Original Article

Free Tissue Transfer during the COVID-19 Pandemic: A Proposed Evidence-Based Protocol for Early Discharge

Matthew E. Pontell[1*], Alexandra L. Alving-Trinh[2], Sara Chaker[3], Julian S. Winocour[1], Wesley P. Thayer[1]

1. Department of Plastic Surgery, Vanderbilt University Medical Center, Nashville, Tennessee, USA
2. School of Medicine, Vanderbilt University, Nashville, Tennessee, USA
3. Vanderbilt University, Nashville, Tennessee, USA

***Corresponding Author:**

Matthew E. Pontell, MD

Department of Plastic Surgery Vanderbilt University Medical Center D-4207 Medical Center North Nashville, TN 37232

Tel.: +1 201-446-3006
Email: matthew.e.pontell@vumc.org

Received: 27 Apr 2021
Revised: 20 Sep 2021
Accepted: 23 Sep 2021

ABSTRACT

BACKGROUND
As free tissue transfer outcomes improve, institutions are examining early discharge protocols. "Early" is generally defined as between one and five days postoperatively, which correlates with the timing of most major complications and most opportunities for flap salvage. Given the trend towards early discharge, the need for healthcare cost reductions and shortage of ICU beds during a viral pandemic, we aimed to propose an evidence-based protocol to select patients for discharge within 72 h of free tissue transfer.

METHODS
A retrospective review of all patients who underwent free tissue transfer at Vanderbilt University Medical Center, Tennessee, USA since the onset of the COVID-19 (2020-2021) pandemic was performed. Patients were included for review if they were discharged within 72 h of surgery. Literature relating to expedited discharge after free tissue transfer was also reviewed.

RESULTS
Six patients met inclusion criteria for retrospective review. None suffered intraoperative or postoperative inpatient complications and all were discharged within 72 h postoperatively. There were no flap failures within 30 d of reconstruction.

CONCLUSION
This study reviews a patient cohort undergoing free tissue transfer during the COVID-19 pandemic. These cases were reviewed for factors that may have contributed to their postoperative success after discharge within 72 hours. These data points were combined with published evidence on risks for failure after free flap reconstruction to design a protocol to select patients for early discharge. The benefits of early discharge include reducing healthcare costs, risks of inpatient hospitalization, and ICU utilization, which is of paramount importance in the midst of a global pandemic..

KEYWORDS
Early, discharge, Free flap, Free tissue, Microvascular, Reconstruction

Please cite this paper as:
Pontell ME, Alving-Trinh AL, Chaker S, Winocour JS, Thayer WP. Free Tissue Transfer during the COVID-19 Pandemic: A Proposed Evidence-Based Protocol for Early Discharge. World J Plast Surg. 2022;11(1):23-29.
doi: 10.52547/wjps.11.1.23

INTRODUCTION

Severe wounds compromised by critical structure exposure often require reconstruction by free tissue transfer. As microvascular reconstruction has become more commonplace and institutional experiences increase, outcomes have subsequently improved[1-5]. Free tissue transfer is now an established tool used to maximize outcomes after reconstruction of post-traumatic, post-infectious and post-extirpative defects[6-8]. A relative disadvantage of microvascular free tissue transfer is the length of surgery

and degree of post-operative care. Average length of stay (LOS) for such patients ranges from 1 to 4 wk depending on the nature of the defect, patient comorbid status, flap selection and postoperative course[9-15]. LOS is highly variable in this patient population and is related to the need for close postoperative observation, physical rehabilitation, consolidation of wound care and the ability to arrange ancillary services needed to safely discharge[12]. Nevertheless, an extended LOS translates into a significant increase in hospital cost[15-17].

As free tissue transfer gains popularity and surgeons become more comfortable, outcomes continue to improve, with free flap failure rates quoted as low as 1%-2% in some series[14,18-23]. This has given rise to trends towards early discharge for patients with few medical comorbidities and are otherwise deemed "low-risk" by their surgeons[7,14,15]. Aside from decreasing healthcare costs, truncating postoperative LOS decreases patient-centric risks associated with prolonged hospitalization[14]. Discharge in as few as 1-3 d postoperatively has been shown to be safe in appropriately selected patients for free tissue reconstruction[14].

The year 2020 has brought with it many challenges, none as great as COVID-19. The viral pandemic has strained hospital systems across the globe and resulted in substantial intensive care unit (ICU) bed shortages in the United States[24]. This has resulted in a difficult situation for patients requiring microvascular reconstruction in the time of the pandemic. Given the need for ICU beds and decreased hospital systems utilization, expedited discharge protocols are needed now more than ever. We aimed to examine a single-institution's experience during the COVID-19 pandemic alongside published literature to propose a protocol for discharge within 72 h of free tissue transfer.

METHODS

After Institutional Review Board approval (IRB 210044), a retrospective chart review was conducted at Vanderbilt University Medical Center, Tennessee, USA. Patients who underwent free tissue transfer from 2020-2021, during the time of the COVID-19 pandemic, were identified. Those patients discharged within 72 h postoperatively were selected for analysis. Data from the preoperative, intraoperative, and postoperative periods were analyzed. Descriptive statistics were utilized with means and ranges plus or minus standard deviations when appropriate.

Criteria consistent among patients was identified again compared to existing literature that has shown to be predictive of complications and prolonged LOS after free tissue transfer. A protocol was then proposed to identify patients who are appropriate for discharge within 72 h after free tissue transfer.

RESULTS

Six patients met inclusion criteria for the retrospective review. There were four males and two females, with an average age of 44.7 years. All patients (6/6) were admitted electively for their procedure and no patient had a history of chronic steroid usage, radiation to the wound bed or a preoperative diagnosis of a bleeding diathesis. All patients were ASA class 3 or lower (Table 1). Five patients underwent free fascia-

Table 1. Preoperative Patient Information

Gender	66.7% Male (4/6)	33.3% Female (2/6)	
Age	44.7 ± 12.8 Years (Range 32 – 63 Years)		
Past Medical History	50% HTN (3/6)	16.7% CAD (1/6)	83.3% Current Smoker (5/6)
Indication for Reconstruction	50% Exposed Bone (3/6)	33.3% Exposed Tendon (2/6)	33.3% Non-healing Surgical Wound (2/6)
Wound Mechanism	50% Post-traumatic (3/6)	33.3% Post-extirpative (2/6)	16.7% Post-infectious (1/6)
Chronic Steroid Usage (>6 months)	100% No (6/6)		
Preoperative Radiation to Wound Bed	100% No (6/6)		
Preoperative Dx of Bleeding Disorder	100% No (6/6)		
	Female	*Male*	
Preoperative Hemoglobin	0% ≥ 12.0 g/dL (0/6) 33.3% < 12.0 g/dL (2/6)	33.3% ≥ 13.0 g/dL (2/6) 16.7% < 13.0 g/dL (1/6)	16.7% N/A (1/6)
Preoperative Albumin Level	50% ≥ 3.5 g/dL (3/6)	50% N/A (3/6)	
ASA Class	I - 0% (0/6)	II - 50% (3/6)	III - 50% (3/6) ≥ IV – 0% (0/6)

HTN – hypertension; CAD – coronary artery disease; Dx – diagnosis; N/A – not available; ASA – American Society of Anesthesiologists

only flap reconstruction and one patient underwent free fasciocutaneous flap reconstruction. All flaps were based on perforators from the descending branch of the lateral femoral circumflex artery. There were no intraoperative complications and no patients required intraoperative transfusions. In every case, surgery time was less than 360 min and intraoperative crystalloid transfusion was 2,900 cc or less (Table 2).

All patients were admitted postoperatively and underwent serial clinical and Doppler examinations. There were no inpatient postoperative complications and length of stay was 48 h in five patients and 72 h in one patient. One patient suffered a postoperative wound infection and one suffered partial flap necrosis. Each of these patients developed their complications after the first follow up visit. There were no flap failures within 30 d postoperatively. One patient developed a delayed postoperative surgical site infection that required hardware extraction and flap excision at 5 months postoperatively. Length of follow up averaged 5.5 months (Table 3).

DISCUSSION

Although free flap failure rates continue to decline, postoperative complications are not infrequent[1,6,7,9,25-30]. Complication rates from 15%-30% in certain cohorts are reported[1]. However, most data corroborates that the majority of complications occur within 48-72 h postoperatively[31-33]. This correlates with the fact that the best opportunity for flap salvage is within the same timeframe[12,31,34-39]. Postoperative monitoring protocols vary greatly between institution; however, most surgeons monitor their patients between five to seven days prior to discharge[32,33]. This highlights the discrepancy between the timing of complications and the length of postoperative monitoring, as the effectiveness of flap monitoring beyond 72 h has been questioned[39]. This discordance has led to the exploration of early discharge after free tissue transfer. While several institutions have subscribed to the belief that some patients are over-monitored, there has not yet been a defined protocol to identify patients who may

Table 2. Intraoperative Patient Information

Flap Type	83.3% Free-fascia only (5/6)	16.7% Free fasciocutaneous (1/6)		
Donor Site	100% Thigh* (6/6)			
Recipient Site	83.3% Foot/Ankle (5/6)	16.7% Scalp (1/6)		
Number of Venous Anastomoses	50% Single (3/6)	50% Double (3/6)		
Venous Coupler Size	16.7% 1.5mm (1/6)	50% 2.0mm (3/6)	16.7% 2.5mm (1/6)	16.7% 3.0mm (1/6)
Arterial Anastomosis	100% Interrupted (6/6)	100% 9-0 Nylon (6/6)		
Intraoperative Complications	100% No (6/6)			
Intraoperative Transfusion	100% No (6/6)			
Estimated Intraoperative Blood Loss	119.2 ± 57.5 cc (Range 50 – 200cc)			
Operative Time	294.5 ± 44.9 minutes (Range 250-360 minutes)			
Intraoperative Crystalloid	2000 ± 640 cc (Range 1250-2900 cc)			

*All flaps were based off the descending branch of the lateral femoral circumflex artery.

Table 3. Postoperative Patient Information

Postoperative Destination	83.3% SICU (5/6)	16.7% Ward (1/6)	
Inpatient Complications	100% No (6/6)		
Length of Stay	83.3% 48 hrs (5/6)	16.7% 72 hrs (1/6)	
Outpatient Complications	83.3% None (4/6)	16.7% Wound Infection (1/6)	16.7% Partial Necrosis (1/6)
Flap Failure	100% None*(6/6)		
Length of Follow Up	5.5 ± 4.3 months (Range 1 – 10 months)		

*One patient developed a deep space wound infection several months postoperatively that ultimately required hardware removal and flap excision. SICU – surgical intensive care unit.

Table 4. Checklist for Discharge within 72 hours of Reconstructive Surgery by Free Tissue Transfer

Preoperative Criteria	
A1c	< 6.5%
Preoperative Radiation to Site of Reconstruction	No
Preoperative Chronic (> 6 months) Steroid Usage	No
Preoperative Diagnosis of Bleeding Diathesis	No
ASA	≤ III
Preoperative Albumin Level	≥ 3.5 g/dL
Preoperative Hemoglobin Level	≥ 12.0 g/dL (women) or ≥ 13.0 g/dL (men)
Intraoperative Criteria	
Intraoperative PRBC Transfusion	None
Intraoperative Crystalloid Infusion	< 7,000 cc
Total Operative Time	< 540 minutes
Flap Selection	Fasciocutaneous or fascia-only perforator

ASA – American Society of Anesthesiologists; PRBC – packed red blood cell.

be candidates for early discharge. Although the NSQIP calculator has been used to predict LOS, it has not been consistent in the free tissue transfer population[7].

Multiple studies have examined potential risk factors for suboptimal outcomes after free tissue transfer. Identified preoperative risk factors for postoperative complications and/or prolonged LOS include a preoperative diagnosis of a bleeding disorder, preoperative albumin level of less than 3.5g/dL, increasing ASA class and a preoperative diagnosis of anemia[1,40]. Notably a preoperative diagnosis of diabetes mellitus has also been associated with complications. While a preoperative diagnosis should not excluded patients from the benefit of free tissue reconstruction, these patients may not be appropriate for expedited discharge[1,41-43]. In the head and neck literature, pre-operative radiation therapy was also associated with prolonged LOS[15]. While a prerogative diagnosis of coronary artery disease (CAD) is a significant predictor or morbidity in many surgeries, there is a lack of consensus on its risk in free flap reconstruction[14]. Additional risk factors include the preoperative use of steroids, which have not only been associated with wound complications, but also free flap failure and thrombosis[1,44]. Interestingly, age itself does not increase the risk of complications after free tissue transfer[45,46].

Intraoperative risk factors include volume resuscitation greater than seven liters[7] and increasing operative time[1,7,47]. Several studies have shown increased complications and LOS with operative times exceeding 510-700 min[1,7,47]. Regardless of the exact duration, increasing operative time has been correlated with poorer outcomes in free flap surgery[1,47-49]. In order to mitigate risks associated with prolonged operative time, institutions have adopted a two-team approach with one team working on recipient bed preparation while the other works on flap elevation[7,14,50-53]. This is the approach used at our institution.

After retrospectively reviewing our institutional experience with early discharge after free flap reconstruction during the COVID-19 pandemic, we identified factors that were consistent amongst these patients that also correlated with published literature. Using these preoperative and intraoperative values we proposed a protocol to select patients who may be candidates for discharge within 72 h of free tissue transfer (Table 4). The protocol consists of two sections, the preoperative section identifies patients who are non-diabetic, have no history of radiation to the wound bed, do not use steroids chronically, do not have a preoperative bleeding disorder, are ASA 3 or less, do not have a preoperative diagnosis of anemia or hypoalbuminemia. The intraoperative section identifies patients who do not require intraoperative PRBC transfusion, receive less than seven liters of crystalloid infusion, have a total operative time of less than 540 min and undergo reconstruction by either fasciocutaneous or fascia-only flaps. These criterion were based on the aforementioned study results[1,7,14,15,40-53], and flap selection criteria was included to minimize donor site morbidity associated with muscle-based flaps.

This study has several limitations, most notably the cohort size. In addition, patients were retrospectively analyzed in order to isolate variables

that are consistent with acceptable outcomes after early discharge. The protocol is a proposal and requires prospective validation alongside a properly controlled group. However, this algorithm serves as a starting point on which to build an evidence based system to select patients who may succeed with early discharge protocols.

CONCLUSION

This study examined a series of patients undergoing free tissue based reconstruction during the COVID-19 pandemic. These cases were reviewed for factors that may have contributed to their postoperative success after discharge within 72 hours. These data points were combined with published evidence on risks for failure after free flap reconstruction to design a protocol to select patients for early discharge after free flap reconstruction. The benefits of early discharge include reduced associated healthcare costs and risks of inpatient hospitalization, as well as reducing ICU utilization which is of paramount importance in the midst of a global pandemic.

CONFLICTS OF INTEREST

The authors have no financial disclosures or conflicts of interest.

ACKNOWLEDGEMENTS

None.

REFERENCES

1. Veith J, Donato D, Holoyda K, Simpson A, Agarwal J. Variables associated with 30-day postoperative complications in lower extremity free flap reconstruction identified in the ACS-NSQIP database. *Microsurgery* 2019;**39**(7):621-628.
2. Ninkovic M, Voigt S, Dornseifer U, Lorenz S, Ninkovic M. Microsurgical advances in extremity salvage. *Clin Plast Surg* 2012;**39**(4):491-505.
3. Egeler SA, de Jong T, Luijsterburg AJM, Mureau MAM. Long-Term Patient-Reported Outcomes following Free Flap Lower Extremity Reconstruction for Traumatic Injuries. *Plast Reconstr Surg* 2018;**141**(3):773-783.
4. Kapoor T, Banuelos J, Adabi K, Moran SL, Manrique OJ. Analysis of clinical outcomes of upper and lower extremity reconstructions in patients with soft-tissue sarcoma. *J Surg Oncol* 2018;**118**(4):614-620.
5. Parrett BM, Matros E, Pribaz JJ, Orgill DP. Lower extremity trauma: trends in the management of soft-tissue reconstruction of open tibia-fibula fractures. *Plast Reconstr Surg* 2006;**117**(4):1315-1322; discussion 1323-1314.
6. Soteropulos CE, Chen JT, Poore SO, Garland CB. Postoperative Management of Lower Extremity Free Tissue Transfer: A Systematic Review. *J Reconstr Microsurg* 2019;**35**(1):1-7.
7. Riley CA, Barton BM, Lawlor CM, Cai DZ, Riley PE, McCoul ED, Hasney CP, Moore BA. NSQIP as a Predictor of Length of Stay in Patients Undergoing Free Flap Reconstruction. *OTO Open* 2017;**1**(1):1-7.
8. McCrory AL, Magnuson JS. Free tissue transfer versus pedicled flap in head and neck reconstruction. *Laryngoscope* 2002;**112**(12):2161-2165.
9. Frederick JW, Sweeny L, Carroll WR, Peters GE, Rosenthal EL. Outcomes in head and neck reconstruction by surgical site and donor site. *Laryngoscope* 2013;**123**(7):1612-1617.
10. Haughey BH, Wilson E, Kluwe L, Picirillo J, Frederickson J, Sessions D, Spector G. Free flap reconstruction of the head and neck: analysis of 241 cases. *Otolaryngol Head Neck Surg* 2001;**125**(1):10-17.
11. Clark JR, McCluskey SA, Hall F, Lipa J, Neligan P, Brown D, Irish J, Gullane P, Gilbert R. Predictors of morbidity following free flap reconstruction for cancer of the head and neck. *Head Neck* 2007;**29**(12):1090-1101.
12. Ryan MW, Hochman M. Length of stay after free flap reconstruction of the head and neck. *Laryngoscope* 2000;**110**(2 Pt 1):210-216.
13. Hanick A, Meleca JB, Fritz MA. Early discharge after free-tissue transfer does not increase adverse events. *Am J Otolaryngol* 2020;**41**(2):102374.
14. Devine CM, Haffey TM, Trosman S, Fritz MA. Short-stay hospital admission after free tissue transfer for head and neck reconstruction. *Laryngoscope* 2016;**126**(12):2679-2683.
15. Lindeborg MM, Sethi RKV, Puram SV, Parikh A, Yarlagadda B, Varvares M, Emerick K, Lin D, Durand ML, Deschler DG. Predicting length of stay in head and neck patients who undergo free flap reconstruction. *Laryngoscope Investig Otolaryngol* 2020;**5**(3):461-467.
16. Wachter RM, Goldman L. The hospitalist movement 5 years later. *JAMA* 2002;**287**(4):487-494.
17. Pirson M, Dehanne F, Van den Bulcke J, Leclercq P, Martins D, De Wever A. Evaluation of cost and length of stay, linked to complications associated with major surgical procedures. *Acta Clin Belg* 2018;**73**(1):40-49.
18. Blackwell KE. Unsurpassed reliability of free flaps for

head and neck reconstruction. *Arch Otolaryngol Head Neck Surg* 1999;**125**(3):295-299.
19. Suh JD, Sercarz JA, Abemayor E, Calcaterra TC, Rawnsley JD, Alam D, Blackwell KE . Analysis of outcome and complications in 400 cases of microvascular head and neck reconstruction. *Arch Otolaryngol Head Neck Surg* 2004;**130**(8):962-966.
20. Singh B, Cordeiro PG, Santamaria E, Shaha AR, Pfister DG, Shah JP. Factors associated with complications in microvascular reconstruction of head and neck defects. *Plast Reconstr Surg* 1999;**103**(2):403-411.
21. Disa JJ, Pusic AL, Hidalgo DH, Cordeiro PG. Simplifying microvascular head and neck reconstruction: a rational approach to donor site selection. *Ann Plast Surg* 2001;**47**(4):385-389.
22. Nuara MJ, Sauder CL, Alam DS. Prospective analysis of outcomes and complications of 300 consecutive microvascular reconstructions. *Arch Facial Plast Surg* 2009;**11**(4):235-239.
23. le Nobel GJ, Higgins KM, Enepekides DJ. Predictors of complications of free flap reconstruction in head and neck surgery: Analysis of 304 free flap reconstruction procedures. *Laryngoscope* 2012;**122**(5):1014-1019.
24. Karaca-Mandic P, Sen S, Georgiou A, Zhu Y, Basu A. Association of COVID-19-Related Hospital Use and Overall COVID-19 Mortality in the USA. *J Gen Intern Med* 2020.
25. Song CT, Koh K, Tan BK, Goh T. Free-Flap Lower Extremity Reconstruction: A Cohort Study and Meta-Analysis of Flap Anastomotic Outcomes between Perforator and Nonperforator Flaps. *J Reconstr Microsurg* 2018;**34**(6):455-464.
26. Sakurai H, Yamaki T, Takeuchi M, Soejima K, Kono T, Nozaki M. Hemodynamic alterations in the transferred tissue to lower extremities. *Microsurgery* 2009;**29**(2):101-106.
27. Fischer JP, Wink JD, Nelson JA, Cleveland E, Grover R, Wu LC, Levin LS, Kovach SJ. A retrospective review of outcomes and flap selection in free tissue transfers for complex lower extremity reconstruction. *J Reconstr Microsurg* 2013;**29**(6):407-416.
28. Ridgway EB, Kutz RH, Cooper JS, Guo L. New insight into an old paradigm: wrapping and dangling with lower-extremity free flaps. *J Reconstr Microsurg* 2010;**26**(8):559-566.
29. Fujiki M, Miyamoto S, Sakuraba M. Flow-through anastomosis for both the artery and vein in leg free flap transfer. *Microsurgery* 2015;**35**(7):536-540.
30. Chow SP, Chen DZ, Gu YD. The significance of venous drainage in free flap transfer. *Plast Reconstr Surg* 1993;**91**(4):713-715.
31. Chen KT, Mardini S, Chuang DC, Lin CH, Cheng MH, Lin YT, Huang WC, Tsao CK, Wei FC. Timing of presentation of the first signs of vascular compromise dictates the salvage outcome of free flap transfers. *Plast Reconstr Surg* 2007;**120**(1):187-195.
32. Xipoleas G, Levine E, Silver L, Koch RM, Taub PJ. A survey of microvascular protocols for lower extremity free tissue transfer II: postoperative care. *Ann Plast Surg* 2008;**61**(3):280-284.
33. Xipoleas G, Levine E, Silver L, Koch RM, Taub PJ. A survey of microvascular protocols for lower-extremity free tissue transfer I: perioperative anticoagulation. *Ann Plast Surg* 2007;**59**(3):311-315.
34. Novakovic D, Patel RS, Goldstein DP, Gullane PJ. Salvage of failed free flaps used in head and neck reconstruction. *Head Neck Oncol* 2009;**1**:33.
35. Pohlenz P, Klatt J, Schon G, Blessmann M, Li L, Schmelzle R. Microvascular free flaps in head and neck surgery: complications and outcome of 1000 flaps. *Int J Oral Maxillofac Surg* 2012;**41**(6):739-743.
36. Hyodo I, Nakayama B, Kato H, Hasegawa Y, Ogawa T, Terada A, Torii S. Analysis of salvage operation in head and neck microsurgical reconstruction. *Laryngoscope* 2007;**117**(2):357-360.
37. Wu CC, Lin PY, Chew KY, Kuo YR. Free tissue transfers in head and neck reconstruction: complications, outcomes and strategies for management of flap failure: analysis of 2019 flaps in single institute. *Microsurgery* 2014;**34**(5):339-344.
38. Yu P, Chang DW, Miller MJ, Reece G, Robb GL. Analysis of 49 cases of flap compromise in 1310 free flaps for head and neck reconstruction. *Head Neck* 2009;**31**(1):45-51.
39. Bonde C, Khorasani H, Eriksen K, Wolthers M, Kehlet H, Elberg J. Introducing the fast track surgery principles can reduce length of stay after autologous breast reconstruction using free flaps: A case control study. *J Plast Surg Hand Surg* 2015;**49**(6):367-371.
40. Hill JB, Patel A, Del Corral GA, Sexton KW, Ehrenfeld JM, Guillamondegi OD, Shack RB. Preoperative anemia predicts thrombosis and free flap failure in microvascular reconstruction. *Ann Plast Surg* 2012;**69**(4):364-367.
41. Ducic I, Attinger CE. Foot and ankle reconstruction: pedicled muscle flaps versus free flaps and the role of diabetes. *Plast Reconstr Surg* 2011;**128**(1):173-180.
42. Oh TS, Lee HS, Hong JP. Diabetic foot reconstruction using free flaps increases 5-year-survival rate. *J Plast Reconstr Aesthet Surg* 2013;**66**(2):243-250.
43. Cho EH, Garcia RM, Pien I, Kuchibhatla M, Levinson H, Erdmann D, Levin LS, Hollenbeck ST. Vascular considerations in foot and ankle free tissue transfer: Analysis of 231 free flaps. *Microsurgery* 2016;**36**(4):276-283.
44. Sbitany H, Xu X, Hansen SL, Young DM, Hoffman WY. The effects of immunosuppressive medications on outcomes in microvascular free tissue transfer.

Plast Reconstr Surg 2014;133(4):552e-558e.
45. Ozkan O, Ozgentas HE, Islamoglu K, Boztug N, Bigat Z, Dikici MB. Experiences with microsurgical tissue transfers in elderly patients. *Microsurgery* 2005;**25**(5):390-395.
46. Serletti JM, Higgins JP, Moran S, Orlando GS. Factors affecting outcome in free-tissue transfer in the elderly. *Plast Reconstr Surg* 2000;**106**(1):66-70.
47. Wong AK, Joanna Nguyen T, Peric M, Shahabi A, Vidar EN, Hwang BH, Leilabadi SN, Chan LS, Urata MM. Analysis of risk factors associated with microvascular free flap failure using a multi-institutional database. *Microsurgery* 2015;**35**(1):6-12.
48. Kim BD, Ver Halen JP, Grant DW, Kim JY. Anesthesia duration as an independent risk factor for postoperative complications in free flap surgery: a review of 1,305 surgical cases. *J Reconstr Microsurg* 2014;**30**(4):217-226.
49. Offodile AC, 2nd, Aherrera A, Wenger J, Rajab TK, Guo L. Impact of increasing operative time on the incidence of early failure and complications following free tissue transfer? A risk factor analysis of 2,008 patients from the ACS-NSQIP database. *Microsurgery* 2017;**37**(1):12-20.
50. White LJ, Zhang H, Strickland KF, El-Deiry MW, Patel MR, Wadsworth JT, Chen AY. 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. *JAMA Otolaryngol Head Neck Surg* 2015;**141**(12):1052-1058.
51. Horn D, Jonas R, Engel M, Freier K, Hoffmann J, Freudlsperger C. A comparison of free anterolateral thigh and latissimus dorsi flaps in soft tissue reconstruction of extensive defects in the head and neck region. *J Craniomaxillofac Surg* 2014;**42**(8):1551-1556.
52. Ettinger KS, Arce K, Lohse CM, Peck BW, Reiland MD, Bezack BJ, Moore EJ. Higher perioperative fluid administration is associated with increased rates of complications following head and neck microvascular reconstruction with fibular free flaps. *Microsurgery* 2017;**37**(2):128-136.
53. Vyas K, Wong L. Intraoperative management of free flaps: current practice. *Ann Plast Surg*