Patient Blood Management: a fresh look at a new approach to blood transfusion

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Abstract: The overall use of allogeneic blood transfusions in clinical practice remains relatively high and still varies widely among centres and practitioners. Moreover, allogeneic blood transfusions have historically been linked with risks and complications: some of them (e.g. transfusion reactions and transmission of pathogens) have been largely mitigated through advancements in blood banking whereas some others (e.g. immunomodulation and transfusion–related acute lung injury) appear to have more subtle aetiologies and are more difficult to tackle. Furthermore, blood transfusions are costly and the supply of blood is limited. Finally, evidence indicates that a great number of the critically ill patients who are being transfused today may not be having tangible benefits from the transfusion. Patient blood management is an evidence–based, multidisciplinary, multimodal, and patient–tailored approach aimed at reducing or eliminating the need for allogeneic transfusion by managing anaemia, perioperative blood conservation, surgical haemostasis, and blood as well as plasma–derivative drug use. From this point of view, the reduction of allogeneic blood usage is not an end in itself but a tool to achieve better patient clinical outcome. This article focuses on the three–pillar matrix of patient blood management where the understanding of basic physiology and pathophysiology is at the core of evidence–based approaches to optimizing erythropoiesis, minimising bleeding and tolerating anaemia. Anaesthesiologists and Critical Care physicians clearly have a key role in patient blood management programmes are and should incorporate its principles into clinical practice–based initiatives that improve patient safety and clinical outcomes.

Originally published at:
Liumbruno, G M; Vaglio, S; Grazzini, G; Spahn, Donat R; Biancofiore, G (2015). Patient Blood Management: a fresh look at a new approach to blood transfusion. Minerva Anestesiologica, 81(10):1127-1137.

Patient blood management: a fresh look at a fresh approach to blood transfusion

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ABSTRACT

The overall use of allogeneic blood transfusions in clinical practice remains relatively high and still varies widely among centres and practitioners. Moreover, allogeneic blood transfusions have historically been linked with risks and complications: some of them (*e.g.* transfusion reactions and transmission of pathogens) have been largely mitigated through advancements in blood banking whereas some others (*e.g.* immunomodulation and transfusion-related acute lung injury) appear to have more subtle etiologies and are more difficult to tackle. Furthermore, blood transfusions are costly and the supply of blood is limited. Finally, evidence indicates that a great number of the critically ill patients who are being transfused today may not be having tangible benefits from the transfusion. Patient blood management is an evidence-based, multidisciplinary, multimodal, and patient-tailored approach aimed at reducing or eliminating the need for allogeneic transfusion by managing anaemia, perioperative blood conservation, surgical haemostasis, and blood as well as plasma-derivative drug use. From this point of view, the reduction of allogeneic blood usage is not an end in itself but a tool to achieve better patient clinical outcome. This article focuses on the three-pillar matrix of patient blood management where the understanding of basic physiology and pathophysiology is at the core of evidence-based approaches to optimizing erythropoiesis, minimising bleeding and tolerating anemia. Anesthesiologists and critical care physicians clearly have a key role in patient blood management programmes are and should incorporate its principles into clinical practice-based initiatives that improve patient safety and clinical outcomes. *(Minerva Anestesiol 2015;81:1127-37)*

Key words: Blood transfusion - Complications - Disease management.

Allogeneic blood transfusion is emerging as a potent risk factor for several complications commonly seen in hospitalized patients and as an independent predictor of, or contributor to, worse patient outcomes.[1] Some of the risks and complications historically linked with blood transfusions (*e.g.* transfusion reactions and transmission of pathogens) have been largely mitigated through advancements in blood banking whereas some others (*e.g.* immunomodulation and transfusion-related acute lung injury) [2] appear to have more subtle aetiologies and are more difficult to tackle. Consequently, the era of thinking of blood transfusion as a vitalizing treatment to improve patients' conditions and accelerate their recovery has now been superseded by judicious consideration of allogeneic blood transfusions when other, less-risky modalities are not available. Despite current evidence indicates that a significant number of the patients who are being transfused, even those in the operatory theatres and intensive care units (ICU), may not be having substantial benefits from that treatment, the overall use of allogeneic red blood cell (RBC) transfusions in clinical practice remains relatively high with wide variations among centres

and practitioners.[1, 3] Finally, pressure is increasing from staggering associated costs and limited supplies. Patient blood management (PBM) is an evidence-based, multidisciplinary, multimodal, and patient-tailored approach aimed at reducing or eliminating the need for allogeneic transfusion by managing anaemia, perioperative blood conservation, surgical haemostasis, and blood as well as plasma-derived medicinal product use.[4] From this point of view, the reduction of allogeneic blood usage is not an end in itself but a tool to achieve better patient clinical outcome. In this article we aim to report the state of the art about PBM through an analysis of the most relevant recent research. We hope that the results will contribute to optimizing the use of blood, which continues to be one of the most relevant resources in caring surgical and critically ill patients.

What is patient blood management: the 3 pillars

The Society for the Advancement of Blood Management (SABM) (a nonprofit multiprofessional and multidisciplinary international society collaborating with governmental organisations, regulatory agencies, and corporate partners to bring together resources, knowledge, and funding to pursue its mission, namely to improve health outcomes by advancing comprehensive PBM practices, promoting innovative research, and providing quality professional and public education) defined PBM as "the timely application of evidence-based medical and surgical concepts designed to maintain haemoglobin concentration, optimise haemostasis and minimise blood loss in an effort to improve patient outcome".[4] Therefore, the primary goal and interest of PBM is the improvement of patient clinical outcome while all other issues and considerations – including the usage of allogeneic transfusions – are secondary. PBM pursues better patient outcomes (and cost reduction) relying "on a patient's own blood rather than on donor blood" and "goes beyond the concept of appropriate use of blood products, because it pre-empts and significantly reduces the resort to transfusions by addressing modifiable risk factors that may result in transfusion long before a transfusion may even be considered".[5] The aforementioned objective(s) can be reached through the so-called three pillars of PBM that are strategic to implementing the paradigm-shift of PBM (which is centred on the patient and not on the blood-component) (Table I): 1) optimizing the patient's erythropoiesis; 2) minimizing bleeding; and 3) harnessing and optimising the patient-specific physiological reserve of anemia.[5]

Actually, the global management (and prevention) of anemia starts from the first pillar but permeates the whole three-pillar approach of PBM through a multifaceted armamentarium of pharmacological and non-pharmacological techniques and strategies.[6] Anemia is defined by the normal range of hemoglobin for a healthy population and the range of its prevalence varies widely among studies according to the definition adopted with the lowest reported prevalence obviously found in studies using the most stringent criterion. Although there is no definitive agreement on the definition of anemia, one of the most commonly used definitions to detect preoperative anemia is the one used by the World Health Organization: children 0.50-4.99 years: 11 g/dL; children 5.00-11.99 years: 11.5 g/dL; children 12.00-14.99 years: 12 g/dL; pregnant women: 11 g/dL; non-pregnant women (≥15.00 years): 12 g/dL; men (≥15.00 years): 13 g/dL. It is worth pointing out that the above haemoglobin concentrations are not relevant thresholds by which to understand either critical bleeding or the need for blood transfusion.[7]

Preoperative anemia in surgical patients has a widely ranging prevalence, namely from 5% (geriatric patients with hip fracture) to 78.5% (patients with Dukes stage D colon cancer).[8] In orthopaedic patients, candidates for elective total hip and total knee arthroplasty or hip fracture surgery, it ranges from 24±9% to 44±9%, respectively. The prevalence of haematinic deficiencies ranges from 23% to 70% for iron (defined by either hypochromic [mean corpuscolar hemoglobin <27 pg] microcytic anaemia or serum-soluble transferring receptor level <1.76 mg/L),[9] is around 12% for vitamin B_{12} (defined by serum concentration <270 pg/mL [200 pmol/L]),[10] and is 3% for folate [defined by serum concentration <3 ng/mL [5 nmol/L]).[10]

Table I.—*The three pillars of patient blood management.*[4]

Stage/pillar	Pillar 1 Optimise erythropoiesis	Pillar 2 Minimise bleeding and blood loss	Pillar 3 Harness and optimise physiological reserve of anaemia
Preoperative	Detect anaemia	Identify and manage bleeding risk	Assess/optimise patient's physiological reserve and risk factors
	Identify underlying disorder(s) causing anaemia	Minimising iatrogenic blood loss	Compare estimated blood loss with patient-specific tolerable blood loss
	Manage disorder(s)	Procedure planning and rehearsal	Formulate patient-specific management plan using appropriate blood conservation modalities to minimise blood loss, optimise red cell mass and manage anaemia
	Refer for further evaluation if necessary	Preoperative autologous blood donation (only in selected cases)	Restrictive transfusion thresholds
	Treat suboptimal iron stores/ iron deficiency/anaemia of chronic disease/iron-restricted erythropoiesis		
	Treat other haematinic deficiencies		
Intraoperative	Timing surgery with haematological optimisation	Meticulous haemostasis and surgical techniques	Optimise cardiac output
		Blood-sparing surgical techniques	Optimise ventilation and oxygenation
		Anaesthetic blood conserving strategies	Restrictive transfusion thresholds
		Autologous blood options	
		Pharmacological/haemostatic agents	
		Point-of-care testing	
	Stimulate erythropoiesis	Vigilant monitoring and management of post-operative bleeding	Optimise anaemia reserve
Postoperative	Be aware of drug interactions that can increase anaemia	Avoid secondary haemorrhage	Maximise oxygen delivery
		Rapid warming/maintaining normothermia (unless hypothermia specifically indicated)	Minimise oxygen consumption
		Autologous blood salvage if appropriate	Avoid/treat infections promptly
		Minimising iatrogenic blood loss and be aware of adverse effects of medication	Restrictive transfusion thresholds
		Haemostasis/anticoagulation management	
		Prophylaxis of upper gastrointestinal haemorrhage	
		Avoid/treat infections promptly	

Several recent studies exploring the relationship between pre-operative anaemia and outcome highlighted a link with higher postoperative mortality and morbidity as well as an increased risk of receiving allogeneic transfusions.[11-13] Therefore, according to PBM, anemia is a contraindication for major elective surgery at high risk of bleeding and/or consistent anticipated blood loss and it should be detected at least 30 days before the scheduled surgical procedure to allow the implementation of appropriate treatment, if available.[6, 14]

However, also up to 74% of patients with normal hemoglobin levels on hospital admission subsequently can develop hospital-acquired anemia, which is associated with increased mortality and resource utilization [15] as well as higher morbidity.[14] Postoperative anaemia prevalence

in elective total hip or knee arthroplasty and in hip fracture surgery is even higher (51% and 87±10%, respectively) [9] and can even be as high as 90% in surgical patients.[8] It is mainly related to peri-operative bleeding but can be worsened by repeated phlebotomy for diagnostic testing as well as by blunted erythropoiesis caused by surgery-induced inflammatory responses, especially through decreased iron availability (*i.e.* hepcidin-dependent down-regulation of intestinal absorption and impaired mobilization from body stores).[16]

The second PBM pillar includes all the strategies to minimise bleeding and save the patient's own blood.[17] The first step is the thorough pre-operative assessment of the patient aimed at identifying and managing the bleeding risk and any potential risk factor for iatrogenic blood loss.[14] Singbartl *et al.* recently ranked the effectiveness of autologous blood conservation measures and very elegantly confirmed that intraoperative blood salvage is the most efficacious and effective autologous blood conservation measure.[18] As far as post-operative blood salvage is concerned, while topical tranexamic acid can be recommended with less strength to contain the transfusion requirements in in total hip and total knee arthroplasty,[19] its systemic use is gaining an ever-increasing evidence of safety and efficacy in significantly reducing the amount of blood loss.[20]

Therefore, the ever-increasing use of peri-operative intravenous tranexamic acid is really questioning the usefulness of postoperative blood salvage as an autologous blood conservation measure in orthopaedic surgery,[21] especially if the post-operative collection devices are indiscriminately used without identifying those patients at real risk of significant early postoperative blood loss and those who, being really anaemic, would actually benefit from shed blood transfusion therapy.[22, 23] Recovery and reinfusion of blood from surgical drains is a very commonly used technique exploiting devices whose primary function is to act as a reservoir for the shed blood. When adequate amounts of blood are collected, the system is flipped over and plugged into an intravenous line. This procedure has earned these devices the nickname of "flip-n-drip" systems. [21]

In addition, bleeding can also be reduced by a joint, coordinated and patient-tailored usage of several pharmacological and non-pharmacological techniques and strategies (*e.g.* less invasive surgery and computer-assisted surgery, neuraxial anesthesia, patient positioning, maintenance of normothermia, controlled hypotension - defined as a reduction of the systolic blood pressure to 80-90 mm Hg, a reduction of mean arterial pressure to 50-65 mmHg or a 30% reduction of its baseline value [24], point-of-care coagulation testing, topical hemostatic agents - such as fibrin sealant - and hemostatic drugs - tranexamic acid) although, at present, different level of evidence supports their efficacy.[17] Furthermore, hyperoxic ventilation in combination with normovolemic hemodilution might be considered a useful method for reducing allogeneic transfusion support during surgical bleeding,[15] or at least for postponing transfusion until bleeding can be controlled but keeping in mind that it may have a role only in short term maintenance of tissue oxygenation.[25]

The third PBM pillar encompasses the preoperative preparation of the patient, the intraoperative optimisation of oxygen transport and tissue oxygenation, the maintenance of the postoperative balance of oxygen delivery and oxygen consumption, and the use of restrictive transfusion thresholds.[17] To this regard, pooled data from randomized trials show that RBC transfusions can increase in-hospital mortality, total mortality, rebleeding, acute coronary syndrome, pulmonary oedema, and bacterial infections.[26] On the other hand, a growing body of evidence from clinical trials, with few dissenting studies [27] indicates that a restrictive transfusion strategy, namely administering RBCs once the hemoglobin falls below either 7 or 8 g/dL is safe in most clinical settings. A 2011 Cochrane review evaluating transfusion trigger in a variety of populations found that a haemoglobin transfusion threshold of 7 or 8 g/dL compared with a higher haemoglobin transfusion threshold (10 g/dL) results in: 1) a reduction of the risk of receiving a RBC transfusion by 39% (risk ratio [RR], 0.61; 95% confidence interval [CI], 0.52-0.72) that equates to an average absolute risk reduction of 34% (95% CI, 24-45%); 2)

fewer blood transfusions (mean difference, 1.19 units per patient; 95% CI, 0.53-1.85 units); 3) a statistically significant reduction of in-hospital mortality (RR, 0.77; 95% CI, 0.62-0.95) but not 30-day mortality (RR, 0.85; 95% CI, 0.70-1.03). The use of restrictive strategies did not cause, cardiac morbidity, impaired functional recovery, or prolonged hospital length of stay (LOS).

A recent meta-analysis and systematic review by Salpeter *et al.*[26] focused on the question whether the lower 7-g/dL threshold is superior to the higher threshold of 8 g/dL and showed that in patients with critical illness or bleed, restricting blood transfusions by using a haemoglobin trigger of <7 g/dL significantly reduces cardiac events (RR, 0.44; CI, 0.22-0.89), re-bleeding (RR, 0.64; CI, 0.45-0.90), bacterial infections (RR, 0.86; CI, 0.73-1.00), in-hospital mortality (RR, 0.74; CI, 0.60-0.92), and total mortality (RR, 0.80; CI, 0.65-0.98). The number needed to treat with a restrictive strategy to prevent 1 death is 33. However, an important limitation of prospectively randomized clinical trials is that patients who are both eligible and who agree to participate in the study might not be representative of all patients in these clinical settings. The impact of RBC transfusion reduction on mortality in a diverse inpatient population has been recently addressed in a real-world setting by Roubinian *et al.* who analysed a large health care database including more than 200,000 patients.[28] They showed that a greater than 20% reduction in RBC use over 3 years and a concurrent more restrictive transfusion practice (*i.e.* a statistically significant drop in median pre-transfusion haemoglobin level from 8.1 g/dL to 7.5 g/dL) over the same period did not affect adjusted and unadjusted mortality rates.

A recent pilot trial addressed even the controversial issue of liberal versus restrictive transfusion thresholds for patients with symptomatic coronary artery disease.[29] The trial recruited patients with acute coronary syndrome or stable angina undergoing cardiac catheterization and a hemoglobin <10 g/dL and showed that the liberal transfusion strategy (*i.e.* raising the hemoglobin level ≥10 g/dL) was associated with a trend for fewer major cardiac events and deaths than a more restrictive strategy (*i.e.* transfusing for symptoms from anemia or for a haemoglobin <8 g/dL) thus supporting the feasibility of and the need for a definitive trial in this specific clinical setting. Interestingly, the same higher blood transfusion threshold (hemoglobin >10 g/dL) was not able to prevent new or worsening delirium symptoms in postoperative hip-fracture older adult patients.[30] Accordingly, a comparison of more recent transfusion guidelines shows that they generally agree that hemoglobin alone is not a very informative parameter to use as a basis for transfusion decision and transfusion is not beneficial when the hemoglobin concentration is >10 g/dL, but is usually indicated when its concentration is <6 g/dL and, for patients with Hb 6-10 g/dL, acknowledge the necessity of individualizing the decision to initiate transfusion by incorporating patient-related factors such as age, comorbidities, and risk or evidence of ischaemia as well as amount and rate of blood loss.[31]

In addition, as new convincing evidence recently showed, a restrictive transfusion approach to RBC transfusion may also have the additional benefit of reducing the incidence of health-care-associated infection.[32] Therefore, the implementation of restrictive strategies among hospitalised patients does seem to be safe and should be the cornerstone of any blood conservation programme,[33] which, in stable, non-bleeding patients with anaemia should also be based on a single-unit-transfusion ordering policy (followed by clinical and laboratory reassessment to determine the need for further transfusion) that is supported by a growing evidence.[34-36]

Although the rational use of blood products is not only driven by rationalization but also by the wish to improve perioperative patient care, PBM also derives from an increasing awareness that in the future blood supply shortages could arise because of an aging population [37] and also from an economic-financial rationale [31] stemming from a growing awareness of the high direct and indirect transfusion therapy costs.[38] This will undoubtedly help the promotion of PBM as a cost-effective strategy, both in the interest of patients and health-care social (sustainable) costs.[39]

Patient blood management: the available evidence

In 1991, one of the first blood conservation strategies in cardiac surgery was developed by Ovrum and co-workers who managed to avoid allogeneic blood transfusion in 484 out of 500 patients (96.8%) through the simple (and cost-effective) intra- and post-operative-re-transfusion of autologous (shed) blood.[40] From the early 90s on, the evaluation of the role that several single strategies included in PBM programmes exerted on clinical and surrogate outcomes has produced a wealth of data showing a reduced use of blood products and the cost-effectiveness of the programmes, which have been mainly applied in cardiac, major orthopedic, and transplantation surgery as well as in trauma centres.[41] This article will only strive to focus on the limited and recently emerging data on the impact of PBM programmes as a whole, being aware that the eagerness of the scientific community who is longing for more outcome data will probably be satisfied in the next few years.[42]

In 2001, Van der Linden *et al.* reported a safe and cost-effective 53% decrease in RBC usage and a 46% decrease in the number of elective-cardiac-surgery patients receiving any blood products, without any significant difference in post-operative haemoglobin.[43] In addition, control and study groups showed similar in-hospital mortality (4.7% *vs.* 3.8%, p: 0.59), intensive care unit (2.6 ± 4.2 days *vs.* 2.7±3.6 days, p: 0.97) and hospital LOS (10.6±8.4 days *vs.* 10.3±6.2 days, p: 0.64). Postoperative complication rate was also comparable (acute myocardial infarction: 7.8% *vs.* 9.2%, P=0.52; respiratory problems: 14.3% *vs.* 12.1%, p: 0.41; wound infections: 2.5% *vs.* 3.2%, P=0.61; neurologic deficit: 1.9% *vs.* 1.6%, P=0.34; renal insufficiency needing haemodialysis: 4.4% *vs.* 3.2%, P=0.46). Still in cardiac surgery, a more recent study determined the effects of a PBM programme based on algorithm-driven transfusion decisions exploiting lower transfusion triggers, point-of-care testing, and blood-saving measures.[44] The total blood product use was reduced by 40% and control patients had a slightly higher pre-discharge hemoglobin level than study patients (median: 9.9 *vs.* 9.5 g/dL, P<0.001). However, no differences ~~in~~ between in-hospital or 30-day mortality (1% *vs.* 1%, P=1; 1% *vs.* 2%, P=0.25, respectively), re-operation for bleeding (4% *vs.* 4%, P=0.89), or other post-operative outcomes such as peri-operative myocardial infarction (<1% *vs.* 0%, P=0.47), atrial fibrillation (23% *vs.* 23%, P=0.82), prolonged (>24 hours) ventilator support (9% *vs.* 10%, p: 0.52), wound infections (< 1% *vs.* 1%, P=0.53), sepsis (1% *vs.* 1%, P=0.74) renal insufficiency needing haemodialysis (2% *vs.* 1%, P=0.53), transient ischaemic attack (1% *vs.* 1%, P=1), multiorgan system failure (<1% *vs.* 0%, P=0.47) were detected between the control and study group. Masud *et al.* implemented a multidisciplinary team-driven PBM programme and reported a reduction in post-operative blood product use among coronary artery bypass graft patients (a 14.3% decrease in the first year and 30.6% from 2006 to 2008), an 18.2% reduction of blood product volume used in the entire cardiovascular intensive care unit, and an estimated savings of more than $ 1 million, with no additional harm to patients and a trend toward better clinical outcomes [i.e. expected operative mortality index (from 1.41 to 1.29), infection rates (including the rate of ventilator-associated pneumonia), and cardiovascular intensive care unit average LOS (from 4.04 days to 3.83 days)] before and after the initiative.[45]

Recently, in Switzerland, a before and after study in elective orthopaedic surgery was carried out to investigate the impact of the introduction of a PBM programme, which resulted in: 1) a significantly lower incidence of immediate preoperative anemia in hip and knee surgery (from 17.6 % to 12.9 % [P<0.001] and from 15.5% to 7.8% [P<0.001], respectively), while in spine surgery its prevalence remained unchanged (12.6% *vs.* 10.3%, P=0.113); ii) an unchanged RBC mass loss in hip surgery (626±434 *vs.* 635±450 mL, P=0.974) and a significantly RBC mass loss reduction in knee and spine surgery (from 573±355 to 476±365 mL [P<0.001] and from 551±421 to 404±337 mL [P<0.001], respectively); 3) a significantly lower transfusion rate (from 21.8% to 15.7% [P<0.001] in hip surgery; from 19.3% to 4.9% [P<0.001] in knee surgery, and from 18.6 to 8.6% [P<0.001]

in spine surgery).[46] Unfortunately, this retrospective study was not able to provide data on long-term effects of PBM such as hospital LOS, postoperative complications, and costs. Moreover, post-operative haemoglobin data were not available for all the patients.

Further studies described the implementation of PBM in larger scale programmes developed in single or multiple hospitals. In 2008, a PBM programme was implemented in 23 Canadian hospitals and it involved education, autologous donation, cell salvage, and erythropoietin administration. After 24 months, most hospitals had demonstrated decreased use of allogeneic blood and patients who did not receive allogeneic transfusions had significantly lower postoperative infection rates ($P<0.05$) and hospital LOS ($P<0.0001$). In multivariate analysis, allogeneic transfusion was an independent predictor for LOS. This study clearly showed that such programmes can be applied widely, effectively, and cost-effectively through centralised management.[47] More recently, the excellent results of hospital-wide PBMs were reported in Australia and in the USA.[34, 48] The results of the USA hospital were "achieved through hospital-wide physician buy-in toward a restrictive transfusion approach" and resulted in a 43% reduction in RBC units transfused per patient discharged.[48] Unfortunately, the authors were not able to determine the number of RBC units in each physician's order and did not analyse patient outcomes pre- and post-PBM. The same consistent reduction of blood product usage was observed also in an Australian teaching hospital where, despite a 22% increase in admissions, the mean number of RBC, fresh-frozen plasma, and platelet units per admission showed 26%, 38%, and 16% reduction, respectively.[34] In the same period, the mean hospital LOS for primary total knee arthroplasty decreased from 5.9 to 4.8 days. Also in this study, other PBM effects were not analysed and the outcomes were "likely" improved by reducing patient exposure to allogeneic blood transfusion. No randomized controlled trial comparing relevant clinical outcomes in patients managed through comprehensive PBM programmes against those who were not has been carried out so far.[42] Therefore, the PBM arena is at present largely dominated by observational studies, which through an ever-increasing wealth of data show that the implementation of this patient-centric-transfusion-medicine tool reduces blood transfusions and hospital costs as well as transfusion-related morbidities and mortality but further research on the impact of PBM strategies on (long-term) patient outcomes is needed. [49]

Being aware that designing and carrying out a PBM randomised trial is extremely challenging, Gross proposed to measure the impact of multimodal PBM strategies on outcomes through registries of treated patients rather than randomised controlled trials since the former more closely resemble those patients we come across in daily clinical practice.[42]

PBM around the world and in Italy

In 2010, the World Health Organization (WHO), with the resolution WHA63.12, urged all member states to implement PBM.[50]

However, at the moment, Australia is the first example of a national public health system thoroughly compliant with the WHO request. In fact, the National Blood Authority developed comprehensive six-module-evidence-based PBM national guidelines.[51] This national policy exerted a major influence in the adoption of PBM by several centres.[52]

In the USA, PBM has attracted the attention of the Association for Advancing Transfusions and Cellular Therapies (AABB), the SABM and the Joint Commission.[53, 54] At present, in this country, PBM programmes are around 100.[53]

Currently, the implementation of PBM in Europe except for the Netherlands, Austria, and Spain is limited.[55] PBM strategies are in place for major elective surgery in a limited number of hospitals in Switzerland,[55] while in the UK some centres are now developing pilot studies on PBM.[55] A multicentre PBM programme will also be implemented in Germany.[53] In Italy, the National Blood Centre, has recently included the implementation of a PBM programme among the objectives of the 2012 national plan for blood and blood product self-sufficiency.[57] Recently the Patient Blood Management Eu-

rope (PaBloE) Consortium, coordinated by the European Blood Alliance (EBA), was founded. It includes Denmark, Germany, Malta, Sweden, the Netherlands, and the UK, and Italy. Finally, a recent call for tender on good practices in the field of blood transfusion issued by the European Commission launched three objectives: 1) develop a European PBM guide for Member States; 2) implement PBM programmes in 5 teaching hospitals in European Member States; 3) prepare strategies to help national authorities to disseminate and implement PBM across Europe.[58]

PBM: role of the anesthesiologist

In many hospitals anaesthesiologists in recent years gradually developed into peri-operative care specialists and therefore are in particularly well-suited position to lead multidisciplinary and multi-professional PBM programmes. Leadership is key in the implementation and maintenance of a PBM programme but the implementation can only be successful with the buy-in of all major surgical disciplines, haematology, blood banking and the Board of Directors of the hospital. Once a PBM steering committee has been founded, it is to issue hospital wide compulsory PBM guidelines and a continuous educational programme in which all included disciplines participate. The PBM guidelines are to define the main processes including rules that patients are being seen as early as possible, ideally 30 days prior to elective surgery, to detect anaemia and to have sufficient time to specifically treat anemia if present. However, also short-term treatment can be successful in orthopedic [59] and cardiac surgery.[60, 61] Also the introduction of blood sparing surgical techniques,[41] the use of cell salvage [62] and transfusion guidelines issued [63] are to be regulated by such PBM guidelines. But guidelines alone are not sufficient. A continuous monitoring system is to be introduced assessing the adherence to the guidelines. Issues to be assessed are percentage of anemic patients operated, use of cell salvage, perioperative transfusion rate, and hemoglobin concentration at transfusion. Ideally, also clinical outcomes such as infections, hospital LOS and thrombotic complications should be prospectively monitored. These assessments are to be performed regularly based on the hospital information system, analysed in the PBM steering committee and reported back to the responsible physicians. Such a monitoring and feedback system has been shown to be highly efficacious.[34] Anaesthesiologists thus have a key role in PBM programmes but should not try to implement such programmes alone. Only the joint effort of all parties included allows long-term success.

Conclusions

All treatments should be assessed for their effect on improving patients' outcomes. Despite widespread use, allogeneic blood transfusions have not undergone such scrutiny and the balance between their established risks and questionable benefits is often overshadowed by a quest to meet arbitrary laboratory thresholds. The result is a transfusion practice that is highly variable, costly and likely to do more harm than good to the patients. Safety and efficacy concerns of allogeneic blood transfusions and their impact on patient outcomes, together with staggering costs and restricted supply, have fuelled the search for new modalities and strategies to reduce use of blood components. PBM focuses on multidisciplinary and multimodal preventive measures to reduce or obviate the need for transfusions and ultimately to improve the clinical outcomes of patients through strategies that can be applied at every stage of care to surgical and non-surgical patients. Although the safety and efficacy of the different modalities used in PBM should be evaluated individually, emerging data support that PBM is safe and effective in providing better care and improving patients' outcomes while reducing transfusion of allogeneic blood components. Therefore, as perioperative medicine leaders, Anaesthesiologists are called to hold a key role in promoting, implementing and auditing PBM programmes at their institutions also introducing quality indexes for PBM such as the recently proposed percentage haematocrit variation index, which reflects haematocrit variations during 7 days of hospital stay in cardiac surgery patients.[64]

Key messages

— Blood transfusions are risky, costly and the supply of blood is limited. Blood transfusion outcomes are therefore undergoing renewed scrutiny by healthcare institutions to reduce blood utilization.

— Patient blood management is an evidence-based, multidisciplinary, multimodal, and patient-tailored approach aimed at reducing or eliminating the need for allogeneic transfusion. These objectives can be reached through the so-called three pillars of Patient blood management: a) optimising the patient's erythropoiesis; b) minimising bleeding and c) harnessing and optimising the patient-specific physiological reserve of anemia.

— Emerging data support that patient blood management is safe and effective in providing better care and improving patients' outcomes while reducing transfusion of allogeneic blood component

— As perioperative medicine leaders, anesthesiologists hold a key role in promoting, implementing and auditing PBM programmes at their institutions.

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Conflicts of interest.—G. Biancofiore has no conflicts of interests. D. Spahn's academic department is receiving grant support from the Swiss National Science Foundation, Berne, Switzerland, the Swiss Society of Anesthesiology and Reanimation (SGAR), Berne, Switzerland, the Swiss Foundation for Anesthesia Research, Zurich, Switzerland, Bundesprogramm Chancengleichheit, Berne, Switzerland, CSL Behring, Berne, Switzerland, Vifor SA, Villars-sur-Glâne, Switzerland.
Dr. Spahn was the chairman of the ABC Faculty and is the co-chairman of the ABC Trauma Faculty, which both are managed by Physicians World Europe GmbH, Mannheim, Germany and sponsored by unrestricted educational grants from Novo Nordisk Health Care AG, Zurich, Switzerland, CSL Behring GmbH, Marburg, Germany and LFB Biomédicaments, Courtaboeuf Cedex, France.
In the past 5 years, Dr. Spahn has received honoraria or travel support for consulting or lecturing from the following companies: Abbott AG, Baar, Switzerland, AMGEN GmbH, Munich, Germany, AstraZeneca AG, Zug, Switzerland, Bayer (Schweiz) AG, Zürich, Switzerland, Baxter AG, Volketswil, Switzerland, Baxter S.p.A., Roma, Italy, B. Braun Melsungen AG, Melsungen, Germany, Boehringer Ingelheim (Schweiz) GmbH, Basel, Switzerland, Bristol-Myers-Squibb, Rueil-Malmaison Cedex, France and Baar, Switzerland, CSL Behring GmbH, Hattersheim am Main, Germany and Berne, Switzerland, Curacyte AG, Munich, Germany, Ethicon Biosurgery, Sommerville, New Jersey, USA, Fresenius SE, Bad Homburg v.d.H., Germany, Galenica AG, Bern, Switzerland (including Vifor SA, Villars-sur-Glâne, Switzerland), GlaxoSmithKline GmbH & Co. KG, Hamburg, Germany, Janssen-Cilag AG, Baar, Switzerland, Janssen-Cilag EMEA, Beerse, Belgium, Merck Sharp & Dohme AG, Luzern, Switzerland, Novo Nordisk A/S, Bagsvärd, Denmark, Octapharma AG, Lachen, Switzerland, Organon AG, Pfäffikon/SZ, Switzerland, Oxygen Biotherapeutics, Costa Mesa, CA, Photonics Healthcare GmbH, Munich, Germany, ratiopharm Arzneimittel Vertriebs-GmbH, Vienna, Austria, Roche Pharma (Schweiz), AG, Reinach, Switzerland, Schering-Plough International, Inc., Kenilworth, New Jersey, USA, Tem International GmbH, Munich, Germany, Vifor Pharma Deutschland GmbH, Munich, Germany, Vifor Pharma Österreich GmbH, Vienna, Austria, Vifor (International) AG, St. Gallen, Switzerland.

Received on May 6, 2014. - Accepted for publication on October 10, 2014. - Epub ahead of print on October 14, 2014.

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