

Impact of Resident Involvement in Outpatient Otolaryngology Procedures: An Analysis of 17,647 Cases

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Objective: This study examines the impact of resident physician participation on postoperative outcomes in outpatient otolaryngologic surgery.

Study Design: Retrospective cohort.

Methods: The American College of Surgeons National Surgical Quality Improvement Program database was queried for outpatient otolaryngologic procedures performed on adult patients. Cases were analyzed with the following cohorts: *attending with resident* or *attending without resident*. Outcomes included complications, readmission, reoperation, and operative time.

Results: A total of 17,647 cases were analyzed, with 13,123 patients in the attending without resident cohort and 4,524 patients in the attending with resident cohort. The majority of patients were female (58.7%) and white (88.0%). The average age was 44 (range 16–89) years, and average body mass index was 29.0 ± 7.3 kg/m². Total relative value units were higher in the attending with resident group 14.6 ± 12.0 compared with 10.2 ± 8.3 in the attending without resident group ($P < 0.01$).

Univariate analysis revealed that resident participation increased complication rate (2.0% vs. 1.4%, $P < 0.01$) and operative time (108 ± 98 minutes vs. 60 ± 55 minutes, $P < 0.01$). There were no differences in readmissions ($P = 0.35$), reoperations ($P > 0.05$), or death rates ($P = 0.32$) between groups. Multivariate regression analysis, however, revealed that resident participation did not increase the rate of any complication, and that operative time was the only significantly impacted variable ($P < 0.01$).

Conclusion: Resident surgical training remains a vital component of the current health care system. Previous research has shown that, despite increased operative time, resident participation does not significantly impact complication rates for otolaryngology procedures. This study confirms these findings in the outpatient setting, thus reassuring both the surgeon and patients that resident participation does not impact procedural safety.

Key Words: Complication, resident education, resident, ACS-NSQIP, National Surgical Quality Improvement Program.

Level of Evidence: 4.

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INTRODUCTION

Surgical residency programs are expected to provide safe, efficient, high-quality patient care while simultaneously providing excellent education to resident surgeons-in-training. In the United States, surgical training in the operating room is hands-on. With increased experience, residents are able to hone their skills under guided supervision of an attending surgeon with graduated independence over many years. Despite close observation of residents by

attending surgeons, many patients are concerned with the role that residents may play in their surgical outcomes. In one study, one-third of patients undergoing surgery did not want any resident involvement as part of their surgical care.¹ This highlights the insecurities patients may face when undergoing surgery at academic institutions, fearful that resident participation may potentiate the possibility of morbidity and mortality after surgery. In addition, recent changes in the healthcare environment increasingly are focused on quality metrics that serve as proxies for both safe and efficient patient care, and information regarding the impact of resident involvement on these outcomes is needed.

In recent years, several studies in surgical fields, including general surgery, urology, vascular surgery, and neurosurgery, have examined the influence of resident participation on postoperative outcomes.^{2–10} In general, these studies demonstrated that resident involvement in surgery is associated with increased operative time but does not result in adverse patient outcomes. Recently, resident presence in otolaryngology cases has been studied and shows no increase in adverse patient outcomes.^{11,12} To the best of our knowledge, the impact of

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resident presence on outpatient procedures and operative time has not been studied in a multi-institutional setting and warrants further investigation for the reasons discussed above.

Therefore, the principal aim of this project is to determine the impact of resident involvement on postoperative morbidity and mortality following outpatient otolaryngology procedures. We hypothesize that resident involvement will not adversely affect postoperative outcomes but may increase operative time.

MATERIALS AND METHODS

Data Source

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) is a validated, prospective, multi-institutional national database that provides patient-specific surgical outcomes data. These data are available to participating hospitals and affiliated individuals in the United States. ACS-NSQIP details more than 300 data points for de-identified cases, including preoperative comorbidities, demographic information, intraoperative variables, and 30-day postoperative outcomes. The ACS-NSQIP and participating hospitals are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors (ACS-NSQIP, Data Use Agreement). The Medical University of South Carolina Institutional Review Board determined that this project meets criteria for “not human subjects” research.

Patient Selection

We performed a retrospective analysis using the ACS-NSQIP database from 2005 to 2013. The surgeon self-described specialty variable was utilized to examine patients undergoing procedures by a surgeon described as a specialist in otolaryngology–head and neck surgery. Patients aged 16 to 89 years were included due to constraints of the information available. Only outpatient surgeries by an otolaryngologist were included. Cases were included if information regarding level of supervision (attending without resident or attending with resident) was available. Exclusion criteria included: unknown operative specialty, specialty other than otolaryngology, inpatient procedure, or unknown supervision level. Patients were separated into groups based on the attending supervision level, yielding two cohorts: attending without resident and attending with resident.

Demographics, Comorbidities, and Operative Characteristics

Demographic information collected were age, body mass index (BMI), race, and gender; these variables were compared between the two cohorts. Smoking status and alcohol consumption were analyzed with comorbidities.

Comorbid conditions and operative characteristics included in the ACS-NSQIP were analyzed. The ACS-NSQIP Participant Use Data File User Guide contains a list of these variables and exact definitions.¹³ Operative characteristics data were available for work relative value units (WRVUs) and elective surgery. For each patient, the total WRVU was calculated by summing the WRVUs for all Current Procedural Terminology codes recorded for that patient. Total WRVU was used to control for differences in procedural complexity as described in prior studies.^{4,14}

Postoperative Outcomes and Complications

The primary outcome measure of interest was the occurrence of a complication within the 30-day postoperative period. Complications were categorized as medical, surgical, or any complication for analysis of predictive factors. This methodology has previously been employed by Lawrence et al.¹⁵ Surgical complications were defined as superficial surgical site infection (SSI), deep SSI, bleeding complication requiring blood transfusion, or wound dehiscence. Medical complications included cardiovascular (cardiac arrest, myocardial infarction, or stroke), pulmonary (pneumonia, unplanned re-intubation, or ventilator-assisted respiration for more than 48 hours), neurologic (coma), renal (progressive renal insufficiency or acute renal failure), thromboembolic (deep vein thrombosis or pulmonary embolism), urinary tract infection, and sepsis or septic shock.

Other outcome measures of interest included reoperation, readmission, total length of operation, and death. Attending without resident cases were compared with attending with resident cases with regard to all outcome measures in separate analyses.

Statistical Analysis

All analyses were performed with SPSS 23.0 (IBM Corp., Armonk, NY). Categorical variables are presented as frequency and percentage of valid data, and continuous variables are presented as mean \pm standard deviation or as mean and range in text and tables. All continuous variables were assessed for normality using the Shapiro-Wilk test. If these variables were not normally distributed, descriptive measurements such as median and interquartile range were calculated. Comparisons of patient characteristics were performed using a chi-square test or Fisher's exact test for categorical variables and an independent *t* test or a Mann-Whitney rank sum test for continuous variables. A correlation model was used to determine the relations between independent and dependent variables; these correlated independent variables were examined between groups. All independent variables that showed a significant correlation with dependent variables were placed in multiple logistic regression or multiple linear regression models. The adjusted odds ratio (OR) was used for logistic regression. The un-standardized B coefficient (B) and its confidence interval were used for linear regression, where B coefficient represents the linear relation between the independent predictors and the dependent variable. A *P* value of < 0.05 was considered to indicate a statistically significant difference for all statistical tests.

RESULTS

Patient Demographics

A total of 60,823 patients who underwent a procedure by an otolaryngologist were identified in the ACS-NSQIP database from 2005 to 2013, of which 39,890 were outpatient procedures. Of those, 17,647 cases included data on attending supervision. Demographic characteristics are presented in Table I.

Comorbidities and Operative Characteristics

Medical comorbidities, laboratory values, and operative characteristics were compared via univariate analysis between attending with resident and attending without resident groups. Several, independent variables differed significantly between groups; these data are depicted in Table II. As expected in outpatient surgeries,

TABLE I.
Demographics.

	All Patients		Attending Without Resident		Attending With Resident		P Value
	Frequency	%	Frequency	%	Frequency	%	
Age of patient, years	44 ± 18 range (16–89)		43 ± 18 range (16–89)		48 ± 18 range (18–89)		< 0.001
Gender	Female	10336 58.7%	7867 60.0%	2469 54.8%	2040 45.2%		< 0.001
	Male	7280 41.3%	5240 40.0%	2040 45.2%			
Race	White or Caucasian	12525 88.0%	9554 89.3%	2971 84.2%			< 0.001
	Black or African American	1097 7.7%	718 6.7%	379 10.7%			
	Asian or Pacific Islander	440 3.1%	275 2.6%	165 4.7%			
	American Indian or Alaska Native	171 1.2%	156 1.5%	15 0.4%			
BMI, kg/m ²	29.0 ± 7.3		29.2 ± 7.4		28.3 ± 6.9		< 0.001

BMI = body mass index.

the majority of cases were elective (98.4%). Importantly, both total WRVUs and American Society of Anesthesiologists (ASA) Class were higher in the attending with resident group ($P < 0.001$, for both). Table III contains the most frequent procedures in each group.

Outcomes

Outcome measures of interest are presented in Table IV. Total operative time was significantly longer in the attending with resident group (108 ± 98 vs. 60 ± 55 minutes, $P < 0.001$).

In the entire cohort, reoperation was required in 2.1% ($n = 376$) of cases. Readmission was noted in 3.1% ($n = 107$) of patients. The mortality rate within 30 days of surgery was low (0.1%). No differences in readmission or mortality were noted between groups. The reoperation rate in the attending with resident group trended lower but did not achieve significance compared with the attending without resident group (1.8% vs. 2.3%, respectively, $P = 0.0503$).

With regard to total complication rates, 1.6% of patients experienced either a surgical or medical postoperative complication. Of these complications, 0.8% were surgical and 0.8% were medical in nature. Univariate analysis demonstrated that when compared with attending without resident cases, patients in the attending with resident group were more likely to experience any complication (91 [2.0%] vs. 188 [1.4%], $P = 0.007$) or a surgical complication (51 [1.1%] vs. 92 [0.7%], $P = 0.007$).

Regression Analysis

To determine the relation between attending with resident versus attending without resident and complication characteristics, univariate and multivariate regression analysis are summarized in Tables V and Table VI. Operative time was left as a continuous variable. The results confirmed the effect that presence of a resident had on the outcomes. Multivariate regression analysis revealed that the presence of a resident was predictive of increased total operative time, even when

controlling for confounding variables ($B = 31.2$ [25.7–36.7], $P < 0.001$). Interestingly, the presence of a resident was no longer a significant predictor of the other outcomes: surgical complication (OR = 2.109 [0.93–4.67]) or any complication (OR = 1.02 [0.70–1.50]).

DISCUSSION

Since the inception of resident training in the 19th century, surgical residency programs have been tasked with producing surgeons capable of treating patients in a variety of surgical specialties.¹⁶ Although the residency training model has persevered through the greater part of a century and a half, the medical climate and mechanism of healthcare delivery have undergone significant change. Recent passage and implementation of the Affordable Care Act has contributed to the increasing legislative interest in outcomes-oriented care and performance tracking through various predetermined metrics. Perhaps most importantly, concerns persist from the perspective of patients, third-party payers, healthcare providers, and policy makers regarding the impact of resident participation on surgical outcomes. For this reason, the principal aim of the current study was to examine the relation between resident participation in otolaryngology outpatient cases and outcomes.

The ACS-NSQIP database has been used to target improvement in surgical decision making and permits in-depth analysis of patient and procedural factors that may influence postoperative outcomes.⁴ Previously published articles have employed the ACS-NSQIP database to conduct large-scale, multi-center analyses to examine the impact of resident involvement on surgical outcomes in the fields of neurosurgery, orthopedics, plastics, general, and vascular surgery.^{2–10} Recently, there have been several articles concerning resident involvement in otolaryngology procedures.^{11,12} To our knowledge, this is the first study to utilize multi-institutional data to analyze the impact of resident participation on specifically outpatient surgical outcomes in otolaryngology procedures.

In this study, multivariate analysis was used to examine factors that were statistically significant on

TABLE II.
Comorbidities and Operative Variables.

	All Patients		Attending Without Resident		Attending With Resident		P Value
	Frequency	%	Frequency	%	Frequency	%	
Elective surgery	7695	98.4%	4745	98.0%	2950	99.0%	0.002
Emergency case	243	1.4%	227	1.7%	16	0.4%	<0.001
Work relative value units (total)	11.5 ± 9.7		10.2 ± 8.3		14.6 ± 12.0		<0.001
Diabetes mellitus	1412	8.0%	1009	7.7%	403	8.9%	0.009
Alcohol > 2 drinks/day in 2 weeks before admission	377	2.2%	217	1.7%	160	3.6%	<0.001
Hypertension requiring medication	4754	26.9%	3433	26.2%	1321	29.2%	<0.001
History of intervention for peripheral vascular disease	69	0.4%	44	0.3%	25	0.6%	0.042
Disseminated cancer	121	0.7%	77	0.6%	44	1.0%	0.007
Open wound/wound infection	176	1.0%	101	0.8%	75	1.7%	<0.001
Steroid use for chronic condition	243	1.4%	146	1.1%	97	2.1%	<0.001
> 10% loss body weight in last 6 months	89	0.5%	44	0.3%	45	1.0%	<0.001
Chemotherapy for malignancy in ≤ 30 days preoperatively	67	0.4%	27	0.2%	40	0.9%	<0.001
Radiotherapy for malignancy in ≤ 90 days preoperatively	64	0.4%	30	0.2%	34	0.8%	<0.001
Systemic sepsis	99	0.6%	85	0.7%	14	0.3%	0.008
Wound classification							
1: clean	6230	35.3%	4192	31.9%	2038	45.0%	<0.001
2: clean/contaminated	10658	60.4%	8319	63.4%	2339	51.7%	
3: contaminated	424	2.4%	330	2.5%	94	2.1%	
4: dirty/infected	335	1.9%	282	2.1%	53	1.2%	
American Society of Anesthesiologists classification							
1	4000	22.9%	3197	24.7%	803	17.8%	<0.001
2	9466	54.1%	7022	54.2%	2444	54.1%	
3	3839	22.0%	2607	20.1%	1232	27.3%	
4–5	182	1.0%	141	1.1%	41	0.9%	

Only variables that were significantly different between groups are shown. Variables that were notably higher in the attending with resident group included total work relative value units, alcohol use, open wound/wound infection, steroid use, and recent chemotherapy or radiotherapy.

univariate analysis. When examined using multivariate analysis, resident presence was not a predictor of total complications or surgical complications. Even after controlling for confounding factors, total operative time remained significantly higher with resident involvement than without ($B = 31.2$ [25.7–36.7], $P < 0.001$). These multivariate findings concerning resident involvement in surgery agree with the previously published literature

examining resident impact on outcomes in otolaryngology procedures.^{11,12,17} Most importantly, these data add further support to the contention that patient safety is not compromised by resident involvement in cases.

Our findings are consistent with published data from other surgical subspecialties. Bydon et al. showed that 30-day morbidity and mortality were not different with resident participation in neurosurgical procedures.²

TABLE III.
Ten Most Frequent Procedures in Each Group.

Attending Alone		Attending Plus Resident	
Procedure	Frequency (%)	Procedure	Frequency (%)
Tonsillectomy (42826)	3623 (27.6%)	Tonsillectomy (42826)	662 (14.6%)
Adenotonsillectomy (42821)	1221 (9.3%)	Tympanoplasty (69631)	323 (7.1%)
Thyroid lobectomy (60220)	752 (5.7%)	Thyroid lobectomy (60220)	321 (7.1%)
Total thyroidectomy (60240)	743 (5.7%)	Palatopharyngoplasty (42415)	238 (5.3%)
Palatopharyngoplasty (42145)	726 (5.5%)	Total thyroidectomy (60240)	181 (4.0%)
Tympanoplasty (69631)	562 (4.3%)	Parathyroidectomy (60500)	143 (3.2%)
Parotidectomy (42415)	478 (3.6%)	Parotidectomy (42415)	139 (3.1%)
Parathyroidectomy (60500)	381 (2.9%)	Adenotonsillectomy (42821)	121 (2.7%)
Excision of submandibular gland (42440)	269 (2.0%)	Cervical lymphadenectomy (38724)	112 (2.5%)
Adenoidectomy (42831)	190 (1.4%)	Excision of submandibular gland (42440)	111 (2.5%)

TABLE IV.
Thirty-Day Outcomes.

	All Patients		Attending Without Resident		Attending With Resident		P Value	
	Frequency	%	Frequency	%	Frequency	%		
Total operation time, minutes	72.4 ± 71.7		60.0 ± 54.9		108.2 ± 97.9		< 0.001	
Return to operating room	No	17271	97.9%	12827	97.7%	4444	98.2%	0.0503
	Yes	376	2.1%	296	2.3%	80	1.8%	
Readmission	No	3309	96.9%	2065	97.1%	1244	96.5%	0.349
	Yes	107	3.1%	62	2.9%	45	3.5%	
Death within 30 days	Alive at 30 days	17638	99.9%	13115	99.9%	4523	100.0%	0.318
	Death within 30 days	9	0.1%	8	0.1%	1	0.0%	
Medical complication	No	17507	99.2%	13023	99.2%	4484	99.1%	0.425
	Yes	140	0.8%	100	0.8%	40	0.9%	
Surgical complication	No	17504	99.2%	13031	99.3%	4473	98.9%	0.006
	Yes	143	0.8%	92	0.7%	51	1.1%	
Any complication	No	17368	98.4%	12935	98.6%	4433	98.0%	0.007
	Yes	279	1.6%	188	1.4%	91	2.0%	

Total operation time, surgical complications, and any complication were increased in the attending with resident group.

Auerbach et al. demonstrated that resident involvement in scoliosis surgery led to increased operative times, but an increased risk of complications with resident participation was not evident.¹⁸ Although not all variables can be controlled for, when adjustments for hospital-level variations were made, observed differences in complications due to resident involvement were no longer significant.

Operative time remained significant even after adjustments were made; this has been shown in several previous studies. In neurosurgery, Bydon et al. noted that operative times were significantly longer in attending with resident operations when compared with attending without resident cases.² Vieira et al. indicated an increase in operative time for otolaryngology procedures in a univariate analysis between junior resident, senior resident, and fellow level involvement.¹¹ Further agreeing with our findings of increased operative time,

Meier et al. indicated that resident participation led to increased operative time in specifically endoscopic sinus surgery; however, no increase in estimated blood loss or complication rates was observed.¹⁷ It is expected that operative times, complexity of cases, and comorbidities would be higher in the attending with resident group, which is confirmed in our analysis.

In this study, we evaluated resident involvement as an independent risk factor on postoperative outcomes. There were several statistically significant differences observed in a number of preoperative demographic and medical comorbidity variables, thereby creating potential bias in our findings. These differences often were small, and their clinical significance remains unclear. Although a multivariate analysis attempts to control for these discrepancies, it cannot eliminate them entirely. The difference in total WRVUs should be noted because composite WRVU can serve as

TABLE V.
Logistic Regression Analysis: Attending With Resident Versus Attending Without Resident.

Attending With Resident Versus Attending Without Resident	Univariate				Multivariate*			
	P Value	OR	95% CI for OR		P Value	OR	95% CI for OR	
			Lower	Upper			Lower	Upper
Readmission	0.349	1.21	0.82	1.78	–	–	–	–
Unplanned readmission	0.659	0.87	0.46	1.65	–	–	–	–
Return to operating room	0.051	0.78	0.61	1.00	–	–	–	–
Death within 30 days	0.339	0.36	0.05	2.90	–	–	–	–
Medical complication	0.425	1.16	0.80	1.68	–	–	–	–
Surgical complication	0.006	1.62	1.15	2.28	0.074	2.09	0.93	4.67
Any complication	0.007	1.41	1.10	1.82	0.905	1.02	0.70	1.50

Complication rates were no longer significantly increased in attending with resident cases upon multivariate analysis.

*Multivariate analysis only was performed on variables with significance upon univariate analysis.

CI = confidence interval; OR = odds ratio.

TABLE VI.
Linear Regression Analysis: Attending With Resident Versus Attending Without Resident.

Attending With Resident Versus Attending Without Resident	Univariate				Multivariate			
	B	P value	95.0% CI for B		B	P value	95.0% CI for B	
			Lower bound	Upper bound			Lower Bound	Upper Bound
Total Operation Time	48.2	<0.001	45.9	50.5	31.2	<0.001	25.7	36.7

Operative time in attending with resident cases remained significantly longer upon multivariate analysis.
CI = confidence interval.

a surrogate marker for case complexity. Total WRVU was higher in the attending with resident cohort when compared with the attending without resident group. One potential explanation for this large difference in WRVU is that at tertiary academic medical centers, residents are involved in operative cases considered to be more complex and often are recruited to help with these cases that provide unique educational opportunities. Resident involvement in more complex cases likely is a reason for increased operative length; this remains an insurmountable limitation in the ACS-NSQIP database. To establish causality, the effect that resident participation has on operative time should be further investigated with case-matched analysis of otolaryngology specific databases within academic centers with and without resident involvement.

Differences in preoperative comorbidities between our cohorts also deserve mention. Specifically, the resident cohort was involved with patients that were characterized by a higher average ASA class, and thus was skewed toward increased operative risk. Cornu et al. have reported that an ASA class 3 score was associated with poorer surgical outcomes in neurosurgical patients.¹⁹ Furthermore, Boakye et al. demonstrated that an ASA class greater than 3 was related to significantly increased risk of mortality for patients undergoing corpectomy.²⁰ These differences in WRVU and ASA may account for the increased complication rates and operative time observed in the resident group on univariate analyses. However, when these and other variables that may confound outcomes are incorporated into a multivariate model, no relation between resident participation and complications was observed.

As referenced in other similar reports, this study design has certain limitations. The retrospective nature of this study can lead to demonstrable differences in each of our cohorts regarding preoperative comorbidities, case complexity, and postoperative course. Multivariate analysis attempts to adjust for these differences though bias cannot be eliminated entirely. Some statistical significance seen in this data is not clinically significant. Resident presence is known, although degree of participation in each case cannot be extracted from the database. The ACS-NSQIP does not include information about hospital setting; therefore, the analysis cannot be limited to tertiary academic medical centers. Finally, ACS-NSQIP database defines its complications within 30 days of surgery, thereby limiting long-term

follow-up and likely underestimating overall complication rates.

CONCLUSION

Resident surgical training remains a vital component of the current health care system. In outpatient otolaryngology cases, resident participation did not significantly affect complications as defined by the ACS-NSQIP, 30-day readmission, reoperation, or death. Total operative time, however, was significantly longer with resident participation, which merits further investigation.

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