

# Key points in reducing transfusion requirements in perioperative period

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## ABSTRACT

*Surgical intervention can lead to blood loss either through perioperative complications, or through disease severity until surgery. For this reason, mastering the main strategies to improve surgical patients' haematological status, to reduce transfusion rate, and to correct haemoglobin level represent the state of art in surgical patient management. In the last period, due to COVID-19 pandemic and the blood shortage crisis across hospitals, applying principles meant to reduce blood loss, and therefore the rate of blood transfusion, have become even more important.*

**Keywords:** bleeding, surgery, anemia, transfusion, perioperative period

## INTRODUCTION: THE IMPORTANCE OF BLOOD MANAGEMENT STRATEGIES

Patient blood management (PBM) programs encompass a series of recommendations focused on maintaining patients' haemoglobin concentration, haemostasis optimization and minimization of blood loss in order to improve surgical patients' outcome, to reduce transfusion requirements and to enhance patients' tolerance to anaemia [1]. Since the first use of the terms PBM, by Professor James Isbister, the worldwide implementation of these principles, based on a multidisciplinary and multimodal approach of surgical patients, the benefits of these strategies have led to improved outcomes and reduced costs [2-4].

Enhanced recovery after surgery (ERAS) programs represent the highest development in surgical patient perioperative management [5]. Some of the principles promoted by ERAS refer to haemoglobin level optimization, especially preoperatively in elderly, patients

with coronary artery disease, members of Jehovah's Witness, or chronic renal diseases, through pharmacological agents, like erythropoietin and intravenous or oral iron [6,7].

Millions of blood products are annually used in hospitals, to manage symptomatic anemia, mostly in surgical patients. Nevertheless, the risks associated with blood transfusion are well known, and are mainly represented by allergic reactions, coagulopathies, volume overload, acute lung injury, febrile reactions, acute haemolytic reactions, or diseases transmission, leading to with increased morbidity and mortality in surgical patients [8-10].

Moreover, a recent clinical trial conducted by Roshanov and al., included over 16,000 surgical patients, and showed that intraoperative or postoperative bleeding, which led to a postoperative haemoglobin concentration less than 7 mg/dl and blood transfusions, were associated with an increased 30-day mortality in non-cardiac surgery [11].

Another challenge with blood transfusion is represented by the fact that blood is an expensive and limited resource, the COVID-19 pandemic aggravating this problem and leading to so called “blood shortage” across the globe [12]. In face of this new crisis, supplementary blood management strategies have been adopted to reduce blood utilization [13,14].

## RISK FACTORS FOR PERIOPERATIVE BLOOD TRANSFUSION

The main risk factors for requiring perioperative blood products transfusion are represented by low preoperative haemoglobin, haematocrit and albumin levels; female gender, low body mass; comorbidities – American Society of Anaesthesiologists (ASA) classification grade 3 or more: patients with severe systemic illness (e.g. chronic renal disease, cardiovascular and respiratory dysfunctions, gastrointestinal disease, hepatic failure); congenital or acquired haemostatic derangements (anticoagulant or antithrombotic therapy; type of surgery (e.g. colorectal cancer, hip or knee arthroplasty, spinal surgery, liver cancer), surgeon’s skill and experience [6,15-17].

## PREOPERATIVE STRATEGIES

Various studies have shown that preoperative anaemia affects up to 60% of patients undergoing major elective surgery, being associated with increased blood transfusions, postoperative complications, wound infection, sepsis, prolonged hospitalization, delayed recovery, and negative outcome [7,18]. Therefore, measures in this regard should be initiated before surgery. In Table 1 are presented the main steps that should be followed during this period [6,19-22].

**TABLE 1.** Preoperative strategies to reduce blood loss and transfusion requirements

<ol style="list-style-type: none"> <li>1. preoperative planning – evaluation with 28 days before surgery</li> <li>2. optimization of patients’ functional status, good control of comorbidities</li> <li>3. laboratory investigations: full blood count, ferritin, transferrin saturation (TSAT), markers of inflammation – C-reactive protein (CRP), VSH, fibrinogen, serum urea and creatinine</li> <li>4. anaemia treatment: oral / intravenous iron, recombinant erythropoietin (rEPO), folic acid, vitamin B12, vitamin K</li> <li>5. clear schedule for anticoagulant or antithrombotic therapy (± bridging therapy)</li> </ol>
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Another aspect that should be taken into consideration is lowering the transfusion trigger during this period, with the purpose of avoiding unnecessary risks, haemoglobin levels of 7 g/dl being accepted for asymptomatic patients. Over the years, these restrictive strat-

egies have shown superiority in terms of survival, morbidity, complication rate, and number of transfused units [23]. Furthermore, for elective surgery, it is considered that any intervention should be postponed until the haemoglobin level reaches normal values for gender and age [18,24,25].

Autologous blood transfusion (ABT) is often used in patients scheduled for major elective surgery, to increase the transfusion safety and to overcome the blood shortage [26,27].

## INTRAOPERATIVE STRATEGIES

During surgery, there are a series of measures that should be performed by both the surgical and anaesthetic teams, starting from ensuring an optimal ambient temperature, to patient’s positioning on the operating table, to warming the intravenous fluids or blood salvage systems use in case of major bleedings. In Table 2 are systematically exposed the essential strategies that can be used over intraoperative period [3,28-31].

**TABLE 2.** Intraoperative strategies to reduce blood loss and transfusion requirements

Surgical principles	Anaesthetic principles
1. topical haemostatic agents	1. central neuraxial anesthesia
2. tourniquet	2. acute normovolaemic hemodilution
3. blood salvage systems	3. permissive hypotensive anesthesia
4. rigorous haemostasis – diathermy	4. protective mechanical ventilation
5. minimally – invasive surgical techniques (e.g. robotic, laparoscopic)	5. antifibrinolytics (e.g. tranexamic acid)
6. drains	6. lower transfusion trigger
	7. point-of-care testing of haemostatic function (viscoelastic testing, platelet function assay)
	8. rapidly correction of acidosis

Over the years, various studies have shown that the duration of surgery is the most important factor in term of blood loss, and that increasing the intervention time, the risk of blood loss and complications appearance is doubled after two hours of operation [32-34].

## POSTOPERATIVE STRATEGIES

Regarding postoperative period, there are various principles set out in Table 3 targeting patients’ haematological optimization, reducing unnecessary blood loss, increasing haemoglobin level, avoiding as much as possible blood products transfusion [3,13,24,35-37].

Various studies demonstrated the negative impact of postoperative anaemia on surgical patients’ outcome, being associated with increased rate of transfusion, increased length of hospital stay, infections, renal failure, and long-term negative impact on quality life scores [38,39].

**TABLE 3.** Postoperative strategies to reduce blood loss and transfusion requirements

1. achieving euvolemia – proper fluid therapy
2. postoperative limb positioning
3. postoperative autologous reinfusion with specific drainage systems
4. intravenous iron administration
5. erythropoiesis stimulation
6. restrictive transfusion threshold
7. minimizing iatrogenic blood loss (reduce blood draws, use of smaller phlebotomy tubes)
8. normothermia
9. proper pain management
10. schedule restarting anticoagulant / antithrombotic therapy
11. nutritional support

## CONCLUSIONS

Throughout the years, various programs, like ERAS or PBM, have been developed in order to guide our clinical practice with the ultimate goal of reducing morbidity and mortality in surgical patients, along with ensuring a proper quality of life after hospital discharge. Surgery is inevitably associated with blood loss, the extension and gravity of the disease being directly proportional with anaemia development. Therefore, knowing the main strategies to optimize surgical patients' haematological status, to reduce transfusion rate, and to correct haemoglobin level represent the state of art in surgical patient management.

## REFERENCES

1. Society for the advancement of patient blood management (SABM). Who We Are. Available at: <http://www.sabm.org/who-we-are/>.
2. Isbister J. Why should health professionals be concerned about blood management and blood conservation. *Updates in Blood Conservation and Transfusion Alternatives*. 2005;2:3-7.
3. Abeyasiri S, Chau M, Richards T. Perioperative Anemia Management. *Semin Thromb Hemost*. 2020 Feb;46(1):8-16.
4. Desai N, Schofield N, Richards T. Perioperative Patient Blood Management to Improve Outcomes. *Anesth Analg*. 2018 Nov;127(5):1211-1220.
5. Ljungqvist O, Scott M, Fearon KC. Enhanced Recovery After Surgery: A Review. *JAMA Surg*. 2017 Mar 1; 152(3):292-298.
6. Bisbe E, Basora M, Colomina MJ; Spanish Best Practice in Peri-operative Anaemia Optimisation Panel. Peri-operative treatment of anaemia in major orthopaedic surgery: a practical approach from Spain. *Blood Transfus*. 2017 Jul;15(4):296-306.
7. Iqbal U, Green JB, Patel S, Tong Y, Zebrower M, Kaye AD, Urman RD, Eng MR, Cornett EM, Liu H. Preoperative patient preparation in enhanced recovery pathways. *J Anaesthesiol Clin Pharmacol*. 2019 Apr;35(Suppl 1):S14-S23.
8. Raval JS, Griggs JR, Fleg A. Blood Product Transfusion in Adults: Indications, Adverse Reactions, and Modifications. *Am Fam Physician*. 2020 Jul 1;102(1):30-38.
9. Fowler AJ, Ahmad T, Phull MK, Allard S, Gillies MA, Pearse RM. Meta-analysis of the association between preoperative anaemia and mortality after surgery. *Br J Surg*. 2015 Oct;102(11):1314-24.
10. Franchini M, Marano G, Mengoli C, Pupella S, Vaglio S, Muñoz M, Liembruno GM. Red blood cell transfusion policy: a critical literature review. *Blood Transfus*. 2017 Jul;15(4):307-317.
11. Roshanov PS, Eikelboom JW, Sessler DI, Kearon C, Guyatt GH, et al. Bleeding Independently associated with Mortality after noncardiac Surgery (BIMS): an international prospective cohort study establishing diagnostic criteria and prognostic importance. *Br J Anaesth*. 2021 Jan; 126(1):163-171.
12. Jacobs JW, Booth GS. Blood shortages and changes to massive transfusion protocols: Survey of hospital practices during the COVID-19 pandemic. *Transfus Apher Sci*. 2021 Oct 20;103297.
13. Shander A, Goobie SM, Warner MA, Aapro M, Bisbe E, et al.; International Foundation of Patient Blood Management (IFPBM) and Society for the Advancement of Blood Management (SABM) Work Group. Essential Role of Patient Blood Management in a Pandemic: A Call for Action. *Anesth Analg*. 2020 Jul;131(1):74-85.
14. Tolich D, Auron M, McCoy K, Dargis M, Quraisy N. Blood management during the COVID-19 pandemic. *Cleveland Clinic Journal of Medicine*. 2020 Aug 7.
15. Song K, Pan P, Yao Y, Jiang T, Jiang Q. The incidence and risk factors for allogenic blood transfusion in total knee and hip arthroplasty. *J Orthop Surg Res*. 2019 Aug 28;14(1):273.
16. Lucas DJ, Schexneider KI, Weiss M, Wolfgang CL, et al. Trends and risk factors for transfusion in hepatopancreatobiliary surgery. *J Gastrointest Surg*. 2014 Apr; 18(4):719-28.
17. Doyle DJ, Goyal A, Bansal P, Garmon EH. American Society of Anesthesiologists Classification. 2021 Oct 9. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan--.
18. Shah A, Stanworth SJ, McKechnie S. Evidence and triggers for the transfusion of blood and blood products. *Anaesthesia*. 2015 Jan;70 Suppl 1:10-9, e3-5.
19. Rineau E, Chaudet A, Chassier C, Bizot P, Lasocki S. Implementing a blood management protocol during the entire perioperative period allows a reduction in transfusion rate in major orthopedic surgery: a before-after study. *Transfusion*. 2016 Mar;56(3):673-81.
20. Muñoz M, Gómez-Ramírez S, Kozek-Langenecker S. Pre-operative haematological assessment in patients scheduled for major surgery. *Anaesthesia*. 2016 Jan;71 Suppl 1:19-28.
21. Munting KE, Klein AA. Optimisation of pre-operative anaemia in patients before elective major surgery - why, who, when and how? *Anaesthesia*. 2019 Jan;74 Suppl 1:49-57.
22. Greenberg JA, Zwiep TM, Sadek J, Malcolm JC, Mullen KA, McIsaac DI, Musselman RP, Moloo H. Clinical practice guideline: evidence, recommendations and algorithm for the preoperative optimization of anemia, hyperglycemia and smoking. *Can J Surg*. 2021 Oct;64(5):E491-E509.
23. Birie Chekol W, Teshome M, Addisu Nigatu Y, Yaregal Melesse D. Hemoglobin threshold and clinical predictors for perioperative blood transfusion in elective surgery: Systemic review. *Trends in Anesthesia and Critical Care*. 2020;31:8-15.
24. Tomic Mahecic T, Dünser M, Meier J. RBC Transfusion Triggers: Is There Anything New? *Transfus Med Hemother*. 2020 Oct;47(5):361-368.

25. Yaddanapudi S, Yaddanapudi L. Indications for blood and blood product transfusion. *Indian J Anaesth.* 2014 Sep;58(5):538-42.
26. Zhou J. A review of the application of autologous blood transfusion. *Braz J Med Biol Res.* 2016 Aug 1;49(9):e5493.
27. Pawaskar A, Salunke AA, Kekatpure A, Chen Y, Nambi GI, Tan J, Sonawane D, Pathak S. Do autologous blood transfusion systems reduce allogeneic blood transfusion in total knee arthroplasty? *Knee Surg Sports Traumatol Arthrosc.* 2017 Sep; 25(9):2957-2966.
28. Barile L, Fominskiy E, Di Tomasso N, Alpizar Castro LE, et al. Acute Normovolemic Hemodilution Reduces Allogeneic Red Blood Cell Transfusion in Cardiac Surgery: A Systematic Review and Meta-analysis of Randomized Trials. *Anesth Analg.* 2017 Mar;124(3):743-752.
29. Shah A, Palmer AJR, Klein AA. Strategies to minimize intraoperative blood loss during major surgery. *Br J Surg.* 2020 Jan; 107(2):e26-e38.
30. Ghadimi K, Levy JH, Welsby IJ. Perioperative management of the bleeding patient. *Br J Anaesth.* 2016 Dec; 117(suppl 3):iii18-iii30.
31. Mikhail C, Pennington Z, Arnold PM, Brodke DS, Chapman JR, Chutkan N, Daubs MD, DeVine JG, Fehlings MG, Gelb DE, Ghobrial GM. Minimizing blood loss in spine surgery. *Global Spine Journal.* 2020 Jan; 10(1\_suppl):71S-83S.
32. Manara J, Sandhu H, Wee M, Odotola A, Wainwright T, Knowles C, Middleton R. Prolonged operative time increases risk of blood loss and transfusion requirements in revision hip surgery. *Eur J Orthop Surg Traumatol.* 2020 Oct;30(7):1181-1186.
33. Ross D, Erkocak O, Rasouli MR, Parvizi J. Operative Time Directly Correlates with Blood Loss and Need for Blood Transfusion in Total Joint Arthroplasty. *Arch Bone Jt Surg.* 2019 May;7(3):229-234.
34. Cheng H, Clymer JW, Po-Han Chen B, Sadeghirad B, Ferko NC, Cameron CG, Hinoul P. Prolonged operative duration is associated with complications: a systematic review and meta-analysis. *J Surg Res.* 2018 Sep;229:134-144.
35. Muñoz M, Acheson AG, Bisbe E, Butcher A, Gómez-Ramírez S, et al. An international consensus statement on the management of postoperative anaemia after major surgical procedures. *Anaesthesia.* 2018 Nov; 73(11):1418-1431.
36. Osorio J, Jericó C, Miranda C, Santamaría M, Artigau E, Galofré G, et al. Improved postoperative outcomes and reduced transfusion rates after implementation of a Patient Blood Management program in gastric cancer surgery. *Eur J Surg Oncol.* 2021 Jun;47(6):1449-1457.
37. Hatton SP, Smith AF. Postoperative anaemia: balancing the risks of anaemia and transfusion. *Anaesthesia.* 2018 Nov;73(11):1313-1316.
38. Moncur A, Chowdhary M, Chu Y, Francis NK. Impact and outcomes of postoperative anaemia in colorectal cancer patients: a systematic review. *Colorectal Dis.* 2021 Apr;23(4):776-786.
39. Musallam KM, Tamim HM, Richards T, Spahn DR, Rosendaal FR, et al. Preoperative anaemia and postoperative outcomes in non-cardiac surgery: a retrospective cohort study. *Lancet.* 2011 Oct 15;378(9800):1396-407.