Factors Associated With Hospital Length of Stay Following Fibular Free-Tissue Reconstruction of Head and Neck Defects Assessment Using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) Criteria

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**IMPORTANCE** Cost containment is at the forefront of responsible health care delivery. One way to decrease costs is to decrease hospital length of stay (LOS). Data are lacking on factors contributing to LOS in patients with head and neck cancer (HNC) undergoing fibular free-tissue reconstruction (FFTR) of head and neck defects.

**OBJECTIVE** To identify factors contributing to increased LOS following FFTR of head and neck defects in patients with HNC using the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) methodology.

**DESIGN** Retrospective medical record review, with reference to the ACS NSQIP form, of 30 consecutive patients with HNC undergoing FFTR of head and neck defects in a single tertiary academic institution from July 2013 through June 2014. Data were collected on demographic and tumor characteristics, preoperative risk factors, operative variables, and postoperative adverse events.

**MAIN OUTCOMES AND MEASURES** Factors associated with increased hospital LOS.

**RESULTS** Median LOS was 10 days (range, 8-31 days), and patients were divided into 2 groups (LOS, ≤10 days [n = 16]; and LOS, >10 days [n = 14]). There were no significant differences in demographics, tumor characteristics, or preoperative medical comorbidities between the 2 groups. Univariate analysis demonstrated that operative time, ventilator dependence, wound event, and altered mental status were associated with longer LOS. Multivariate analysis revealed significant association with LOS greater than 10 days for operative time of longer than 11 hours (odds ratio [OR], 7.26; 95% CI, 1.12-47.29; \( P = .04 \)) and ventilator dependence for more than 48 hours postoperatively (OR, 12.05; 95% CI, 1.06-137.43; \( P = .045 \)).

**CONCLUSIONS AND RELEVANCE** Evaluated by the ACS NSQIP criteria, FFTR of head and neck defects in patients with HNC was associated with LOS longer than 10 days for procedures lasting longer than 11 hours and for patients who are ventilator dependent for more than 48 hours.
osteocutaneous free-tissue reconstruction for mandibular defects has been shown to be safe and effective and has become a standard of care.\(^1\) As free-tissue reconstruction is becoming more common, the desire to make standardized protocols to improve patient outcomes and control costs is increasing.\(^2,3\) The average length of hospital stay (LOS) for patients undergoing fibular free-tissue reconstruction (FFTR) of head and neck defects has been reported to range from 8.8 to 15.1 days.\(^4-6\) Increased LOS contributes to substantially higher costs to both the patient and the hospital.\(^2,7\) To our knowledge, no one has sought to determine factors contributing to an increased LOS in patients with head and neck cancer undergoing FFTR of head and neck defects. Determining these factors with the goal of modifying them could result in decreased LOS and reduced costs.

The National Surgical Quality Improvement Program (NSQIP) started as a program to measure and report comparative risk-adjusted surgical outcomes in Department of Veterans Affairs (VA) hospitals. The American College of Surgeons (ACS) collaborated with the VA to offer the program to private-sector hospitals. The result of that collaboration, the ACS NSQIP, aims to improve surgical outcomes by providing risk-adjusted data to stimulate quality-improvement initiatives.\(^8\)

The ACS NSQIP has been used to assess outcomes and create initiatives to improve quality in a wide variety of general surgical procedures. However, to our knowledge, the methodology has not been applied to head and neck surgery. Given the high resource utilization of FFTR, a small cost savings per patient could lead to large cost savings to academic centers; therefore, performing procedural quality assessments in these patients is important. The goal of the present study was to use ACS NSQIP methodology to determine factors contributing to increased LOS in patients with head and neck cancer undergoing FFTR of head and neck defects to determine which factors might be modified to improve outcomes and reduce costs.

### Methods

#### Data Sources and Study Patients

Following approval by the Emory University institutional review board, which waived patient written informed consent, we conducted a retrospective review of medical records of consecutive adult patients (age ≥18 years) with head and neck cancer undergoing FFTR at Emory University Hospital Midtown, Atlanta, Georgia, from July 2013 to June 2014. Two ablative and reconstructive surgeons performed all of the procedures during the study period, and no operations were performed by only a single surgeon. The work of tumor ablation and FTTR were evenly distributed between the 2 surgeons. Clinical and demographic information was collected using a head and neck surgery adaptation of the ACS NSQIP data form.

Principal otolaryngology procedures that included FFTR were identified using Current Procedural Terminology codes (Table 1). At our institution during the study period, it was standard that all patients undergoing FFTR also undergo placement of a tracheostomy; therefore, all of the surgical procedures listed included tracheostomy. Other studies have demonstrated differing complication rates and LOS by type of free-tissue reconstruction\(^4,6\); therefore, the decision was made to focus exclusively on patients undergoing FFTR.

The ACS NSQIP form included demographic data, tumor characteristics, preoperative risk factors, operative variables, and postoperative adverse events (Table 2). Our primary outcome measure was factors associated with increased hospital LOS. Other outcome measures included 30-day readmission rates and postoperative deaths within 30 days of surgery. Factors analyzed for association with longer LOS included occurrence of postoperative complications (including both discharge and postdischarge complications), unplanned reoperation, flap loss, and mortality within 30 days of surgery between the 2 groups (LOS ≤10 days and LOS >10 days).

Postoperative complications were grouped into surgical site complications (superficial, deep, and organ space infections and wound dehiscence), systemic infections (pneumonia, urinary tract infection, sepsis, or shock), prolonged ventilator use (>48 hours), unplanned reintubation, venous thromboembolism (pulmonary embolism, deep venous thrombosis, or thrombophlebitis), renal failure (progressive renal insufficiency or acute renal failure), cardiovascular failure (stroke, cardiac arrest, myocardial infarction, or bleeding requiring a number of units of packed red blood cells), graft failure (graft, prosthesis, or flap failure), and other complications (peripheral nerve injury or coma).

#### Statistical Analysis

\(t\) Tests and Wilcoxon rank-sum tests were used for continuous variables; \(χ^2\) tests and Fisher \(t\) tests were used for categorical variables. A multiple logistic regression model was used to control for potential confounding variables and to identify independent risk factors for LOS longer than 10 days, unplanned 30-day readmission and 30-day reoperation, and continuous variables were dichotomized using median cutoff values. Multivariate logistic regressions were used to identify risk factors associated with LOS longer than 10 days, 30-day postreoperation readmission, and unplanned reoperation by entering all demographic characteristics, preoperative risk factors, and postoperative complications as covariates into a logistic regression model and using a backward variable selection method with an alpha level of removal of 0.1. Odds ratios (ORs) and 95% CIs were calculated for the strength of association between each risk factor and the outcomes of interest. All tests were 2 sided, and \(P = .05\) was considered statistically significant. All analyses were performed using SAS software, version 9.3 (SAS Institute Inc.).

### Table 1. CPT Code Definitions for Primary Outcome of Interest

<table>
<thead>
<tr>
<th>CPT Code</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>14300</td>
<td>Adjacent tissue transfer or rearrangement, more than 30 sq cm, unusual or complicated, any area</td>
</tr>
<tr>
<td>15374</td>
<td>Muscle, myocutaneous, or fasciocutaneous flap; trunk</td>
</tr>
<tr>
<td>20955</td>
<td>Bone graft with microvascular anastomosis; fibula</td>
</tr>
<tr>
<td>21045</td>
<td>Excision of malignant tumor of mandible; radical resection</td>
</tr>
<tr>
<td>21244</td>
<td>Reconstruction of mandible, extraoral, with transosteal bone plate (eg, mandibular staple bone plate)</td>
</tr>
</tbody>
</table>

### Results

Thirty patients underwent FFTR during the study period, and all were included in the study. Median LOS was 10 days (range, 8-31 days). The patients were divided into 2 groups based on median length of stay: 16 patients with an LOS of 10 days or shorter and 14 patients with an LOS longer than 10 days. There were no differences in age, sex, race, or body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) between the 2 groups (Table 3). There was also no difference between the groups in tumor staging or site of tumor (Table 3). Preoperative risk factors including comorbidity and previous cancer treatment were indistinguishable between the groups (Table 3). However, duration of surgery was significantly increased in the longer LOS group (>10 days; Table 3). The risk of LOS exceeding 10 days was not significantly associated with the surgeon who performed the ablation or reconstruction (OR, 0.45; 95% CI, 0.10-1.95; \( P = .46 \)). Univariate analysis of intraoperative variables (Table 3) revealed that patients in the longer LOS group (>10 days) were significantly more likely to have an operative time greater than 11 hours (OR, 7.80; 95% CI, 1.48-41.21; \( P = .02 \)).

Table 4 lists postoperative occurrences by LOS. Patients in the longer LOS group were significantly more likely to be

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### Table 2. Preoperative Risk Factors, Operative Variables, and Postoperative Outcomes

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Collected Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preoperative risk factors</td>
<td>Body mass index, diabetes, smoking history, alcohol use, dyspnea, history of severe chronic obstructive pulmonary disease, current pneumonia, heart disease, cerebrovascular disease (cerebrovascular accident), sepsis, disseminated cancer, hypertension, chronic steroid use</td>
</tr>
<tr>
<td>Operative variables</td>
<td>Surgeon specialty, emergent or nonemergent surgery, operative time, ASA classification, operative wound classification</td>
</tr>
<tr>
<td>Postoperative outcomes</td>
<td>Wound infections or disruptions, pneumonia, pulmonary embolism, prolonged ventilation, urinary tract infections or renal failure, CNS injury or mental status changes; supraventricular tachycardia, myocardial infarction, or cardiac arrest; hyperglycemia and hypocalcemia; operative site seroma, hematoma, or thrombosis; partial or total flap loss, hospital length of stay, unplanned reoperation, unplanned hospital readmission, or mortality within 30 days postoperatively</td>
</tr>
</tbody>
</table>

Abbreviations: ASA, American Society of Anesthesiologists; CNS, central nervous system.

* Definitions were described in the American College of Surgeons National Surgical Quality Improvement Program user guide in detail. Briefly, a smoker was defined as any patient who had smoked cigarettes in the year prior to admission for surgery. Alcohol use was defined as 2 or more drinks per day in the 2 weeks prior to admission. Dyspnea was grouped into "at rest," "with moderate exertion," and "none." Heart disease included congestive heart failure, including newly diagnosed or an acute exacerbation within 30 days of surgery, history of myocardial infarction in the 6 months prior to surgery, previous percutaneous coronary intervention or cardiac surgery, or any history of angina in the month prior to surgery. Cerebrovascular accident included any patient with history of a transient ischemic attack or cerebrovascular accident. Sepsis included any case that met criteria for systemic inflammatory response syndrome, sepsis, or septic shock. Surgeon specialty was classified into "otolaryngology" and "other." Wound classification was categorized into "clean/contaminated" (representing clean and clean/contaminated classifications) and "contaminated/dirty/infected" (representing contaminated and dirty/infected classifications).
ventilator dependent for more than 48 hours or have any postoperative respiratory adverse event (OR, 13.00; 95% CI, 1.60-124.30; P = .05), to have any adverse wound event at the recipient site (OR, 7.0; 95% CI, 1.14-52.97; P = .05), and to have postoperative altered mental state (AMS) (OR, 10.83; 95% CI, 1.96-59.83; P = .01). Odds ratios with 95% CIs were only reported for variables that were found to be significant. There was no significant difference in hypocalcemia, hyperglycemia, cardiac events, or renal failure between the 2 groups.

Multivariate logistic regression was then used to evaluate the independent association of risk factors associated with LOS, controlling for possible confounders. In this model (Table 5), multivariate analysis revealed that the increased risk of LOS longer than 10 days was significantly associated with operative time of greater than 11 hours (OR, 7.26; 95% CI, 1.12-47.29; P = .04) and ventilator dependence for more than 48 hours postoperatively (OR, 12.05; 95% CI, 1.06-137.43; P = .045). Due to the highly correlated nature between postoperative AMS and ventilator dependence for greater than 48 hours, we included only ventilator dependence in the model. Similar results were obtained when we analyzed for AMS rather than ventilator dependence (OR, 7.73; 95% CI, 1.26-47.44; P = .03).

Though LOS was the primary outcome of interest in this study, we also investigated unplanned reoperations, 30-day readmission rates, and deaths. Multivariate analysis revealed that any central nervous system complication contributed to the risk of unplanned reoperation (OR, 8.33; 95% CI, 0.84-83.17), though this effect was not significant

Table 3. Demographics, Preoperative Risk Factors, and Intraoperative Data by Hospital LOS (continued)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>≤10 Days (n = 16)</th>
<th>&gt;10 Days (n = 14)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of insurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Government</td>
<td>11</td>
<td>6</td>
<td>.26</td>
</tr>
<tr>
<td>Commercial</td>
<td>5</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Self-pay</td>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>IVF total volume, mean (SD), L</td>
<td>6.0 (1.8)</td>
<td>8.0 (2.1)</td>
<td>.01</td>
</tr>
<tr>
<td>Positive margin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3</td>
<td>4</td>
<td>&gt;.99</td>
</tr>
<tr>
<td>No</td>
<td>10</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>NA</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); COPD, chronic obstructive pulmonary disease; HTN, hypertension; IVF, intravenous fluid; LN, lymph node; LOS, length of stay; NA, not applicable; RMT, retromolar trigone.

a No patients in our population had pulmonary ventilator dependence, ascites, congestive heart failure, percutaneous coronary intervention, cardiac surgery, preoperative acute renal failure, dialysis, disseminated cancer, immunosuppressant use, bleeding disorder, transfusion within 72 hours of surgery, or systemic sepsis.

b Unless otherwise indicated, data are reported as number of patients.

c Includes 1 case of osteomyelitis, 1 case of osteosarcoma, and 3 cases of osteoradionecrosis in the shorter LOS group (≤10 days); and 1 case of fistula in the longer LOS group (>10 days).

d Includes 1 case of osteomyelitis, 1 case of osteosarcoma, and 3 cases of osteoradionecrosis in the shorter LOS group (≤10 days); and 1 case of fistula in the longer LOS group (>10 days).
Table 5. Multivariate Analysis of Clinical Factors Significantly Associated With LOS Greater Than 10 Days*  

<table>
<thead>
<tr>
<th>Clinical Factor</th>
<th>AOR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative time &gt;11 h</td>
<td>7.26 (1.12-47.29)</td>
<td>.04</td>
</tr>
<tr>
<td>Ventilator dependence &gt;48 h</td>
<td>12.05 (1.06-137.43)</td>
<td>.045</td>
</tr>
</tbody>
</table>

Abbreviations: AOR, adjusted odds ratio; LOS, length of stay.

* All demographic characteristics, preoperative risk factors, laboratory test results, and postoperative complications were included in the analysis, where continuous variables were dichotomized using median as the cutoff value. Any variable with an α level ≤.10 remained in the model.

(P = .07). Multivariate analysis indicated that any donor-site complication was associated with a higher risk of 30-day readmission (OR, 8.14; 95% CI, 0.72-91.89), though this was not significant (P = .09).

In addition, there were 2 deaths within 30 days of admission. One patient was discharged but readmitted for repair of a wound dehiscence around the gastrostomy tube (G-tube) site; cause of death was found to be secondary to acute pulmonary thromboembolus. The second patient underwent reoperation for thoracic duct injury, including pectoralis major flap closure and G-tube placement; cause of death was presumed to be severe peritonitis after patient withdrew from care secondary to hepatoportal syndrome. Both patients were aged between 55 and 65 years, underwent unplanned reoperation, and had histories of smoking and hypertension.

Discussion

Repair of head and neck defects with FFTR offers improved functional outcomes over primary closure or regional flaps9 and has therefore become the gold standard for reconstruction of complex head and neck defects.10 However, FFTR is associated with increased operative time and increased cost compared with local pedicled flap reconstruction.9 Because of the increasing pressures of cost containment in the delivery of high-quality care, assessment of surgical quality and costs is necessary. With the activation in 2013 of the Centers for Medicare & Medicaid Services Hospital Value-Based Purchasing Program,11 incentives are now based on how well hospitals perform on certain quality measures. This program creates a strong impetus to provide evidence-based postoperative practices, particularly in high-resource-utilization cases such as head and neck FFTR.

We identified 2 factors that were significantly associated with increased LOS: increased time of ventilator dependence and increased operative time. We also found that increased ventilator dependence and altered mental status were highly correlated.

This study demonstrates that in patients who are on the ventilator for more than 48 hours postoperatively, there is twice the rate of hospital stay greater than 10 days. This is consistent with previous literature on disease other than head and neck cancer, demonstrating that prolonged ventilator dependence is associated with increased LOS in the intensive care unit (ICU) and increased overall hospital LOS.12,13 Therefore, protocols for early ventilator weaning (EVW) have been initiated for ICU patients.14 However, owing to concerns about flap failure, EVW protocols have been avoided in patients undergoing FFTR, including at our institution. Recent studies, however, have demonstrated that EVW in patients with head and neck cancer undergoing FFTR does not affect flap survival,15 and many academic institutions have initiated EVW protocols.16 In this study we have shown that EVW is associated with significantly shorter hospital LOS in patients undergoing FFTR. During the study period, ventilation use was based on the surgeon’s concern for flap failure and the patient’s ability to medically tolerate EVW. There were no differences between LOS groups in rates of preoperative smoking status, diagnosis of chronic obstructive pulmonary disorder, ASA class (American Society of Anesthesiologists), or postoperative pneumonia rates to explain the increased ventilator dependence in the longer LOS group. Therefore, new protocols have been launched for EVW at our institution.

Total operative time was found to significantly affect hospital LOS. In patients with an operative time greater than 11 hours, there was a 7-fold greater risk of hospital LOS longer than 10 days. This is consistent with studies in the general surgery literature. In a large study using the NSQIP database, increased hospital LOS was associated with prolonged surgery time in patients undergoing major elective general surgery, vascular surgery, and urology operations.27 In FFTR, operative time is a potentially modifiable factor. The 2-surgeon technique of simultaneous surgery in head and neck reconstruction has been shown to decrease operative time by greater than 3 hours.18

In the present study population, there was no significant difference between groups in tumor stage, prior chemotherapy or radiation therapy, reoperation rates, or ASA class. However, there were high rates of late-stage disease (69% and 92%), reoperation (56% and 21%), and salvage surgery (38% and 14%) in the short LOS and longer LOS groups, respectively, demonstrating the difficult and complex nature of all of these procedures. In our institution, there is always an ablative surgeon and a separate reconstructive surgeon; however, simultaneous harvest is not always possible. This study shows that efforts to decrease operative time could lead to shorter hospitalizations in FFTR surgery, and so efforts to perform the simultaneous harvest in head and neck reconstruction are recommended.

The association between AMS and prolonged mechanical ventilation dependence has been previously demonstrated.19,20 Because of the collinearity of ventilator dependence and AMS, efforts to reduce AMS are likely to reduce ventilator dependence and therefore LOS. Patients in the ICU are known to have increased rates of delirium compared with patients in a regular hospital ward.21 A study evaluating postoperative complications and flap failure in patients undergoing free tissue reconstruction who are monitored in the ICU vs a specialized hospital ward have shown that complication rates, flap failure rates, and patient outcomes are equivalent between postoperative step-down unit care and ICU care.22 Further studies evaluating differences in postoperative delirium in patients in the ICU vs step-down units is warranted.
In addition, at institutions that do not have specialized wards and continue to utilize ICU care postoperatively, identification of at-risk patients, early detection, and aggressive management of AMS is necessary. Previous studies have demonstrated that preoperative depression and history of alcohol abuse are risk factors for postoperative delirium.\textsuperscript{23-25} Therefore, preoperative psychiatric evaluation and early postoperative management of delirium with evidence-based approaches is imperative for early detection and management of AMS.\textsuperscript{26}

The small number of cases is a limitation of the present study. However, this study is strengthened by the consistency of including only FFTR cases. We were able to include all 30 patients who underwent FFTR during the study period, and there were no patients with missing data.

However, certain perioperative risk factors were difficult to capture. One of these factors was postoperative glycemic control. The ACS NSQIP form lacks clear definition of what constitutes poor glycemic control. In our study, we identified 20 patients who required subcutaneous insulin administration postoperatively, but only 6 cases of poor glucose control. No preoperative risk was detected that was associated with this postoperative complication. This may be due in part to heavy prescreening of patients who would be eligible for FFTR, which demands strict performance status and medical clearance. However, owing to the retrospective nature of the data we cannot know for certain.

We were also not able to distinguish between alcohol withdrawal and postoperative AMS. Finally, the retrospective nature of the study may introduce selection bias to the study. However, in spite of our limited sample size, we were able to determine important clinically significant factors affecting hospital LOS in patients undergoing FFTR.

Conclusions

This study demonstrates that ACS NSQIP methodology can effectively be applied to head and neck FFTR cases to evaluate surgical quality outcomes. We were able to identify 2 modifiable factors that were significantly associated with longer LOS. By applying this methodology, which was originally designed for general surgery cases, to the resource-intensive environment of FFTR, we demonstrated feasibility and proof of concept.

In this study of patients undergoing FFTR, LOS was significantly increased by longer length of surgery and longer postoperative ventilator dependence. Furthermore, postoperative ventilator dependence was highly correlated with AMS. Each of these factors is modifiable, and results indicate that targeted efforts aimed to improve these measures could lead to overall shorter hospital LOS in patients undergoing FFTR. In our institution, results of this study have helped launch protocols of EVW and preoperative psychiatric and social work assessments to help minimize postoperative delirium in patients undergoing FFTR. The impact of these changes will be measured in an ongoing prospective study.

We have also demonstrated that using ACS NSQIP methodology is effective in evaluating quality outcomes in head and neck reconstructive cases. Ongoing and continuous assessment of surgical quality utilizing methodology such as the ACS NSQIP is essential to improving the outcomes of our patients through, first, identifying factors leading to adverse outcomes and, second, implementing changes that lead to fewer adverse outcomes.
research following cancer resection. 


