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ARTICLE

Associations of discharge destination and length of stay in lower extremity free flap reconstruction

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ABSTRACT

Patients with lower extremity defects requiring free flap reconstruction often have difficult postoperative courses with prolonged length of stay and need for transfer to a post-acute care facility. The primary aim of this study was to determine associations of preoperative and perioperative variables with length of stay and discharge destination in patients undergoing lower extremity free flap reconstruction. The secondary aim was to determine associations of various complications with their discharge destination. The 2011– 2017 NSQIP database was queried for CPT codes for free flap procedures and ICD-9/ICD-10 codes for lower extremities. Univariate and multivariate analyses were used to determine associations of preoperative and perioperative variables with length of stay and discharge destination in patients undergoing lower extremity free flap reconstruction and associations of complications with their discharge destination. A total of 420 patients were identified who underwent lower extremity reconstruction in 2011–2017. Of 79.8% were discharged home and 21.2% were discharged to destinations other than home. On multivariate analysis, female gender, age $>$ 55, ASA class $>$ 2 and dependent functional status were found to have independent associations with discharge to post-acute care facilities. ASA classification greater than 2, active smoking, and discharge to a post-acute care facility all were independently associated with prolonged length of stay. Increased length of stay and discharge to post-acute care facility are closely associated. Understanding variables that influence length of stay and need for discharge to post-acute care facilities can help identify patients that may be triaged through appropriate interventions and expectation management.

Abbreviations: ASA: American Society of Anesthesiologists; BMI: body mass index; CI: confidence interval; CPT: current procedural terminology; CDC: Center for Disease Control and Prevention; COPD: chronic obstructive pulmonary disease; DM: diabetes mellitus; ICD: International Classification of Diseases; NSQIP: National Surgical Quality Improvement Program; OR: odds ration; SAS: statistical analysis system; US: United States; VTE: venous thromboembolism

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Introduction

Complex defects of the lower extremity are often treated with microvascular free tissue transfers [1]. Post-operatively, these patients often have prolonged lengths of stay and require additional post-acute care after discharge from the hospital. Post-acute care can include services, such as skilled nursing facilities, inpatient rehabilitation facilities and home health care. Minimizing length of hospital stay has been a major initiative in saving healthcare resources and decreasing costs. A number of enhanced recovery programs and postoperative strategies such as dangle protocols and compression wrapping have been successful in this regard [2–6].

The primary aim of this study was to use the NSQIP database to determine associations of preoperative and perioperative variables with length of stay and discharge destination in patients undergoing lower extremity free flap reconstruction. The secondary aim was to determine associations of various complications with discharge destination in the same population. Similar studies have been conducted among the otolaryngology and orthopedic patient populations, but not in the plastic surgery literature [7–9]. Understanding these associations could aid in planning interventions or constructing recovery protocols to decrease length of stay, minimize complications and triage patients in an efficient and timely manner. We used a multi-institutional outcomes database to identify associations among this patient population.

Methods

This study was conducted using the American College of Surgeons National Quality Improvement Program (ACS-NSQIP) database. Data are collected prospectively and include preoperative, intraoperative, and postoperative variables. Data is collected for 30 d following an operation. Over 250 variables are tracked, including patient demographics, past medical history and comorbidities and surgical outcomes. The database is collected from over 700 participating hospitals, and the number of participating

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institutions increases annually. De-identified database information is available to participating institutions and complies with the Health Insurance Portability and Accountability Act of 1996 [10]. Institutional review board exemption was obtained from the University of Utah on the basis of de-identified patient information.

Patient identification

The 2011 through 2017 NSQIP participant data files were used in this study. The database was queried using Current Procedural Terminology (CPT) corresponding to free flap procedures (15756, 15757, 15758, 20955, 20956, 20957, 20962, 20969, 20970, 20972 and 20973). Using the ICD-9 and ICD-10 codes, patients with diagnoses corresponding to lower extremity pathology (Supplemental Tables 1 and 2) were identified and included. Patients with diagnoses corresponding to another body part or those that were nonspecific were excluded.

Patient and perioperative variables were identified. Variables included for analysis were demographic (age, gender, and body mass index (BMI)) and comorbidity (diabetes, smoking, COPD, hypertension, bleeding disorder, preoperative steroid use and American Society of Anesthesiology (ASA) classification. ASA classification is a widely used marker of overall systemic health and is assigned at the time of surgery by the anesthesiologist [11]. Patient preoperative functional status was also collected. Independent functional status connotes the ability to carry out activities of daily living on one's own while dependent functional status connotes the inability to do so. Operative variables collected included operative time, wound classification, flap type, and use of skin grafting. Hematocrit and albumin are reported in NSQIP, these variables contained high numbers of missing values (>15%), and were therefore excluded from analysis. Co-morbidities including preoperative dialysis and history of congestive heart failure were omitted due to low incidence.

The primary outcomes of interest were discharge destination (post-acute care facility *vs.* home) and increased length of stay. We considered discharge to a post-acute care facility as discharge to a skilled care facility, unskilled care facility or an inpatient rehabilitation facility. Patients who did not have discharge destination information available were excluded. Prolonged length of stay was defined as the top twentieth percentile. This correlated to 14 d or longer. Complications were also assessed as outcomes. Any complication was defined as a reoperation, readmission, wound infection, medical complication or transfusion. Medical complications were categorized as cardiac, renal, respiratory, VTE or infectious. Wound complications were categorized as superficial infection, wound infection, organ space infection or dehiscence. Timing of complication was also assessed (pre- *vs.* post-discharge).

Statistical analysis

All statistical analyses were performed using SAS version 9.4 (Cary, NC). Cross-tabulation and descriptive analyses were performed to characterize demographic information and identify missing or deficient variables.

Univariate analyses were calculated using Chi-square and Fishers exact tests where appropriate. Multivariate logistic regression models were used to identify independent associations between identified variables and outcomes. Associations with a p value of .05 or less were considered significant. Associations with a p value less than .10 on univariate analysis were included in the multivariable model that evaluates risk factors associated with discharge to a post-acute care facility. Our multivariable model evaluating risk factors associated with LOS $\geq$ 14 d included the same variables as our preceding model with the addition of two variables, smoking and discharge destination other than home.

Results

Database

Between 2011 and 2017, 5,302,529 patients were identified in the NSQIP database. Of these, 6287 underwent non-breast free flaps. A total of 420 of these had a lower extremity diagnosis (Figure 1). Of these, 79.8% ($n = 335$) was discharged to home and 21.2% ($n = 85$) were discharged to a destination other than home.

Demographics and complications

A higher proportion of patients who were discharged to a location other than home were older (age > 55), female, had a bleeding disorder, hypertension, diabetes, ASA classification greater than 2 and were partially or totally dependent prior to surgery (Table 1).

The overall 30-d complication rate was 31.9% ($n = 134$). A higher proportion of patients eventually discharged to destinations other than home had any complication (47.1 *vs.* 28.1%, $p = .001$) and medical complications (18.8 *vs.* 3.0%, $p < .001$) including renal failure (4.7 *vs.* 0%, $p = .002$), respiratory complications (3.5 *vs.* 0.3%, $p = .026$), thromboembolic complications (4.7 *vs.* 0.9%, $p = .034$), and infectious complications (9.4 *vs.* 2.1%, $p = .004$). Patients eventually discharged to a destination other than home also had higher rates of intra-operative or post-operative transfusions (29.4 *vs.* 14.0%, $p = .002$) and complications prior to discharge from the hospital (32.9 *vs.* 17%, $p = .012$). Overall wound complications were not statistically significant (16.5 *vs.* 10.1%, $p = .125$), but wound infections were increased in patients discharged to a destination other than home (8.2 *vs.* 2.7%, $p = .026$) (Table 2).

Multivariate analysis

On multivariate analysis, female gender (OR 1.78, 1.06–2.96, $p = .027$), age greater than 55 (OR 2.02, 1.16–3.52, $p = .013$), ASA classification greater than 2 (OR 1.86, 1.07–3.24, $p = .028$) and partially or totally dependent functional status prior to surgery (OR 4.3, 1.26–14.63, $p = .02$) were all independently associated with discharge to somewhere other than home. Hypertension, diabetes, preoperative steroid use and bleeding disorders were not found to be independently associated (Table 3).

The mean length of stay was 9.9 d (95% CI 8.63–11.17). Prolonged length of stay was defined as greater than the 80th percentile which was greater than or equal to 14 d. On multivariate analysis, ASA classification greater than 2 (OR 2.06, 1.21–3.50, $p = .008$) and discharge destination other than home (OR 2.41, 1.37–4.23, $p = .002$) were associated with prolonged length of stay. Patients who were active smokers were associated with decreased lengths of stay (OR 0.45, 0.24–0.85, $p = .014$) (Table 4).

Discussion

There is an increasing incidence of discharge to post-acute care facilities in the United States [12]. Patients who undergo reconstruction of the lower extremity with free flaps have often lost significant function and may have a prolonged clinical course leading to greater lengths of stay or a need for some level of post-acute care. The goal of this study was to identify associations of variables with discharge to post-acute care facilities and length of stay after lower extremity free tissue transfer.

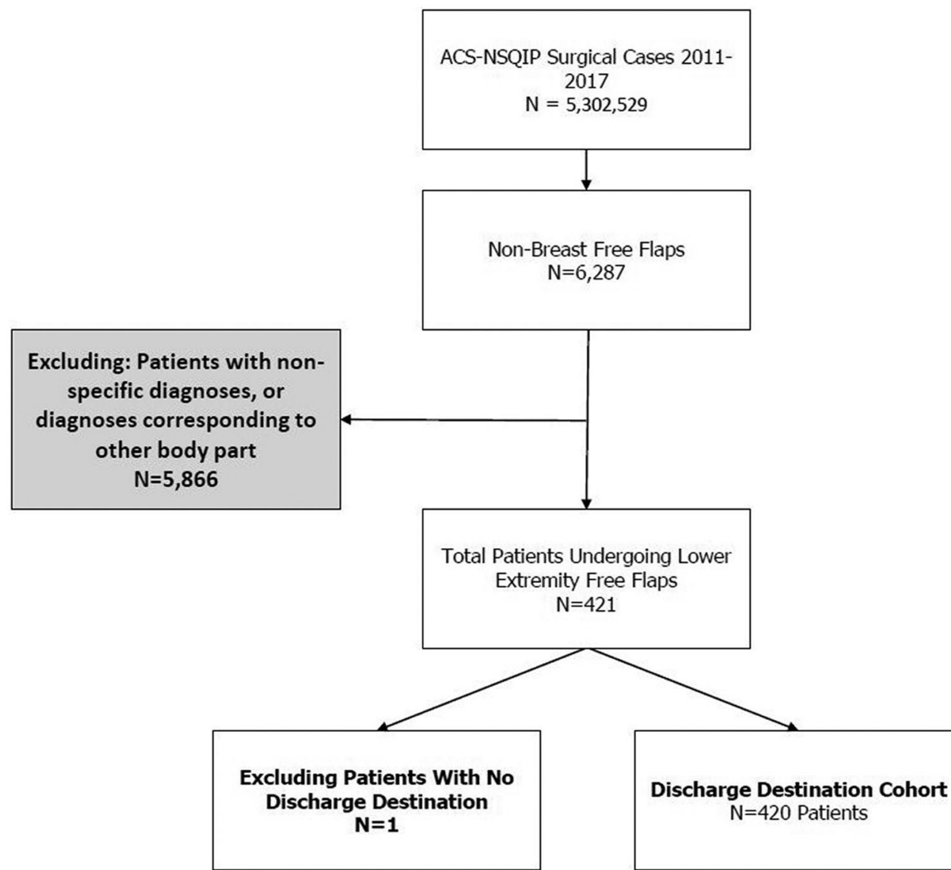

Figure 1. Flowchart of inclusion and exclusion criteria.

Table 1. Characteristics of patients who were discharged to home and post-acute care 60 with DM of 420 = 14%.

	Discharge destination other than home ($N = 85$)	%	Discharge destination home ($N = 335$)	%	p Value
Sex					
Male	42	16.5	212	83.5	
Female	43	25.9	123	74.1	.025
Age > 55	55	28.8	136	71.2	<.001
BMI > 30	34	20.6	131	79.4	.901
Bleeding disorder	9	37.5	15	62.5	.038
Preoperative steroids	7	36.8	12	63.2	.079
Hypertension	43	28.1	110	71.9	.004
COPD	3	23.1	10	76.9	.732
Smoker	15	14.6	88	85.4	.12
Diabetic	21	35.0	39	65.0	.005
Dyspnea	4	25.0	12	75.0	.542
ASA classification >2	53	29.9	124	70.1	<.001
Operative time (min)					
longest 25% (>200)	27	25.7	78	74.3	.123
Skin graft	25	20.7	96	79.3	.894
Flap type					
Muscle	42	23.3	138	76.7	
Skin	16	20.0	64	80.0	
Fascia	13	25.5	38	74.5	
Bone	14	12.8	95	87.2	.131
Wound classification					
Clean/clean contaminated	55	18.5	242	81.5	
Contaminated/infected	30	24.4	93	75.6	.183
Functional status					
Independent	78	19.2	329	80.8	
Dependent	7	53.8	6	46.2	.007

We identified independent associations between female gender and discharge to a post-acute care facility. Gender associations with discharge destination are inconsistent across the literature, some authors finding similar associations between female gender and discharge destination following anterior spinal deformity surgery, while others show male gender as a risk factor for discharge to a post-acute care facility following head and neck surgery [7,8]. Several explanations could support our association

Table 2. Complications after lower extremity free flap in patients discharged to post-acute care and home.

	Discharge destination other than home ($N = 85$)	%	Discharge destination home ($N = 335$)	%	p Value
Any complication	40	47.1	94	28.1	.001
Unplanned reoperation	12	14.1	31	9.3	.228
Reoperation within 48 h	3	3.5	6	1.8	.395
Medical complications – Total	16	18.8	10	3.0	<.001
—Cardiac	1	1.2	0	0.0	.202
—Renal	4	4.7	0	0.0	.002
—Respiratory	3	3.5	1	0.3	.028
—VTE	4	4.7	3	0.9	.034
—Infection	8	9.4	7	2.1	.004
Wound complication – Total	14	16.5	34	10.1	.125
— Superficial infection	5	5.9	20	6.0	1
—Wound infection	7	8.2	9	2.7	.026
—Organ space infection	4	4.7	2	0.6	.17
—Dehiscence	0	0.0	8	2.4	.368
Transfusion	25	29.4	47	14.0	.002
Unplanned readmission	9	10.6	18	5.4	.087
Timing of complication					
Prior to discharge	28	32.9	57	17.0	.012
Post-discharge	9	10.6	27	8.1	.514

Table 3. Multivariate regression analysis of associated with discharge to post-acute care.

	OR	95% Confidence interval	p Value
Female gender	1.78	1.06–2.96	.027
Age > 55	2.02	1.16–3.52	.013
ASA classification > 2	1.86	1.07–3.24	.028
Hypertension	1.17	0.65–2.08	.606
Diabetes	1.59	0.82–3.08	.172
Preoperative steroids	1.38	0.48–3.95	.554
Bleeding disorders	1.68	0.66–4.23	.275
Dependent functional status	4.3	1.26–14.63	.02

Table 4. Multivariate regression analysis of associated with prolonged length of stay (14 d or greater).

	OR	95% Confidence interval	p Value
Female gender	0.65	0.39–1.09	.100
Age > 55	1.11	0.65–1.88	.712
ASA classification > 2	2.06	1.21–3.50	.008
Hypertension	0.97	0.56–1.69	.920
Diabetes	1.13	0.58–2.23	.716
Preoperative steroids	0.55	0.16–1.83	.326
Bleeding disorders	2.40	0.98–5.86	.056
Dependent functional status	0.77	0.21–2.81	.687
Smoker	0.45	0.24–0.85	.014
Discharge destination other than home	2.41	1.37–4.23	.002

between female gender and discharge destination other than home. Females tend to maintain lower muscle mass throughout life when compared to males, thus periods of prolonged immobility may lead to faster deconditioning following reconstructions, which would prompt a longer course of rehabilitation. A recent study revealed that females were more likely to experience a discharge destination other than home following ankle arthroplasty, where authors cite differences in muscular strength between genders as a possible explanation for their discharge destination [13]. Similarly, females were more likely to be discharged to a post-acute care facility following complex abdominal wall reconstructions. These authors hypothesized that a female's longer life expectancy resulted in them outliving their spouse, thus leading to an inadequate support system at home [14]. We also found associations between discharge to a post-acute care facility and ASA classification greater than 2, increasing age and functional dependence. Patients with these characteristics have less physiological reserve and often more comorbidities leading to great complication rate [15,16]. In an age of patient-reported outcomes, discharge to a destination other than home is an easily understood outcome for patients. Identifying patients who will require these services prior to surgery can aid in both setting patient expectations and the recovery from surgery, as well as early discharge planning.

We found that ASA classification greater than 2 was independently associated with increased length of stay and smoking was independently associated with decreased length of stay, while diabetes was not associated with a difference in length of stay. Higher ASA classifications may lead to greater length of stay as patients will require a higher level of care for management of comorbidities and complications [17,18]. Smokers had a decreased likelihood of length of stay $\geq$ 14 d. Further studies are warranted to assess this interesting finding, which may be explained by smokers wanting to leave the hospital earlier to return to their habit. Along these lines, other authors studying associations with discharge destination after surgery have commented that length of stay could be artificially lengthened as a result of delays in post-discharge planning [14]. Smokers are motivated for discharge due to their habit and therefore may be avoiding such delays. This also may be a selection bias, as surgeons may select for smokers with better functional reserve. This may not be able to be captured by the variables in the NSQIP database. It is also interesting to note that the presence of diabetes was not independently associated with a change in the length of stay in our cohort, though it has previously been identified as an independent risk factor for longer hospital length of stay in spine surgery [19]. The rate of diabetes in patients included in this study was 14%, which is comparable to the national prevalence of 13% reported by the CDC [20]. Another consideration for this group is that neither the perioperative blood glucose levels nor the preoperative HbA1c were analyzed. The literature has shown that optimizing perioperative blood glucose levels in diabetic patients enhances recovery and reduces wound complications [21]. Similarly to smoking, there may have been selection bias in this group, with providers selecting to move forward with surgery in patients who had better glucose control and more carefully regulating blood glucose inpatient due to concerns with wound healing. We also found a close association between discharge to a post-acute care facility and increased length of stay. This may be explained by patients needing longer hospitalizations and eventually further rehabilitation at post-acute care facilities after not meeting their postoperative recovery milestones. Identifying

patients at risk for increased length of stay can help with managing expectations and lead to earlier triage to post-acute care facilities when appropriate.

This study has several limitations. With regards to differences in length of stay, we cannot be sure of homogenized cohort as reasons for delay in discharge, such as severity of injury or comorbid factors are unknown. As a retrospective review, we are limited by the variables collected and could be missing some confounding variables. There was no mention on the database for the indications of the surgery, yet it would be helpful to know if the surgeries were performed primarily for coverage of nonhealing wounds in the setting of diabetes or vasculopathy *vs.* trauma. Unknown status of concomitant injury also poses a limitation to the study, as patients who experience polytrauma and traumatic brain injuries tend to have longer lengths of stay and increased need for placement in post-acute care facilities at baseline [22]. Additionally, there are other variables specific to plastic surgery and extremity reconstructions that would be of interest to analyze but cannot be extracted by the database. These include history of peripheral vascular disease, the time-to-reconstruction, other care including surgery provided at outside hospitals prior to transfer for definitive flap coverage, operative technique or antibiotic regimens, all of which could have implications on our primary objectives and would be of interest to the readership. This database does not consider varying postoperative protocols, such as weight-bearing status and dangling, nor does it account for the variability in the resources available to the different hospitals sampled in our dataset that may translate to an easier transition for patients requiring further rehabilitation. Another factor that was not considered in the database includes patients who are underinsured or uninsured, as some of these patients may have been sent home despite a need for post-acute care or discharged sooner than their insured counterparts due to financial concerns. Similarly, this database may over-represent large and academic medical centers and therefore may not be an accurate representation of all US hospitals, though these centers likely have the most volume of lower extremity free tissue transfer procedures. Lastly, we attempted to decrease the risk of type I error by using a p value of $<.1$ for including variables in our multivariable analysis, however, we acknowledge that the risk of type I error will always exist when identifying associations with certain outcomes while controlling for multiple variables.

Conclusion

Patients who are female, older than 55, have an ASA classification greater than 2, are partially or totally dependent prior to surgery or who experience complications have an association with discharge to post-acute care facilities. Length of stay greater than 14 d has an association with discharge to a post-acute care facility. This data can be used in the preoperative counseling of patients to manage expectations for post-surgical care, as well as in creating new treatment strategies to decrease length of stay and appropriately triage patients to post-acute care facilities.

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Disclosure statement

The authors have no conflicts of interest to report.

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