INTRODUCTION

Plastic surgery is a vast and complex surgical discipline based on fundamental principles. Plastic surgeons are not limited to working in one anatomical region and are not bound to a certain organ system, and as a result, reconstruct various types of tissues including bone, muscle, tendon, nerve, vessels, and skin. We are often described as the “Surgeon’s Surgeon,” closing complex wounds with ever more difficult surgeries, such as microvascular free flaps. However, because plastic and reconstructive surgeons do not “own” a specific anatomic region, do not control referrals, and are increasingly removed geographically from hospitals, other surgical specialties have increasingly assumed procedures historically performed by plastic surgery. These procedures including head and neck reconstructions by otolaryngology/ear, nose and throat (ENT) surgeons, breast reconstructions and burn surgery by general surgeons, local facial flap reconstructions by the Mohs surgeons/dermatologists, eyelid reconstructions by ophthalmologists and oculoplastics, hand surgery by our orthopedics colleagues, and oral maxillofacial surgeons.
are involved in a large portion of facial traumas and orthognathic surgery.

There is much more overlap in our field than in any other field of surgery, stemming likely from the fact that plastic surgery is relatively young field, with modern roots in the post World War periods. Plastic surgeons are also trained in maintaining and restoring form and function, with ultimate results dictating the range of procedures available to the plastic surgeon’s armamentarium. Gone are the days where flap failure was the only variable that defined success. Now, individual successes with flaps include restoration of anatomy, form, esthetics, and function.

Examples are many in the literature that exist for determining surgical outcomes as stratified by surgical specialty. There is no clear consensus on what factors between specialties are the most important when looking at surgical outcomes, and examples in the literature suggest minimal differences. Previous studies with marginal differences featured a small studied population, and only a few studies looked at the microsurgical outcomes.

Herein, we present a large-scale, big-data national comparison of the effect of differing surgical specialty and their outcomes with microsurgical reconstruction. The National Surgical Quality Improvement Program (NSQIP), an American College of Surgeon (ACS)-led initiative, is a robust, nationally validated, outcomes-based dataset. It tracks 136 demographic, preoperative, intraoperative, and postoperative 30-day complication data points.

The most costly NSQIP-tracked complications are those of reoperation, readmission, and surgical site infections (SSIs), which are measured in this study. They can be stratified as major complications in terms of NSQIP-tracked outcomes. We also determine if case volume influences these complications. It is postulated that decreased case volumes are associated with higher complication rates, as evidenced previously in the literature.

METHODS

The NSQIP Program Participant Use File was queried by Current Procedural Terminology (CPT) code for breast and head/neck microsurgeries. The period of study was 2005–2015, inclusive, for a total of 11 years of data. To ensure the data qualify for research use, the ACS NSQIP developed standardized reporting mechanisms for the operating staff in ACS member hospitals. The 8-day cycle schedule undertakes the balance of its systematic sampling process, and several exclusion criteria have been established to maintain the integrity of the dataset; this methodology for case inclusion has been described previously.

For our study, included CPT codes are listed in Table 1. These include breast reconstruction free flap (19354) and various musculocutaneous and other microvascular procedures (15756, 15757, 15758, 15842, 20955, 20962, 42894). These were extracted from the Participant Use File for analysis. Pedicled flaps were excluded because they did not feature a microsurgical anastomosis. Orthopedic and lower extremity reconstruction cases were excluded in this study because NSQIP does not capture traumatic cases and the ones captured were few in number.

Two independent reviewers searched all relevant CPT codes involving microsurgery, and it was established that these CPT codes were comprehensive for microsurgical operations. We then stratified by body area (ie, head and neck and breast) and surgical specialty, be it otolaryngologists, general surgeons, or plastic surgeons who would be the operating specialty.

Primary outcomes we evaluated included SSI, reoperation, and readmission rates for each of the breast and head/neck reconstruction subgroups. A multivariate logistic regression model was performed to compare outcomes between surgical specialties. The regression variables included sex, age, surgical specialty, height, weight, body mass index (BMI), diabetes, smoking, steroid used, wound class, American Association of Anesthesiologists Physical Status Classification (ASA Class), and total length of stay and postoperative diagnosis.

To investigate the effect of case volume on complication rates, a cumulative frequency variable was introduced into the regression model based on CPT code and surgical specialty. This was a surrogate for cumulative specialty experience, not surgeon experience, with a particular CPT code. Based on the International Classification of Diseases, Ninth Revision (ICD-9) diagnoses, the reasons for reoperation were categorized into complications relating to specific procedures, general medical, preexisting diseases, wound management, and unspecified.

Statistics

A P value of <0.05 was set at significant. Descriptive statistics such as the Student’s t test and χ2 were used. The multivariate logistic regression models were used to

| CPT Code | Anatomical Location | Procedure Name |
|----------|---------------------|----------------|
| 19364    | Breast              | Breast reconstruction free flap |
| 15756    | Head and neck       | Muscle/myocutaneous flap with microvascular anastomosis |
| 15757    | Head and neck       | Free skin flap with microvascular anastomosis |
| 15758    | Head and neck       | Free fascial flap with microvascular anastomosis |
| 15842    | Head and neck       | Graft for facial nerve paralysis; free muscle flap by microsurgical technique |
| 20955    | Head and neck       | Bone graft microvascular anastomosis fibula |
| 20962    | Head and neck       | Bone graft with microvascular anastomosis |
| 42894    | Head and neck       | Resection of pharyngeal wall requiring closure with myocutaneous or fasciocutaneous flap or free muscle, skin, or fascial flap with microvascular anastomosis |
quantify the effects of predicative variables (including surgical specialty) on SSI, reoperation, and readmission.

**RESULTS**

We focused our analysis on 2 anatomic regions: head/neck reconstruction and breast reconstruction. The 2005–2015 11-year dataset yielded 4,608,309 cases. NSQIP captured a total of 6,617 microsurgical cases or 0.14% of all NSQIP-captured cases. Flap location in the extremities, trunk and unknown locations, was excluded from the study due to insufficient power for analysis. For head and neck microsurgeries, otolaryngology performed 898 and plastic surgery performed 285 cases. For breast reconstruction using free flaps, plastic surgery performed 4,127 and general surgery performed 168 cases (Fig. 1).

Stratifying the surgeries performed by year illustrates the increase in captured cases by NSQIP. Although over time expanded definitions in NSQIP has permitted additional microsurgeries being captured overall, the number of microsurgical procedures has accelerated more rapidly in otolaryngology than in plastic surgery. This is not seen with the general surgery cohort.

**Patient Population**

Patient demographics are illustrated in Table 2. There were significant differences between the surgical subspecialty patient populations. Compared with plastic surgery, in the head and neck surgery cohort, the ENT population was significantly older ($P < 0.001$), and the operative time was significantly shorter ($P < 0.05$). In the breast surgery cohort, the general surgery population was significantly older ($P < 0.01$), higher BMI ($P < 0.01$), and had a longer operative time ($P < 0.01$). The remainder of the demographic and patient variables was comparable between the different subspecialties performing microsurgical reconstruction.

**Raw Rates Analysis**

The rate of each primary outcome is listed in Table 3. We found that there were no significant differences in SSI, reoperation, and unplanned readmission rates in head and neck microsurgeries as performed by ENT surgeons versus plastic surgeons. Similar results were attained when comparing breast free flaps performed by general surgeons versus plastic surgeons. There were slightly more deaths associated with ENT surgery, potentially attributable to an older patient population.

Although the rates of SSIs were lower in plastic surgery compared with otolaryngology for head and neck operations (10.5% versus 13.3%) and compared with general surgery for breast reconstructions (4.7% versus 5.4%), this failed to reach statistical significance ($P = 0.23$; $P = 0.66$). The raw rate of reoperation was lower in the surgical
specialty performing a greater number of cases (Table 3), but again there was no statistical significance reached.

**Multivariate Logistic Regression Analysis**

A multivariate regression analysis was performed to control for patient comorbidities. The following variables were included: age, BMI, diabetes, smoking, steroid use, surgical wound classification, ASA class, and operative time. Surgical specialty was included to evaluate if it was an independent predictive factor of our primary outcomes of SSIs, reoperations, and readmissions. The significant factors are listed in Table 4.

In summary, surgical specialty was not a predictive factor of SSI, reoperation, and readmission between ENT surgeons versus plastic surgeons and general surgeons versus plastic surgeons (Table 4). Interestingly, smoking is not a significant risk factor in the head and neck population. In addition, higher ASA class resulted in a negative coefficient for SSIs and thus seemed protective.

To simplify the table, and to answer if there are differences between surgical specialties, the data are summarized in Table 5, by surgical specialty. Although rates of SSI and readmission in head and neck microsurgical cases had a negative coefficient (protective effect) if plastic surgery was the specialty involved, this did not reach statistical significance. In the breast microsurgical population, SSI and

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**Table 2. Patient Population, Demographics, and Characteristics**

| Flap Location | Head and Neck | Breast |
|---------------|---------------|--------|
| Demographics  | Plastic Surgery, N = 285, Median ± SD | Otolaryngology, N = 898, Median ± SD | Plastic Surgery, N = 4,127, Median ± SD |
| Age (y)       | 56.0 ± 16.0   | 62.1 ± 13.6 | 50.4 ± 9.2  |
| Sex           | 117 (41.1)    | 298 (33.2)  | 4,118 (99.8) |
| Male          | 168 (58.9)    | 509 (66.7)  | 185 (99.5)  |
| Height (cm)   | 168.1 ± 43.7  | 165.6 ± 43.9 | 63.4 ± 11.4 |
| Weight (kg)   | 26.5 ± 6.1    | 25.8 ± 6.2  | 170.2 ± 36.8 |
| BMI           | 10 (3.5)      | 31 (3.5)    | 29.2 ± 5.6  |
| Diabetes      | 28 (9.7)      | 67 (7.3)    | 63.4 ± 11.4 |
| Insulin       | 0 (0.0)       | 8 (0.9)     | 46 (1.1)    |
| Non-insulin   | 247 (86.7)    | 792 (88.2)  | 159 (5.9)   |
| Oral§         | 46 (1.6)      | 4 (2.2)     | 8 (4.3)     |
| None          | 3,920 (95.0)  | 174 (93.5)  | 2 (0.0)     |
| Smoking       | 79 (27.7)     | 265 (29.5)  | 323 (7.8)   |
| Yes           | 296 (72.3)    | 633 (70.5)  | 3,804 (92.2)|
| No            | 9 (3.2)       | 31 (3.5)    | 53 (1.3)    |
| Steroid use   | 276 (96.8)    | 867 (96.5)  | 4,074 (92.2)|
| Yes           | 22 (0.7)      | 1 (0.1)     | 3 (0.1)     |
| No            | 8 (2.8)       | 15 (1.7)    | 222 (5.4)   |
| ASA class     | 167 (41.4)    | 203 (22.6)  | 2,309 (55.9)|
| 1             | 108 (37.9)    | 189 (21.0)  | 4,058 (98.3)|
| 2             | 145 (50.9)    | 646 (71.9)  | 182 (97.8)  |
| 3             | 26 (9.1)      | 44 (4.9)    | 45 (1.1)    |
| 4             | 6 (2.1)       | 19 (2.1)    | 17 (0.4)    |
| None assigned | 0 (0.0)       | 1 (0.1)     | 7 (0.2)     |
| Wound class   | 535.7 ± 210.1 | 510.0 ± 177.5 | 493.1 ± 172.9 |
| 1: Clean      | 30 (10.5)     | 119 (13.3)  | 0.0422     |
| 2: Clean/contaminated | 64 (22.5) | 170 (18.9)  | 0.0422     |
| 3: Contaminated | 19 (6.7)   | 74 (8.2)    | 0.0117     |
| 4: Dirty/infected | 12.5 ±15.7 | 10.4 ± 10.9 | 0.0498     |
| Operation time (min) | 193 (4.7) | 10 (5.4)    | 0.6593     |
| Reoperation   | 64 (22.5)     | 170 (18.9)  | 531 (12.9) |
| Unplanned readmission | 19 (6.7) | 74 (8.2)    | 225 (5.5)  |
| Total length of stay (d) | 12.5 ±15.7 | 10.4 ± 10.9 | 4.40 ± 6.5 |
| Death         | 0 (0.0)       | 12 (1.3)    | 3 (0.07)   |

*P < 0.001.
†P < 0.01.
‡P < 0.05.
§By definition, same as non-insulin, labeling change in 2010.

**Table 3. Microsurgery Raw Rates Outcomes Analysis**

| Outcome                  | Plastic Surgery, N = 285, n (%) | Otolaryngology, N = 898, n (%) | Plastic Surgery, N = 4,127, n (%) | General Surgery, N = 186, n (%) | P, χ², t Test |
|--------------------------|---------------------------------|---------------------------------|-----------------------------------|---------------------------------|--------------|
| Surgical site infection  | 30 (10.5)                       | 119 (13.3)                      | 0.267                             | 193 (4.7)                       | 0.0270       |
| Reoperation              | 64 (22.5)                       | 170 (18.9)                      | 0.1950                            | 531 (12.9)                      | 0.0373       |
| Unplanned readmission    | 19 (6.7)                        | 74 (8.2)                        | 0.3171                            | 225 (5.5)                       | 0.4970       |
| Total length of stay (d) | 12.5 ±15.7                      | 10.4 ± 10.9                     | 0.0117*                           | 4.40 ± 6.5                      | 0.5439       |
| Death                    | 0 (0.0)                         | 12 (1.3)                        | 0.0498*                           | 3 (0.07)                        | 0.7130       |

*P < 0.05.
Statistical tests used: χ² test for categorical variables and Student’s t test for continuous variables.
reoperation also had negative coefficients, but again did not reach statistical significance.

Cumulative Frequency Effect on Outcomes

With regard to cumulative frequency, a separate variable, named “Cumulative” or “CMLT,” is created and included in the multivariate regression. This variable encompasses surgical specialty and cumulative volume. The result of the CMLT variable on SSI, reoperation, and readmission is shown in Table 6. There is a slight statistically significant improvement in SSI rates if the surgical specialty is plastic surgery.

Although there are some outliers, CMLT is an independent predictor of decreased SSI (coefficient, −0.0001; odds ratio, 0.9998623; $R^2$, 0.0478; $P < 0.05$) (Fig. 3). This is not significant for reoperation or readmission.

Table 4. Multivariate Analysis for SSI, Reoperation, and Readmission

| Outcome        | Flap Location | Head and Neck | Breast |
|----------------|---------------|---------------|--------|
|                | Coefficient   | Odds Ratio    | P      | Coefficient   | Odds Ratio    | P      |
| SSI Sex: male  | −0.0883       | 0.9155        | 0.7383 | 0.8834       | 2.419         | 0.421  |
| Age            | −0.0104       | 0.9896        | 0.129  | 0.0071       | 1.0071        | 0.3920 |
| Height         | −0.129        | 0.879         | 0.1819 | 0.0419       | 1.0428        | 0.739  |
| Weight         | 0.0351        | 1.0358        | 0.0522 | −0.0026      | 0.9974        | 0.9015 |
| BMI            | −0.2264       | 0.7974        | 0.0561 | 1.007        | 1.1059        | 0.4081 |
| Diabetes       | −0.1583       | 0.8366        | 0.3931 | 0.6341       | 1.8853        | 0.0120 *|
| Smoking        | 0.0708        | 1.0798        | 0.0992 | 0.849        | 2.3573        | 0.0000 †|
| Steroid use    | 0.4473        | 1.5641        | 0.2895 | 0.795        | 2.2145        | 0.0765 |
| Wound class    | 0.369         | 1.4464        | 0.0122 *| 0.2392       | 1.2702        | 0.3953 |
| ASA class      | 0.1544        | 1.1669        | 0.3472 | −0.3146      | 0.7301        | 0.0174 *|
| Operation time | 0.1206        | 1.1282        | 0.0000 | 0.0494       | 1.0507        | 0.0418 *|
| Surgical specialty: plastics | −0.3460 | 0.7075        | 0.1306 | −0.0164      | 0.9837        | 0.9613 |

Reoperation Sex: male | −0.2322 | 0.7928 | 0.2854 | 0.4587 | 1.582 | 0.5677 |
| Age            | 0.0073       | 1.0073        | 0.221  | 0.0051       | 1.0032        | 0.5386 |
| Height         | 0.0806       | 1.0839        | 0.3441 | −0.0316      | 0.9689        | 0.6896 |
| Weight         | −0.011        | 0.9891        | 0.5038 | 0.0036       | 1.0036        | 0.7939 |
| BMI            | 0.0397        | 1.0405        | 0.7049 | 0.0074       | 1.0074        | 0.9275 |
| Diabetes       | 0.383         | 1.4667        | 0.0877 | −0.3771      | 0.6839        | 0.0904 |
| Smoking        | 0.0273        | 1.0276        | 0.8748 | 0.2968       | 1.2297        | 0.1916 |
| Steroid use    | 0.4478        | 1.5649        | 0.2274 | 0.3819       | 1.465         | 0.2668 |
| Wound class    | 0.3614        | 1.4353        | 0.0030 | −0.294       | 0.7453        | 0.2969 |
| ASA class      | 0.2944        | 1.3423        | 0.0385 | 0.2561       | 1.2919        | 0.0018 |
| Operation time | 0.1357        | 1.143         | 0.0000 | 0.0615       | 1.0634        | 0.0001 †|
| Surgical specialty: plastics | 0.2713 | 1.3116 | 0.1274 | −0.3073      | 0.7354        | 0.1243 |

Readmission Sex: male | −0.003 | 0.997 | 0.9933 | 1.6659 | 5.2905 | 0.0427 |
| Age            | 0.0082       | 1.0082        | 0.4192 | 0.0179       | 1.0181        | 0.3050 *|
| Height         | 0.0613       | 1.0613        | 0.6618 | 0.1104       | 1.1168        | 0.3675 |
| Weight         | −0.0062      | 0.9938        | 0.8159 | −0.0138      | 0.9862        | 0.4924 |
| BMI            | 0.0278       | 1.0282        | 0.8712 | 0.1564       | 1.1693        | 0.1856 |
| Diabetes       | 0.3441       | 1.4107        | 0.3254 | −0.4241      | 0.6544        | 0.217  |
| Smoking        | 0.029        | 1.0294        | 0.922  | 0.2921       | 1.326         | 0.254  |
| Steroid use    | −0.399       | 0.671         | 0.5923 | 0.4162       | 1.5161        | 0.3976 |
| Wound class    | 0.2223       | 1.2489        | 0.282  | −0.6102      | 0.5432        | 0.3092 |
| ASA class      | 0.1988       | 1.22          | 0.3848 | 0.0535       | 1.0359        | 0.7884 |
| Operation time | 0.0277       | 1.0281        | 0.5045 | 0.0895       | 1.0937        | 0.0004 †|
| Surgical specialty: plastics | −0.3188 | 0.727 | 0.2876 | 0.4220 | 1.525 | 0.2878 |

$^aP < 0.05.$  
$^bP < 0.001.$  
$^cP < 0.01.$

Table 5. Multivariate Regression Analysis by Surgical Specialty

| Outcome        | Plastic Surgery versus Otolaryngology | Plastic Surgery versus General Surgery |
|----------------|---------------------------------------|---------------------------------------|
|                | Coefficient   | Odds Ratio    | P      | Coefficient   | Odds Ratio    | P      |
| SSI            | −0.3460       | 0.7075        | 0.1306 | −0.0164       | 0.9837        | 0.9613 |
| Reoperation    | −0.2713       | 1.3136        | 0.1274 | −0.3073       | 0.7354        | 0.1243 |
| Readmission    | −0.3188       | 0.727         | 0.2876 | 0.4220        | 1.525         | 0.2878 |

Table 6. Effect of Cumulative Case Load on SSI, Reoperation, and Readmission

| Outcome        | Coefficient   | Odds Ratio   | P      |
|----------------|---------------|--------------|--------|
| CMLT SSI       | −0.0001       | 0.9999       | 0.0133 *|
| Reoperation    | 0             | 1            | 0.2964 |
| Readmission    | −0.0001       | 0.9999       | 0.1783 |

$^aOdds ratio in this chart is the odds of the specified outcome if surgical specialty performing the surgery was plastic surgery.

Reasons for reoperation are displayed in Table 7. There are no significant differences between the surgical specialties for each complication type. However, flap failure is not a separately tracked NSQIP complication. In addition, reoperation reasons and diagnoses are only tracked for the date from 2012 onward. For the head and neck subgroup, 124 (73.0%) of ENT and 53 (82.8%) of plastic
Fig. 2. A, NSQIP-captured microsurgical cases in general surgery and plastic surgery. B, NSQIP-captured microsurgical cases in ENT and plastic surgery.

Fig. 3. Scatter plot of CMLT variable.

Table 7. Reasons for Reoperation

| Flap Location | Head and Neck | Plastic Surgery, n (%) | Otolaryngology, n (%) | Plastic Surgery, n (%) | General Surgery, n (%) | P, χ² |
|---------------|--------------|------------------------|-----------------------|------------------------|------------------------|-------|
|               |              | Specific procedure†    | 12 (22.64)            | 35 (28.23)             | 0.5587                 |       |
|               |              | General medical‡       | 6 (11.32)             | 8 (6.45)               | 0.4264                 |       |
|               |              | Preexisting disease§   | 7 (13.21)             | 18 (14.52)             | 0.9947                 |       |
|               |              | Wound management¶      | 21 (39.62)            | 41 (35.06)             | 0.3056                 |       |
|               |              | Unspecified∥           | 7 (13.21)             | 22 (17.74)             | 0.5997                 |       |
|               |              | Total                  | 53                    | 124                    |                        |       |
|               |              | Plastic Surgery, n (%) | 141 (29.31)           | 5 (15.63)              | 0.1444                 |       |
|               |              | General Surgery, n (%) | 39 (8.11)             | 4 (12.50)              | 0.5901                 |       |

*Complication groupings:
†Mechanical complication of internal prosthesis or graft, infection of internal prosthesis or graft, deformity and disproportion of reconstructed breast.
‡Cellulitis and abscess, venous thromboembolism and thrombosis (not related to microsurgery), stridor, edema.
§Malignancy, dysphagia, nutritional deficiencies.
¶Hematoma, seroma, hemorrhage complicating a procedure, disruption of surgical wound.
∥Any other NSQIP-captured reason.
surgery reasons are captured [total of 177 (75.6%)]. For the breast subgroup, 52 (97.0%) of general surgery and 481 (91.0%) of plastic surgery reasons are captured [total of 513 (91.0%)]. This is a significant limitation of NSQIP because complications related to microsurgical procedures, such as flap failure or thrombosis, are not directly tracked. However, operations due to a complication relating to the specific procedure are more common for ENT flaps than for plastic surgery flaps. In the general surgery database, a similar pattern emerges.

**DISCUSSION**

**Subspecialty Outcomes: How Do They Differ?**

This study sought to explore the influence of surgical specialty on the complications of SSI, reoperation, and readmission in microvascular free flap surgery. We find that the rates of these complications do not significantly change between the differing specialties, suggesting a further need to retain specific caseloads. This is especially important in this ever-evolving age of super-subspecializing.

Two other NSQIP projects with similar aims were found in the literature. A 2009 study in the same database by Drinan et al. used a similar date range from 2005 to 2015 and thus have similar numbers compared with this study. They only evaluated ENT surgeons versus plastic surgeons with a non-regression type analysis, despite recognizing that their patient populations differ. Thus, their conclusions may be confounded by patient factors.

An unpublished comparison by Butala et al. has a sounder methodology. They used univariate and multivariate logistic regression on an analysis of 281 patients. They found that although plastic surgery patients were at high risk in terms of comorbidity, the results do not differ in terms of SSI, flap failure, reoperation, and mortality. It was important to note, however, that flap failure was not a currently tracked NSQIP complication, and it was unclear how the authors define this. Interestingly, in their study, ENT surgeons performed more fasciocutaneous flaps compared with myocutaneous flaps.

Other small studies reveal relatively similar findings. Another small 193 patient study by Offodile et al. also found that complication rates and flap failure rates were not significantly different between plastic surgery and otolaryngology. They did, however, suggest that larger flaps performed by otolaryngology had more complications.

In all these articles, and including ours, one thing is loud and clear: ENT surgeons have a higher volume than plastic surgeons at head and neck free flaps (Fig. 2). Smoking does not have significant effect on the head and neck region, as demonstrated by the multivariate logistic regression (Table 4), perhaps due to the abundant vascular supply to this region.

**Is Our Specialty at Risk? Can Any Surgeon Do Any Procedure Well?**

Plastic surgery is vulnerable to competition from our subspecialty colleagues. Because more and more cases are being taken over by other specialties, plastic surgeons should aim to maintain their wide range of competencies and skills. Although plastic surgeons still “own” most of breast reconstruction, general surgery is increasingly starting to perform alloplastic and autologous breast reconstruction, including free flap microsurgery.

One of the reasons for this shift is likely secondary to referral patterns as the oncologic surgeon controls the referral to the reconstructive surgeon. They serve as the gateway to reconstructive microsurgery. This may explain a shift in general surgeons performing microvascular free flap breast reconstruction. This cumulative case load required plays a role in complications. Limited data exist on performance experienced by large academic centers versus smaller centers (a proxy for hospital volume), but the consensus is that academic centers with larger volumes tend to have less complication rates,14–16 Much of this, however, is likely procedure based.17 Additional data are required to determine the exact or specific cumulative case load required to decrease other complication rates (SSIs, reoperations, and readmissions). The surgical specialty with the higher case load tends to have less reoperations. In our cumulative frequency analysis, this trend is significant for SSIs (Table 6 and Fig. 3). Lower surgical volumes are associated with longer operative durations, a risk factor for SSI.18

Some studies in the past have suggested that case volume is not a proxy for successful outcome and modern plastic surgery training programs produce competency in their trainees, as evidenced by no changes in microsurgery outcomes in 3 microsurgeons with various levels of experience over 7 years.19 The majority of the literature, however, suggests that higher case volumes lead to better outcomes, which is intuitive. This is seen at hospital volume level,14,15,20–22 individual level,14,15,23 procedure and perceived difficulty level,17 and in free flap outcomes.23 Most of the above studies use hospital or surgeon volumes, as evidenced by meta-analysis data.16 However, herein, a new cumulative specialty volume is proposed. As seen in Figure 3 and Table 6, CMLT is defined as cumulative frequency stratified by CPT code and surgical specialty. This is needed to avoid confounders or effect modification by surgical specialty and is crucial in analysis of procedures performed by multiple different specialties. Our study has confirmed the importance of volumes on surgical outcomes. In addition, this strengthens our conclusion that once another specialty amasses enough case volume, resulting outcomes may very well be similar.

**Limitations**

There are limitations to this research, mainly related to the nature of NSQIP. NSQIP is a representative sample, coded by humans doing retrospective chart reviews and prospective follow-up protocols. Coding incongruency can happen, and subtle descriptions may differ site to site. NSQIP allows only one entry for specialty per case, even when multiple procedures are performed and multiple specialties are involved. It does not include all cases that may be important to plastic surgeons, including trauma (eg, lower extremity trauma free flap surgery).
is not included in this study) and burn reconstruction. It also does not capture flap failure or thrombosis as an outcome, and, thus, the cause of reoperations cannot be clearly elicited. It also only captures 30-day outcomes, which although would include most flap failures, does not capture functional or patient-reported outcomes which are a critical element to outcome performance reporting.

Conclusions and Recommendation

The subject of surgical outcomes by surgical subspecialty must be approached with caution, and studies on the matter are scarce in the literature. Regardless, the outcomes of this study are important in an environment of quality and pay for performance metrics and surgeon-tracked outcomes. The rate of microsurgeries complications including readmission, reoperation, and SSI is similar between specialties in our study. Plastic surgery is at risk—plastic surgeons should protect caseloads to maintain relevance. System-based outcome measures are an important additional methodology to report, measure, and manage complications. In fact, the ideal outcome measure would include surgeon-reported, patient-reported, and even system-reported outcomes such as NSQIP. Finally, because plastic surgeons do not have direct control on patient referrals and are increasingly not geographically hospital based, these factors impose an increased risk on the sustainability of our specialty as it currently exists, particularly in the setting of our present research, which implies statistically equivalent free flap outcomes irrespective of specialty doing the procedure.

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