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Frequency and Factors Associated with Use of Videolaryngostroboscopy in Voice Disorder Assessment

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Abstract

Objective—Videolaryngostroboscopy (VLS) is considered an important diagnostic tool in the evaluation of patients with laryngeal/voice disorders. We evaluated the frequency of, diagnoses associated with, and factors related to VLS use in the evaluation of outpatients with laryngeal/voice disorders.

Study Design—Retrospective analysis of a large, national administrative U.S. claims database.

Methods—Patients with a laryngeal disorder based on ICD-9-CM codes from January 1, 2004 to December 31, 2008, seen by an otolaryngologist were included. Patient age, gender, geographic region, laryngeal diagnosis, comorbid conditions, and whether laryngoscopy or VLS was performed during the outpatient otolaryngology visit were collected.

Results—168,444 unique patients saw an otolaryngologist for 272,112 outpatient visits. 6.2% of outpatient otolaryngology visits had a VLS performed. Patient age was related to VLS use with lower odds in the elderly (≥ 65 years of age) and those 0–17 years of age. Geographic variation was noted with higher odds of VLS use in urban versus rural areas and greater odds in the northeast versus the south. Laryngeal diagnosis was associated with VLS use with greatest odds for patients with multiple diagnoses, vocal fold paralysis and paresis followed by non-specific dysphonia and benign vocal fold/laryngeal pathology followed by acute and chronic laryngitis and

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laryngeal cancer. Patients with gastro-esophageal reflux (GER) had greater odds of VLS use than patients without GER.

Conclusions—VLS was used in 6.2% of outpatient otolaryngology outpatient visits, and its use was influenced by multiple factors.

Level of evidence—2b

Keywords

laryngeal disorders; voice disorders; hoarseness; stroboscopy; dysphonia; voice; MarketScan

Introduction

Examination of the larynx is an essential component in the evaluation and management of patients with laryngeal/voice disorders. In patients with dysphonia, the diagnostic accuracy from history and physical exam excluding laryngoscopy is only 5% compared with a 68.3% accuracy following an initial endoscopic laryngeal evaluation.¹ Because of the wide range of potential causes for the dysphonia, determining the precise etiology of the laryngeal/voice disorder is necessary to plan treatment. A survey of members of the American Broncho-Esophagological Association found that laryngeal examination helps determine the next steps in management and is imperative prior to beginning treatment.²

The larynx can be evaluated through indirect and direct laryngoscopy. In the office, indirect laryngoscopy with mirrors and rigid and flexible endoscopes is common. The addition of videolaryngostroboscopy (VLS) provides the ability to evaluate mucosal vibration and is considered one of the most essential diagnostic tools for patients with laryngeal/voice disorders.^{3, 4} Compared to laryngoscopy, VLS changed or modified the diagnosis in 10 to 47% of cases in which an initial laryngoscopy was followed by VLS.^{5–7} The European Laryngological Society has recommended that the multidimensional assessment of adults with laryngeal/voice disorders include VLS, and similar recommendations have been made for dysphonic pediatric patients.^{8, 9}

Yet, the prevalence of VLS examinations during outpatient otolaryngology visits on a national scale and the factors associated with obtaining VLS are not known. Previous investigations into the utilization of VLS have relied on cross-sectional surveys.^{10, 11} The MarketScan[®] database, a large national administrative claims database, provides the means to systematically explore the practice patterns and variation associated with VLS use, an important step in understanding the current state of VLS utilization among laryngeal/voice disordered patients. The purpose of this study is 1) to examine the prevalence of VLS use among outpatient otolaryngology visits, 2) to evaluate laryngeal diagnostic patterns among visits with laryngoscopy versus VLS, and 3) to explore factors associated with VLS use.

Methods

This study was approved by the Duke University Medical Center Institutional Review Board. The MarketScan[®] Commercial Claims and Encounters dataset and Medicare Supplemental and Coordination of Benefits dataset, a large, national administrative U.S.

claims database, was retrospectively analyzed for January 1, 2004 to December 31, 2008. The MarketScan® databases (Truven Health Analytics, Ann Arbor, MI) contain the annual health care claims of approximately 55 million individuals including employees < 65 years of age, Medicare beneficiaries ≥ 65 years of age, and their dependents integrated from all care providers and linked to health care utilization and cost records at the patient level.¹²

Patients with a primary or non-primary diagnosis of at least one of the *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes (Table I), seen as an outpatient by an otolaryngologist during the period January 1, 2004 to December 31, 2008 were included. Since patients with a brainstem stroke may have a disordered voice from nucleus ambiguus involvement, 438.10 and 438.19 (late effects of cerebrovascular disease) were included. The Evaluation and Management (E & M) Current Procedural Terminology (CPT) codes of 99201, 99202, 99203, 99204, 99205, 99211, 99212, 99213, 99214, 99215, 99241, 99242, 99243, 99244, 99245, 99354, 99355 and internal MarketScan® database codes identified outpatient visits and were coded as new or consult and return. Patients who did not see an otolaryngologist as an outpatient were not included.

The CPT code 31579 designated VLS and 31505 and 31575 were classified as laryngoscopy. The 31575 code does not distinguish between distal chip tip and fiberoptic endoscopy nor whether video-recording was used or not. Because mirror laryngoscopy is included in the E & M code, visits during which a laryngoscopy or VLS code was not provided were grouped with laryngoscopy. Age, gender, geographic region (divided into four census regions: northeast, north central, south, and west), and urban versus rural status (based on residence in a metropolitan statistical area (MSA)) were collected.

Otolaryngologists were classified as otolaryngology, pediatric otolaryngology, or head & neck surgery based on the MarketScan® database dictionary. The impact of comorbid conditions on VLS use was assessed by identifying specific comorbidities: sinusitis (461.x, 473.x), asthma (493.x), chronic obstructive pulmonary disease (490, 491.xx, 492), gastro-esophageal reflux (530.81), acute pharyngitis (462), acute bronchitis (466.xx), acute upper respiratory illness (465.x), pneumonia (481, 482.xx, 483.x, 486), and allergic rhinitis (477.x). The laryngeal diagnoses provided during each laryngoscopy versus VLS visit were separately tabulated. Patients with more than one aggregate laryngeal diagnosis during an outpatient otolaryngology visit were classified as “multiple diagnoses.”

MarketScan® database management and statistical analysis was completed with SAS 9.3 statistical analysis software (SAS Institute, Cary, NC). Summary statistics were calculated. A logistic regression model among all otolaryngology outpatient visits was performed to evaluate the impact of age, gender, urban versus rural status, geographic region, visit type, and laryngeal diagnosis during a patient visit on the outcome VLS use during an outpatient otolaryngology visit. This model investigates the association of each independent variable with the outcome of having a VLS during an outpatient otolaryngology visit. A second logistic regression model was also performed to examine the impact of age, gender, urban versus rural status, geographic region, visit type, and laryngeal diagnosis at the initial laryngoscopy visit on obtaining a VLS within the subsequent 90 days. This model investigates the association of each independent variable with the outcome of obtaining a VLS within 90 days of the initial laryngoscopy visit. The 90 day window was chosen to

account for initial treatment trials and follow-up visits to determine symptom resolution and need for further evaluation with VLS. The Wald test was used to compare the impact of different laryngeal diagnoses and age groups on VLS utilization.

Results

54,600,465 unique patients were in the MarketScan® databases during January 1, 2004 to December 31, 2008 with 536,943 (1%) unique patients having an ICD-9 code related to laryngeal disease. 168,444 (31.4%) of these patients saw an otolaryngologist as an outpatient for a total of 272,112 visits (Table II). 16,820 (6.2%) of these outpatient otolaryngology visits, and 5.4% of unique patients, had a VLS with 7823 on the first visit (46.5%). 256,796 (94.4%) patient visits had laryngoscopy of which 2865 (1.1%) were coded 31505, 136,938 (53.3%) were coded 31575, and 116,974 (45.6%) were not associated with 31505 or 31575 and assumed to represent mirror laryngoscopy.

The distribution of laryngeal diagnoses differed for visits during which a laryngoscopy versus VLS was performed (Table III). Vocal fold paralysis, vocal fold paresis, non-specific dysphonia, benign vocal fold/laryngeal pathology were a greater proportion of VLS versus laryngoscopy-related diagnoses. Acute and chronic laryngitis and laryngeal cancer were a greater proportion of laryngoscopy versus VLS-related diagnoses.

A logistic regression model was computed to evaluate the association of the a priori independent variables with the odds of receiving VLS during an outpatient otolaryngology visit and the odds of having VLS within 90 days of the first laryngoscopy (Tables IV and V, respectively). Patients 0–17 years of age and the elderly had the lowest odds of obtaining VLS during an outpatient otolaryngology visit and within 90 days of the initial laryngoscopy ($p < 0.05$, Wald statistic). Patients who lived in urban versus rural settings had higher odds of VLS during an outpatient otolaryngology visit and within 90 days of the initial laryngoscopy. The geographic region with the greatest odds for VLS use was the northeast. Patients with associated diagnoses of vocal fold paralysis, paresis, and multiple diagnoses had higher odds of undergoing VLS during an outpatient otolaryngology visit and within 90 days of the initial laryngoscopy than diagnoses of acute and chronic laryngitis, benign vocal fold/larynx pathology, non-specific dysphonia, and laryngeal cancer ($p < 0.05$, Wald statistic). Non-specific dysphonia and benign vocal fold larynx pathology were associated with higher odds of VLS use during an outpatient otolaryngology visit and within 90 days of the initial laryngoscopy than chronic laryngitis which had higher odds than laryngeal cancer and acute laryngitis ($p < 0.05$, Wald statistic). The comorbid conditions asthma and GER were associated with greater odds of having VLS during an outpatient otolaryngology visit and within 90 days of the initial laryngoscopy than patients without these conditions. Gender and visit type did not impact the odds of undergoing VLS.

Discussion

Several approaches for laryngeal examination were identified in our national dataset. The two most common methods of laryngeal examination were flexible laryngoscopy and presumed mirror laryngoscopy. VLS was employed in 6.2% of outpatient otolaryngology

visits associated with laryngeal/voice disorders. A prior survey of general otolaryngologists also revealed that flexible and mirror laryngoscopy were the primary methods of laryngeal examination with 16.9% of respondents never obtaining VLS.¹¹ Furthermore, 56% of surveyed otolaryngologists were unlikely to obtain VLS, even before surgical management of benign vocal fold lesions.¹⁰ Given the reported impact of VLS on diagnosis and treatment decisions and its potential influence on patient outcomes, understanding the factors associated with the utilization of VLS seems essential.⁵⁻⁷

Patient age was a determining factor in the use of VLS. The elderly and patients 0–17 years of age had the lowest odds of having VLS during an outpatient otolaryngology visit and within 90 days of the first laryngoscopy (Tables IV and V, $p < 0.05$, Wald statistic). Although we cannot assess this directly, concerns regarding patient tolerance and uncertainty about its benefit may affect the decision to use VLS. However, the ability to perform VLS in children has been documented and been shown to influence diagnosis and treatment decisions in the pediatric population.^{13, 14} Physician training and specialty, data which were unavailable in our dataset, may partly explain the impact of age on VLS use. Compared to fellowship trained laryngologists of whom 75% felt VLS was very helpful, 57.1% of otolaryngologists who only cared for children felt VLS had little or no value.² Similar biases may exist with regards to evaluating elderly patients and should be explored.

Geographic variability in VLS utilization was also observed. Patients in an urban versus rural setting and in the northeast and north central region compared to the south had greater odds of receiving VLS at some point during the evaluation process and within 90 days of the first laryngoscopy visit (Tables IV and V). Cost differences between VLS and laryngoscopy equipment and available health care resources across regions of the country may affect the accessibility of VLS. Physician practice type may also influence VLS use, although this could not be measured directly in our study. Otolaryngologists in academic and group practices have reported more often obtaining VLS than those in solo or hospital practices.¹¹ Compared to otolaryngologists in academic practices, 84.6% of whom found VLS moderately to very helpful, 63% of private practice otolaryngologists felt VLS was not at all helpful.² With such regional and provider-specific differences regarding the value of VLS, further inquiry into how VLS affects treatment decisions/approaches may provide additional insight regarding its impact on patient outcomes and health care costs.

Patients' laryngeal diagnoses were linked to VLS utilization. Diagnoses of vocal fold paralysis and paresis had higher odds for VLS use during outpatient otolaryngology evaluation compared to most other laryngeal diagnoses (Table IV, $p < 0.05$, Wald statistic). Despite this observed association, judging motion impairment of one or both vocal folds may not require VLS. Various methods of laryngoscopy may also be recorded and thus facilitate the assessment of vocal fold mobility. Nonetheless, assessing the phase closure using a frame by frame analysis technique has been reported as beneficial in determining the degree of glottal insufficiency in patients with vocal fold atrophy and vocal fold paresis.¹⁵ Perhaps for similar reasons, VLS has been found to be useful in some patients with vocal fold paralysis.⁵ Despite the perceived benefit in this clinical scenario, the exact motivation for the VLS and how and for which patients with vocal fold paralysis and paresis VLS was beneficial remain important unknowns.

In addition, VLS was common in the evaluation of benign vocal fold lesions. While benign vocal fold/laryngeal pathology accounted for only one-fifth of laryngoscopy diagnoses, this diagnostic category accounted for almost one-third of laryngeal diagnoses made during visits with VLS (Table III). The increased association of performing VLS with benign vocal fold/laryngeal pathology may be secondary to the ability to assess mucosal wave and the potential effect of a lesion on the voice. VLS has been recommended to further the examination of small lesions of undetermined type noted on laryngoscopy.¹⁶ In these circumstances, VLS, allowing inspection of the vibratory patterns, may aid in differentiating between nodules, polyps, and cysts.^{17, 18} Patients with benign vocal fold/laryngeal pathology diagnosed on the initial laryngoscopy had increased odds for VLS within 90 days of this first laryngoscopy as compared to acute and chronic laryngitis and laryngeal cancer, perhaps to better characterize the type of pathology (Table V). The frequency of VLS-related diagnostic changes and the related impact on treatment decisions among patients with benign vocal fold/laryngeal pathology in the general otolaryngology community needs further examination to identify patients most likely to benefit from VLS.

Associations between VLS and patients without obvious vocal fold movement abnormalities and without obvious vocal fold lesions were identified. Patients with non-specific dysphonia were a greater proportion of VLS than laryngoscopic diagnoses and had greater odds for receiving VLS than acute and chronic laryngitis and laryngeal cancer (Tables III, IV, $p < 0.05$, Wald statistic). Prior investigators have recommended VLS for patients with unremarkable laryngoscopic examinations.^{5, 16} Non-specific dysphonia on initial laryngoscopy did have greater odds for VLS within 90 days than acute and chronic laryngitis and laryngeal cancer (Table V).

In addition, patients may have more than one condition causing their voice disorder. Patients with multiple laryngeal diagnoses had greater odds of having VLS than all other laryngeal diagnostic categories except for vocal fold paresis (Table IV). Among mostly professional voice users, additional laryngeal diagnoses were made with VLS compared to laryngoscopy.⁶ Even in the dysphonic pediatric population, multiple diagnoses were commonly noted after VLS compared to laryngoscopy.¹⁴ Whether VLS leads to additional diagnostic information in a general voice disordered population is worthy of investigation and may further clarify the role of VLS in the management of laryngeal/voice disordered patients.

One common condition proposed to occur in patients with laryngeal/voice disorders is extraesophageal reflux disease. Although the initial study of the Reflux Finding Score was validated based on laryngoscopic examination, patients also coded for GER had higher odds of undergoing VLS than patients without GER (Tables IV and V).¹⁹ As the original findings reported to be associated with laryngeal reflux disease were described on laryngoscopic examination, the increased association of VLS with GER may represent a misuse of VLS or confusion between laryngoscopy and VLS.

Certain methodologic issues must be addressed. The accuracy of ICD-9 coding could not be confirmed. Whether VLS was performed for treatment failure or for post-surgical dysphonia could not be evaluated in the current study. Additionally, patient characteristics for which

data were not captured, such as professional voice users and socioeconomic status, may have impacted the frequency of VLS utilization. As previously mentioned, otolaryngologist-related variables such as years in practice, practice setting, training, financial reimbursement, and referral to a laryngologist may influence VLS use. Since patients had Medicare and commercial employee-sponsored plans, these results may not be generalizable to the Medicaid or uninsured population. Despite these limitations, database research has been performed to assess the utilization of diagnostic procedures in other disease states.²⁰ This large, national population-based study provides insights regarding the frequency of and factors associated with VLS use.

Conclusions

VLS was performed in 6.2% of outpatient otolaryngology visits for patients with laryngeal/voice related diagnoses. Patient age was a determining influence with lower odds of VLS use in the elderly and young. Geographic variability in VLS utilization was also noted. Specific laryngeal diagnoses were related to VLS use and consistent with current recommendations in the literature. Further investigations should focus on identifying subsets of patients likely to benefit from VLS examination. Future studies in a national population-based cohort are also needed to further our understanding of how VLS affects patient diagnosis, treatment decisions, outcomes, and ultimately health care costs.

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Table I

ICD-9 code groupings

Category	ICD-9 Codes
Vocal fold paralysis	478.30, 478.32
Bilateral vocal fold paralysis	478.34
Vocal fold paresis	478.31, 478.33
Non-specific dysphonia	784.49, 784.42, 784.40, 784.41
Acute laryngitis	464, 464.01, 464.20, 464.21
Benign laryngeal/vocal fold pathology	478.4, 478.5, 478.6, 478.71, 478.79, 212.1
Other larynx/vagus	478.70, 352.3
Chronic laryngitis	476.0, 476.1
Laryngeal cancer	161.0, 161.1, 161.2, 161.3, 161.8, 161.9
Laryngeal spasm	478.75
Late effect cerebrovascular disease, other speech deficits	438.10, 438.19

Table II

Demographics of outpatient otolaryngology visits. (n = 272,112)

Variable	All Visits Number (%)	Laryngoscopy Visits Number (%)	Videolaryngostroboscopy Visits Number (%)
Age			
0–17	5.3%	5.3%	4.6%
18–34	9.0%	8.7%	13.3%
35–44	13.6%	13.5%	15.4%
45–54	21.6%	21.5%	23.3%
55–64	26.6%	26.7%	25.7%
> 65	23.9%	24.3%	17.7%
Gender			
Male	40.4%	40.6%	37.7%
Female	59.6%	59.4%	62.3%
Geographic location			
Northeast	14.0%	13.8%	17.8%
North Central	25.5%	25.4%	25.9%
South	46.9%	47.4%	43.9%
West	13.6%	13.4%	12.4%
Live in Metropolitan Statistical Area			
Yes	85.2%	84.9%	89.7%
No	14.8%	15.1%	10.3%
Visit type			
Return	59.8%	60.0%	43.4%
New or consult	40.2%	40.0%	56.6%
Employment			
Employed	39.0%	38.4%	46.9%
Retired	30.6%	31.0%	24.8%
Missing, other	30.4%	30.6%	28.3%

Table III

Laryngeal diagnosis counts among outpatient otolaryngology visits. (n = 272,112)

Dysphonia Diagnostic Category*	All Patient Visits Number (%)	Laryngoscopy Visits Number (%)	Videolaryngostroboscopy Visits Number (%)
Unilateral vocal fold paralysis	12,342 (4.5%)	11,133 (4.3%)	1,209 (7.2%)
Bilateral vocal fold paralysis	760 (0.3%)	703 (0.3%)	57 (0.3%)
Vocal fold paresis	3,832 (1.4%)	2,863 (1.1%)	969 (5.8%)
Non-specific dysphonia	123,795 (45.2%)	114,041 (44.4%)	9,754 (58.0%)
Acute laryngitis	19,855 (7.3%)	19,420 (7.6%)	435 (3.0%)
Benign vocal fold pathology	54,766 (20.0%)	49,850 (19.4%)	4,916 (29.2%)
Other larynx/vagus	1,603 (0.6%)	1,361 (0.5%)	242 (1.4%)
Chronic laryngitis	52,408 (19.2%)	50,095 (19.5%)	2,313 (13.8%)
Laryngeal cancer	21,492 (7.9%)	20,920 (8.2%)	572 (3.4%)
Laryngeal spasm	3,552 (1.3%)	3,136 (1.2%)	416 (2.5%)
Other speech disorder	155 (0.1%)	153 (0.1%)	2 (0.01%)

* Patients could have more than one diagnosis at a given outpatient visit.

Table IV

Multiple logistic regression model for videolaryngostroboscopy during an outpatient otolaryngology visit. (n = 272,112)

Covariate	Adjusted Odds Ratio (OR)	95% Confidence Interval	p-value
Age			< 0.001
< 18	1.08	0.97 – 1.17	
18–34	2.01	1.90 – 2.14	
35–44	1.53	1.45 – 1.62	
45–54	1.43	1.36 – 1.51	
55–64	1.32	1.26 – 1.39	
65+	Reference		
Gender			0.002
Male	Reference		
Female	1.05	1.02 – 1.09	
Geographic region			
South	Reference		< 0.001
Northeast	1.50	1.43 – 1.57	
North central	1.21	1.16 – 1.26	
West	1.08	1.03 – 1.14	
Metropolitan statistical area			< 0.001
Yes	1.54	1.46 – 1.62	
No	Reference		
Visit type			
Return	Reference		0.001
New/consult	1.06	1.02 – 1.09	
Comorbidities*			
Sinusitis	0.68	0.64 – 0.73	< 0.001
Asthma	1.15	1.05 – 1.26	< 0.001
Chronic obstructive lung disease	0.75	0.64 – 0.88	< 0.001
Gastro-esophageal reflux	1.56	1.48 – 1.65	< 0.001
Acute pharyngitis	0.62	0.57 – 0.69	< 0.001
Acute bronchitis	0.72	0.63 – 0.82	< 0.001
Acute upper respiratory infection	0.56	0.48 – 0.64	< 0.001
Pneumonia	0.94	0.77 – 1.15	0.6
Allergic rhinitis	1.10	1.03 – 1.17	0.002
Laryngeal disorder			< 0.001
Unilateral vocal fold paralysis	2.44	2.22 – 2.68	
Bilateral vocal fold paralysis	1.96	1.39 – 2.75	
Vocal fold paresis	7.19	6.43 – 8.03	

Covariate	Adjusted Odds Ratio (OR)	95% Confidence Interval	p-value
Non-specific dysphonia	1.97	1.86 – 2.09	
Acute laryngitis	0.41	0.36 – 0.48	
Benign laryngeal/vocal fold pathology	1.98	1.86 – 2.11	
Other larynx/vagus	1.92	1.51 – 2.44	
Chronic laryngitis	Reference		
Laryngeal cancer	0.72	0.64 – 0.81	
Laryngeal spasm	2.23	2.00 – 2.70	
Multiple diagnoses	7.13	6.69 – 7.59	

* Reference condition for each comorbid condition is not having the specific comorbid condition.

Table V

Multiple logistic regression model for videolaryngostroboscopy within 90 days of the first laryngoscopy visit.
(n = 228,510)

Covariate	Adjusted Odds Ratio (OR)	95% Confidence Interval	p-value
Age			< 0.001
< 18	0.66	0.54 – 0.81	
18–34	1.80	1.59 – 2.05	
35–44	1.67	1.49 – 1.88	
45–54	1.57	1.42 – 1.74	
55–64	1.37	1.24 – 1.52	
65+	Reference		
Gender			0.7
Male	Reference		
Female	0.99	0.92 – 1.06	
Geographic region			
South	Reference		< 0.001
Northeast	1.41	1.29 – 1.55	
North central	1.11	1.03 – 1.21	
West	0.97	0.87 – 1.08	
Metropolitan statistical area			< 0.001
Yes	1.21	1.10 – 1.34	
No	Reference		
Visit type			
Return	Reference		0.5
New/consult	0.98	0.91 – 1.04	
Comorbidities*			
Sinusitis	0.83	0.73 – 0.95	0.006
Asthma	1.32	1.11 – 1.57	0.002
Chronic obstructive lung disease	1.05	0.81 – 1.37	< 0.001
Gastro-esophageal reflux	1.22	1.09 – 1.36	< 0.001
Acute pharyngitis	0.97	0.83 – 1.14	0.7
Acute bronchitis	0.85	0.66 – 1.08	0.2
Acute upper respiratory infection	0.81	0.64 – 1.02	0.08
Pneumonia	1.14	0.79 – 1.64	0.5
Allergic rhinitis	0.97	0.86 – 1.10	0.7
Laryngeal disorder			< 0.001
Unilateral vocal fold paralysis	2.92	2.47 – 3.45	
Bilateral vocal fold paralysis	3.19	1.86 – 5.48	
Vocal fold paresis	3.79	2.91 – 4.95	

Covariate	Adjusted Odds Ratio (OR)	95% Confidence Interval	p-value
Non-specific dysphonia	1.86	1.67 – 2.07	
Acute laryngitis	0.84	0.69 – 1.02	
Benign laryngeal/vocal fold pathology	1.70	1.50 – 1.93	
Other larynx/vagus	2.41	1.61 – 3.60	
Chronic laryngitis	Reference		
Laryngeal cancer	0.80	0.64 – 0.98	
Laryngeal spasm	0.99	0.66 – 1.48	
Multiple diagnoses	2.72	2.36 – 3.13	
Late effects cerebrovascular disease, other speech	1.35	0.19 – 9.72	

* Reference condition for each comorbid condition is not having the specific comorbid condition.