

Patient blood management in the cardiac patient undergoing non-cardiac surgery

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Patient blood management (PBM) is a multimodal concept that aims to detect, prevent and treat anemia, optimize hemostasis, minimize iatrogenic blood loss, and support a patient-centered decision to provide optimal use of allogeneic blood products. PBM is intended to reduce three major risks as follows:

1. **Anemia.** Before surgery, about 30% of non-cardiac surgery patients have anemia with an increased risk of RBC transfusions, complications and postoperative mortality. Consequently, the diagnostics and (if medically possible) the therapy of anemia are important elements of PBM. Since anemia in many of these patients is based on a treatable iron deficiency, it is fundamentally crucial to identify anemic patients and/or iron deficient patients at an early stage (two to four weeks before surgery). The preoperative diagnosis and therapy of anemia should also be proceed even if the time interval before surgery is shorter in order to enable a more rapid hemoglobin increase after surgery, whenever necessary.
2. **Blood loss.** The prevention and minimization of unnecessary blood losses is essential to counteract the occurrence of hospital-acquired anemia. The following objectives should be pursued:
 - Reduction of the number of blood withdrawals to the necessary minimum,
 - Use of blood sampling tubes with the smallest volume sufficient for the analysis (e.g. use of smaller tube sizes or minimising the filling level of the tubes),
 - Avoidance of discarding diluted blood residues in withdrawal syringes by using closed blood sampling systems.
3. **RBC transfusion.** The objective of RBC transfusion is the assurance of a sufficient global oxygen supply and the avoidance of potential complications, which might be associated with acute anemia. However, a transfusion is the last resort in the treatment of anemia if a causal therapy of the anemia had not been possible or satisfactory before. Novel data suggest a safe corridor of a hemoglobin of 7-9 g/dL in clinical medicine. A restrictive transfusion regime in cardiac surgery patients suggested a benefit in comparison to a more liberal transfusion strategy.
4. **Study.** In a prospective, multicenter study, surgical inpatients from four German University Hospitals (Frankfurt, Bonn, Kiel and Muenster) were analyzed before (pre-PBM) and after the implementation of PBM. The PBM program included multiple measures (ie, preoperative optimization of hemoglobin levels, blood-sparing techniques, and standardization of transfusion practice).

Primary aim was to show non-inferiority of the PBM cohort with a margin of 0.5%. Secondary endpoints included red blood cell utilization.

A total of 129,719 patients discharged between July 2012 and June 2015 with different inclusion periods for pre-PBM (54,513 patients) and PBM (75,206 patients) were analyzed. The primary endpoint was 6.53% in the pre-PBM versus 6.34% in the PBM cohort. The non-inferiority aim was achieved ($p < 0.001$). Incidence of acute renal failure decreased in the PBM cohort (2.39% vs 1.67%; $p < 0.001$, regression model). The mean number of red blood cell transfused per patient was reduced by approx. 20% ($p < 0.001$). The implementation of PBM can be achieved even in large hospitals without impairment of patient's safety.

Trial Registration: PBM-Study ClinicalTrials.gov, NCT01820949

Other important single PBM measures are: coagulation SOPs, maintaining pH, temperature and calcium levels among others.

RECOMMENDED READINGS

1. Meybohm P, Schmitz-Rixen T, Steinbicker A, Schwenk W, Zacharowski K. The patient blood management concept: Joint recommendation of the German Society of Anaesthesiology and Intensive Care Medicine and the German Society of Surgery. *Chirurg*. 2017;88:867-870.
2. Meybohm P, Richards T, Isbister J, Hofmann A, Shander A, Goodnough LT, et al. Patient blood management bundles to facilitate implementation. *Transfus Med Rev*. 2017;31:62-71.
3. Meybohm P, Herrmann E, Steinbicker AU, Wittmann M, Gruenewald M, Fischer D, et al. Patient blood management is associated with a substantial reduction of red blood cell utilization and safe for patient's outcome: a prospective, multicenter cohort study with a noninferiority design. *Ann Surg*. 2016;264:203-211.