laryngectomy (n = 248) were admitted through the emergency department.

The proportion of men undergoing laryngectomy compared with women stayed stable over time. In 1997, 78% (n = 3937) were male, and in 2008, 79% (n = 2708) were male. This is

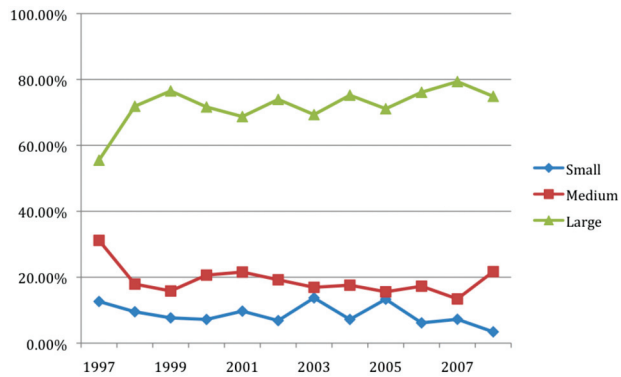

Figure 2. Size of the hospital performing the procedures over time.

consistent with the proportion of laryngeal cancers diagnosed among men compared with women over the same time period (SEER data).

Over time, the proportion of patients aged 45 to 64 years increased, while the proportion of patients aged 65 to 84 years decreased. In 1997, 6% (n = 277) of patients were between the ages of 18 and 44 years, 47% (n = 2369) were between the ages of 45 and 64 years, and 46% (n = 2291) were between 65 and 84 years of age. In 2008, slightly more patients were in middle age: 5% (n = 184) of patients were between the ages of 18 and 44 years, 52% were between the ages of 45 and 64 years, and 41% were between the ages of 65 and 84 years.

Hospital Characteristics

The proportion of laryngectomies done in large or teaching hospitals trended upward. In 1997, 56% of total laryngectomies were performed at large hospitals (n = 2796). In 2008, that number increased to 75% (n = 2556). Hospitals designated as teaching hospitals—regardless of size—performed 72% of procedures in 1997 (n = 3609), and that steadily increased to 83% (n = 2841) by 2008 (**Figure 2**).

The mean length of hospital stay increased slightly. A weighted mean of the first 3 years of the study period (1997-1999) shows a hospital length of stay of 13 days, whereas a weighted mean from the last 3 years of the study period (2006-2008) shows a hospital length of stay of 14 days.

Rates of patient discharge to a fully independent (ie, no home health services) setting decreased over the study period. In 1997, 51% (n = 2555) of patients undergoing total laryngectomy had a routine discharge. This fell to 31% (n = 1045) by the end of the study period in 2008. There was a trend toward transfer to another short-term hospital: 0.5% of patients had this type of discharge in 1997 compared with 1.7% in 2008. Furthermore, there was an increased reliance on home health services, with just 32% (n = 1594) having home health care in 1997 but 50% (n = 1707) requiring this care in 2008.

Regional Location of Surgery

The largest numbers of laryngectomy were done in the South over the entire period of the study. In the Southern census region in 1997, an estimated 2211 total laryngectomies were performed, which was 44% of the total number done in the United States. The Midwest was next at 24%, followed by the Northeast at 18% and the West at 15%. In the Southern census region in 2008, an estimated 1521 were performed (45%). The Northeast moved to second highest at 20%, followed by the West at 18% and the Midwest at 17%.

Hospital Charges and Payers

Hospital charges more than doubled during the study period, but this was the same as the increase in the overall National Health Expenditures as calculated by the US Census Bureau and the Centers for Medicare and Medicaid Services (**Table 3**).

The predominant insurance payer over the entire study period was Medicare (**Figure 3**). In 1997, Medicare was the payer for 46% of cases and in 2008 for 44% of cases. Private insurance remained the second most common payer at 31% in both 1997 and 2008. All government payers (Medicare, Medicaid, and other; **Table 1**) combined covered 64% of laryngectomies in 1997 and 65% in 2008. Those designated as uninsured were 5% in 1997, with a peak of 8% in 2006, falling back to 5% in 2008.

Discussion

Rates of laryngectomy have fallen 48%, while the incidence of larynx cancer has fallen only 33%. This observation confirms the trend reported by Hoffman et al.[3] We document

Table 3. Incremental Increase in Mean Hospital Charges for the Study Period, Used as a Surrogate for Resource Utilization

	Total Mean Hospital Charges, %					
	1998	2000	2002	2004	2006	2008
Cost in dollars each year	40,102	47,644	54,787	58,583	78,969	109,342
Adjusted to 2008 dollars	52,969	59,569	65,568	66,771	84,336	109,342
National Health Expenditures (in billions of dollars)[a]	1208.6	1378.0	1637.0	1894.7	2152.1	2391.4

[a]Data are from the Centers for Medicare and Medicaid Services, Offices of the Actuary, National Health Statistics group; US Department of Commerce, Bureau of Economic Analysis; and US Bureau of the Census.

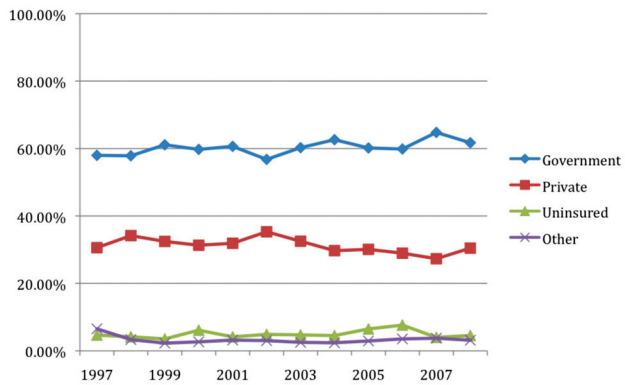

Figure 3. Insurance payer type over time.

here the effects of lowered laryngectomy rates on outcomes and utilization.

As laryngectomy rates were falling, more of the surgeries were done in large or teaching hospitals, a higher percentage of patients were admitted through the emergency department, length of stay increased, and fewer patients were discharged fully independently to home, without visiting nursing services. Among patients operated on during the study period, more of those undergoing laryngectomy were middle aged, but about the same number died in the hospital.

There are 2 possible explanations for these findings. First, the lower volume of surgeries performed overall might have resulted in higher complication rates, as documented in previous studies of the relationship between operative volume and patient outcome.[6,7] This might explain longer lengths of stay and fewer discharges to a fully independent setting. This might also explain why mortality failed to fall substantially, although the age of the patients undergoing surgery was younger at the end of the study period than at the beginning.

A second possible explanation for the trends observed is that more of the patients undergoing laryngectomy were having salvage surgery after failure of chemoradiation treatment. Postoperative wound complications are higher after nonsurgical management.[8-10] This would likely contribute to longer length of stay and the need for more support after discharge. HCUP-NIS data do not provide information on salvage surgery status, so this hypothesis cannot be tested in this data set. These data are also not captured in other available data sets such as The National Cancer Data Base (NCDB), maintained by the American College of Surgeons or SEER.

Two trends are not easily explained: the falling age of patients undergoing laryngectomy overall and the increased rate of admission through the emergency department. The median age at diagnosis of laryngeal cancer was 66 years in 2000 (the first year this calculation was made available by SEER) but has only decreased to age 65 years in 2008.[11] This makes changing epidemiology of the disease unlikely to be the reason for the shifting ages of those undergoing surgery. Further research to understand this trend might focus on current practice patterns related to the choice of surgical versus nonsurgical management according to age. The increased rate of admission through the emergency department (ED) cannot be explained by changes in insurance status since the payer mix did not change during the study period. It may be related to the larger number of laryngectomies done in large centers, as patients are transferred from one hospital to another through an ED.

A striking finding in our data is the small number of cases performed nationally overall compared with other diseases. For example, a recent HCUP-NIS study of colon cancer had 240,446 cases available for analysis over a 3-year period.[12] While our data set of 3414 laryngectomies is a large number by head and neck cancer surgery literature standards, it is not possible to produce complex analyses of outcomes and quality with small numbers like this. As each variable of interest is added to an analysis, the number of cases becomes smaller, and soon the power of the study is so low (ie, confidence intervals get so wide) that the findings are no longer trustworthy. This is commonly referred to as the problem of "small cell sizes." Institutional or even state-level registries will never be enough for us to fully understand how our changing practice patterns have affected laryngectomy care and how we can best work to improve outcomes and quality as the influence of chemoradiation treatment matures.

What can we as clinicians learn from these data? First, that presently available data sets allow us to outline the relevant questions that need to be asked about the effects—both intended and unintended—of our treatments for laryngeal cancer. However, our data sets do not contain the details necessary to answer the questions that matter the most to patients: whether one treatment results in fewer complications and treatment failures than another. Second, the data here show (by the smallness of the numbers) that to obtain these answers, a concerted effort to obtain full data on every larynx cancer case will be required. Clinicians should consider this a call to action to contribute data to the places available and ask for more of the necessary variables to be collected.

Where should clinicians contribute data? SEER data are captured automatically by states and require no specific action on the part of physicians (unless your state does not participate, in which case you should lobby for participation). The National Surgical Quality Improvement Program (NSQIP), managed by the American College of Surgeons, is another option. Few laryngectomies are currently captured in this system. In 2009, the most recent year for which data are available, NSQIP contained only 71 laryngectomies. The National Cancer Data Base, also managed by the American College of Surgeons, is another place to contribute data, and this system also collects demographics and some co-morbidity data. Last, the American Head & Neck Society supports a detailed program, called Oto-Base, which has the advantage of being designed specifically for head and neck cancer but it is not yet widely used and so getting large numbers of cases for analysis is still some time away.

The data we present here have specific limitations. Because it is a stratified 20% sample designed to represent

the nation as a whole, the data cannot be directly compared with other database estimates. For instance, our report of regional rates of laryngectomy lacks a denominator that would allow one to infer whether laryngectomy rates are greater in the South because of higher larynx cancer rates or because of differing practice patterns among surgeons. The other major limitation of the HCUP-NIS data is its administrative source. Because the data were originally gathered for billing, biases related to reimbursement can occur. We restricted our analysis to variables less likely to be affected by this sort of preferential coding and chose a principal diagnosis unlikely to be overridden by another, more complex procedure.

In conclusion, as rates of laryngectomy have fallen over the past 12 years, length of stay and rates of discharge to an assisted setting have increased. At the same time, younger patients have undergone the surgery more often, but in-hospital mortality has not decreased substantially. These findings suggest that there are important lessons to be learned about how best to care for our patients with larynx cancer. The best way to get those answers is for otolaryngologists to actively contribute data wherever they are able and lobby for the addition of variables to currently available systems, such as salvage status, which are so relevant to measuring outcomes about the issues our patients face.

Author Contributions

Patrick Tate Maddox, conception, design, acquisition of data, interpretation of data, drafting the article, final approval of version to be published; **Louise Davies**, conception, design, interpretation of data, revising draft critically, final approval of version to be published.

Disclosures

Competing interests: None.

Sponsorships: None.

Funding source: None.

Supplemental Material

Additional supporting information may be found at http://oto.sagepub.com/content/by/supplemental-data

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Appendix A:

Bedsize Categories

Region	Location and Teaching Status	Hospital Bedsize		
		Small	**Medium**	**Large**
Northeast	Rural	1-49	50-99	100+
	Urban, nonteaching	1-124	125-199	200+
	Urban, teaching	1-249	250-424	425+
Midwest	Rural	1-29	30-49	50+
	Urban, nonteaching	1-74	75-174	175+
	Urban, teaching	1-249	250-374	375+
South	Rural	1-39	40-74	75+
	Urban, nonteaching	1-99	100-199	200+
	Urban, teaching	1-249	250-449	450+
West	Rural	1-24	25-44	45+
	Urban, nonteaching	1-99	100-174	175+
	Urban, teaching	1-199	200-324	325+