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Reducing Unnecessary Transfusions in Surgery: A Frontline Anaesthesiologist's Perspective on Patient Blood Management

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Abstract

Unnecessary perioperative blood transfusion remains common in surgical practice worldwide and is associated with increased morbidity, mortality, and health care costs. From the perspective of anaesthesiologists working on the frontline, transfusion decisions are often made under time pressure, uncertainty, and incomplete information. Patient blood management (PBM) offers a practical, evidence-based framework to support safer, more rational transfusion practice. In this article, we present a frontline anaesthesiologist's perspective on how unnecessary transfusions can be reduced across the 3 PBM pillars: optimisation of preoperative anaemia, reduction of perioperative blood loss, and restrictive, evidence-driven transfusion strategies. Drawing on real-world experience from diverse health care settings, including low- and middle-income countries, we highlight pragmatic interventions that can be implemented even where resources are limited. These include early anaemia detection, targeted iron therapy, routine use of antifibrinolytics, meticulous anaesthetic and surgical techniques, single-unit transfusion policies, haemoglobin trend monitoring, clinician education, audit, and multidisciplinary collaboration. In this article, we emphasise that effective PBM does not depend on advanced technology alone but on culture change, teamwork, and consistent bedside decision-making. PBM empowers anaesthesiologists to move from reactive transfusion to proactive, patient-centred care.

Key words: patient blood management, anaesthesia, transfusion, surgery, perioperative care

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INTRODUCTION

For anaesthesiologists working in operating theatres worldwide, blood transfusion is both familiar and paradoxical. It is a potentially life-saving therapy yet one that is frequently administered without clear benefit. Despite decades of research, up to 30%-50% of perioperative red blood cell transfusions are still considered unnecessary or inappropriate.[1,2]

From the frontline perspective, this is not surprising. Transfusion decisions are often made during complex surgery, under time pressure, with dynamic physiology and imperfect data. Visual estimation of blood loss is unreliable, laboratory results may be delayed, and concern about patient safety can easily push clinicians toward just - in-case transfusion.

Patient blood management (PBM) was developed to address this exact problem. PBM is a structured healthcare strategy that integrates robust governance, standardized clinical pathways, continuous audit and feedback systems, and effective multidisciplinary coordination to optimize patient outcomes and ensure the appropriate use of blood and related resources. It is a patient-centred, evidence-based approach that aims at optimising a patient's own blood, minimising blood loss, and ensuring that transfusion is used only when truly necessary.[3] For anaesthesiologists, PBM is not an abstract policy; it is a practical framework that supports better decisions at the bedside.

This article reflects a anaesthesiologist's view of PBM implementation, focusing on strategies that genuinely reduce unnecessary transfusion in everyday surgical practice, across a wide range of health care systems.

WHY UNNECESSARY TRANSFUSION MATTERS

Patient Outcomes

Allogeneic blood transfusion is not a benign intervention. It is associated with well-established risks, including transfusion-associated circulatory overload, transfusion-related acute lung injury, infection, immunomodulation, thromboembolic events, acute kidney injury, and prolonged hospital stay.[4-6]

Both large-scale observational studies and meta-analyses frequently indicate a dose-response relationship between transfusion and adverse outcomes: the more units transfused, the greater the risk.[6] Importantly, these associations persist even after adjustment for anaemia severity and comorbidities.

Randomised controlled trials have transformed our understanding of transfusion thresholds. Restrictive strategies, using haemoglobin thresholds of 70-80 g/L in stable patients, are at least as safe as liberal strategies for most surgical and critically ill populations.[7-9] From a frontline perspective, this evidence challenges long-standing habits and reinforces the principle that transfusion should be prescribed with the same caution as any other high-risk therapy.

Health System Impact

Blood is a scarce and costly resource. In low- and middle-income countries, limited donation rates, fragile supply chains, and competing health priorities enhance the consequences of unnecessary transfusion.[10] Even in high-income settings, transfusion represents a significant financial burden.

Implementation of PBM programmes has repeatedly been associated with reductions in blood utilisation of 20%-40%, alongside substantial cost savings and improved outcomes.[11,12] A large state-wide PBM programme in Brazil demonstrated sustained reductions in transfusion rates, marked increases in single-unit transfusion, and multimillion-dollar savings without compromising patient safety.[13] These findings confirm that PBM aligns patient safety with system sustainability.

PILLAR 1: OPTIMISING PREOPERATIVE ANAEMIA

Recognising Anaemia as a Modifiable Risk

Preoperative anaemia affects approximately 20%-40% of patients undergoing major surgery and is one of the strongest predictors of perioperative transfusion and postoperative complications.[14,15] From the frontline perspective, the most powerful step is simply recognising anaemia early.

Routine haemoglobin measurement 4-8 weeks before elective moderate- or high-risk surgery allows time for investigation and treatment.[3,16] Even in resource-limited settings, a basic haemoglobin test enables identification of high-risk patients and more informed perioperative planning. Apart from haemaemoglobin, ferritin is a key biomarker used in the evaluation of anaemia as it reflects the body's iron stores. Serum ferritin should not be used in isolation, as it may be elevated in inflammatory states, and should instead be interpreted alongside markers such as C-reactive protein (CRP) using appropriate thresholds. The addition of transferrin saturation (TSAT), and where available reticulocyte haemoglobin content, improves the identification of iron deficiency, particularly functional forms. Overall, integrating these parameters into a stepwise framework enables more accurate diagnosis and targeted treatment, while a pragmatic adaptation is necessary in resource-limited settings to prioritise the most accessible tests.

Anaemia Treatment Versus Transfusion

Iron deficiency is the most common cause of anaemia worldwide. Oral iron may be appropriate for mild anaemia when surgery is distant, but intravenous iron has become a cornerstone of PBM for moderate or severe anaemia, inflammatory states, when surgery is imminent, or when oral iron is poorly tolerated or ineffective.[17,18]

Although some randomised trials and meta-analyses have shown that intravenous iron reduces transfusion requirements and improves postoperative haemoglobin recovery without increasing infection risk, these benefits are still debated.[18] Real-world PBM programmes confirm that system-wide access to intravenous iron can significantly reduce transfusion dependence, even in public health systems with limited resources.[13]

While intravenous iron is widely cited as a cornerstone treatment of anaemia in the perioperative period, several important limitations should be considered, including higher costs and resource requirements, the potential risk of hypersensitivity and infusion reactions, iron overload with inappropriate use, a possible increased risk of infection, and logistical challenges that may increase patient burden. However, when used according to appropriate indications and dosing, intravenous iron has demonstrated a favourable safety profile in the perioperative setting. Overall, the choice between intravenous and oral iron therapy should be individualised based on patient characteristics and clinical context.

For anaesthesiologists, the key message is clear: elective transfusion to optimise haemoglobin ahead of surgery is rarely indicated. Anaemia should be treated, not masked.

PILLAR 2: REDUCING PERIOPERATIVE BLOOD LOSS

Fundamental Principles That Matter Everywhere

In any operating theatre, the prevention of blood loss begins with basic principles, regardless of available resources. Meticulous surgical haemostasis, gentle tissue handling, precise dissection along anatomical planes, minimally invasive approaches where feasible, and early identification and control of bleeding sources remain fundamental pillars of blood conservation.[19-21] The use of mechanical blood-sparing techniques, such as surgical tourniquets in selected orthopaedic and limb procedures, may further reduce intraoperative blood loss when applied with appropriate indications and monitoring.[22,23] At the clinical level, many episodes of major haemorrhage do not present as sudden catastrophic events but rather evolve progressively, resulting from a series of unrecognised or inadequately managed factors that lead to the accumulation of smaller blood losses over time. Early communication between the anaesthesiologist and surgeon when bleeding patterns change is therefore critical to prevent progression to uncontrolled haemorrhage.

From the anaesthetic perspective, optimisation of physiological conditions plays a central and often underappreciated role in haemostasis. Maintenance of normothermia is essential, as even mild hypothermia affects platelet function and coagulation enzyme activity, leading to an increased bleeding risk.[19-21] Similarly, avoiding unnecessary haemodilution through judicious fluid management helps preserve clotting factor concentration and platelet count, particularly during long or complex procedures. Excessive crystalloid administration may transiently improve haemodynamics while simultaneously worsening coagulopathy and obscuring the true extent of blood loss.

Maintenance of stable and appropriate haemodynamics is another important component of blood conservation. In selected procedures, controlled hypotensive anaesthesia may reduce surgical bleeding and improve operative field visibility when carefully titrated and used in appropriately monitored patients.[24] Regional and central neuraxial anaesthesia techniques can also contribute to reduced intraoperative blood loss in certain surgical settings by lowering arterial and venous pressures and improving peripheral perfusion, while allowing better haemodynamic control.[25] These strategies should always be individualised, balancing the potential benefit of reduced bleeding against the need to maintain adequate organ perfusion.

Correction of hypocalcaemia is another key intervention frequently overlooked in the operating theatre. Ionised calcium is essential for multiple steps of the coagulation cascade, and citrate exposure from transfused blood products or large-volume fluid resuscitation can rapidly reduce calcium levels, exacerbating bleeding if not promptly corrected.[19-21] Preserving acid -base balance is equally important, as acidosis impairs thrombin generation and fibrin polymerisation, further compromising haemostasis.

Together, these measures represent low-cost, high-impact interventions that are universally applicable and immediately actionable. For the anaesthesiologist at the bedside, attention to temperature, volume status, electrolytes, and metabolic balance transforms blood loss management from a reactive response to a proactive strategy. When consistently applied, these fundamental principles reduce bleeding, limit transfusion exposure, and create the physiological conditions necessary for effective haemostasis, even before advanced haemostatic therapies or technologies are considered.

Antifibrinolytics: One of the Most Effective Tools

Tranexamic acid (TXA) is among the most effective and scalable PBM interventions available. Large, randomised trials and systematic reviews across multiple surgical specialties have demonstrated that TXA significantly reduces blood loss and transfusion requirements without increasing thromboembolic complications.[26,27]

For frontline anaesthesiologists, TXA is particularly valuable because it is inexpensive, readily available, and relatively easy to administer. Its routine use in appropriate surgical populations can dramatically reduce transfusion exposure, especially in settings with limited access to blood products.

Despite its proven efficacy and safety, the use of TXA faces multiple challenges across diverse healthcare settings. In low-resource environments, access to TXA may be limited by weak supply chains, stock-outs, distribution delays, and competing priorities for essential medicines. Even where available, cost constraints and lack of inclusion in insurance or reimbursement schemes can restrict uptake. Implementation is further affected by gaps in provider knowledge, insufficient training on dosing and timing, resistance to new protocols, and variability in clinical guidelines, which may differ across specialties and patient populations. Safety concerns, including misconceptions about thromboembolic risk and hesitancy in high-risk patients, also influence clinician behavior.

The effective use of TXA may be limited by system-level, regulatory, and patient-related factors. Delays in administration, inadequate infrastructure, limited monitoring capacity, and weak integration into PBM programmes can reduce its impact. Additional barriers include regulatory constraints, variability in clinical practice, and patient-specific considerations such as contraindications and population heterogeneity. Furthermore, gaps in local data and audit systems may hinder consistent implementation. Ultimately, maximising the real-world benefits of TXA requires coordinated health system support, clinician education, and integration into standardised care pathways.[28]

Understanding Bleeding in Real Time

One of the most important challenges in the operating theatre is distinguishing actual surgical bleeding from haemodilution or transient haemoglobin changes. Intermittent laboratory testing often lags behind the clinical situation.

Continuous non-invasive haemoglobin monitoring (SpHb) does not replace laboratory measurements, but it provides real-time trend information that enhances situational awareness. Observing haemoglobin trends rather than reacting to isolated values allows earlier recognition of significant bleeding and supports more confident adherence to restrictive transfusion thresholds.[29] Experience from tertiary centres has shown that this approach reduces precautionary transfusions and shifts practice from reactive to proactive haemostasis.

Even if SpHb provides valuable real-time trend information and enhances clinical awareness, its effective use is limited by several challenges. Issues with accuracy and reliability affected by factors such as poor perfusion, patient movement, and physiological variability can reduce clinician confidence, particularly in critical care settings. There is also a risk of over-reliance on trend data without adequate laboratory confirmation. High costs, including equipment and disposable sensors, restrict adoption in resource-limited environments, while successful implementation further depends on adequate training and user competence. Technical and infrastructure constraints, along with patient-related factors that may interfere with readings, add additional complexity. Variability in clinical guidelines, limited integration into PBM and resistance to practice change also hinder uptake. Overall, despite its potential to support more proactive transfusion strategies, widespread implementation of SpHb monitoring requires addressing limitations related to accuracy, cost, training, infrastructure, and clinical acceptance.[30]

Where available, viscoelastic haemostatic testing (e.g., TEG®, ROTEM®) can further improve bleeding management by enabling goal-directed therapy and minimising unnecessary plasma and platelet transfusion.[31,32] Crucially, significant improvements can still be achieved without these technologies, using conventional tests in conjunction with clinical judgement.

Table 1 – Summary of Key Patient Blood Management (PBM) Strategies for Frontline Anaesthesiologists

Strategy/ Methodology	Primary Mechanism	Main Target	Strength & Type of Evidence	Practical Considerations (Frontline Anaesthesiologist)	Feasibility in Low-Resource Settings
Early detection of anaemia	Identifies modifiable risk preoperatively	Anaemia	Strong (observational studies, guidelines)	Requires Hb testing 4–8 weeks pre-op; enables planning	High basic Hb testing widely available
Oral iron therapy	Replenishment of iron stores	Anaemia	Moderate (RCTs, meta-analyses)	Slow onset; adherence and GI tolerance issues	High inexpensive and accessible
Intravenous iron therapy	Rapid correction of iron deficiency	Anaemia	Strong (RCTs, meta-analyses, PBM programs)	Useful when surgery is imminent; requires monitoring, cost considerations	Moderate limited by cost and infrastructure
Antifibrinolytics (e.g., TXA)	Inhibits fibrinolysis, stabilises clot	Blood loss	Strong (large RCTs, systematic reviews)	Easy to administer; major impact on bleeding	High low cost, widely applicable
Meticulous surgical haemostasis	Direct control of bleeding sources	Blood loss	Strong (clinical practice, observational evidence)	Requires communication with surgical team	High fundamental surgical principle
Optimisation of physiology (normothermia, fluids, calcium, acid-base)	Preserves coagulation function	Blood loss	Strong (physiological + clinical evidence)	Continuous monitoring required; prevents coagulopathy	High low-cost, high-impact
Restrictive transfusion thresholds (70–80 g/L)	Reduces unnecessary transfusion	Decision-making	Strong (RCTs, guidelines)	Must integrate clinical context, not Hb alone	High no additional cost
Trend monitoring (Hb trends, lactate, perfusion markers)	Improves real-time clinical judgement	Decision-making	Moderate (clinical studies, expert consensus)	Avoid reliance on single lab values	Moderate depends on monitoring availability
Single-unit transfusion policy	Minimises over-transfusion	Decision-making	Strong (PBM program data, observational studies)	Requires behavioural/ cultural change	High simple and effective
Viscoelastic testing (TEG®, ROTEM®)	Goal-directed haemostatic therapy	Decision-making	Strong (RCTs, meta-analyses)	Improves targeted transfusion; requires expertise	Low Moderate equipment dependent
Continuous non-invasive Hb monitoring (SpHb)	Real-time Hb trend tracking	Decision-making	Moderate (clinical studies)	Supports early detection of bleeding trends	Low Moderate device dependent
Audit and feedback systems	Improves adherence to PBM practices	Implementation	Strong (quality improvement studies)	Requires data collection and institutional support	Moderate depends on system organisation
Multidisciplinary collaboration	Enhances coordinated care	Implementation	Strong (PBM program outcomes)	Requires engagement across teams	Moderate High adaptable locally
Education and training	Drives behaviour change	Implementation	Strong (implementation science evidence)	Essential for sustainability	High scalable and low-cost

Alternatives to viscoelastic haemostatic testing include several approaches. Conventional coagulation tests (CCTs) comprise prothrombin time, activated partial thromboplastin time, fibrinogen level, and platelet count. These tests are the most widely available, standardized, and useful for identifying baseline abnormalities. However, they have a slow turnaround time, are plasma-based, and provide poor reflection of clot strength and fibrinolysis.

Anti-factor assays represent more targeted biochemical assessments and include anti-factor Xa assays and specific coagulation factor assays. These tests are highly specific and useful in anticoagulation management. Their main limitations are a narrow scope and limited utility in assessing global haemostasis.

Clinical and ratio-based transfusion algorithms focus on protocol-driven management, including massive transfusion protocols, shock and trauma scoring systems, and obstetric hemorrhage bundles. These approaches offer the advantage of immediate implementation without the need for specialized equipment and have been proven effective in resource-limited settings. However, they are not individualized and carry a risk of over- or under-transfusion.[19,20]

Point-of-care testing methods are faster than conventional laboratory tests but are less comprehensive than viscoelastic testing such as TEG or ROTEM. These include activated clotting time, bedside hemoglobin or hematocrit measurement devices, and lactate monitoring. Their advantages include rapid results and bedside usability, while their main limitation is the lack of detailed information on coagulation status.

Fibrinolysis-specific tests may be used when hyperfibrinolysis is suspected. These include D-dimer testing and euglobulin clot lysis time.

A hybrid strategy is commonly employed in many centers without access to viscoelastic testing. This approach combines prothrombin time/INR, fibrinogen levels, platelet count, clinical assessment of bleeding, and protocol-based transfusion strategies.[33]

PILLAR 3: RESTRICTIVE, EVIDENCE-DRIVEN TRANSFUSION PRACTICE

Moving Beyond the Number

International guidelines consistently recommend restrictive transfusion thresholds for haemodynamically stable patients, typically in the range of 70-80 g/L, depending on clinical context and comorbidities.[7,9] While these numerical thresholds provide an important safety framework, frontline anaesthesiologists recognise that transfusion decisions cannot be reduced to a single haemoglobin value.

In real-world intraoperative practice, haemoglobin concentration is only one component of a complex physiological equation. Transfusion decisions should be guided by the overall clinical picture, integrating haemodynamic stability, the presence and rate of ongoing bleeding, trends in haemoglobin rather than isolated measurements, markers of oxygen delivery (such as lactate levels and mixed or central venous oxygen saturation), and signs of end-organ perfusion or dysfunction. Integrating haemoglobin values with these dynamic parameters enhances conceptual clarity and and aligns practice with evidence-based principles, recognizing that the ultimate goal of transfusion is to restore adequate oxygen delivery to tissues rather than to correct laboratory value in isolation.[7,9] A stable patient with a low haemoglobin value but adequate perfusion and no active bleeding may not benefit from immediate transfusion, whereas a patient with higher haemoglobin but compromised oxygen delivery may require earlier intervention. By linking haemoglobin concentration to overall oxygen delivery rather considering it in isolation, clinicians can adopt a more nuanced and patient-centred approach that better reflects the dynamic balance between oxygen supply and demand.

From the anaesthesiologist's perspective, transfusion in the absence of active or uncontrolled bleeding should be the exception rather than the rule. Over reliance on laboratory values obtained during dynamic surgical conditions can lead to premature or unnecessary transfusion, particularly in the context of haemodilution from intravenous fluids.[8] Recognising this distinction is central to PBM and represents a shift from reactive transfusion to physiology-driven decision-making (Table 1).[3,12]

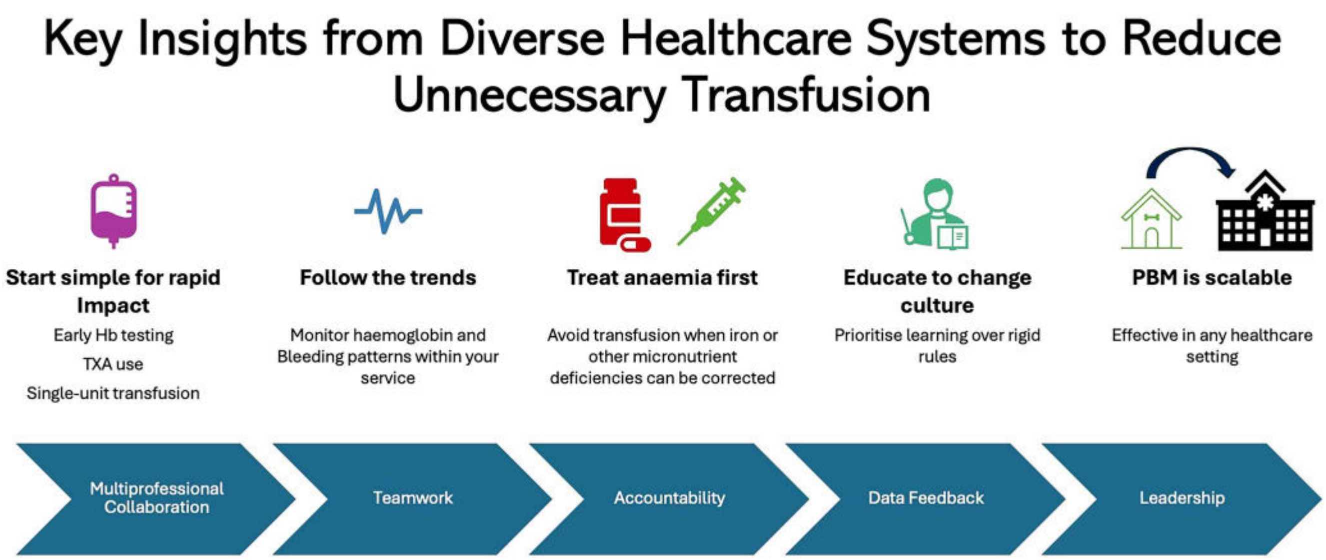

Figure 1 – Lessons from the frontline for effective patient blood management. Key clinical and organisational components supporting successful PBM implementation across diverse health care settings, including early simple interventions, monitoring of trends, prioritisation of anaemia treatment, education, scalability, multi-professional teamwork, accountability, data feedback, and leadership

Single-Unit Transfusion: A Simple Cultural Shift

One of the most successful PBM strategies is the adoption of a single-unit transfusion policy with reassessment after each unit. This approach interrupts habitual multi-unit transfusion and reinforces the concept that each unit is a therapeutic trial.

Large PBM programmes have shown that increasing adherence to single-unit transfusion dramatically reduces overall blood use without compromising safety.[13,34] From the frontline perspective, this strategy is simple, powerful, and immediately applicable.

Education, Audit, and Teamwork

Technology alone does not change practice. Sustainable PBM implementation depends on education, audit, and multidisciplinary collaboration. Regular feedback on transfusion decisions, discussion of real cases, and shared ownership among anaesthesiologists, surgeons, nurses, and haematologists are central to success.[11,12]

Frontline experience has shown that, when clinicians understand the rationale behind PBM strategies, adherence improves naturally. PBM becomes part of routine care rather than an imposed restriction (Figure 1).

SUMMARY

From the perspective of anaesthesiologists working on the frontline, unnecessary transfusion is not a failure of evidence but a failure of systems and support. PBM provides a practical framework that empowers clinicians to make safer, more rational decisions under pressure. By optimising anaemia, reducing blood loss, and applying restrictive, physiology-driven transfusion strategies (supported by education, audit, and teamwork), PBM transforms transfusion from a reflex into a thoughtful, patient-centred therapy. PBM is not about doing less for patients; it is about doing better, every day, in every operating theatre.

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