NSQIP as a Predictor of Length of Stay in Patients Undergoing Free Flap Reconstruction

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Abstract

Objective. The National Surgical Quality Improvement Program (NSQIP) calculator was created to improve outcomes and guide cost-effective care in surgery. Patients with head and neck cancer (HNC) undergo ablative and free flap reconstructive surgery with prolonged postoperative courses.

Methods. A case series with chart review was performed on 50 consecutive patients with HNC undergoing ablative and reconstructive free flap surgery from October 2014 to March 2016 at a tertiary care center. Comorbidities and intraoperative and postoperative variables were collected. Predicted length of stay was tabulated with the NSQIP calculator.

Results. Thirty-five patients (70%) were male. The mean (SD) age was 67.2 (13.4) years. The mean (SD) length of stay (LOS) was 13.5 (10.3) days. The mean (SD) NSQIP-predicted LOS was 10.3 (2.2) days ($P = .027$).

Discussion. The NSQIP calculator may be an inadequate predictor for LOS in patients with HNC undergoing free flap surgery. Additional study is necessary to determine the accuracy of this tool in this patient population.

Implications for Practice: Head and neck surgeons performing free flap reconstructive surgery following tumor ablation may find that the NSQIP risk calculator underestimates the LOS in this population.

Patients with head and neck cancer (HNC) often have numerous risk factors that complicate their perioperative care, such as advanced age, history of tobacco or alcohol use, and cardiopulmonary disease. With this, these patients are more likely to experience prolonged hospital stays. This results in increased cost and burden on the health care system.[1,2] Previous studies have demonstrated that these patients use more physician and hospital resources and necessitate more complex care than patients undergoing other otolaryngologic surgeries.[3,4]

Microvascular free flaps are commonly used for reconstruction following ablation of head and neck tumors. Free flaps have been shown to improve functional outcomes over primary closure or regional flaps; introduce healthy, well-vascularized tissue to promote healing; and can be tailored to the size of the defect.[5] The short-term complications are well known and include anastomotic failure, the need for revision surgery, and prolonged hospitalizations.[6] Despite this, many head and neck surgeons argue that free flap reconstruction represents the ideal reconstructive option for complex defects of the upper aerodigestive tract.[7]

In the 1990s, the Veterans Affairs Administration (VA) faced increasing pressures to improve quality of care and

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outcome measures for its patients undergoing surgical procedures due to high rates of morbidity and mortality. The VA established a risk calculator that stratified a patient's surgical risk based on the comorbidities and procedure performed. This was associated with a 45% decline in postoperative morbidity and 27% decrease in postoperative mortality; these changes led to a marked improvement in morbidity, mortality, and overall cost.[8,9] With these data, the onus was placed upon the private sector to develop a similar calculator. The American College of Surgeons (ACS) thus developed the National Surgical Quality Improvement Program (NSQIP) and the online risk calculator.[10,11] This is validated, risk adjusted, and outcome based.[12] Currently, this tool is used on a national level as a means to counsel patients regarding their preoperative risk for surgery, expected postoperative course, and length of stay.[13]

In this study, our objective was to assess the accuracy of the NSQIP calculator in predicting the expected length of stay (LOS) in patients with HNC undergoing free flap reconstructive surgery. To our knowledge, there are no studies examining the accuracy of the NSQIP-predicted LOS in patients with HNC undergoing free flap reconstruction following cancer ablation.

Methods

A retrospective chart review was performed on 50 consecutive outpatient adults (age >18 years) with HNC undergoing ablative and free flap reconstructive surgery at Ochsner Clinic and Foundation in New Orleans, Louisiana, from October 2014 to March 2016. Two ablative and reconstructive HNC surgeons performed all of the procedures during the study period. The work of tumor ablation and free flap reconstruction was equally distributed between the 2 surgeons. Patients were excluded if admitted for inpatient preoperative medical optimization prior to surgery or if no HNC ablative procedures were performed at the time of free flap reconstruction.

Preoperative risk factors and patient demographics were recorded (**Table 1**). Intraoperative variables, including type of free flap used, total operative minutes, intraoperative volume status, and postoperative factors such as length of time on the ventilator, time in the intensive care unit, and total LOS, were collected. A patient's morbidities were tabulated in the online ACS NSQIP calculator to determine predicted LOS.[14]*Current Procedural Terminology* (*CPT*) codes for myocutaneous and fasciocutaneous free flap with microvascular anastomosis (*CPT* 15756 and 15757, respectively) were used depending on the type of free flap performed. Surgeon adjustment of risks was designated as ''1 = no adjustment necessary'' for all patients. Institutional review board approval was obtained from the Ochsner Clinic Foundation.

Data analysis was conducted in May 2016. The associations were calculated with *t* tests, Pearson correlation, or analysis of variance (ANOVA) tests dependent on the type of the variables examined. Statistical significance for all tests was defined as $P < .05$ with calculation of 95%

confidence intervals (CIs) when appropriate. Effect size was calculated by either standardized difference or eta square dependent on the type of variable examined. Statistical calculations were performed with SPSS version 21 (SPSS, Inc, an IBM Company, Chicago, Illinois).

Results

The mean (SD) age was 67.2 (13.4) years, and 35 (70%) patients were male (**Table 1**). Mean tumor stage was 3.4. The most common subsites of disease in decreasing order were oral cavity (18 patients), skin (17), larynx (8), and paranasal sinus or anterior skull base (7). Five patients had a tracheostomy performed prior to admission, while 24 had a tracheostomy placed at the time of surgery. Six patients had a gastrostomy feeding tube prior to admission, with 18 receiving a gastrostomy tube at the time of surgery. Average body mass index (BMI) was 26.6 kg/m^2. Eleven patients received an American Society of Anesthesiology (ASA) classification of 2, 36 had an ASA of 3, and 3 were ASA 4.

All patients underwent free flap reconstruction; 2 patients required a second free flap at the time of initial reconstruction due to the complexity of the defect. Thirty-one patients (62%) underwent reconstruction with an anterolateral thigh (ALT) free flap, 10 (20%) with a radial forearm free flap, 7 (14%) with a fibula free flap, and 4 (8%) with a latissimus dorsi free flap. Four flaps (8%) required exploration due to concern for flap compromise. Two of these flaps (4%) were nonviable. Nineteen patients (38%) required an unplanned reoperation, and 5 were readmitted within 30 days of surgery. There were no deaths within 30 days of surgery.

The mean (SD) LOS for our patients was 13.4 (10.3) days, ranging from 4 to 57 days. The NSQIP-calculated LOS resulted in a mean (SD) expected LOS of 10.3 (2.2) days ($P = .027$) (**Table 2**). Of the collected preoperative risk factors, none of the examined comorbidities correlated to an increased LOS (**Table 1**).

Intraoperative variables such as tracheostomy ($P < .0001$) or gastrostomy tube insertion ($P = .03$) at the time of surgery were correlated with an increased LOS, as was a clean contaminated wound ($P < .0001$) compared with a clean wound (**Table 3**). Other factors such as total operative time greater than 700 minutes (Pearson $r = 0.43$, $P = .002$; 95% CI, 0.17-0.63) and intraoperative volume status greater than 7 L (Pearson $r = 0.46$, $P < .0001$; 95% CI, 0.21-0.66) were associated with an increased LOS.

Postoperative factors associated with a longer hospital stay included time on a ventilator greater than 36 hours (Pearson $r = 0.52$, $P = .0001$; 95% CI, 0.282-0.697), length of stay in the intensive care unit greater than 99.0 hours (Pearson $r = 0.68$, $P = .00001$; 95% CI, 0.494-0.805), unplanned return to the operating room ($P = .004$), and inability to decannulate within 30 days after surgery ($P = .04$) (**Table 4**).

Discussion

The NSQIP calculator is an important tool for preoperative planning and is associated with improved quality of surgical

Table 1. Patient Demographics and Preoperative Risk Factors Correlated to Length of Stay.

Characteristic	No.	P Value	Effect size	Average LOS	95% CI
Age, y	50	.93	0.002		
<65	16			13.31	10.94 to 15.68
65-75	13			14.10	9.03 to 19.15
>75	21			12.77	5.55 to 19.99
Sex	50	.10	0.60		
Male	35			11.34	9.40 to 13.28
Female	15			18.55	10.46 to 26.63
BMI	50	.33	0.05		
<20	4			20.75	1.82 to 43.14
20-30	34			13.17	10.06 to 16.38
>30	12			12.0	8.54 to 15.46
TSH level	19	.62	0.43		
<5.0	16			17.12	11.19 to 23.0
>5	3			25.67	−3.1 to 54.3
Albumin	37	.90	0.006		
<2.0	3			16.3	6.7 to 26.0
2.0-3.0	17			13.3	7.81 to 18.77
>3	17			14.53	8.54 to 20.5
Prealbumin	24	.24	0.52		
<20	11			20.1	9.31 to 30.87
20-40	13			13.0	9.65 to 16.35
Diabetes	14	.33	0.05	10.0	5.64 to 24.35
Smoking	24	.71	0.11	14.08	9.9 to 19.0
Alcohol use	13	.78	0.07	13	10.0 to 15.9
Dyspnea	7	.19	0.68	21	9.44 to 32.56
COPD	7	.46	0.38	17.9	5.4 to 30.4
Heart disease	19	.92	0.03	13.68	8.36 to 19.0
CVA	2	.52	0.48	9.5	0.7 to 18.3
HTN	38	.20	0.52	11.8	9.8 to 13.7
Steroid use	3	.66	0.25	15.7	7.3 to 24.1
Independent status	44	.26	0.44	14.0	10.7 to 17.2
Tracheostomy prior to surgery	5	.45	0.49	20.4	2.45 to 38.4
Gastrostomy tube prior to surgery	6	.22	0.79	25.5	6.5 to 44.5
Tumor stage	50	.55	0.05		
1	2			16.0	13.48 to 18.52
2	8			11.85	9.33 to 14.37
3	8			20.5	7.64 to 33.36
4	32			14.6	9.2 to 19.9
History of RT	10	.21	0.36	11.0	7.8 to 14.2
History of CRT	8	.84	0.09	14.63	2.5 to 26.7
History of RT or CRT	18	.68	0.13	12.6	7.1 to 18.1
ASA classification	50	.11	0.09		
2	11			10.7	7.7 to 13.7
3	36			13.4	10.4 to 16.4
4	3			24.7	7.22 to 46.6
Dialysis	3	.25	0.38	10.7	7.3 to 14.1

Abbreviations: ASA, American Society of Anesthesiology; BMI, body mass index; CI, confidence interval; COPD, chronic obstructive pulmonary disease; CRT, chemoradiation therapy; CVA, cerebrovascular accident; HTN, hypertension; LOS, length of stay; RT, radiation therapy; TSH, thyroid-stimulating hormone.

care. Throughout the United States, hospitals have used this tool to decrease morbidity and mortality, improve resource allocation,[12] and limit health care expenditure.[15] With growing emphasis on outcomes and interest in cost containment, there has been a focus on evaluating surgical quality within head and neck surgery using the NSQIP method.[13] To our

Table 2. Ablative and Reconstructive Surgery.

Characteristic	No.	Actual LOS, Mean (SD), d	NSQIP-Calculated LOS, Mean (SD), d	P Value
All patients	50	13.4 (10.3)	10.4 (2.2)	.027
Reconstructive type				
ALT	31	13.4 (12.5)	11 (2.3)	.08
Radial forearm	10	11.8 (4.5)	8.8 (1.7)	.04
Fibula	7	19.6 (5.6)	10 (2.1)	.002
Latissimus	4	6.5 (2.4)	10.1 (1.6)	.03
Primary site				
Oral cavity	18	16.6 (11.0)	9.9 (2.5)	.01
Skin	17	7.7 (2.8)	10.5 (1.9)	.0002
Larynx	8	16.5 (16.4)	11.3 (1.4)	.2
Paranasal sinus	7	15.5 (7.3)	10.2 (2.8)	.04

Abbreviations: ALT, anterolateral thigh; LOS, length of stay.

Table 3. Intraoperative Factors Correlated to Length of Stay.

Characteristic	No. of Minutes or Liters	P Value	Effect Size	Average LOS	95% CI	Pearson r
Total operative time	700	.002			0.167-0.629	0.43
Intraoperative volume status	7.0	.0006			0.213-0.657	0.46
Transfused during surgery	17	.19	0.41	16.35	10.8-21.9	
Tracheostomy insertion at time of surgery	24	.0001	1.55	17.5	13.7-21.3	
Gastrostomy tube insertion at time of surgery	18	.03	0.70	14.2	11.5-16.9	
Clean contaminated wound	37	.0001	1.07	15.7	12.1-19.3	

Abbreviations: CI, confidence interval; LOS, length of stay.

knowledge, this is the first study examining the accuracy of the NSQIP-predicted LOS in patients with HNC undergoing free flap reconstruction following cancer ablation. Our data demonstrate a statistically significant difference between actual and predicted LOS, suggesting that the current NSQIP calculator may be an inadequate predictor of LOS in this patient population. It remains unclear which variable(s) cause this underestimation.

Interestingly, we found no correlation between any preoperative risk factors and LOS. Factors that might complicate microvascular reconstruction such as diabetes, tobacco use, hypertension, and chronic steroid use[16] were not associated with an increased LOS. This is consistent with a recent publication examining fibula free flap patients.[17] White et al[17] found that increased operative time and increased time on the ventilator were associated with increased LOS, which we corroborate. Efficient 2-teamed approaches,[18] early ventilator-weaning protocols,[19] and mindful intraoperative fluid management are critical in this cohort.[20,21]

Mean LOS was significantly longer for patients who received a tracheostomy or gastrostomy tube at the time of surgery. These procedures add to the already lengthy operative time; require further resources such as home health supplies, family education, and coordination with time of patient discharge[22]; and are fraught with added complexity while admitted. A planned tracheostomy or gastrostomy

suggests that the surgeon anticipates a more lengthy postoperative recovery with concern for complications such as respiratory failure, inability to extubate, salivary fistula, complex wound management, or prolonged nil per os (NPO) status. These complexities warrant special consideration for quality improvement efforts. Productive, team-oriented dialogues to optimize systems-based care such as operating room efficiency and avoiding fluid overall is critical.

Several postoperative factors were associated with longer hospitalizations. Patients requiring a return to the OR had a mean LOS of 20.6 vs 9.5 days ($P = .004$), regardless of the type of procedure performed, which included washout with or without debridement, feeding tube placement, neck exploration, rotational flap, or an additional free flap.[23] Only 4 patients required emergent exploration due to flap compromise. Of these, 2 flaps were nonviable, which is consistent with current national data.[5,7,24,25] Nine patients required feeding tube insertion during the course of admission. This highlights the importance of preoperative assessment of postoperative swallowing function and wound status to avoid unnecessary second surgeries and prolonged LOS.

Current efforts at M.D. Anderson Cancer Center are focused on the development of a specialty-specific head and neck surgery NSQIP platform.[26] Lewis et al[26] recently

Table 4. Postoperative Factors Correlated to Length of Stay.

Characteristic	No. of Hours	P Value	Effect Size	Average LOS	CI	Pearson r Correlation
Time on ventilator	36	0.0001			0.282-0.697	0.52
Length in ICU	99	0.00001			0.494-0.805	0.68
Return to OR	19	0.004	1.02	20.0	13.8-26.2	
Readmission within 30 days	5	0.50	0.18	12.2	9.7-14.7	
Unable to decannulate within 30 days	7	0.004	0.20	23.0	12.0-34.0	

Abbreviations: CI, confidence interval; ICU, intensive care unit; OR, operating room.

examined preoperative, intraoperative, and postoperative variables to assess the feasibility of developing this system. Their goals were to determine the numerous comorbidities specific to patients with HNC requiring ablative and reconstructive surgery. The authors found that tobacco use, alcohol abuse, and hypertension were correlated with serious postoperative morbidity. They attribute these findings to the direct impact on the physiology of wound healing, tissue viability, and microcirculation.[27] Despite these wound-healing and microvascular issues, there was no mention of their impact on the patients' LOS, specifically in the patients undergoing free flap reconstruction. Interestingly, we did not see a correlation between tobacco use, alcohol abuse, or hypertension and LOS in our cohort.

It has been previously demonstrated that preoperative radiation therapy (RT) is predictive of increased rate of complications after laryngectomy.[28] The NSQIP calculator does not account for history of RT or chemoradiation (CRT). Lewis et al[26] and White et al[17] both examined the relationship between history of RT or CRT and serious morbidity or increased LOS in fibula free flaps, respectively. Neither group was able to demonstrate an association. Our cohort also failed to demonstrate a significant difference in LOS of patients who had CRT or RT and those who did not. Future studies should examine these and other factors that may influence wound healing to determine if their inclusion in the head and neck surgery NSQIP platform is necessary.

Limitations of the NSQIP calculator have been well documented in the literature.[15] Only 2% of the *CPT* procedures are head and neck codes, limiting the ability to code for the precise operation. Furthermore, only 1 *CPT* code can be used per calculation. All patients in this study required multiple ablative and reconstructive procedures concurrently. The input of multiple *CPT* codes may allow for a more accurate description of the complexity of the operation and a more realistic assessment of the morbidity inherent to such an operation. For example, a patient with squamous cell carcinoma of the oral tongue might undergo a tracheostomy; hemiglossectomy; composite resection of the floor of mouth and mandible; bilateral neck dissections of levels I, II, and III for resection; and a radial forearm free flap with microvascular anastomosis and split-thickness skin graft for reconstruction. Despite these multiple procedures, only a single *CPT* code can be evaluated at one time, which may not capture the surgical complexity.

Because the focus of this study was to examine the accuracy of the NSQIP calculator in predicting LOS following free flap reconstruction, we entered the *CPT* code for myocutaneous free flap (*CPT* 15756) or fasciocutaneous free flap (*CPT* 15757) into the calculator. However, due to insufficient data inherent to the NSQIP platform, the online calculator reflexively changed *CPT* 20955 (bone graft with microvascular anastomosis) to *CPT* 15756 (myocutaneous free flap with microvascular anastomosis). As such, although we performed 7 fibula free flaps in this cohort, each was evaluated as a myocutaneous free flap, demonstrating a limitation of the risk calculator and an area of further study.

The heterogeneous cohort of ablative surgeries performed in this study presents a limitation in our analysis, although it does reflect the diversity, heterogeneity, and complexity inherent to HNC reconstruction. This sample is the experience at a single institution. The variance between actual and predicted LOS may reflect a performance gap within our team, rather than a limitation of the tool itself. However, our free flap results are consistent with the published experiences from other centers.[24,25,29]

Future studies should look at specific subsites of ablative surgery such as oral cavity or larynx with free flap reconstruction to determine the predictive value of the NSQIP calculator and should involve multiple institutions to establish risk-adjusted benchmarks. Last, additional studies should determine the utility of the various "Surgeon Adjustment of Risks" designations on the NSQIP calculator. We selected the "1 = no adjustment necessary" label, which has been used in several publications across surgical specialties.[15,30,31] Further research is required to determine which surgeon-selected adjustment is best suited for this particular patient population.

Conclusions

The ACS NSQIP platform has been shown to reduce morbidity and mortality, improve surgical outcomes, and reduce health care spending. However, the current ACS NSQIP calculator may be an inadequate predictor of expected LOS in patients with HNC undergoing free flap reconstruction. Additional studies should focus on the various risk factors pertinent to this patient population that explain this discrepancy.

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