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Anaesthetic Challenging in Microsurgical Flap Reconstruction: A Systematic Review

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Abstract

Background: Anaesthetic management for microvascular reconstructive surgery is challenging and clearly affects the risk of major complications such as flap hypo-perfusion.

In this systematic review we explore recent (last 7 years) clinical evidences related to perioperative management and anaesthetic controversy of patients undergoing microvascular reconstructive surgery, especially focused on head and neck surgery with free flaps (FF) and breast reconstructive surgery with deep inferior epigastric perforator flap (DIEP-flap).

Methods: A literature search of published clinical studies between 2011 and 2018 was conducted, yielding a total of 4307 papers. Only 150 were eligible, according inclusion and exclusion criteria.

Results: 62 studies were selected for this review and categorized in 3 groups: preoperative-intraoperative-postoperative anaesthetic management and areas of controversy for patients undergoing head and neck surgery with FF and breast reconstructive surgery with DIEP-flap.

Discussion: Anaesthetic management for flap reconstructive surgery remains an open field of interest with limited evidences regarding a standard care. Main components of research currently are: the need to join standard multidisciplinary enhanced recovery pathways, as well as the necessity to develop a standard intraoperative management. In theatre, the recent hemodynamic parameter "Hypotension Probability Indicator" (HPI) is promising: the advantage to predict a drop in the mean arterial pressure can be more effective than a fluid therapy titrated to maintain SVV less than 13%. Prospective studies are necessary to clarify.

Keywords: Flap reconstructive surgery; Anaesthetic management; Perioperative management

Introduction

Microvascular flap surgery is one of the best and fine options for reconstruction in head and neck cancer patients, plastic, trauma and burns [1].

Anaesthetic management in these settings has limited evidences of standard care and clearly affects the outcome, with high impact on flap survival. Main areas of controversy for anaesthesiologist involve the need to take part into standard multidisciplinary enhanced recovery after surgery protocols (ERAS protocols), as well as a standard perioperative management, especially in terms of pre-operative assessment, hemodynamic monitoring, goal-directed fluid therapy, thermoregulation, flap monitoring, deep vein thrombosis (DVT) prophylaxis, intensive therapy unit admission (ITU), early mobilization, antibiotics guidelines, analgesia [2].

Methods

Two medical databases Pubmed and Medline were queried, according with Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) recommendations [3]. The methodological features of this analytic review have been registered and accepted into the International Prospective Register of Systematic Review (PROSPERO) database (registration number: CRD42018082433) [4]. Key words used for literature search were "Intraoperative management for free flap surgery"; "Anaesthetic management for microvascular reconstructive surgery"; "Perioperative management for microvascular surgery"; "Anaesthetic assessment for flap reconstructive surgery"; "Anaesthesia for head and neck reconstructive surgery"; "Anaesthesia for plastic reconstructive surgery"; "ERAS protocols for microvascular reconstructive surgery"; "Haemodynamic monitoring in flap reconstructive surgery"; "Goal-directed therapy for reconstructive surgery"; "Blood loss management in reconstructive flap surgery"; "Postoperative care for flap reconstructive surgery". Completed studies published in peer-reviewed journals between January 2011 and January 2018 was considered to be eligible and abstracts were excluded. The search criteria for inclusion in this review were: language

(English), study type (human, clinical article, clinical trial, controlled clinical trial, controlled study, randomized controlled trials, case report, cohort studies, institutional surveys), type of surgery (head and neck reconstructions with FF and plastic breast reconstructions with DIEP flap). Authors independently screened and assessed the titles, abstracts, and the full-text articles.

Results

A total of 4307 papers were retrieved using the keywords, only 1070 were assesses for eligibility. According the inclusion criteria, 62 were selected and categorized in 3 groups (Figure 1):

- Preoperative anaesthetic management and areas of controversy for patients undergoing microvascular reconstructive surgery.
- Intraoperative anaesthetic management and areas of controversy for patients undergoing microvascular reconstructive surgery.
- Postoperative anaesthetic management and areas of controversy for patients undergoing microvascular reconstructive surgery.

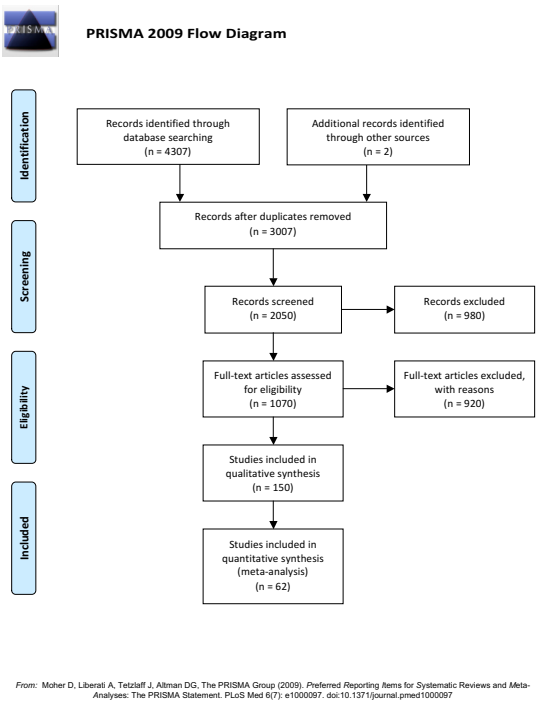


Figure 1: Flow chart of identification of papers included in systematic review.

Preoperative Anaesthetic Management and Areas of Controversy for Patients Undergoing Microvascular Reconstructive Surgery

Risk stratification

Patients presenting for head and neck FFs surgery and breast reconstructive surgery are fragile cancer patients with a number of dangerous co-morbidities [5]. Hence, pre-operative assessment and investigations play a role for the risk stratification [6]. Although technical issues are prevailing factors, clinical characteristics also contribute to flap failure [7]. The Division of Plastic and Reconstructive Surgery, University of Southern California, investigated a number of non-technical variables in 2015, using the American College of Surgeons' National Surgical Quality Improvement Program (NSQIP) database. Univariate analysis was conducted to determine the association of FF failure with the individual factors: age, gender, ethnicity, body mass index, intraoperative transfusion, diabetes, smoking, alcohol, American Society of Anaesthesiologists classification, year of operation, operative time, number of flaps, and type of reconstruction. Flap loss rate was 4.4%. Operative time was the only significant independent risk factor, as resulted from the multivariate logistic regression [8]. According the analysis conducted by another plastic unit in Istanbul, patient's age was not an independent variable for increased risk in microvascular reconstruction. However, operative time and reconstruction sites were associated with higher incidence of complications and ITU admissions [9]. Another important study, held in Toronto in 2016, recognized operative time and smoking as the independent risk factors for intraoperative complications in reconstructive breast flap surgery [10]. Several preoperative investigations play a role in the risk stratification of these patients. Studies revealed how cardiopulmonary exercise testing (CPET) in complex patients is pivotal to assess the functional capacity. Many institutions routinely use CPET to design the operation and to inform patients about risks and benefits of surgery [11]. In conclusion, flap ischemia is a multifactorial event and, according recent literature, demographics and medical patient's characteristics such as: age, ethnicity, radiation, and chemotherapy, medical comorbidities, smoking, are not independent risk factors. Preoperatively, patients need to be assessed to ensure the best perioperative management but intraoperative management and technical variables may have higher importance for the outcome [12].

Nutrition, preoperative fasting and preoperative education

According recent evidences, the basic nutritional state should be estimated and optimised: preoperative quantity of albumin has inverse correlation with wound dehiscence, fistula, salivary leak, pleural effusion, renal function [13]. Preoperative fasting should be minimal. In patients eligible for oral intake, clear solids should be allowed up to 2 h and clear fluids up to 6 h before anaesthesia [14,15]. All patients undergoing major head and neck cancer surgery with FFs and breast reconstructive surgery should be adequately prepared regarding the surgical journey and evidences suggest they should receive a systematic teaching. If anaesthetists and qualified health professionals should share this discussion, is still not clarified, due to shortage of specifically focused trials [16]. In conclusion, the implementation of a multidisciplinary pre-operative evaluation driven by anaesthetists, nutritionists, other medical specialists and health practitioners may reduce post-operative complications derived from pre-existing conditions [17].

Intraoperative Anaesthetic Management and Areas of Controversy for Patients Undergoing Microvascular Reconstructive Surgery

As we highlighted in the previous chapter, intraoperative management has great influence for the surgical outcome and the anaesthetist plays a pivotal role [12].

Fluid management

Different studies, demonstrated the predictive relationship between the quantity of intraoperative fluid administrated and the rate of postoperative complications in FF surgery [18,19]. From the analysis on 154 patients with head and neck reconstructions with fibular FFs, fluid volume higher than 5500 ml was associated with an increase in medical and surgical complications, and a cut-off value of 7000 ml was identified as the only significant risk factor for major complications [19]. FFs don't present lymphatic drainage, therefore, every anaesthesiologist needs to consider these characteristics in order to maintain intravascular blood volume, prevent flap oedema and the pro-coagulant state due to rapid administration of crystalloids [20]. Regarding the use of colloids, data have shown that volume higher than 20-30 ml/kg/24 h can increase perioperative morbidity, and Hydroxyethyl starch seems more promising to expand plasma volume and reduce blood viscosity if compared to gelatine-based colloids [21]. Every patient can be identified as fluid responsive by measuring cardiac output (CO), cardiac index (CI), stroke volume or pulse pressure variation (SVV, PPV). According recent literature, a goal-directed fluid therapy, titrated to keep SVV ≤ 13%, with the use of mini invasive arterial pulse contour device, results in improved oxygen delivery and reduces the intravenous fluid administration, with better outcomes [22]. We will discuss later on in this paper, other details regarding hemodynamic monitoring.

Haemoglobin

Haemoglobin target is a sliding value in head and neck and plastic microvascular surgery. In UK, as a resulted from a national survey, practice for blood loss in theatre is varied, with a mean trigger for blood transfusion of Haemoglobin 7.8 g/dl [21]. Even if flap perfusion and peripheral oxygen delivery is a priority, several observational studies in head and neck cancer have highlighted how allogenic blood transfusion is associated with higher rate of postoperative complications and worse prognosis, and anaesthesiologist usually follow blood conservation strategies in high-risk patients [23].

Blood Pressure (BP) management

BP management, again, is not well standardised in this type of surgery, and enhancement of flap perfusion in theatre is always a priority. The use of vasopressors in FFs surgery is a matter of controversy. Evidence from animal models has revealed that the use of vasopressors leads to vasoconstriction in the microcirculation of the flap; however, this has not been shown in the clinical settings [24]. According different clinical studies, a general intraoperative well recognized target for mean arterial blood pressure (MAP) during anastomosis is a value equal or major than 70 mmHg, while a MAP lower than 60 mmHg is considered "hypotension" [25]. Dobutamine and vasoconstrictors can be safely used if the goals for BP and CI are not achieved with SVV<10-13% [25-27].

Glycaemic control

Stress hyperglycaemia is a very common feature of complex patients: targets and relationships with outcome are not clear, with contrasting results from literature [28]. Authors from the national survey in UK evidenced how the majority of anaesthesiologist, involved in head and neck FFs reconstructions, would intraoperatively commence an insulin infusion at a blood sugar level of 10-12 mmol/l, a minority of them would use a slightly higher trigger of 12–14 mmol/l [21]. The tightlinkbetweeninsulinand thebrain, with discernible effects on memory, learning abilities, and motor functions in fragile patients has been widely explored in literature by a number of authors [29].

Type of anaesthesia

Only few studies, evaluate the impact of anaesthesia management in microvascular reconstructive surgery. One of these recently recorded the differences between patients who received inhalation and total intravenous anaesthesia (TIVA) in FF surgery [30]. Patients in the TIVA group required less perioperative fluids (both crystalloid and colloid) to maintain hemodynamic stability, furthermore, after multivariate regression, patients in the TIVA group had a significantly reduced risk of pulmonary complication compared with the inhalation group. Some anaesthetist may be concerned about the possibility of metabolic acidosis-propofol infusion syndrome (PRIS)-which would cause damage to a fresh anastomosis in flaps. The association between PRIS and propofol infusion is demonstrated only for doses higher than 4 mg/kg/h when the duration lasts longer than 48 h [31]. Moreover, as part of a good anaesthetic strategy, patients undergoing head and neck or plastic cancer surgery should always receive intraoperative medications to mitigate postoperative nausea and/or vomiting (PONV) and a combination of corticosteroid and antiemetic is always indicated [32].

Antibiotics

Many patients undergoing FFs surgery have a number of risk factors potentially able to trigger postoperative infections (alcohol, smoking abuse, radiation, chemotherapy, poor nutritional status, long operation time). In this setting, antibiotic prophylaxis is still under debate and every centre has specific protocols. From a number of international studies, the choice of antibiotic appears to affect the incidence of postoperative infections and flap site infections more than the duration [33,34]. From a number of evidence ampicillin-sulbactam or cefuroxime are the preferred prophylactic antibiotic for major clean-contaminated head and neck procedures, less than or equal to 24 h ofantibiotic prophylaxis is likely sufficient. Clindamycin prophylaxis increases the risk of recipient surgical site infection, moreover, for patients with penicillin allergy, broader gram-negative coverage is recommended [33,35,36].

Intraoperative monitoring

Again as a result forms the UK national survey, in theatre, a number of anaesthesiologists use additional monitoring including: core temperature, central venous pressure, bispectral index (BIS), cardiac output monitoring (CO monitoring). Temperature monitoring is pivotal to ensure normothermia and the urinary bladder thermistor catheter correlates well with pulmonary artery thermistors [21,37]. Recent guidelines suggest that hemodynamic monitoring should be used in high risk patients undergoing major surgery to enhance fluid optimisation, reduce mortality, morbidity and reduce costs. Flo/Trac

Vigileo system, based on arterial waveform analysis, and patient's age, sex, height, weight is often used in FF reconstructive surgery as mini invasive and reliable [38]. As additional parameter, the recent "Hypotension Probability Indicator" (HPI) could be promising: the advantage to predict a drop in the mean arterial pressure, before hypotension occurs, can be more effective than a fluid therapy titrated to maintain SVV less than 13% [39]. Prospective studies are required to investigate the relationship between HPI and flap perfusion in theatre (Figure 2) [40].

Figure 2: Hypotension probability indicator (HPI).

Postoperative Anaesthetic Management and Areas of Controversy for Patients Undergoing Microvascular Reconstructive Surgery

ITU admission

A number of recent studies support that uncomplicated FFs patients may be safely assisted outside ITU [41,42]. Panwar et al. recently, with an interesting cohort study, tried to understand if postoperative management in ITU is necessary. Ninety-nine patients were included in the historical cohort of ITU patients, and 157 patients were enrolled in the prospective arm after creation of a head and neck surgical unit. They noted no significant changes in flap survival, inpatient morbidity, or mortality. They did, however, note a significant 1-day reduction of hospitalization and a reduction in total costs [41,42]. From an interesting survey held in USA, nurses employed in an academic medical center and nurses with more than 5 years of experience were significantly more comfortable with their ability to care for microsurgical patients [43]. Ideally, uncomplicated patients receiving microvascular surgery should be step down in high-dependency units or equipped specialized surgical units, however, the pivotal role of nursing and health practitioner staff cannot be underestimated, such as their workload.

Early postoperative extubation and tracheostomy

Airway management in patients undergoing major head and neck procedures with FFs reconstruction includes the protection of the airway if bleeding, swelling and oedema occur. Surgical tracheotomy has rare severe complications but presents the danger to prolong the hospital stay. According the last indications of ERAS protocols, the decision to perform a tracheotomy is now linked to the presence of specific conditions such as advanced cancer stage and location, otherwise, early extubation is always preferred [15].

Early feeding

Recent recommendations support early re-entrance of enteral nutrition in head and neck FFs and DIEP-flap reconstructive surgery [44,45]. However, for head and neck patients, considerations as risk of wound dehiscence, fistula, and aspiration must be done. Recent studies compared early (prior to postoperative day 6) and late oral intake groups (postoperative day 6 or late) and the "early" group was not linked to any increased morbidity or adverse outcome, at the same time, duration of hospital stay was lower [46,47]. Enteral feeding *via* either nasogastric (NG) or percutaneous endoscopic gastrostomy (PEG) tube is now recommended up to 12 h after surgery.

Pain management

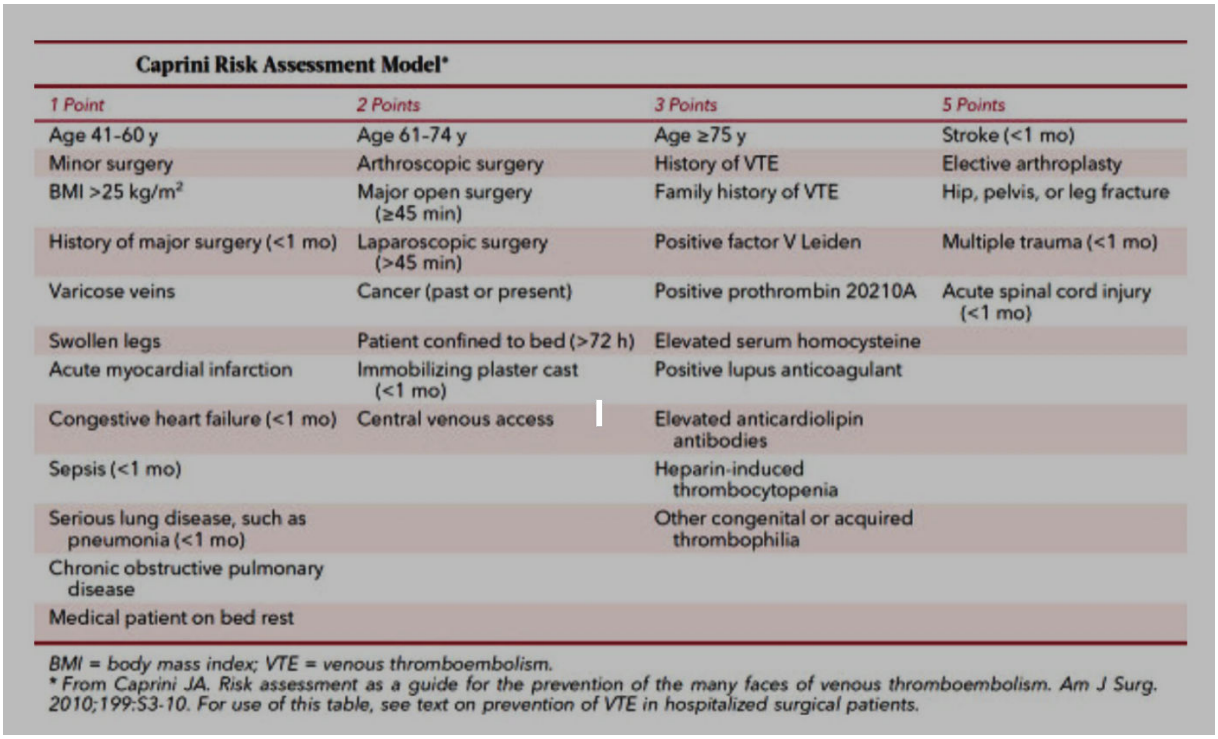
Opioid-sparing and multimodal analgesia, prescribing nonsteroidal anti-inflammatory drugs (NSAIDs), cyclooxygenase inhibitors (COX inhibitors), and paracetamol, is safe, effective, able to reduce narcotic side effects and to facilitate rapid recovery after surgery: when this approach is not sufficient, patient controlled analgesia (PCA) can be eligible [48]. For plastic reconstructive surgery with DIEP-flaps, additional nerve blocks can be considered, such as the transversus abdominal plane block (TAP block), while small catheter injecting local anaesthetics can be promising in a number of head and neck reconstruction such as FFs with fibular harvest [49,50].

Flap perfusion monitoring

Postoperatively, a number of different instruments are accountable to assess flap perfusion and viability including: Doppler, implantable Doppler, micro-dialysis, video-based application (Eulerian), fluorescence angiography, near infrared spectroscopy (NIRS), contrast-enhanced duplex. Of these, implantable arterial Doppler have recent and wide set of data showing efficacy, less false-positive and less flow variability [51,52]. NIRS on the other side, based on the differential absorption of light by regional oxygenated and not oxygenated haemoglobin, has the advantage to be non-invasive, cheap, reliable and reproducible. In different studies, authors reported how regional oxygen saturation drops before the flap colour modified, improving salvage rates and decreasingflaplosses [52,53].

Mobilization and DVT prophylaxis

Data on early mobilization come from studies in major abdominal procedures but few retrospective cohort studies evidenced how early mobilization removal of drains, urinary and epidural catheter (since day 2), in head and neck and plastic reconstructive surgery is associated with fewer pulmonary complications [54,55]. For head and neck patients, early execution of speech and swallowing exercises should be respectively started since day 2 and 4 after surgery [56]. Different authors recommend for all microsurgery patients a venous thrombosis prophylaxis since 6 h after surgery but, in presence of an history of previous thrombosis or in presence of high score for macrovascular thrombosis [Caprini score is one of most valid in plastic reconstructive surgery (Figure 3)] a prompt referral to the haematology team should be considered [57,58].



Caprini Risk Assessment Model*

1 Point	2 Points	3 Points	5 Points
Age 41-60 y	Age 61-74 y	Age ≥75 y	Stroke (<1 mo)
Minor surgery	Arthroscopic surgery	History of VTE	Elective arthroplasty
BMI >25 kg/m^2	Major open surgery (≥45 min)	Family history of VTE	Hip, pelvis, or leg fracture
History of major surgery (<1 mo)	Laparoscopic surgery (>45 min)	Positive factor V Leiden	Multiple trauma (<1 mo)
Varicose veins	Cancer (past or present)	Positive prothrombin 20210A	Acute spinal cord injury (<1 mo)
Swollen legs	Patient confined to bed (>72 h)	Elevated serum homocysteine	
Acute myocardial infarction	Immobilizing plaster cast (<1 mo)	Positive lupus anticoagulant	
Congestive heart failure (<1 mo)	Central venous access	Elevated anticardiolipin antibodies	
Sepsis (<1 mo)		Heparin-induced thrombocytopenia	
Serious lung disease, such as pneumonia (<1 mo)		Other congenital or acquired thrombophilia	
Chronic obstructive pulmonary disease			
Medical patient on bed rest			

BMI = body mass index; VTE = venous thromboembolism.
** From Caprini JA. Risk assessment as a guide for the prevention of the many faces of venous thromboembolism. Am J Surg. 2010;199:S3-10. For use of this table, see text on prevention of VTE in hospitalized surgical patients.*

Figure 3: Caprini Score and algorithm.

Conclusion

Microvascular surgery is among the best and advanced options for reconstruction in head and neck and breast fragile cancer patients.

Anaesthetic management in these settings clearly affects the outcome and flap viability; however, evidences of standard care are still under investigation. Main areas of controversy involve the need to develop standard multidisciplinary ERAS protocols, as well as standard perioperative management pathways [59,60]. As discussed in this paper, the main fields of research and debate for anaesthetists currently are: pre-operative risk stratification, CO monitoring and hemodynamic intraoperative target limits, ITU admission indications, early extubation, mobilization protocols and pain management strategies. The necessity to embed anaesthetists in new standard multidisciplinary recovery pathways makes their role as "perioperative doctors" extremely challenging and the understanding conveyed in this paper will guide future studies [20].

Acknowledgments

The methodological features of this analytic review have been registered and accepted into the International Prospective Register of Systematic Review (PROSPERO) database (registration number: CRD42018082433).

References

1. Franke A, Hentsch S, Bieler D, Schilling T, Weber W, et al. (2017) Management of Soft-Tissue and Bone Defects in a Local Population: Plastic and Reconstructive Surgery in a Deployed Military Setting. Mil Med 182: e2010-e2020.
2. Kinzinger MR, Bewley AF (2017) Perioperative care of head and neck free flap patients. Curr Opin Otolaryngol Head Neck Surg 25: 405-410.
3. http://www.prisma-statement.org.
4. https://www.crd.york.ac.uk/PROSPERO.
5. Nelson JA, Fischer JP, Chung CU, Fosnot J, Selber JC, et al. (2014) Preoperative anaemia impacts early postoperative recovery following autologous breast reconstruction. J Plast Reconstr Aesthet Surg 67: 797-803.
6. Lo SL, Yen YH, Lee PJ, Liu CC, Pu CM (2017) Factors influencing postoperative complications in reconstructive microsurgery for head and neck cancer. J Oral Maxillofac Surg 75: 867-873.
7. Hand WR, McSwain JR, McEvoy MD, Wolf B, Algendy AA, et al. (2015) Characteristics and intraoperative treatments associated with head and neck tissue transfer complications and failures. Otolaryngol Head Neck Surg 152: 480-487.
8. Wong AK, Joanna Nguyen T, Peric M, Shahabi A, Vidar EN, et al. (2015) Analysis of risk factors associated with microvascular free flap failure using a multi-institutional database. Microsurgery 35: 6-12.
9. Saçak B, Akdeniz ZD, Certel F, Kocaaslan FN, Tuncer B, et al. (2015) Risk assessment for free tissue transfers: is old age a determining factor? J Craniofac Surg 26: 856-859.
10. O'Neill AC, Haykal S, Bagher S, Zhong T, Hofer S (2016) Predictors and consequences of intraoperative microvascular problems in autologous breast reconstruction. J Plast Reconstr Aesthet Surg 69: 1349-1355.
11. Hennis PJ, Meale PM, Grocott MPW (2011) Cardiopulmonary exercise testing for the evaluation of perioperative risk in non-cardiopulmonary surgery. Postgrad Med J 87: 550-557.
12. Chang EI, Soto-Miranda MA, Zhang H, Nosrati N, Crosby MA, et al. (2016) Comprehensive Evaluation of Risk Factors and Management of Impending Flap Loss in 2138 Breast Free Flaps. Ann Plast Surg 77: 67-71.

13. Leung JS, Seto A, Li GK (2017) Association between preoperative nutritional status and postoperative outcome in head and neck cancer patients. Nutr Cancer 69: 464-469.
14. Lambert E, Carey S (2015) Practice guideline recommendations on perioperative fasting: a systematic review. JPEN J Parenter Enteral Nutr 40: 1158-1165.
15. Awad S, Varadhan KK, Ljungqvist O, Lobo DN (2013) A meta-analysis of randomised controlled trials on preoperative oral carbohydrate treatment in elective surgery. Clin Nutr 32: 34-44.
16. Yarlagadda BB, Hatton E, Huettig J, Deschler D (2015) Patient and staff perceptions of social worker counseling before surgical therapy for head and neck cancer. Health Soc Work 40: 120-124.
17. McMahon JD, MacIver C, Smith M, Stathopoulos P, Wales C, et al. (2013) Postoperative complications after major head and neck surgery with free flap repair-prevalence, patterns, and determinants: a prospective cohort study. Br J Oral Maxillofac Surg 51: 689-695.
18. Pearse RM, Ackland GL (2012) Perioperative fluid therapy. BMJ 344: e2865.
19. Ettinger KS, Arce K, Lohse CM, Peck BW, Reiland MD, et al. (2017) Higher perioperative fluid administration is associated with increased rates of complications following head and neck microvascular reconstruction with fibular free flaps. Microsurgery 37: 128-136.
20. Davison SP, Clemens MW, Kochuba AL (2013) Anatomy of free flap failures: dissection of a series. MPS 03: 89-95.
21. Gooneratne H, Lalabekyan B, Clarke S, Burdett E (2013) Perioperative anaesthetic practice for head and neck free tissue transfer-a UK national survey. Acta Anaesthesiol Scand 57: 1293-1300.
22. Funk D, Bohn J, Mutch W, Hayakawa T, Buchel EW (2015) Goal-directed fluid therapy for microvascular free flap reconstruction following mastectomy: A pilot study. Plast Surg (Oakv) inter 23: 231-234.
23. Perisanidis C, Mittlböck M, Dettke M, Schopper C, Schoppmann A, et al. (2013) Identifying risk factors for allogenic blood transfusion in oral and oropharyngeal cancer surgery with free flap reconstruction. J Oral Maxillofac Surg 71: 798-804.
24. Monroe MM, Cannady SB, Ghanem TA, Swide CE, Wax MK (2011) Safety of vasopressor use in head and neck microvascular reconstruction: a prospective observational study. Otolaryngol Head Neck Surg 144: 877-882.
25. Chalmers A, Turner MWH, Anand R, Puxeddu R, Peter A. et al. (2012) Cardiac output monitoring to guide fluid replacement in head and neck microvascular free flap surgery-what is current practice in the UK? Br J Oral Maxillofac Surg 50: 500-503.
26. Lahtinen SL, Liisanantti JH, Poukkanen MM, Laurila PA (2017) Goal-directed fluid management in free flap surgery for cancer of the head and neck. Minerva Anestesiol 83: 59-68.
27. Szabo Eltorai A, Huang CC, Lu JT, Ogura A, Caterson SA, et al. (2017) Selective intraoperative vasopressor use is not associated with increased risk of DIEP flap complications. Plast Reconstr Surg 140: 70e-77e.
28. Robba C, Bilotta F (2016) Admission hyperglycemia and outcome in ICU patients with sepsis. J Thorac Dis 8: E581-E583.
29. Bilotta F, Lauretta MP, Tewari A, Haque M, Hara N, et al. (2017) Insulin and the brain a sweet relationship with intensive care. J Intensive Care Med 32: 48-58.
30. Chang YT, Wu CC, Tang TY, Lu CT, Lai CS, et al. (2016) Differences between Total Intravenous Anesthesia and Inhalation Anesthesia in Free Flap Surgery of Head and Neck Cancer. PLoS One 11: e0147713.
31. Kam PC, Cardone D (2007) Propofol infusion syndrome. Anaesthesia 62: 690-701.
32. Manahan MA, Basdag B, Kalmar CL, Shridharani SM, Magarakis M, et al. (2014) Risk of severe and refractory postoperative nausea and vomiting in patients undergoing diep flapbreast reconstruction. Microsurgery 34: 112-121.
33. Mitchell RM, Mendez E, Schmitt NC, Bhrany AD, Futran ND (2015) Antibiotic Prophylaxis in Patients Undergoing Head and Neck Free Flap Reconstruction. JAMA Otolaryngol Head Neck Surg 141: 1096-1103.
34. Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, et al. (2013) American Society of Health-System Pharmacists (ASHP). Infectious Diseases Society of America (IDSA). Surgical Infection Society (SIS); Society for Healthcare Epidemiology of America (SHEA). Clinical practice guidelines for antimicrobial prophylaxis in surgery. Surg Infect (Larchmt) 14: 73-156.
35. Haidar YM, Tripathi PB, Tjoa T, Walia S, Zhang L, et al. (2018) Antibiotic prophylaxis in clean-contaminated head and neck cases with microvascular free flap reconstruction: A systematic review and meta-analysis. Head Neck 40: 417-427.
36. Pool C, Kass J, Spivack J, Nahumi N, Khan et al. (2016) Increased Surgical Site Infection Rates following Clindamycin Use in Head and Neck Free Tissue Transfer. Otolaryngol Head Neck Surg 154: 272-278.
37. Shin J, Kim J, Song K, Kwak Y (2013) Core temperature measurement in therapeutic hypothermia according to different phases: comparison of bladder, rectal, and tympanic versus pulmonary artery methods. Resuscitation 84: 810-817.
38. Corcoran T, Rhodes JE, Clarke S, Myles PS, Ho KM (2012) Perioperative fluid management strategies in major surgery: a stratifies meta-analysis. Anesth Analg 114: 640-651.
39. Salmasi V, Maheshwari K, Yang D, Mascha EJ, Singh A, et al. (2017) Relationship between Intraoperative Hypotension, Defined by Either Reduction from Baseline or Absolute Thresholds, and Acute Kidney and Myocardial Injury after Noncardiac Surgery: A Retrospective Cohort Analysis. Anesthesiology 126: 47-65.
40. http://www.edwards.com/gb/devices/decision-software/hpi.
41. Panwar A, Smith R, Lydiatt D, Vascu, Lindau R, et al. (2016) Vascularized tissue transfer in head and & neck surgery: is intensive care unit-based management necessary? Laryngoscope 126: 73-79.
42. Arshad H, Ozer HG, Thatcher A, Old M, Ozer E, et al. (2014) Intensive care unit versus non– intensive care unit postoperative management of head and neck free flaps: comparative effectiveness and cost comparisons. Head Neck 36: 536-539.
43. Broyles JM, Smith M, Coon D, Bonawitz SC (2016) Assessment of Nursing Deficiencies in the Postoperative Care of Microsurgical Patients. J Reconstr Microsurg 32: 615-624.
44. Coyle MJ, Tyrrell R, Godden A, Hughes CW, Perkins C, et al. (2013) Replacing tracheostomy with overnight intubation to manage the airway in head and neck oncology patients: towards an improved recovery. Br J Oral Maxillofac Surg 51: 493-496.
45. Zelken JA, Berli JU (2015) Coffee, tea, and chocolate after microsurgery: why not?. Ann Plast Surg 74: 139.
46. Guidera AK, Kelly BN, Rigby P, MacKinnon CA, Tan ST (2013) Early oral intake after reconstruction with a free flap for cancer of the oral cavity. Br J Oral Maxillofac Surg 51: 224-227.
47. McAuley D, Barry T, McConnell K, Smith J, Stenhouse J (2015) Early feeding after free flap reconstruction for oral cancer. Br J Oral Maxillofac Surg 53: 618-620.
48. Gupta P, Sharma H, Jethava DD, Durga Jethava (2015) Use of dexmedetomidine for multimodal analgesia in head and neck cancer surgeries: a prospective randomized double blind control study. IOSR Journ Dental and Med Sci 14: 8-13.
49. Zhong T, Wong KW, Cheng H, Ojha M, Srinivas C, et al. (2013) Transversus abdominis plane (TAP) catheters inserted under direct vision in the donor site following free DIEP and MS-TRAM breast reconstruction: a prospective cohort study of 45 patients. J Plast Reconstr Aesthet Surg 66: 329-336.
50. Ferri A, Varazzani A, Valente A, Pedrazzi G, Bianchi B, et al. (2017) Perioperative pain management after fibular free flap harvesting for head-and-neck reconstruction using mini-catheters to inject local anesthetic: A pilot study. Microsurgery.
51. Ho MW, Cassidy C, Brown JS, Shaw RJ, Bekiroglu F, et al. (2014) Rationale for the use of the implantable Doppler probe based on 7 years' experience. Br J Oral Maxillofac Surg 52: 530-534.

52. Takasu H, Hashikawa K, Nomura T, Sakakibara S, Osaki T, et al. (2017) A Novel Method of Noninvasive Monitoring of Free Flaps With Near-Infrared Spectroscopy. Eplasty 17: e37.
53. Koolen PG, Vargas CR, Ho OA, Ibrahim AM, Ricci JA, et al. (2016) Does Increased Experience with Tissue Oximetry Monitoring in Microsurgical Breast Reconstruction Lead to Decreased Flap Loss? The Learning Effect. Plast Reconstr Surg 37: 1093-1101.
54. Yeung JK, Harrop R, McCreary O, Leung LT, Hirani N, et al. (2013) Delayed mobilization after microsurgical reconstruction: an independent risk factor for pneumonia. Laryngoscope 123: 2996-3000.
55. Bonde C, Khorasani H, Eriksen K, Wolthers M, Kehlet H, et al. (2015) 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 49: 367-371.
56. Italian perioperative program: http://www.italianperioperative program.it.
57. Pannucci CJ, Dreszer G, Wachtman CF, Bailey SH, Portschy PR, et al. (2011) Postoperative enoxaparin prevents symptomatic venous thromboembolism in high-risk plastic surgery patients. Plast Reconstr Surg 128: 1093-1103.
58. Pannucci CJ, Bailey SH, Dreszer G, Fisher Wachtman C, Zumsteg JW, et al. (2011) Validation of the Caprini risk assessment model in plastic and reconstructive surgery patients. J Am Coll Surg 212: 105-112.
59. Dort JC, Farwell DG, Findlay M, Huber G, Kerr P, et al. (2017) Optimal Perioperative Care in Major Head and Neck Cancer Surgery With Free Flap Reconstruction: A Consensus Review and Recommendations From the Enhanced Recovery After Surgery Society. JAMA Otolaryngol Head Neck Surg 143: 292-303.
60. Batdorf NJ, Lemaine V, Lovely JK, Ballman KV, Goede WJ, et al. (2015) Enhanced recovery after surgery in microvascular breast reconstruction. J Plast Reconstr Aesthet Surg 68: 395-402.