Review Article

Access this article online

Quick Response Code:

Website:
www.ajts.org

DOI:
10.4103/ajts.ajts_128_21

A review of issues and challenges of implementation of patient blood management

Azita Chegini, Ali Jamalian[1], Mohammad Reza Abolhassani[1], Ali Boroujerdi Alavi[1]

Abstract:

INTRODUCTION: Patient blood management (PBM) is outlined as evidence-based medical and surgical concepts with a multidisciplinary method.

AIMS AND OBJECTIVES: The aim of this article is to review the PBM implementation and analyses the issues, challenges, and opportunities.

METHODOLOGY: In this article, we have an overview of PBM implementation in literature and our experience in one hospital in Iran. We used databases including Embase, CINAHL, Scopus, Google Scholar, Google, Science Direct, ProQuest, ISI Web of Knowledge, and PubMed to attain the related literature published in the English language.

RESULTS: There are different barriers and challenges of implementation of PBM, such as hospital culture confrontation, reduced staff with restricted time, lack of interdisciplinary conversation, change of practice, the lack of experience with PBM, the feasibility to integrate PBM, electronic documentation and schedule budget for required instruments, resources, and personnel. Hospitals differ globally in the aspect of infrastructure, personnel and properties, and it is necessary to individualize according to the local situation.

CONCLUSION: The review highlights the importance of PBM and its implementation for obtaining patient safety. PBM establishing in hospitals as a complex process have different challenges and barriers. Sharing experiences is essential to success in the PBM programs. Cooperation between countries will be useful in PBM spreading.

Keywords:

Anemia, blood transfusion, patient care management, perioperative care

Department of Immunohematology, Blood Transfusion Research Center, High Institute for Research and Education in Transfusion Medicine, [1]Department of Cardiac and Cardiac Surgery, Shahid Lavasani Hospital, Sorkheh Hesar, Tehran, Iran

Address for correspondence:
Dr. Azita Chegini, Department of Immunohematology, Blood Transfusion Research Center, High Institute for Research and Education in Transfusion Medicine, Tehran, Iran.
E-mail: azita_chegini@yahoo.com, a.chegini@ibto.ir

Submitted: 04-09-2021
Revised: 14-06-2022
Accepted: 10-07-2022
Published: 12-12-2022

Introduction

According to the aspect of "World Health Organization," (WHO) blood and its components as biological drugs are necessary for medicine.[1] Blood transfusion can save lives and is effective while utilized correctly.[2] Different specialists and groups of health-care systems such as Laboratory personnel, nurses, and physicians are engaged in transfusion practice in which safety should be considered an integral part of their practice.[2] Moreover, allogeneic transfusion has risks such as human error, ABO incompatibility, infectious complications, and transfusion-related immunomodulation. On the one hand, several surveys demonstrated that transfusion might be deteriorating patients' outcomes and increasing mortality and morbidity.[3] On the other hand, some studies predict that the world's people are aging at an unprecedented scale which raises blood utilization and that, in turn, results in an inadequate number of people to donate blood.[4] These difficulties have led to the establishment of patient-focused approach as "Patient Blood Management" (PBM). PBM is outlined as evidence-based medical

How to cite this article: Chegini A, Jamalian A, Abolhassani MR, Alavi AB. A review of issues and challenges of implementation of patient blood management. Asian J Transfus Sci 2024;18:115-23.

and surgical concepts with a multidisciplinary method, with the intention of maintaining hemoglobin (Hb) concentration level, optimizing hemostasis, diminishing bleeding, and increasing physiologic tolerance to anemia to progress patient outcomes. Admittedly, PBM is a "three pillars" therapeutic approach constructed to maintain patient's own blood.[5]

The primary pillar contains preoperative patient evaluation, in which the anesthetic department involves significantly.[6] Precise diagnosis and treatment of anemia and risk assessment play the main role in this pillar. Simultaneously, it has been shown that anemia is an indicator for reduction of clinical improvement, principally in surgical patients. The primary causes of anemia in these patients are iron deficiency (23%–33%) and the occurrence of chronic inflammation (64%).[7] Sometimes the patinets require a complete evaluation and further tests and their surgery might be delayed.[8] There is evidence proving that anemia comes with hypoalbuminemia, extreme surgical stress, and suppressed immunologic response after transfusion in medical patients such as cancer-stricken patients.[9]

Undoubtedly, obtaining an accurate medication and bleeding history is essential in the preoperative period, especially taking a history of anticoagulants and antiplatelets. It has been revealed that the number of patients who are on the treatment of anticoagulants and antiplatelets in the perioperative period is rising to virtually 10%.[10]

The second pillar underlines decreasing intraoperative bleeding by surgical techniques (minimally invasive), special anesthetic methods for reducing hemorrhage, use of pharmacological remedies such as antifibrinolytics, targeted transfusion therapy by point-of-care tests, avoidance of hypothermia, and the use of cell salvage.[11] Maintaining patient hemostasis basis on normal PH, serum electrolytes and their body temperature, coagulation management with point-of-care diagnostic tests, using target therapy instead of empiric prescription of Fresh Frozen plasma and platelet, and using alternatives in treating coagulopathy are significant in this pillar.[12,13]

Another pillar emphasizes rising tolerance to anemia which includes increasing tissue oxygenation, averting infection, and maintaining intraoperative normovolemia (or goal directed fluid therapy) using fluids, suitable transfusion, and vasopressors.[14]

In above mention methods, "Patient-based Decision Making," using autologous transfusion and reduction of iatrogenic anemia due to phlebotomy in these three pillars are the core subjects.[15,16]

Given the importance of "Patient-centered" policy and establishing PBM in hospitals, the purpose of this article is to review PBM, establishing strategies, analyses issues, challenges, and opportunities for establishing PBM in Iran.

Methodology

In this review article, we used databases including Embase, CINAHL, Scopus, Google Scholar, Google, Science Direct, ProQuest, ISI Web of Knowledge, and PubMed to attain the related literature published in the English language. The Keywords used included PBM strategy, implementation, transfusion medicine challenges, patient care management, medical audit, clinical practice, Patient outcomes, Practice change, and Culture change. We restricted the search to English and carefully chosen the documents by reviewing their titles and abstracts. The ultimate choice was based on a careful study of the manuscript. We also present our experience of the steps of implementation of PBM in a hospital in Iran.

Results

Importance of patient blood management

Bleeding is a primary concern in surgeries, and blood transfusion can save lives by promoting oxygen delivery in tissues. There are remarkable risks with transfusion, for instance: acute lung injury, febrile and allergic reactions, infection, and compromised immune response which are infrequent.[3,17,18] Moreover, it has been revealed that transfusion induced increasing mortality and morbidity instead of clinical improvement.[3,18,19] The PBM strategy has required several modifications in clinical conceptions, approaches, and treatment manner. Admittedly, one of the significant variations has been the change of product-focused vision to a patient-based view and his outcome in PBM.[20] In this regard, World Health Organization has been advised to implement PBM since 2010 (WHA63.12), and the PBM program has been implemented effectively in several hospitals in Western Australia, Europe, and the United States.[8,21-23]

The purpose of WHO recommendations is to manage the subjects of preoperative anemia and patient safety in transfusion practice. (WHA63.12) However, some of PBM programs emphasize an RBC-restrictive transfusion strategy and decreasing of blood utilization.[23] On the one hand, there is evidence that PBM implementation has benefits on suitable transfusion, improved patient outcomes, and decreased length of hospital stay.[5,24] On the other hand, PBM can help preserve blood supply throughout the crisis and shortage and diminish the pressure on blood requests.[25]

Hence, Western Australia had intended an educational PBM program,[26] and National Institute for Health and Care Excellence published quality announcements such as iron supplementation, Tranexamic acid for adults, and rechecking after red blood cell transfusions.[27]

The Challenges of Implementation of Patient Blood Management

The challenges of implementation of PBM have been determined, for instance, personnel's lack of knowledge of the latest guidelines, hospital culture confrontation, reduced staffs with restricted time, lack of interdisciplinary conversation, and miscomprehension.[28,29] Undoubtedly, hospitals differ globally in the aspect of infrastructure, personnel, and properties, and it is necessary to individualize according to the local situations for agreement on the novel principles.[30] According to recommendations of Australian National PBM Guidelines,[31,32] experience of Europe in PBM implementation,[33-35] success in PBM implementation does not obey an "all-or-non-law," minor periods designed to adjust to resources of the hospital, obtaining small achievable goals then moving to next stage might guarantee more success. As variations of conditions in hospitals stated earlier, a self-chosen stage method with grading PBM implementation has been suggested.[5]

PBM progresses national health status through health protection, health promotion, disease prevention, reducing the average length of hospital stay, and resource consumption.

PBM can reduce health system costs by improving health outcomes, preventing secondary health conditions, and preserving blood resources. This supports health systems by reducing the intensity of the use of blood resources.

Using PBM methods, institutional and national dependence on blood transfusion and blood bank services, donation centers, and donors is reduced.[36] PBM implementation has resulted in a reduction in red blood cell utilization per 1000 population in Australia, and it is estimated that a 5% reduction in red blood cell utilization. They were able to save $ 14.6 million in national savings in 2011–2012.[37]

Barriers of Implementation of Patient Blood Management

One of the significant strategies before surgery reported preoperative anemia management, which causes allogeneic blood transfusion and worse outcomes in the patient. Muñoz *et al*. revealed that preoperative anemia was often ignored, and allogeneic blood transfusions were a common practice in most hospitals. Thus, one of the serious barriers in implementing PBM was misconceptions in anemia, such as the prevalence of anemia in surgical patients, Hb level and definition of anemia in the preoperative period, cost-effectiveness of anemia treatment, and a high thrombotic risk of preoperative erythropoietin administration and so on.[35]

The most important barriers to implementation of PBM were observed as follows: change of practice, need for collaboration and communication, the lack of experience with PBM, the feasibility to integrate PBM, and strong belief in transfusion.[38]

Implementation of Patient Blood Management in Different Countries

Eichbaum *et al*. compared PBM implementation in four countries (England, Uganda, China, and Brazil). They used six key questions related to their PBM program(s) and observed significant variation between countries. This was due to differences in health systems and their resources. Differences in international health-care systems can also face multiple challenges and opportunities. They believed that sharing PBM experiences would help to promote collaboration between blood transfusion medicine and related health professionals and increase PBM implementation success internationally.[39]

Meier *et al*. stated that there was a huge difference in transfusion practice in different hospitals and patients in perioperative, which was an opportunity to improve the quality of patient safety.[40]

Hofmann *et al*. performed semi-structured interviews with 1–4 PBM presenters from 12 countries in Asia, Latin America, Australia, Central and Eastern Europe, the Middle East, and Africa. They summarized drivers, barriers, measures, and stakeholders regarding PBM implementation measures in each country. They showed that the PBM implementation matrix is a complex process. Six levels for intervention were recognized, including government, health-care providers, education, funders, research, and patients.[38]

Sharing experiences is essential to success in the PBM programs, learning from experiences, and using them in other countries may improve results and avoid mistakes.

Cooperation between countries will be useful in spreading knowledge as well as obtaining information to provide acceptable comparison and benchmarking.[39]

The Experience with Implementation of Patient Blood Management in Iran

From October 2014 to the present, PBM has been implemented in Shahid Lavasani Hospital in Tehran, Iran. After myriad discussions with varied specialists,

anesthesiologists, general surgeons, cardiac surgeons, cardiologists, and internists, PBM was decided to be implemented. The proposal for stages implementation was written and accepted by the research committee at High Institute for Research and Education in Transfusion Medicine, Tehran, Iran. Following Approval by Research Committee, The Research was sent to Ethics Committee and later revised twice; this performance was established to the first step (IR.TMI.REC.1394.1668).

Patients received consent forms, in which information as regarding PBM project, threats and benefits of transfusion, transfusion alternatives, and treatment with Iron and autologous transfusion (with different techniques) was clearly outlined. Patients with signed consent in the hospital were accommodated in the survey.

The first phase was allotted to data gathering and monitoring transfusion practice in different departments such as cardiac surgery, general surgery, emergency room, and medical wards. The practice of transfusion varies among Institutions and their doctors; it was required to monitor and audit of the quality of the existing transfusion practice. The audition was performed monthly, and the use of blood and its components were assessed. In doing so, the audit process was manual and missing data in wards was closely observed. Undoubtedly, documentation in the blood transfusion process is significant and improved by transfusion soft wares that can support and facilitate the whole process and its monitoring. If we could simplify the collection of all referred patients' data in the hospital, the required information might be obtained earlier.

The second phase focused on the policies in the hospital, organizing the transfusion committee, and approval of transfusion guidelines. In this respect, the main challenges in the implementation of PBM are the lack of transfusion guidelines, patient-centered aspects and communication between among staff and physicians. The purpose of the meetings was to obtain agreement from the members of the transfusion committee to write a restricted collaborative transfusion guideline. The committee decided to implement PBM in the hospital by performing restrictive triggers of transfusion. They established Maximum Surgical Blood Ordering Schedule (MSBOS schedules) in the hospital. The transfusion hospital committee oversaw the process of anticoagulant and antiplatelet administration and bridging to the safe anticoagulant in the preoperative period, especially in cardiac surgery. In addition to the agreement on prescribing and ordering of appropriate blood components, a program for the autologous transfusion arrangement was established.

The third phase was theoretical instruction of PBM from varied aspects, including autologous transfusion and its methods by four conferences and symposiums. The educational material included three pillars of PBM, intraoperative autologous transfusion methods, and revision of the transfusion alternatives.

The fourth phase concentrated on preoperative blood management and anemia treatment. There are solid evidence in association with anemia perioperative and blood transfusion. Patients referred to a clinic to be evaluated during the preoperative period. In the hospital, there previously was anesthetic preoperative clinic, after which, as a wise step, an internist clinic was established before the start of implementation PBM in the start of implementation of PBM.

The patients were categorized as anemic, nonanemic, major and minor thalassemia, and bleeding disorders such as hemophilia. Our focus was on nondisorder bleeding patients.

Anemic patients were classified as mild, moderate, and severe. Brochures were provided, giving information regarding the diet before the surgery and recommending a special regimen for them. They found out the hematologic situation, benefits of autologous transfusion, and the risks of allogeneic transfusion during consultation; consequently, they could choose to enter the PBM program. Anemic patients were evaluated by advanced tests, and afterward definite diagnoses were done, they treated with Intra Venous Iron, Vitamin B12, erythropoietin, and so on, according to scientific references.

The fifth phase involved the referral of patients to the anesthetic preoperative consulting room for choosing the anesthetic method, medication choice, and autologous transfusion. Accordingly, approved hospital guidelines by the transfusion hospital committee, the patients were evaluated for the second time and classified as follows:

a. physical examination and evaluation over again
b. Patient classification was suggested by the transfusion hospital committee.

B1-Class 1; Nonanemic patients: Anesthesiologist ordered and reserved blood for surgery for nonanemic patients and autologous transfusion at their own consent. If the patient had no anemia, autologous transfusion was to be carried out. After getting consent and reading autologous brochure, they were prepared for autologous transfusion by oral iron.

B2-Class 2; Treated anemic patients. Treated patients were prepared for surgery and blood ordered, reserved, and cross-matched (By recommended MSBOS). Treated

patients were chosen for autologous transfusion as whether it was appropriate and safe.

B3-Class 3; Treated anemic patients. They were still anemic despite being treated, referred to the internist, evaluated once more and in need of special remedies.

C-blood reserved and ordered by recommended MSBOS in transfusion hospital committee.

D-Major thalassemia and bleeding disorders patients such as hemophilia, they mentioned for special treatment.

The sixth phase concentrated on intraoperative operation. The avoidance of hemodilution in Extracorporeal circulation (or cardiopulmonary bypass pump), planned prime volume in cardiopulmonary bypass pump, use of heparin coated cardiopulmonary bypass pump, using of heparin protocols, and avoidance of severe hypothermia were the main segments of PBM implementation in cardiac surgery. Autotransfusion methods such as cell salvage and acute normovolemic hemodilution, using pharmacologic agents, for example, antifibrinolytics, using hemostasis management protocols and performance of point-of-care tests such as rotational thromboelastometry (ROTEM) or thromboelastography (TEG) were other parts of this stage.

The checklists have been provided for measuring the success rate of PBM implementation in each phase [Table 1]. Our checklists were regulated according to the PBM program, phases and scores for quantifying the success of the process. As outlook of the PBM committee, scores determined the valuation of every item from 0 to 5. For instance, suitable utilization considered 1.5–2 and specified the maximum score, or Ab-screening reflected the advanced movement. Attendance of clinicians in varied specialties received one score each, in case of lack of collaboration, they did not. Not to mention, an extra score was given to the Chief of the hospital due to his authority ranking. Thus, the progress percentage in each phase was totally calculated as a figure [Table 1].

We planned the observational study focuses on PBM implementation ways for obtaining experience in spreading national PBM. It needed to assess the medical record, and our audit process was manual, and missing data in wards were closely observed. Internal and external audits are the most important tools in determining the change.[5] Electronic medical records can accelerate PBM implementation and evaluate its effects on the use of blood. For this reason, the progress rate of the first phase obtained 65%. Using transfusion software, electronic documentation system, and computer-ruled physician ordering may assist PBM implementation progress; facilitate auditing of current transfusion practice, and restrictive transfusion achievement.

In the above-mentioned hospital, three guidelines were approved, which was expected to be totally obeyed; nevertheless, it was not followed due to the relocation of staff and physicians. After 3 years, there was a need for a formal authority to apply the recommendations in the guidelines. A proper authority was allocated for an internist and one perfusionist for PBM auditing; following this, we could apply iron treatment in the limited number of patients and restrictive transfusion trigger.

We had to change the specifically designed use of salvage limited and stop considering providing some instruments such as ROTEM or TEG due to financial problems. These challenges encountered it has brought about the reduction of scores in the fifth and sixth phases. A planned schedule budget for required instruments, resources, and personnel by the PBM committee might promote PBM implementation and its maintenance.

However, our experience revealed that hospital's infrastructure and resources play an important role, and then the time have been extended to more than 5 years. In addition, there is no guarantee for continuing the previous phase despite constant education and accreditation. Then, auditing and authority allocation has been considered since last year. For streamlining, reporting and analyzing the results, checklists had been provided [Table 1].

Conclusion

"Patient-centered" policy and establishing PBM in hospitals as a complex process have different challenges and barriers. Sharing experiences is essential to success in the PBM programs. Cooperation between countries will be useful in PBM spreading.

Acknowledgments

This work was supported by a grant from the "High Institute for Research and Education in Transfusion Medicine." One hundred vials of Ferric Carboxymaltose (Ferinject), a product manufactured by Vifor Pharma Switzerland, were donated by its Marketing Authorization Holder in Iran, Barsian Darou; for administration in eligible patients.

Financial support and sponsorship

Nil.

Table 1: Quantitative checklists of patient blood management implementation

Planned valuation topic	Total
Phase I: Evaluation of current transfusion practice	
How many RBC, PLT, FFP, cryo does it use	
Impossible in laboratory ☐ (score=0)	
Impossible in wards ☐ (score=0)	
Manual in laboratory ☑ (score=1)	1
Manual in wards ☑ (score=2)	2
In laboratory by software ☑ (score=3)	3
In wards by software ☐ (score=4)	
Total	6/10
Evaluation number of cross-match	
No evaluation ☐ (score=0)	
Manual ☑ (score=1)	1
Software-based ☑ (score=2)	2
Evaluation number of Ab-screening☑ (score=3)	3
Total	6/6
Evaluation cross match/transfusion	
C/T=1.5-2 ☑ (score=5)	5
C/T=2-2.5 ☐ (score=4)	
C/T=2.5-3 ☐ (score=3)	
C/T=3-3.5 ☐ (score=2)	
C/T=3.5-4 ☐ (score=1)	
C/T>4 ☐ (score=0)	
Total	5/5
Evaluation of wastage	
No evaluation of wastage in laboratory☐ (score=0)	
Evaluation of wastage in laboratory ☑ (score=1)	1
Evaluation of wastage in wards ☑ (score=2)	2
Evaluation of blood drawing for tests in wards ☐ (score=3)	
use of smaller blood in Laboratory ☐ (score=4)	
Total	3/10
SOP and protocols	
No SOP in laboratory ☐ (score=0)	
SOP for cross match ☑ (score=1)	1
SOP for Ab-screening in laboratory ☑ (score=2)	2
SOP for patient safety in wards: (e.g., Transfusion manner) ☑ (score=3)	3
Protocols for adverse events in wards ☑ (score=4)	4
Protocols for massive hemorrhage in wards ☐ (score=5)	
Total	10/15
Phase II: Policies in the hospital	
Organizing hospital PBM committee	
No cooperation in organizing hospital PBM committee ☐ (score=0)	
Attendance PBM committee (Chief of hospital ☑ (score=2), chief nursing officer ☑ (score=1), cardiac surgeons ☑ (score=1), general surgeons ☑ (score=1), anesthesiologist ☑ (score=1), intensive care specialists ☑ (score=1), internists ☑ (score=1) and cardiologists ☑ (score=1))	9
PBM planner (communication, benchmarking) ☑ (score=2)	2

Contd...

Table 1: Contd...

Planned valuation topic	Total
MSBOS schedules ☑ (score=2)	2
approval transfusion guideline ☑ (score=3)	3
Agreement among the members of transfusion committee to write a restricted collaborative transfusion trigger ☑ (score=4)	4
Agreement on prescribing and ordering of appropriate blood components then the evaluation step in PBM committee ☑ (score=5)	5
Establishment of a program for the autologous transfusion arrangement ☑ (score=6)	6
Total	31/31
Phase III	
Theoretical instruction of patient blood management	
No theoretical instruction of PBM as recommending PBM committee ☐ (score=0)	
Three pillars of PBM ☑ (score=1)	1
Transfusion alternatives and pharmacologic agents ☑ (score=2)	2
Education of autologous transfusion and its methods ☑ (score=3)	3
Running conferences as planned ☑ (score=4)	4
Total	10/10
Phase IV	
Preoperative blood management and anemia treatment	
No cooperation in implementation of preoperative blood management and anemia treatment as recommending PBM committee ☐ (score=0)	
anesthetic preoperative clinic ☑ (score=1)	1
internist clinic for Diagnosing and managing preoperative anemia ☑ (score=2)	2
Diagnosis and categorized Iron deficiency anemia patients ☑ (score=3)	3
Diagnosis of anemia 3-4 weeks before surgery ☑ (score=4)	4
Diagnosis and treatment of VitB12 and folic acid deficiency ☑ (score=1)	1
Treatment of 25% iron deficiency anemia patients ☐ (score=1)	
Treatment of 50% iron deficiency anemia patients ☐ (score=2)	
Treatment of 75% iron deficiency anemia patients ☐ (score=3)	
Treatment of 100% iron deficiency anemia patients ☐ (score=4)	
Extended diagnostic anemia (eg., endoscopy, bone marrow biopsy) ☑ (score=1)	1
Prescribing erythropoietin ☐ (score=1)	1
Optimization of cardiovascular or pulmonary function ☑ (score=1) (e.g., optimization of cardiac output, optimization of asthma)	1
Optimization coagulopathy ☑ (score=1)	1
Anticoagulant and antiplatelet bridging to the safe anticoagulant in preoperative period ☑ (score=1)	1
Informing patients of anemia treatment ☑ (score=1)	1
Informing patients of pre-surgery proper regimen ☑ (score=1)	1
Informing patients for autologous transfusion and administration oral iron ☑ (score=1)	1
Total	19/23
Phase V	
Choosing anesthetic method, medication choice, and autologous transfusion in anesthetic preoperative clinic	
No cooperation in implementation of anesthetic preoperative clinic and anemia treatment as recommending PBM committee ☐ (score=0)	
Physical examination and evaluation afresh ☑ (score=1)	1
Patient classification suggested by PBM hospital committee ☑ (score=2)	2
Ordering and reserving blood recommended by MSBOS approved in PBM hospital committee ☑ (score=3)	3

Contd...

Table 1: Contd...

Planned valuation topic	Total
Referring selected patients for Autologous patients ☑ (score=4)	4
Special treatment of genetic hemorrhagic patients ☑ (score=4) (eg., Hemophilia patients)	4
Total	14/14
Phase VI	
Intraoperative period	
No cooperation in implementation of intraoperative period as recommending PBM committee ☐ (score=0)	
Avoidance of Hemodilution in Extracorporeal circulation (ECC or cardiopulmonary bypass pump) ☑ (score=1)	1
Planned prime volume ☑ (score=1)	1
RAP in cardiopulmonary bypass pump ☑ (score=1)	1
Ultrafiltration in cardiopulmonary bypass pump ☑ (score=1)	1
Hemofiltration in cardiopulmonary bypass pump ☑ (score=1)	1
Avoidance of sever hypothermia(except in TCA) ☑ (score=1)	1
Using of HEPARIN protocols ☑ (score=2)	2
Heparin coated cardiopulmonary bypass pump ☑ (score=2)	2
Autotransfusion methods such as the cell salvage ☑ (score=3)	3
ANH ☑ (score=3)	3
Using of pharmacologic agents e.g., antiphybrinolytics ☑ (score=3)	3
using hemostasis management protocols ☑ (score=3)	3
Performance of point-of-care tests such as Thromboelastometry (ROTEM) or TEG ☐ (score=4)	
Total	22/26

ANH: Acute Normovolemic Hemodilution, RAP: Retrograde autologous priming, ROTEM: Rotational thromboelastometry, MSBOS: Maximum Surgical Blood Ordering Schedule, SOP: Standard of procedure, TEG: Thromboelastography, PLT: Platelet, FFP: Fresh frozen plasma, RBC: Red blood cell, TCA: Total circulatory arrest

Conflicts of interest

There are no conflicts of interest.

References

1. World Health Organization. Blood donor selection: guidelines on assessing donor suitability for blood donation. World Health Organization. 2012. available from: http://apps.who.int/iris/handle/10665/76724.
2. Bolton-Maggs PH, Cohen H. Serious H azards of T ransfusion (SHOT) haemovigilance and progress is improving transfusion safety. Br J Haematol 2013;163:303-14.
3. Hopewell S, Omar O, Hyde C, Yu LM, Doree C, Murphy MF. A systematic review of the effect of red blood cell transfusion on mortality: Evidence from large-scale observational studies published between 2006 and 2010. BMJ Open 2013;3:e002154.
4. Greinacher A, Fendrich K, Brzenska R, Kiefel V, Hoffmann W. Implications of demographics on future blood supply: A population-based cross-sectional study. Transfusion 2011;51:702-9.
5. 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.
6. Goodnough LT, Maniatis A, Earnshaw P, Benoni G, Beris P, Bisbe E, *et al.* Detection, evaluation, and management of preoperative anaemia in the elective orthopaedic surgical patient: NATA guidelines. Br J Anaesth 2011;106:13-22.
7. Beris P, Muñoz M, García-Erce JA, Thomas D, Maniatis A, Van der Linden P. Perioperative anaemia management: Consensus statement on the role of intravenous iron. Br J Anaesth 2008;100:599-604.
8. Goodnough LT, Shieh L, Hadhazy E, Cheng N, Khari P, Maggio P. Improved blood utilization using real-time clinical decision support. Transfusion 2014;54:1358-65.
9. Gascón P. Safety update on erythropoiesis-stimulating agents: Trials within and outside the accepted indications. Oncologist 2008;13 Suppl 3:4-10.
10. Douketis JD, Berger PB, Dunn AS, Jaffer AK, Spyropoulos AC, Becker RC, *et al.* The perioperative management of antithrombotic therapy: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest 2008;133:299S-339S.
11. Butcher A, Richards T. Cornerstones of patient blood management in surgery. Transfus Med 2018;28:150-7.
12. Kozek-Langenecker SA. Coagulation and transfusion in the postoperative bleeding patient. Curr Opin Crit Care 2014;20:460-6.
13. Weber CF, Klages M, Zacharowski K. Perioperative coagulation management during cardiac surgery. Curr Opin Anesthesiol 2013;26:60-4.
14. Casans Francés R, Ripollés Melchor J, Calvo Vecino JM; Grupo Español de Rehabilitación Multimodal GERM/ERAS-Spain. Is it time to integrate patient blood management in ERAS guidelines? Rev Esp Anestesiol Reanim 2015;62:61-3.
15. Carless PA, Henry DA, Moxey AJ, O'Connell DL, Fergusson DA. Cell salvage for minimising perioperative allogeneic blood transfusion. Cochrane Database Syst Rev 2003;(4):CD001888.
16. Ranasinghe T, Freeman WD. 'ICU vampirism'–Time for judicious blood draws in critically ill patients. Br J Haematol 2014;164:302-3.
17. de Almeida JP, Vincent JL, Galas FR, de Almeida EP, Fukushima JT, Osawa EA, *et al.* Transfusion requirements in surgical oncology patients: A prospective, randomized controlled trial. Anesthesiology 2015;122:29-38.
18. Glance LG, Dick AW, Mukamel DB, Fleming FJ, Zollo RA, Wissler R, *et al.* Association between intraoperative blood transfusion and mortality and morbidity in patients undergoing non-cardiac surgery. Anesthesiology 2011;114:283-92.

19. Kuduvalli M, Oo AY, Newall N, Grayson AD, Jackson M, Desmond MJ, *et al.* Effect of peri-operative red blood cell transfusion on 30-day and 1-year mortality following coronary artery bypass surgery. Eur J Cardiothorac Surg 2005;27:592-8.
20. Spahn DR, Theusinger OM, Hofmann A. Patient blood management is a win-win: A wake-up call. Br J Anaesth 2012;108:889-92.
21. Leahy MF, Roberts H, Mukhtar SA, Farmer S, Tovey J, Jewlachow V, *et al.* A pragmatic approach to embedding patient blood management in a tertiary hospital. Transfusion 2014;54:1133-45.
22. Theusinger OM, Kind SL, Seifert B, Borgeat L, Gerber C, Spahn DR. Patient blood management in orthopaedic surgery: A four-year follow-up of transfusion requirements and blood loss from 2008 to 2011 at the Balgrist University Hospital in Zurich, Switzerland. Blood Transfus 2014;12:195-203.
23. Oliver JC, Griffin RL, Hannon T, Marques MB. The success of our patient blood management program depended on an institution-wide change in transfusion practices. Transfusion 2014;54:2617-24.
24. Gross I, Seifert B, Hofmann A, Spahn DR. Patient blood management in cardiac surgery results in fewer transfusions and better outcome. Transfusion 2015;55:1075-81.
25. Chegini A. Evaluating the importance of patient blood management during COVID-19 pandemic. Anesth Pain Med 2021;11:e112910.
26. Leahy MF, Hofmann A, Towler S, Trentino KM, Burrows SA, Swain SG, *et al.* Improved outcomes and reduced costs associated with a health-system-wide patient blood management program: A retrospective observational study in four major adult tertiary-care hospitals. Transfusion 2017;57:1347-58.
27. NICE. Quality Statements 1,2,3. London: NICE (National Institute for Health and Care Excellence); 2016. Available from: https://www.nice.org.uk/guidance/qs138/chapter/Quality-statement. [Last accessed on 2016 Dec 15].
28. Vamvakas EC. Reasons for moving toward a patient-centric paradigm of clinical transfusion medicine practice. Transfusion 2013;53:888-901.
29. Fischer DP, Zacharowski KD, Müller MM, Geisen C, Seifried E, Müller H, *et al.* Patient blood management implementation strategies and their effect on physicians' risk perception, clinical knowledge and perioperative practice-**T**he frankfurt experience. Transfus Med Hemother 2015;42:91-7.
30. Eddy DM, Adler J, Patterson B, Lucas D, Smith KA, Morris M. Individualized guidelines: The potential for increasing quality and reducing costs. Ann Intern Med 2011;154:627-34.
31. National Patient Blood Management guidelines implementation strategy 2013-2017.
32. Hofmann A, Farmer S, Towler SC. Strategies to preempt and reduce the use of blood products: An Australian perspective. Curr Opin Anaesthesiol 2012;25:66-73.
33. Shander A, Van Aken H, Colomina MJ, Gombotz H, Hofmann A, Krauspe R, *et al.* Patient blood management in Europe. Br J Anaesth 2012;109:55-68.
34. Muñoz M, Gómez-Ramírez S, Cuenca J, García-Erce JA, Iglesias-Aparicio D, Haman-Alcober S, *et al.* Very-short-term perioperative intravenous iron administration and postoperative outcome in major orthopedic surgery: A pooled analysis of observational data from 2547 patients. Transfusion 2014;54:289-99.
35. Muñoz M, Gómez-Ramírez S, Kozek-Langeneker S, Shander A, Richards T, Pavía J, *et al.* 'Fit to fly': Overcoming barriers to preoperative haemoglobin optimization in surgical patients. Br J Anaesth 2015;115:15-24.
36. World Health Organization 2021.The urgent need to implement Patient blood Management policy brief. World Health Organization Available from: http://apps.who.int/iriis/handle/10665/346655.
37. National Blood Authority. National Blood Authority Annual Report 2011-2012. Canberra, Australia: National Blood Authority; 2012.
38. Hofmann A, Spahn DR, Holtorf AP, PBM Implementation Group. Making patient blood management the new norm (al) as experienced by implementors in diverse countries. BMC Health Serv Res 2021;21:634.
39. Eichbaum Q, Murphy M, Liu Y, Kajja I, Hajjar LA, Smit Sibinga CT, *et al.* Patient Blood Management: An International Perspective. Anesth Analg 2016;123:1574-81.
40. Meier J, Kozek-Langenecker S, Filipescu D, Pitarch JV, Mallett S, Martus P, *et al.* ESA Clinical Trials Network 2012: ETPOS – European transfusion practice and outcome study. Eur J Anaesthesiol 2013;30:199-201.