Research Square

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Impact of Race on Surgical Risk and Outcomes of Head and Neck Free-Flap Reconstruction: A National Database Analysis of 5,206 Reconstructions

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Abstract

Background

Surgical free flaps are often used for head and neck (H&N) reconstruction for defects from cancer, trauma, and congenital anomalies. While socioeconomic variables have been studied in the H&N cancer population, racial disparities in H&N free-flap reconstruethicction need to be further studied. This study examines differences in comorbidities and outcomes between White and non-White patients undergoing H&N free-flap reconstruction.

Methods

Using the National Surgical Quality Improvement Program Database, patients undergoing H&N reconstructions were classified into White and non-White racial groups. Statistical associations were assessed using univariate chi-square and multivariate regression analyses in SPSS.

Results

Of 5,026 patients, 4,111(82%) were White and 915(18%) were non-White. Non-White patients were younger($p < 0.001$), had longer lengths of stay($p = 0.001$), and had longer operative times($p < 0.001$). There was a higher incidence of diabetes mellitus($p = 0.005$) and infected wounds($p = 0.010$) in the non-White group. In comparison, White patients had a higher incidence of preoperative wound infection($p = 0.002$) and chronic obstructive pulmonary disease($p = 0.01$). Non-White patients were 1.65 times more likely to experience bleeding($p < 0.001$), 2.08 times more likely to undergo flap failure($p < 0.05$), and 1.65 times more likely to experience surgical complications($p < 0.001$) after adjusting for pre-operative characteristics.

Conclusions

This study emphasizes racial disparities for free-flap reconstruction in the H&N population, suggesting an association between socioeconomic determinants and increased risk of flap failure in non-White patients. Increased awareness of racial disparities in H&N free-flap reconstruction amongst surgeons can help improve treatment for those respective populations.

Level of Evidence

III

Introduction

Surgical free flaps, also known as microvascular free tissue transfer, have become the preferred technique and gold standard for large head and neck (H&N) defect reconstruction following cancer, trauma, or congenital anomalies.[1, 2] Free flaps are limited by the flap survival, complications, costs, and operative time.[3–7] Despite these limitations, free flaps are widely used for their greater versatility in supplying many different types of tissues and superior cosmetic outcomes, which yield improved quality of life.[8, 9] Free flap surgery is generally a reliable reconstructive technique, with success rates from 95% to 97%.[10–13] Free flap failure, occurring at a rate of 1–5%, is the most concerning complication with common causes including vascular occlusion due to hypercoagulability and prolonged operative time.[14–17] Other complications include return to the operating room, partial flap necrosis, surgical site infection (SSI), and wound dehiscence. Comorbidities that increase the risk for flap-related complications include hypertension, chronic obstructive pulmonary disease (COPD), and hypercholesterolemia.[18] Chronic pulmonary disease and congestive heart failure were also associated with 30-day readmission.[19]

Other independent risk factors for flap and wound complications include social determinants of health. Median household income in the lowest quartile and Medicaid or Medicare insurance status were shown to be significant risk factors for 30-day readmission due to wound complications.[19–22] Patients of lower socioeconomic status often have limited access to healthcare and are thus cared for by publicly-funded county hospitals with limited resources.[23–25] Compared with a university hospital, a greater proportion of patients who underwent H&N free flap surgery at a county hospital experienced flap failure and reoperation.[26] Low socioeconomic status has also been correlated with African American and Hispanic races, which are associated with a greater risk of chronic conditions, obesity, health disparities, and low healthcare satisfaction.[27–30]

Low socioeconomic status and specific races are also factors in developing COPD, hypertension, hypercholesterolemia, chronic pulmonary disease, and congestive heart failure, suggesting a higher risk for free flap procedures.[31–36] African American race is associated with a higher risk of arterial thrombotic issues, which may increase the chances of unplanned reoperation, emergent take-backs, and major surgical and respiratory issues.[37–39] African American race is also associated with unplanned reoperation during lower extremity free flap surgery and prolonged breast drain requirement and fat necrosis during breast free flap surgery.[40–42] Additionally, Hispanic ethnicity is also associated with prolonged drain requirement and higher odds of reoperation.[41, 43] While race has been examined to some extent as a predictor of postoperative complications of free flap surgery, the existing literature does not provide an analysis of the impacts of free flap head and neck reconstruction. Given the visibility of head and neck deformities and profound impact on patient quality of life, an assessment of racial impacts on head and neck free flaps is essential. Our study examines differences in comorbidities and outcomes between White and non-White patients undergoing H&N free-flap reconstruction.

Materials & Methods

This retrospective review used data from 2005 to 2018 in the National Surgical Quality Improvement Program Database (NSQIP). Patients undergoing head and neck reconstruction using a free flap were isolated using the following CPT codes: 15756, 15757, 15758, 15842, 20962, 20969, 20955, and 43496. Surgeon data was identified from the database using the variable “Surgical Specialty.” Patients were included if they were operated on by an otolaryngologist or plastic surgeon or if the primary surgical site was localized at the H&N. Included patients were then divided by race into “White” or “Non-White,” which encompassed Asian, Hispanic, and African American populations, among others. Races besides “White” were pooled into one category to avoid statistical bias due to the small sample size. Patients with unknown race or missing data were excluded from this analysis.

Patients were classified to have received one of the following five flaps: cutaneous, fascial, muscle, bone, or other. Demographic data, including age, body mass index (BMI), comorbidities, transfusion status, wound classification, and American Society of Anesthesiologists (ASA) classification, were collected. Operative details such as operative times and length of stay were also identified. The main outcome of interest included overall surgical complication rates. Subgroup analyses were also performed to find racial differences in specific major complications, minor complications, pulmonary complications, renal complications, cardiovascular complications, and sepsis.

Statistical analysis was performed using IBM SPSS Version 28. A p-value less than 0.05 was set as significant. Continuous variables were compared using a t-test, and dichotomous or categorical variables were compared across races using a chi-square test. Multivariate regression was performed to determine the role of race in causing bleeding, flap failure, and overall surgical complications while controlling for significant differences between groups.

Results

A total of 5,026 patients who underwent H&N free flap surgery between 2005 and 2018 were included in the study The 5,026 patients underwent 6,015 flap procedures consisting of 2,285 (38.0%) cutaneous flaps, 787 (13.1%) fascial flaps, 1,656 (27.5%) muscular flaps, 1,261 (21%) bone flaps, and 26 (0.4%) others. Of the 5,026 patients undergoing H&N procedures, 4,111 (82%) were White, and 915 (18%) were non-White. The average age of white patients was 61.81 ± 13.41 years old, while the average age of non-White patients was 56.73 ± 14.80 ($p < 0.001$) (Table 1). White patients experienced shorter operative times (539.75 ± 188.37 minutes) and shorter length of stay (10.21 ± 7.10 days) than non-White patients (566.40 ± 197.58 minutes; $p < 0.001$; 11.09 ± 8.41 days; $p = 0.001$, respectively).

Table 1
Pre-operative characteristics of patients undergoing H&N free-flap reconstruction by race.

Variable	White (N = 4111)	Non-White (N = 915)	p-value
Age, mean [SD]	61.81 [13.41]	56.73 [14.80]	**< 0.001**
BMI, mean [SD]	26.29 [6.20]	26.22 [6.49]	0.736
Operative time (min), mean [SD]	539.75 [188.37]	566.40 [197.58]	**< 0.001**
Length of stay (days), mean [SD]	10.21 [7.10]	11.09 [8.41]	**0.001**
BMI classification, n (%)			0.974
Underweight	356 (8.66%)	80 (8.74%)	
Healthy	1602 (38.97%)	363 (39.67%)	
Overweight	1228 (29.87%)	267 (29.18%)	
Obese	925 (22.50%)	205 (22.40%)	
Surgical specialty, n (%)			0.113
Otolaryngology	3229 (78.55%)	757 (82.73%)	
Plastics	680 (16.54%)	120 (13.11%)	
Other	202 (4.91%)	38 (4.15%)	
Diabetes mellitus, n (%)	492 (11.97%)	141 (15.41%)	**0.005**
Current smoker, n (%)	1175 (28.58%)	291 (31.80%)	0.053
COPD, n (%)	284 (6.91%)	42 (4.59%)	0.010
Ascites, n (%)	2 (0.05%)	0 (0.00%)	0.505
CHF, n (%)	24 (0.58%)	7 (0.77%)	0.527
Hypertension, n (%)	1953 (47.51%)	426 (46.56%)	0.603
Dialysis, n (%)	14 (0.34%)	5 (0.55%)	0.359
Cancer of H&N, n (%)	3349 (81.46%)	734 (80.22%)	0.762
Disseminated cancer, n (%)	283 (6.88%)	50 (5.46%)	0.118
Open wound/wound infection, n (%)	469 (11.41%)	72 (7.87%)	**0.002**
Steroid use for chronic condition, n (%)	177 (4.31%)	31 (3.39%)	0.208

BMI = body mass index, H&N = head and neck, COPD = chronic obstructive pulmonary disease, CHF = congestive heart failure, ASA = American Society of Anesthesiologists

Variable	White (N = 4111)	Non-White (N = 915)	p-value
Transfusion before surgery, n (%)	28 (0.68%)	10 (1.09%)	0.193
Wound classification, n (%)			**0.010**
Clean	946 (23.01%)	170 (18.58%)	
Clean/Contaminated	2851 (69.35%)	674 (73.66%)	
Contaminated	193 (4.69%)	36 (3.93%)	
Dirty/Infected	121 (2.94%)	35 (3.83%)	
ASA classification, n (%)			0.827
1	58 (1.41%)	16 (1.75%)	
2	828 (20.17%)	188 (20.57%)	
3	2915 (71.01%)	639 (69.91%)	
4	304 (7.41%)	71 (7.77%)	
5	0 (0.00%)	0 (0.00%)	

BMI = body mass index, H&N = head and neck, COPD = chronic obstructive pulmonary disease, CHF = congestive heart failure, ASA = American Society of Anesthesiologists

Non-White patients experienced higher comorbidities, with 15.41% of patients with diabetes mellitus compared to 11.97% of white patients (p = 0.005). On the contrary, a significantly lower number of non-White patients were diagnosed with COPD (4.59%) compared to white patients (6.91%) (p = 0.01). Open wounds or wound infections were found in 11.41% of white patients compared to 7.87% of non-White patients (p = 0.002). A significant difference was also found between wound classifications, with white patients presenting with more clean and contaminated wounds but fewer clean/contaminated and dirty wounds (Table 1).

A total of 1968 surgical complications were found across all patients, and in 45.03% of non-White patients and 37.85% of white patients (p < 0.001). Non-White patients were 1.65 times more likely to undergo any surgical complication (p < 0.001) after adjusting for preoperative characteristics through multivariate regression. For major complications, a 21.11% complication rate in white patients and a 24.59% complication rate in non-White patients (p = 0.791) was found. Nonsignificant differences in complication rates were found when comparing organ space SSI (p = 0.978), return to the operating room (p = 0.402), and death (p = 0.484) between white and non-White patients. Flap failure was reported in a total of 44 patients, with a significantly higher rate in non-White populations (1.20%) than in white populations (0.80%) (p = 0.035). Multivariate regression found that non-White patients were 2.08 times

more likely to undergo flap failure ($p < 0.05$) and 1.65 times more likely to experience bleeding ($p < 0.001$).

Overall, minor complications, including superficial SSI, deep incisional SSI, and wound dehiscence, were found at a similar rate in white and non-White patients ($p = 0.067$). White patients had a higher rate of superficial SSI at 6.86% compared to 4.70% in non-White patients ($p = 0.016$). There was no significant difference in the number of deep incisional SSI ($p = 0.467$) or wound dehiscence ($p = 0.679$) between both groups (Table 2).

Table 2
Postoperative outcomes of patients undergoing H&N free-flap reconstruction by race.

Variable	Total (N = 5026)	White (N = 4111)	Non-White (N = 915)	p-value
Major complications	1,093 (22.72%)	868 (21.11%)	225 (24.59%)	0.791
Organ space SSI	127 (2.44%)	104 (2.53%)	23 (2.51%)	0.978
Return to OR	855 (18.15%)	674 (16.40%)	181 (19.78%)	0.402
Flap failure	44 (0.85%)	33 (0.80%)	11 (1.20%)	**0.035**
Death	67 (1.29%)	57 (1.39%)	10 (1.09%)	0.484
Minor complications	783 (15.04%)	663 (16.13%)	120 (13.11%)	0.067
Superficial SSI	325 (6.24%)	282 (6.86%)	43 (4.70%)	**0.016**
Deep incisional SSI	197 (3.78%)	165 (4.01%)	32 (3.50%)	0.467
Dehiscence	261 (5.01%)	216 (5.25%)	45 (4.92%)	0.679
Pulmonary	732 (14.06%)	583 (14.18%)	149 (16.28%)	
Pneumonia	296 (5.69%)	224 (5.45%)	72 (7.87%)	**0.005**
Unplanned intubation	128 (2.46%)	107 (2.60%)	21 (2.30%)	0.593
Pulmonary embolism	37 (0.71%)	32 (0.78%)	5 (0.55%)	0.458
On ventilator > 48 hours	271 (5.21%)	220 (5.35%)	51 (5.57%)	0.788
Renal	68 (1.31%)	54 (1.31%)	14 (1.53%)	
Progressive renal insufficiency	8 (0.15%)	7 (0.17%)	1 (0.11%)	0.676
Acute renal failure	5 (0.10%)	4 (0.10%)	1 (0.11%)	0.917
Urinary tract infection	55 (1.06%)	43 (1.05%)	12 (1.31%)	0.485
Cardiovascular	1633 (31.37%)	1269 (30.87%)	364 (39.78%)	
Stroke/CVA	29 (0.56%)	28 (0.68%)	1 (0.11%)	**0.039**
Cardiac arrest requiring CPR	41 (0.79%)	35 (0.66%)	6 (0.63%)	0.552
Myocardial infarction	43 (0.83%)	38 (0.92%)	5 (0.55%)	0.262
Transfusions: peri-op/post-op	1459 (28.02%)	1121 (27.27%)	338 (36.93%)	**< 0.001**

SSI = surgical site infection, OR = operating room, CVA = cerebrovascular accident, CPR = cardiopulmonary resuscitation, peri-op = peri-operative, post-op = postoperative, DVT = deep vein thrombosis

Variable	Total (N = 5026)	White (N = 4111)	Non-White (N = 915)	p-value
DVT requiring therapy	61 (1.17%)	47 (1.14%)	14 (1.53%)	0.337
Sepsis	176 (3.38%)	147 (3.58%)	29 (3.17%)	0.545
Septic shock	38 (0.73%)	31 (0.75%)	7 (0.77%)	0.972
Any surgical complication	1968 (37.80%)	1556 (37.85%)	412 (45.03%)	**< 0.001**

SSI = surgical site infection, OR = operating room, CVA = cerebrovascular accident, CPR = cardiopulmonary resuscitation, peri-op = peri-operative, post-op = postoperative, DVT = deep vein thrombosis

Pneumonia occurred at a higher rate in non-White patients (7.87%) than in white patients (5.45%) after H&N free flap procedures (p = 0.005). Unplanned intubation occurred at a combined rate of 2.46%, which was not different between the two groups (p = 0.593). Similarly, there was no difference in the progression of renal insufficiency, acute renal failure, or urinary tract infection. Rates of sepsis and septic shock were also similar in both groups.

White patients encountered a higher incidence of stroke, which was found in 0.68% of patients compared to 0.11% of non-White patients (p = 0.039). There were no significant differences in the rates of cardiac arrest requiring CPR (p = 0.552), myocardial infarction (p = 0.262), or deep vein thrombosis (DVT) requiring therapy (p = 0.337) between white and non-White populations. Finally, rates of perioperative and postoperative transfusions were significantly higher in non-White populations (36.93%) compared to white populations (27.27%) (p < 0.001).

Discussion

Microvascular free flap transfer has contributed greatly to treatment options for patients with head and neck (H&N) cancer. However, as with many reconstructive surgeries, postoperative outcomes of free flap surgery differ across patient groups. This study investigated differences in postoperative outcomes between White and non-White groups undergoing H&N free flap reconstructive surgery.

In the US, racial disparities in the delivery of health care have been thoroughly demonstrated.[44, 45] These disparities are caused by social and systemic factors, including decreased access to healthcare, provider mistrust, and implicit bias of healthcare providers.[46, 47] A study on racial disparities in gender-affirming surgery found that black patients had a higher likelihood of reoperation, 30-day readmission, and organ space surgical site infection than white patients. [36] Similarly, a study on bariatric surgery concluded that black patients had higher odds of postoperative complications and readmissions.[37] While these studies examined the role of race in surgical outcomes, literature examining race as a predictor of H&N surgery outcomes is lacking, and existing studies examine a limited range of outcomes. The effects of race on free flap outcomes were examined to a degree in a study by Brauer et

al., which compared three racial groups (White, Black, and Asian/Native American) simultaneously. This approach may have limited the ability to detect differences between Black and White patients due to similarities between Asian/Native Americans and White patients.[48] However, when a binary comparison was utilized as in our study, the disparities in bleeding, flap complications, and more adverse events are clearly isolated, even though Asians and Native Americans were included in the non-White group.

Racial disparities were observed in our study, suggesting an association between socioeconomic determinants and increased risk of complications in non-White patients. Transfusions have been associated with increased wound dehiscence, myocardial infarction, and pneumonia, explaining a potential source of higher complications in the non-White group.[49] Greater anesthesia duration and longer operative times are also independent predictors of increased length of stay, flap failure, and surgical complications such as infections.[50–54] This could also partially explain the disparities. Another explanation could be due to the disproportionate number of racial minorities seeking treatment from low-volume hospitals.[55] Madrigal et al. found that patients undergoing H&N surgeries at high-volume hospitals had a lower likelihood of surgical and medical complications, shorter hospitalizations, and decreased costs.[56] Mulvey et al. found an association between high-volume hospital care and lower patient mortality and a lower failure-to-rescue rate.[57] While these factors may explain racial differences in outcomes, further research and community interventions are needed to identify and address the underlying causes of such disparities.

In the current study, larger numbers of white patients were found to have COPD as a comorbidity, which contradicts the literature showing a greater incidence in African American populations.[33] This could be attributed to occupational exposure, family history, and asthma in white populations or underdiagnosis in non-White populations.[58] The higher incidence of superficial SSI in white patients may be due to advanced age. However, diabetes and operative time are also correlated with superficial SSI and were greater in non-White patients.[59] While superficial SSI and some comorbidities were found to be higher in white populations, overall complications were still significantly higher in non-White populations, highlighting the impact of racial disparities.

Limitations

Limitations of this study include a greater number of white patients compared to “non-White” patients in the database. In addition, separating into the groups “White” and “Non-White” does not account for the diversity within non-White populations. Furthermore, the NSQIP database only reports 30-day outcomes, failing to account for long-term complications.

Conclusion

This study examined outcomes and racial disparities in head and neck free flaps at a national scale. Non-White patients were found to have increased comorbidities, operative time, length of stay,

postoperative surgical complications, flap failure, and bleeding. This further emphasizes the need for greater comorbidity reduction, which can facilitate reduced operative times and postoperative complications. These findings add to the body of literature highlighting the need for greater societal interventions to reduce socioeconomic barriers for non-White races receiving plastic surgery.

Declarations

Clinical trial number: not applicable

Author Contribution

Author Contributions: PS: writing, data analysis; IH: data collection, idea formation; DP: writing; SS: writing; DM: data analysis; PM: editing, idea formation; EL: idea formation, editing

References

1. Neligan PC (2013) Head and Neck Reconstruction. Plast Reconstr Surg Febr 131(2). 10.1097/PRS.0b013e3182778938
2. Wong C-H, Wei F-C (2010) Microsurgical free flap in head and neck reconstruction. Head Neck 910.1002/hed.21284. 09/01;32
3. McCrory AL, Magnuson JS (2002) Free tissue transfer versus pedicled flap in head and neck reconstruction. Laryngoscope 112(12):2161–2165. 10.1097/00005537-200212000-00006. PubMed PMID: 12461333
4. Kondra K, Roohani I, Swerdlow M, Brown M, O'Brien D, Pekcan A et al (2022) Outcomes of Local versus Free Flaps for Lower Extremity Trauma. Am Surg 88(10):2544–2550 Epub 20220517. doi: 10.1177/00031348221103651. PubMed PMID: 35581551
5. Gabrysz-Forget F, Tabet P, Rahal A, Bissada E, Christopoulos A, Ayad T (2019) Free versus pedicled flaps for reconstruction of head and neck cancer defects: a systematic review. J Otolaryngol Head Neck Surg 48(1):13 Epub 20190314. 10.1186/s40463-019-0334-y
6. Geiger EJ, Basques BA, Chang CC, Son Y, Sasaki CT, McGregor A et al (2016) Pedicle versus free flap reconstruction in patients receiving intraoperative brachytherapy. J Plast Surg Hand Surg 50(4):227–232 Epub 20160316. 10.3109/2000656X
7. Howard BE, Nagel TH, Barrs DM, Donald CB, Hayden RE (2016) Reconstruction of Lateral Skull Base Defects: A Comparison of the Submental Flap to Free and Regional Flaps. Otolaryngol Head Neck Surg 154(6):1014–1018 Epub 20160315. doi: 10.1177/0194599816634296. PubMed PMID: 26980913
8. Basaran B, Unsaler S, Kesimli MC, Aslan I (2021) Free Flap Reconstruction of the Head and Neck Region: A Series of 127 Flaps Performed by Otolaryngologists. Turk Arch Otorhinolaryngol 59(2):103–110 Epub 20210730. 10.4274/tao.2021.2021-1-9

9. Dolan RT, Butler JS, Murphy SM, Cronin KJ (2012) Health-related quality of life, surgical and aesthetic outcomes following microvascular free flap reconstructions: an 8-year institutional review. Ann R Coll Surg Engl 94(1):43–51 PubMed PMID: 22524928; PubMed Central PMCID: PMCPMC3954186
10. Gusenoff JA, Vega SJ, Jiang S, Behnam AB, Sbitany H, Herrera HR et al (2006) Free tissue transfer: comparison of outcomes between university hospitals and community hospitals. Plast Reconstr Surg. ;118(3):671-5. 10.1097/01.prs.0000233203.84078.6b. PubMed PMID: 16932175
11. Almadori G, Rigante M, Bussu F, Parrilla C, Gallus R, Barone Adesi L et al (2015) Impact of microvascular free flap reconstruction in oral cavity cancer: our experience in 130 cases. Acta Otorhinolaryngol Ital 35(6):386–393. 10.14639/0392-100X-919. PubMed PMID: 26900243; PubMed Central PMCID: PMCPMC4755058
12. Tarsitano A, Ciocca L, Cipriani R, Scotti R, Marchetti C (2015) Mandibular reconstruction using fibula free flap harvested using a customised cutting guide: how we do it. Acta Otorhinolaryngol Ital 35(3):198–201 PubMed PMID: 26246665; PubMed Central PMCID: PMCPMC4510936
13. Novakovic D, Patel RS, Goldstein DP, Gullane PJ (2009) Salvage of failed free flaps used in head and neck reconstruction. Head Neck Oncol 1:33 Epub 20090821. 10.1186/1758-3284-1-33
14. Crawley MB, Sweeny L, Ravipati P, Heffelfinger R, Krein H, Luginbuhl A et al (2019) Factors Associated with Free Flap Failures in Head and Neck Reconstruction. Otolaryngol Head Neck Surg 161(4):598–604 Epub 20190806. doi: 10.1177/0194599819860809. PubMed PMID: 31382816
15. Zhou W, Zhang WB, Yu Y, Wang Y, Mao C, Guo CB et al (2017) Risk factors for free flap failure: a retrospective analysis of 881 free flaps for head and neck defect reconstruction. Int J Oral Maxillofac Surg 46(8):941–945 Epub 20170414. 10.1016/j.ijom.2017.03
16. Bui DT, Cordeiro PG, Hu QY, Disa JJ, Pusic A, Mehrara BJ (2007) Free flap reexploration: indications, treatment, and outcomes in 1193 free flaps. Plast Reconstr Surg 119(7):2092–2100. 10.1097/01.prs.0000260598.24376.e1. PubMed PMID: 17519706
17. Copelli C, Tewfik K, Cassano L, Pederneschi N, Catanzaro S, Manfuso A et al (2017) Management of free flap failure in head and neck surgery. Acta Otorhinolaryngol Ital 37(5):387–392. 10.14639/0392-100X-1376. PubMed PMID: 29165433; PubMed Central PMCID: PMCPMC5720866
18. Ekin Y, Gunusen I, Ozdemir OY, Tiftikcioglu YO (2019) Effect of Coagulation Status and Co-Morbidity on Flap Success and Complications in Patients with Reconstructed Free Flap. Turk J Anaesthesiol Reanim 47(2):98–106 Epub 20190129. doi: 10.5152/TJAR.2019.07752. PubMed PMID: 31080950; PubMed Central PMCID: PMCPMC6499041
19. Goel AN, Raghavan G, St John MA, Long JL (2019) Risk Factors, Causes, and Costs of Hospital Readmission After Head and Neck Cancer Surgery Reconstruction. JAMA Facial Plast Surg 21(2):137–145. 10.1001/jamafacial.2018.1197. PubMed PMID: 30418467; PubMed Central PMCID: PMCPMC6439803
20. Chen MM, Orosco RK, Harris JP, Porter JB, Rosenthal EL, Hara W et al Predictors of readmissions after head and neck cancer surgery: A national perspective. Oral Oncol. 2017/08/01;71.

10.1016/j.oraloncology.2017.06.010

21. Noel CW, Forner D, Wu V, Enepekides D, Irish JC, Husain Z et al (2020) Predictors of surgical readmission, unplanned hospitalization and emergency department use in head and neck oncology: A systematic review. Oral Oncol. 10.1016/j.oraloncology.2020.105039. /12/01;111
22. Hu J, Gonsahn MD, Nerenz DR Socioeconomic Status And Readmissions: Evidence From An Urban Teaching Hospital. Health Aff. 2017-08-02;33(5). 10.1377/hlthaff.2013.0816
23. Patel UA, Thakkar KH, Holloway N (2008) Patient compliance to radiation for advanced head and neck cancer at a tertiary care county hospital. Laryngoscope 118(3):428–432. 10.1097/MLG.0b013e31815ae3d2. PubMed PMID: 18043491
24. Grimes CE, Bowman KG, Dodgion CM, Lavy CBD, Grimes CE, Bowman KG et al Systematic Review of Barriers to Surgical Care in Low-Income and Middle-Income Countries. World J Surg 2011 35:5. 2011-03-01;35(5). 10.1007/s00268-011-1010-1
25. Regidor E, Martínez D, Calle ME, Astasio P, Ortega P, Domínguez V et al Socioeconomic patterns in the use of public and private health services and equity in health care. BMC Health Serv Res 2008 8:1. 2008-09-14;8(1). 10.1186/1472-6963-8-183
26. Swanson MS, Gantz O, Zhou S, Fisher L, Kezirian E, Tan MH et al (2023) Comparison of Free Flap Outcomes at a University Hospital versus County Hospital Setting for Head and Neck Reconstruction. Int Arch Otorhinolaryngol 27(2):e183–e90 Epub 20230428. 10.1055/s-0043-1768204
27. Molina KM, Simon Y, Molina KM, Simon Y Everyday discrimination and chronic health conditions among Latinos: the moderating role of socioeconomic position. J Behav Med 2013 37:5. 2013-11-12;37(5). 10.1007/s10865-013-9547-0
28. Haviland MG, Morales LS, Dial TH, Pincus HA, Mark G, Haviland LSM, Thomas H, Dial (2005) Harold Alan Pincus. Race/Ethnicity, Socioeconomic Status, and Satisfaction With Health Care. Am J Med Qual 410.1177/1062860605275754. -07-01;20
29. RogersRobert FE, SheetzAnne, WoodwardAlan, LeibowitzRobert SMK et al The Relationship between Childhood Obesity, Low Socioeconomic Status, and Race/Ethnicity: Lessons from Massachusetts. Child Obes. 2015-12-14;11(6). 10.1089/chi.2015.0029
30. Stepanikova I, Oates GR (2017) Perceived Discrimination and Privilege in Health Care: The Role of Socioeconomic Status and Race. Am J Prev Med 110.1016/j.amepre.2016.09.024. /01/01;52
31. Bahrami H, Kronmal R, Bluemke DA, Olson J, Shea S, Liu K et al Differences in the Incidence of Congestive Heart Failure by Ethnicity. Archives Intern Med 2008/ 10/27;168(19). 10.1001/archinte.168.19.2138
32. Deere BP, Ferdinand KC (2020) Hypertension and race/ethnicity. Curr Opin Cardiol July 35(4). 10.1097/HCO.0000000000000742
33. Eisner MD, Blanc PD, Omachi TA, Yelin EH, Sidney S, Katz PP et al Socioeconomic status, race and COPD health outcomes. J Epidemiol Community Health. 2011-01-01;65(1). 10.1136/jech.2009.089722

34. Foreman MG, Zhang L, Murphy J, Hansel NN, Make B, Hokanson JE et al (2012) Early-Onset Chronic Obstructive Pulmonary Disease Is Associated with Female Sex, Maternal Factors, and African American Race in the COPDGene Study. Am J Respir Crit Care Med 410.1164/rccm.201011-1928OC. -12-14;184
35. Lee H, Shin SH, Gu S, Zhao D, Kang D, Joi YR et al (2018) Racial differences in comorbidity profile among patients with chronic obstructive pulmonary disease. BMC Med 16(1). 10.1186/s12916-018-1159-7. :1. 2018-10-04;16
36. Tharu BP, Tsokos CP (2017) A Statistical Study of Serum Cholesterol Level by Gender and Race. J Res Health Sci 17(3):e00386 Epub 20170725. PubMed PMID: 28878106
37. Chang CS, Chu MW, Nelson JA, Basta M, Gerety P, Kanchwala SK et al (2017) Complications and Cost Analysis of Intraoperative Arterial Complications in Head and Neck Free Flap Reconstruction. J Reconstr Microsurg 33(5):318–327 Epub 20170225. 10.1055/s-0037-1598618
38. Dilley A, Austin H, Hooper WC, Lally C, Ribeiro JA, Wenger NK et al (1998) Relation of Three Genetic Traits to Venous Thrombosis in an African-American Population. Am J Epidemiol 110.1093/oxfordjournals.aje.a009363. 01/01;147
39. Wong AK, Nguyen TJ, Peric M, Shahabi A, Vidar EN, Hwang BH et al Analysis of risk factors associated with microvascular free flap failure using a multi-institutional database. Microsurgery 2015/01/ 01;35(1). 10.1002/micr.22223
40. Elmer NA, Araya S, Panichella J, Egleston B, Deng M, Patel SA (2023) Ann Plast Surg 90(3):229–236 0000000000003429. PubMed PMID: 36796044; PubMed Central PMCID: PMCPMC10084812. Timing of Unplanned Reoperation After Lower Extremity Free Flap Reconstruction: What Are the Roles of Procedure Indication and Defect Etiology?
41. Dinis J, Allam O, Junn A, Park KE, Mozaffari MA, Shah R et al (2022) Predictors for Prolonged Drain Use Following Autologous Breast Reconstruction. J Reconstr Microsurg 38(2):160–167 Epub 20210720. 10.1055/s-0041-1731765
42. Wu C, Clayton JL, Halvorson EG (2014) Racial differences in ischemic complications of pedicled versus free abdominal flaps for breast reconstruction. Ann Plast Surg 72(6):S172–S175 .0000000000000102. PubMed PMID: 24691350
43. Huayllani MT, Torres-Guzman RA, Avila FR, Advani PP, Spaulding AC, Cochuyt JJ et al (2022) Effect of health care disparities on procedure selection of autologous breast reconstruction in Florida. Breast Dis 41(1):75–80 3233/BD-210004. PubMed PMID: 34487016
44. Mahajan S, Caraballo C, Lu Y, Valero-Elizondo J, Massey D, Annapureddy AR et al (2021) Trends in Differences in Health Status and Health Care Access and Affordability by Race and Ethnicity in the United States, 1999–2018. JAMA 326(7):637–648 PubMed PMID: 34402830; PubMed Central PMCID: PMCPMC8371573
45. Smedley BD, Stith AY, Nelson AR (eds) (2003) Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care. Washington (DC)

46. Kennedy BR, Mathis CC, Woods AK (2007) African Americans and their distrust of the health care system: healthcare for diverse populations. J Cult Divers 14(2):56–60 PubMed PMID: 19175244
47. Chapman EN, Kaatz A, Carnes M (2013) Physicians and implicit bias: how doctors may unwittingly perpetuate health care disparities. J Gen Intern Med 28(11):1504–1510 Epub 20130411. 10.1007/s11606-013-2441-1
48. Brauer P, Culbert A, Zhang E, Xu J, Ku J, Bottalico D et al (2025) Positive Trends in Racial Disparities for Head and Neck Microvascular Reconstructive Surgery - PubMed. Laryngoscope 135(2). 10.1002/lary.31708
49. Cotton KM, Mangan AR, Gardner JR, Shay A, King D, Vural EA et al Association between blood transfusion and outcomes of free flap head and neck cancer surgery. Am J Otolaryngol. 2024/11/01;45(6). 10.1016/j.amjoto.2024.104497
50. Brady JS, Desai SV, Crippen MM, Eloy JA, Gubenko Y, Baredes S et al (2018) Association of Anesthesia Duration With Complications After Microvascular Reconstruction of the Head and Neck. JAMA Facial Plast Surg 20(3):188–195 PubMed PMID: 28983575; PubMed Central PMCID: PMCPMC6145788
51. Kuo SCH, Kuo PJ, Yen YH, Chien PC, Hsieh HY, Hsieh CH (2019) Association between operation- and operator-related factors and surgical complications among patients undergoing free-flap reconstruction for head and neck cancers: A propensity score-matched study of 1,865 free-flap reconstructions. Microsurgery 39(6):528–534 Epub 20190610. 10.1002/micr.30477
52. Irawati N, Every J, Dawson R, Leinkram D, Elliott M, Ch'ng S et al Effect of operative time on complications associated with free flap reconstruction of the head and neck. Clin Otolaryngol. 2023/03/01;48(2). 10.1111/coa.14000
53. Pattani KM, Byrne P, Boahene K, Richmon J (2010) What makes a good flap go bad? A critical analysis of the literature of intraoperative factors related to free flap failure. Laryngoscope 410.1002/lary.20825. /04/01;120
54. Cannady S, Hatten K, Bur A, Brant J, Fischer J, Newman J et al (2017) Use of free tissue transfer in head and neck cancer surgery and risk of overall and serious complication(s): An American College of Surgeons-National Surgical Quality Improvement Project analysis of free tissue transfer to the head and neck - PubMed. Head Neck 39(4). 10.1002/hed.24669
55. Liu JH, Zingmond DS, McGory ML, SooHoo NF, Ettner SL, Brook RH et al (2006) Disparities in the utilization of high-volume hospitals for complex surgery. JAMA 296(16):1973–1980. 10.1001/jama.296.16.1973. PubMed PMID: 17062860
56. Madrigal J, Mukdad L, Han AY, Tran Z, Benharash P, St John MA et al (2022) Impact of Hospital Volume on Outcomes Following Head and Neck Cancer Surgery and Flap Reconstruction. Laryngoscope 132(7):1381–1387 Epub 20211012. 10.1002/lary.29903
57. Mulvey CL, Pronovost PJ, Gourin CG (2015) Hospital volume and failure to rescue after head and neck cancer surgery. Otolaryngol Head Neck Surg 152(5):783–789 Epub 20150213. doi: 10.1177/0194599815570026. PubMed PMID: 25681489

58. Adeloye D, Song P, Zhu Y, Campbell H, Sheikh A, Rudan I Global, regional, and national prevalence of, and risk factors for, chronic obstructive pulmonary disease (COPD) in 2019: a systematic review and modelling analysis. Lancet Respiratory Med. 2022/05/01;10(5). 10.1016/S2213-2600(21)00511-7
59. Korol E, Johnston K, Waser N, Sifakis F, Jafri HS, Lo M et al (2013) A Systematic Review of Risk Factors Associated with Surgical Site Infections among Surgical Patients. PLOS ONE Dec 18(12). 10.1371/journal.pone.0083743