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Does hospital volume affect outcomes in patients undergoing vestibular schwannoma surgery?

Jonathan L. Hatch, MD^{1,*}, Michael J. Bauschard, MD, MS^{1,*}, Shaun A. Nguyen, MD, FAPCR¹, Paul R. Lambert, MD¹, Ted A. Meyer, MD, PhD¹, and Theodore R. McRackan, MD¹

¹Department of Otolaryngology – Head and Neck Surgery, Medical University of South Carolina, Charleston, SC, USA

Abstract

Objective—To determine the effect of hospital surgical case volume on the outcomes of vestibular schwannoma surgery

Study Design—Retrospective case review

Setting—University HealthSystem Consortium member hospitals (includes nearly every US academic medical center)

Patients—3,697 patients who underwent vestibular schwannoma resection over a three year timespan (2012 – 2015) grouped by race, age, comorbidities, payer, and gender

Intervention—Surgical resection of vestibular schwannoma

Main Outcome Measures—Morbidity and mortality following vestibular schwannoma excision are compared by hospital volume (low, medium, and high) including deciles.

Results—There was significantly longer length of stay ($p = 0.005$) among groups with low-volume hospitals followed by medium-volume hospitals and high-volume hospitals. Low-volume hospitals had a significantly higher rate of complications including stroke, aspiration, and respiratory failure ($p = 0.0175$). Patient characteristics of age, sex, gender, and baseline comorbidities were similar between hospital groups. However, patients at high-volume hospitals were more likely to be Caucasian (83.1%, $p = 0.0001$) and have private insurance (76.7%, $p < 0.0001$). There was a strong negative correlation between complication rates and hospital volume ($r = -0.8164$, $p = 0.0040$).

Conclusions—The volume of vestibular schwannoma surgeries performed at a hospital impacts length of stay and rates of postoperative complications. Demographics among hospital groups were similar though high-volume hospitals had significantly more patients who were privately insured and Caucasian.

Correspondence may be sent to: Theodore McRackan, Mailing Address: Medical University of South Carolina, 135 Rutledge Avenue, MSC 550, Charleston, SC 29425, mcrackan@musc.edu, Fax: (843) 792-5910, Phone: (843) 792-7161.

*These authors contributed equally to this work.

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Introduction

Vestibular schwannomas (VS) are slow-growing, benign tumors of the myelin-producing cells of the vestibular nerve. The current incidence has risen to approximately 1–2 per 100,000 due to greater awareness amongst practitioners and improved imaging capabilities.^{1–3} Initial attempts at surgical removal of VS resulted in mortality rates ranging from 68–86% during the onset of the 20th century.⁴ With improvements and refinements in radiology, surgical techniques and perioperative care the current mortality rate has dramatically decreased to approximately 0.5% to 0.8%.^{5,6} The management of VS has also seen a shift from microsurgical excision towards more equal use of observation, stereotactic radiation, and microsurgery.⁷

Observation is more commonly chosen in cases with a small tumor size, advanced age, or lack of significant neurological symptoms.^{3,8} As surgical volume has decreased and health economics has placed an emphasis on pay for performance (such as limiting complications), there has been a shift towards regionalization for subspecialty care.^{3,8} A study utilizing the California Hospital Inpatient Database from 1996–2010 noted this decrease in surgical volume, as well as finding significant correlations in decreased mortality and morbidity in centers with higher volumes of VS surgery.⁹ A study based on Maryland Health Service Cost Review Commission found similar results.¹⁰

This study aims to evaluate recent trends in care for surgical excision of VS over the period of three years utilizing a nationwide database from the University HealthSystem Consortium (UHC). Herein, we review key indicators of healthcare delivery across most US academic medical centers in order to examine inter-institutional trends.

Methods

The UHC is an organization whose membership includes virtually all academic medical centers and health systems, and delivers approximately 30% of medical care in the US. The UHC maintains a data repository that compiles measures of medical care from its member organizations, which can be accessed online via the UHC Clinical Database/Resource Manager (CDB/RM). The data accessed via the CDB/RM contains no patient identifiers, and our institutional review board determined this study to be exempt from IRB review. The UHC CDB/RM has shown to have a high level of concordance when compared with institutional charts.¹¹

The UHC CDB/RM was accessed in July 2016 for inpatient discharges that occurred over the three year period from October 2012 through September 2015. Patients undergoing excision of VS were identified by the corresponding ICD-9-CM procedure code (04.01). We filtered these results excluding any diagnosis of neurofibromatosis (ICD-9-CM diagnostic codes 2377, 2377.0 – 2377.2) as these patients typically have unique symptomatology and comorbidities that are outside the scope of this article.

UHC-tracked complications are acute complications that must develop during admission. These complications are assigned to cases when they met any of the criteria set by the reportable complication metrics developed by the UHC, Agency for Healthcare Research

and Quality, or Centers for Medicare & Medicaid. The complication rate was determined by the number of cases with one or more UHC-tracked complication(s) present.

Patient comorbidities are those present on admission and are assigned based on ICD-9-CM diagnostic codes by utilizing Elixhauser Comorbidity software, a software tool developed as part of the Healthcare Cost and Utilization Project.¹² Comorbidities analyzed included hypertension, obesity, chronic pulmonary disease, depression, hypothyroidism, diabetes without chronic complications, diabetes with chronic complications (retinopathy, neuropathy, vasculopathy), rheumatoid arthritis, valvular disease/collagen vascular diseases, valvular disease, renal failure, diabetes with chronic complications, and drug abuse. Readmission rates were calculated as percentage of patients readmitted to the hospital within 30 days after discharge for reasons related to the initial admission. Other diagnoses of interest in VS surgery were identified for analysis through their corresponding ICD-9-CM code(s): CSF rhinorrhea (349.81), UTI (599.0), intracerebral hemorrhage (431), unilateral vocal cord paralysis (478.31, 478.32), CSF otorrhea (388.61), dysphagia (780.20–780.22, 780.29). ICU readmission is defined as the patient was transferred from the ICU to the floor and subsequently returned to the ICU. Length of stay is the total time the patient spent in the hospital (either on the floor and/or ICU).

Patients were categorized into six age groups: <18 years, 18–30 years, 31–50 years, 51–64 years, 65–74 years, >74 years. Some age groups were combined from smaller subgroups due to a low number of cases. Patients were excluded from analysis by race if they declined to identify, had unavailable data, or were categorized as “other.”

Statistical Analysis

All analyses and graphs were performed using Microsoft Excel 2013 (Redmond, WA, USA) and MedCalc 16.4.3 (MedCalc Software bvba, Belgium). Comorbidities and demographic variables such as age, race, and gender were evaluated by means of summary statistics. Continuous variables were summarized by mean $\pm$ standard deviation. Nominal variables were summarized by frequency and percentage. All continuous variables were tested for normal distribution, as determined by the Kolmogorov-Smirnov test. Comparisons of outcomes (nominal variables) were performed using Fisher’s exact test or Chi Square test. For continuous variables, comparisons were made using an independent t-test. A One-Way ANOVA was also used followed by a Tukey posthoc comparison test. Lastly, a correlation model was used to determine association among variables including LOS, ICU LOS, complication rate, and readmission rate with r-values expressing coefficients of correlation. A value of p less than 0.05 was considered indicative of statistical significance.

Analysis by Hospital Volume

Institutions were grouped according to average number of cases performed per month: High-volume hospitals (HVHs) averaging two or more per month, medium-volume hospitals (MVHs) averaging one or more but less than two per month, and low-volume hospitals (LVHs) averaging less than one per month. All MVHs and HVHs submitted data for the entire time period, while some LVHs did not due to the low volume of cases. Hospitals were

also grouped into deciles with hospitals not submitting data for the entire time period or performing less than 5 cases over the period excluded.

Results

A total of 3,697 cases were found meeting our criteria across 133 institutions (Table 1). There were 97 LVHs, 21 MVHs, and 15 HVHs in our study which performed 941, 1067, and 1689 cases, respectively. The mean LOS across all institutions was 4.9 ± 5.0 days. There were 2,648 (71.6%) patients admitted to the ICU with a mean ICU LOS of 2.0 days (standard deviation data unavailable). The overall complication rate was 5.27% and overall mortality rate was 0.38%. During their initial hospital stay, 2.8% of patients were found to require readmission to the ICU. There were 230 patients (6.2%) readmitted within 30 days after discharge with 73% (167) of these within 14 days and 43% (98) within 7 days.

Patient Outcomes by Institution

Low-volume hospitals had a significantly longer LOS (6.1 ± 7.7 days, $p < 0.0001$) compared to both MVHs and HVHs, and MVHs had a significantly longer LOS (4.9 ± 4.0 days, $p = 0.0053$) compared to HVHs (4.3 ± 3.2 days). There was a significant difference ($p = 0.0003$) among groups with respect to ICU admissions with HVHs having the lowest admission rate to the ICU (68.4%) followed by MVHs (74.1%) and LVHs (74.6%). There was a significant difference in complication rate among institutions ($p < 0.0001$). LVHs had the highest complication rate (8.0%) followed by MVHs (5.1%) and HVHs (3.9%). There was no significant difference in mortality rate based on case volume (LVH = 0.74%; MVHs = 0.28%; HVHs = 0.24%; $p = 0.1056$). There was also no difference in 30 day readmission rates. ($p = 0.24$)

Demographics

There was no significant difference found between prevalence of age groups among institutions (Table 2). The overall female to male ratio was found to be 1.25:1, which was similar across institutions. High-volume hospitals had the greatest percentage of insured patients (76.7%) followed by MVHs (68.1%) and LVHs (63.2%, $p < 0.0001$). There was also a significant difference in percentage of Medicaid patients among institutions with LVHs had the greatest percentage (11.9%) followed by MVH (8.3%) and HVHs (5.0%; $p < 0.0001$).

In this cohort, 80.3% of patients were Caucasian, 4.1% were African American, and 4.3% were Asian while 11.3% did not identify or identified as "other". We found HVHs had the highest percentage of Caucasian patients with (83.1%) followed by MVHs (79.5%) and LVHs (76.3%) ($p = 0.0001$). There was also a significant difference in Asian population among the institutions ($p < 0.0001$) with LVHs having the highest (7.5%) followed by MVHs (3.7%) and HVHs (2.9%). The overall prevalence of African Americans was similar across institutions (4.1%; $p = 0.2628$).

Comorbidities

The top twelve most prevalent comorbidities were analyzed for differences across institutions (Table 3). With some exceptions, the rate of specific comorbidities did not

greatly differ among institutions as separated by surgical volume. However, there were slight differences among institutions in prevalence of hypertension ($p = 0.0194$) and depression ($p = 0.0098$). The HVH patient population had the lowest incidence of hypertension (32.6%) followed by LVHs (36.6%) and MVHs (37.4%) ($p = 0.0194$). The prevalence of comorbidities such as diabetes without chronic complications ($p = 0.2242$), COPD ($p = 0.3474$), and renal failure ($p = 0.7896$) were not significantly different across institutions.

Complications and diagnoses of interest

Complications had significant differences among institutions with LVHs having the highest rate of each: stroke (3.2%, $p = 0.0175$), postoperative respiratory failure (3.2%, $p < 0.0001$), aspiration pneumonia (1.6%, $p = 0.0071$), and PE or DVT (1.3%, $p = 0.0079$) Table 4). Analysis of complication rate versus institutional volume by decile revealed a strong correlation of higher volumes institutions having less complications ($r = -0.84$, $p = 0.0026$) (Figure 1).

When reviewing other diagnoses of interest, LVHs also had the highest rates of postoperative dysphagia (4.5%, $p = 0.0087$) and UTI (2.2%, $p = 0.0309$). The rates of postoperative intracerebral hemorrhage were overall very low, but there was a significant difference in rates with LVHs having the highest (1.9%) followed by MVHs (1.1%) and HVHs (0.8%) ($p = 0.0475$). There was no statistically significant difference among institutions regarding postoperative CSF rhinorrhea ($p = 0.1981$) or unilateral vocal paralysis ($p = 0.2529$).

Discussion

We present a study of 3,697 cases investigating VS surgical outcomes versus hospital volume through utilization of the UHC database. In key metrics, such as hospital LOS and complication rate, we found a clear trend of improved outcomes in institutions performing high volumes of VS surgery. We found many significant differences among institutions while the patient demographics we analyzed were mostly similar across institutions.

Prior studies have examined the effect of volume on outcomes for VS using the California hospital inpatient database with findings supporting our data; institutions that perform higher volumes of VS surgery have lower complication rates, shorter LOS, and more routine discharges.^{9,13} Additional studies analyzing the National Inpatient Sample Quality Insurance database found similar improved outcomes in VS surgery with either increasing surgeon or hospital volume.^{5,14} Our study utilizes a national database of mostly academic institutions and shows a more detailed level how improved VS surgery outcomes are associated with institutions that more regularly perform VS surgery.

There is no clear trend in hospital volume reducing LOS for many other high-risk surgeries, whereas we found a difference for VS surgery.^{15,16} Due to shortened LOS, reduced number of complications, and admitting significantly fewer patients to the ICU, HVHs may have a significant cost savings. Admission directly to the floor may have been possible through a specialty nursing unit. Analysis of a specialty unit utilized for postoperative head and neck microvascular free tissue transfer procedure patients showed significant cost savings while achieving similar morbidity outcomes.¹⁷ Clinicians with greater caseloads may also feel

more comfortable with discharging patients sooner after surgery due to their ability to better discriminate the severity and seriousness of symptoms. Also, high volume centers likely have ancillary staff (social work, physical and occupational therapy, nursing staff) that are more comfortable caring for and anticipating the needs of these post-operative patients. This can lead to decreased ICU and hospital stay.

Our study shows clear differences in outcomes for VS surgery based on institutional volumes, which is potentially a result of many factors. Surgeon experience is clearly a factor in VS surgery patient outcomes..^{14,18–23} It is estimated that inexperienced surgical teams need approximately 50–60 surgical cases to have outcomes comparable to experienced surgeons when it comes to outcomes on facial nerve and hearing preservation rates . However, it has been shown that inexperienced surgical teams have similar rates of complications including CSF leaks, complete tumor resection, hearing preservation, stroke, or mortality when compared to experience surgeons.²⁰ Unfortunately, this database does is unable extract outcomes based on the operating surgeon (or surgeons). However, we assume that centers with the highest volume contain the individual surgeons with the greatest operative volume and may serve as the best available surrogate. Individual surgeons along with their complication rates at any institution are not available through the database. We believe surgical experience is mainly influenced by three variables: current caseload, cumulative case experience, and presence or absence of subspecialty training. Other procedures have also shown to have better outcomes with greater surgeon experience. The Whipple procedure (pancreaticoduodenectomy), a complex procedure with a mortality rate of approximately 5%, was shown to have much more favorable outcomes including shorter LOS and lower mortality with more surgeon experience, independent of hospital volume.²⁴ Similarly, surgeon caseload and specialty training have also been associated with reduced mortality after rectal cancer resection, total hip replacement, and abdominal aortic aneurysm repair.^{25–27}

We found a clear reduction of number of complications with increasing hospital volume by decile for VS surgery. When analyzing the top four tracked complications (stroke, postoperative respiratory failure, aspiration pneumonia, PE or DVT), LVHs were shown to have the highest rate. Low-volume hospitals also had high rates of other serious complications including UTI, dysphagia, and intracerebral hemorrhage. Besides their associated increase in morbidity, these complications can also lead to poorer outcomes including longer length of stay and need for more intensive care. High-volume hospitals may have the added benefit of economies of scale which can justify fixed-cost investments in improving health care delivery, such as development of nursing protocols and education resources that help mitigate errors and complications.

There was a higher prevalence of insured patients at HVHs, which has been shown to be associated with a higher likelihood of routine disposition (as opposed to mortality, step down facility, or home health).²⁸ A possible explanation for this difference is that underinsured patients have been shown to have worse overall health and more often have delayed diagnoses leading to more advanced disease at time of presentation which can complicate their postoperative course.^{29,30} This may hold especially true for patients with VS patients who need, but don't obtain, expensive MR imaging for early diagnosis, as later diagnosis

may portend a larger tumor size leading to a higher risk of complications.^{31,32} Furthermore, HVHs might also benefit from several factors that affect referral patterns. Privately insured patients on average have greater personal resources,³³ which may enable them to seek care at institutions located far from their residence. Also, these patients typically have attained higher educational attainment, potentially leading them to seek out more experienced hospitals and surgeons.³³ Specific institutional and/or provider philosophies regarding the use of stereotactic radiation (STR) is an important issue as it relates to patient outcomes including subtotal resection followed by SRT. The rates of SRT vs. VS surgery in regards to patient socioeconomics has not been addressed. However, individual patient data at this level is not accessible through this database and is beyond the scope of this paper.

Our study shows overall mortality rates for VS were very low with no detectable difference found based on hospital volume ($p = 0.11$). Similarly, analysis of the National Inpatient Sample database of institutions performing VS surgery from 1996–2000 found a mortality rate of 1.1% at the lowest quartile versus 0.6% at the highest quartile, with these differences also not significant ($p = 0.10$).¹⁴ Higher institutional volume has previously been associated with reduced mortality for many high-risk surgeries.^{15,34–37}

Our study is limited by the analysis of summary data from the UHC database that precludes us from performing multivariate analysis, whereas patient-level data would have allowed this. Although we were unable to extract this data, we were still able to draw meaningful conclusions concerning the role of institutional volume on patient care. Coding practices employed by institutions may vary based on institutional size creating another potential bias which would substantially change the capture rate for diagnoses and complications. We were also unable to assess differences in cases (especially complications) with regards to tumor size, completeness of the resection and surgical approach as ICD-9-CM codes do not capture these attributes. As all of the above factors have been shown to impact surgical outcomes, interpretation of the data can be challenging. However, patients with VS present with variable symptoms of audiovestibular dysfunction which does not necessarily correlate with tumor size. So, it is reasonable to conclude that patients with comparable tumor sizes present at low or high volume centers. There is no literature to support the assertion that low volume centers be operating on disproportionately larger tumors as compared to high volume centers which would adjust for the higher rate of complications. Further, the completeness of tumor resection has not been studied at low vs. high volume centers. Unfortunately, when the UHC database started ICD 9 coding was used. There are ICD 9 codes for CSF leaks (rhinorrhea/Otorrhea) but there are not ICD 9 codes for an incisional CSF leak. The use of a lumbar drain or which surgical approaches used are CPT codes which are not used in the database. Within the ICD 9 classification only the procedural of excision of acoustic neuroma exists which is v04.01. The UHC has transitioned to ICD 10 which in the future should hopefully be able to provide more specific information. Long-term follow-up to examine outcomes such as hearing and facial nerve function is also lacking. Individual surgeon volume data was inaccessible in our study, therefore hospital versus surgeon driven differences could not be assessed.

Conclusion

Lower institutional volume was associated with a significantly longer LOS and higher complication rates in patients with VS undergoing surgical resection of their tumor. Demographics among hospital groups were mostly similar though HVH had significantly more patients who were privately insured and Caucasian. Further studies are warranted examining the role of surgeon and institutional experience on patient outcomes for VS surgery.

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Figure 1. Trend of Complications by volume deciles

University HealthSystem Consortium (UHC)-tracked complication rate versus hospital volume deciles. Linear regression demonstrated a strong correlation of -0.84 (r).

Table 1

Patient outcomes comparison

	LVH	MVH	HVH	Total	p
Institutions	97	21	15	133	
Cases (n)	941	1067	1689	3,697	
LOS (days $\pm$ SD)	6.1 $\pm$ 7.7 *	4.9 $\pm$ 4.0 †	4.3 $\pm$ 3.2	4.9 $\pm$ 5.0	* p<0.001 † p=0.005
ICU mean LOS (days)	2.8	1.8	1.7	2.02	n/a
ICU Cases (%)	702 (74.6%)	791 (74.1%)	1155 (68.4%)	2,648 (100%)	0.0003
Complications (n / %)	75 (8.0%)	54 (5.1%)	66 (3.9%)	195 (5.3%)	< 0.0001
Mortality (n / %)	7 (0.7%)	3 (0.3%)	4 (0.2%)	14 (0.4%)	0.11
Readmissions (n / %)	66 (7.0%)	71 (6.7%)	93 (5.5%)	230 (6.2%)	0.24
Return to ICU (n / %)	44 (4.7%)	39 (3.7%)	22 (1.3%)	105 (2.8%)	< 0.0001

Patient outcomes compared across varying hospital volumes and total population.

* compared to MVC or HVC.

† compared to HVC.

Length of Stay (LOS); Intensive Care Unit (ICU); Low-volume Hospitals (LVH); Medium-volume Hospitals (MVH); High-volume Hospitals (HVH).

Table 2

Comparison of demographic groups

Age Group	LVH n (%)	MVH n (%)	HVH n (%)	Total n (%)	p
< 18	9 (1.0%)	13 (1.2%)	17 (1.0%)	39 (1.1%)	0.82
18 – 30	94 (10.0%)	89 (8.3%)	133 (7.9%)	316 (8.5%)	0.17
31 – 50	343 (36.5%)	361 (33.8%)	635 (37.6)	1339 (36.2%)	0.13
51 – 64	358 (38.0%)	447 (41.9%)	660 (39.1%)	1465 (39.6%)	0.17
65 – 74	109 (11.6%)	126 (11.8%)	202 (12.0%)	437 (11.8%)	0.96
> 74	28 (3.0%)	30 (2.8%)	42 (2.5%)	99 (2.7%)	0.74
Sex					
Female	522 (55.5%)	572 (53.6%)	958 56.7%)	2052 (55.5%)	0.28
Male	419 (44.5%)	495 (46.4%)	731 (43.3%)	1645 (44.5%)	
Payer					
Insured	595 (63.2%)	727 (68.1%)	1,296 (76.7%)	2618 (70.8%)	< 0.0001
Medicare	156 (16.6%)	177 (16.6%)	241 (14.3%)	574 (15.5%)	0.15
Medicaid	112 (11.9%)	89 (8.3%)	85 (5.0%)	286 (7.7%)	< 0.0001
Self-Pay	22 (2.3%)	12 (1.1%)	18 (1.1%)	52 (1.4%)	0.019
Other	56 (6.0%)	62 (5.8%)	49 (2.9%)	167 (4.5%)	0.0001
Race					
African American	47 (5.0%)	40 (3.7%)	64 (3.8%)	151 (4.1%)	0.26
Asian	71 (7.5%)	40 (3.7%)	49 (2.9%)	160 (4.3%)	< 0.0001
Caucasian	718 (76.3%)	848 (79.5%)	1,404 (83.1%)	2970 (80.3%)	0.0001
Total	941 (100%)	1,067 (100%)	1,689 (100%)	3697	

Comparison of demographic groups including age, sex, payer, and race. Low-volume hospitals (LVH); Medium-volume hospitals (MVH); High-volume hospitals (HVH)

Table 3

Comparison of prevalence of comorbidities

Comorbidity	LVH n (%)	MVH n (%)	HVH n (%)	Total n (%)	p
Hypertension	344 (36.6%)	399 (37.4%)	551 (32.6%)	1294 (35.0%)	0.019
Obesity	116 (12.3%)	145 (13.6%)	223 (13.2%)	484 (13.1%)	0.69
Chronic pulmonary disease	101 (10.7%)	117 (11.0%)	159 (9.4%)	377 (10.2%)	0.35
Depression	99 (10.5%)	114 (10.7%)	130 (7.7%)	343 (9.3%)	0.0098
Hypothyroidism	80 (8.5%)	94 (8.8%)	162 (9.6%)	336 (9.1%)	0.60
Diabetes without chronic complications	80 (8.5%)	76 (7.1%)	113 (6.7%)	269 (7.3%)	0.22
Rheumatoid arthritis	21 (2.2%)	18 (1.7%)	23 (1.4%)	62 (1.7%)	0.25
Valvular disease	13 (1.4%)	20 (1.9%)	26 (1.5%)	59 (1.6%)	0.66
Renal failure	9 (1.0%)	13 (1.2%)	21 (1.2%)	43 (1.2%)	0.79
Diabetes with chronic complications	9 (1.0%)	12 (1.1%)	18 (1.1%)	39 (1.1%)	0.93
Drug abuse	12 (1.3%)	10 (0.9%)	13 (0.8%)	35 (0.9%)	0.44

Comparison of prevalence of comorbidities across varying hospital volumes and total population. Low-volume hospitals (LVH); Medium-volume hospitals (MVH); High-volume hospitals (HVH).

Table 4

Comparison of prevalence of complications.

Complications	LVH n (%)	MVH n (%)	HVH n (%)	Total n (%)	p
Dysphagia	42 (4.5%)	32 (3.0%)	39 (2.3%)	113 (3.1%)	0.0087
CSF Rhinorrhea	11 (1.2%)	21 (2.0%)	36 (2.1%)	68 (1.8%)	0.20
UTI	21 (2.2%)	13 (1.2%)	17 (1.0%)	51 (1.4%)	0.031
Intracerebral Hemorrhage	18 (1.9%)	12 (1.1%)	14 (0.8%)	44 (1.2%)	0.050
Unilateral Vocal Cord Paralysis	9 (1.0%)	4 (0.4%)	14 (0.8%)	27 (0.7%)	0.25
CSF Otorrhea	5 (0.5%)	5 (0.5%)	8 (0.5%)	18 (0.5%)	0.97
UHC-tracked Complications					
Stroke	30 (3.2%)	17 (1.6%)	29 (1.7%)	76 (2.1%)	0.020
Postoperative Respiratory Failure	30 (3.2%)	11 (1.0%)	9 (0.5%)	50 (1.4%)	<0.0001
Aspiration Pneumonia	15 (1.6%)	10 (0.9%)	7 (0.4%)	31 (0.8%)	0.0071
PE or DVT	12 (1.3%)	12 (1.1%)	5 (0.3%)	29 (0.8%)	0.0079
Total	941 (100%)	1,067 (100%)	1,689 (100%)	3,697 (100%)	

Comparison of prevalence of complications including UHC-tracked Complications, University HealthSystem Consortium (UHC); Low-volume Hospitals (LVH); Medium-volume hospitals (MVH); High-volume hospitals (HVH).