"Art Corner for Kids" – specific populations

Moderators: Gabor Erdoes, Patricia Guilabert

Thursday, April 30, 2026

1. PBM IN PAEDIATRICS

Vanessa Marchesini

Patient Blood Management (PBM) is a systematic, multidisciplinary, multiprofessional concept aimed at minimizing risk factors and improving clinical and health outcomes in patients. According to the World Health Organization, it applies to all populations that require it, including children. PBM is a multimodal strategy focused on the patient and blood health.

BLOOD HEALTH IS AN INNOVATIVE CONCEPT, including the optimization of blood function, prevention, diagnosis and treatment of blood conditions.

PBM in paediatric patients has certain unique characteristics that must be considered:

Unique challenges	Lack of literature and evidence to inform clinical decision-making A wide variety of physiological conditions, ranging from preterm newborns to adolescents
Higher impact of transfusion practice in clinical outcomes[1]	Mortality and morbidity Infections and other complications

For all these reasons, and although the 3 pillars of PBM in paediatrics remain the same, it is crucial in this population **to prioritize the preservation of the patients' own blood**.

PAEDIATRIC PBM IN PERIOPERATIVE PERIOD

1. Pre-surgery

Preoperative anaemia in data:

Incidence in newborns 32%	Incidence in children 24-46%	Common in weaker patients	Risk factor for transfusion	Entails a higher risk of hospital mortality	Entails a higher risk of post-surgery complications

Preoperative anaemia management[2]:

3-6-week screening before surgery → Detection → Treatment

The current recommendation is to postpone scheduled surgeries, if needed, in order to correct preoperative anaemia.

In most cases, this anaemia corresponds to a diet-related iron deficiency, and there is evidence that correcting it through iron supplementation reduces the need for a transfusion[3,4].

2. Surgery

During the intraoperative period, applying certain elements is key:

- Role of the surgeon to minimize blood loss and preserve haemostasis.
- Role of the anaesthetist in selecting the right anaesthetic techniques and minimising haemodilution
- Use of intraoperative cell salvage
- Use of tranexamic acid and other fibrinogenic drugs
- Transfusion reserved to necessary cases

Blood cell salvage should be applied to children under 10 kg and estimated volemia loss of at least 10%.

Within the concept of cell salvage, normovolemic haemodilution should be mentioned, which is about preserving the patient's blood and maintaining normovolemia with crystalloid serum infusion. This technique requires training, preparation and organization, as well as a careful selection of patients, and IT MUST NOT BE APPLIED to low-volemia or anaemic patients.

3. Post-surgery

It is essential to prevent iatrogenic or hospital-induced anaemia.

In paediatric patients in which, despite everything, a transfusion is needed, the following recommendation must be taken into account[5]:

- Administering the right **product**,
- in the right **dose**,
- to the right **patient**,
- at the right **time**,
- for the right **indication**.

In general, in paediatrics, the recommendation is to never transfuse a haemodynamically stable paediatric patient with a haemoglobin concentration above 7 g/dL. It is key to avoid overtransfusion and to aim for a target of 9 - 9,5 g/dL after the transfusion. It is also crucial to consider several factors to set personalized transfusion thresholds, rather than basing transfusion decisions on a single value: age, weight, but also comorbidities, physiological status, prematurity, cause of the anaemia, etc.

PBM implementation is essential in paediatrics and should be a team effort. Actions and changes are required at various levels to implement PBM in paediatrics.

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2. PBM IN CARDIAC SURGERY

Kyung Hwan Kim

Cardiac surgery carries a high risk of perioperative bleeding and allogenic transfusion due to the invasive nature of the procedure, the need for anticoagulation and the use of extracorporeal circulation. The latter is a part of cardiac surgery, and the heart was typically primed with blood, but nowadays this is done with crystalloid solutions.

In this context, PBM may help to optimise haemostasis, minimise bleeding, reduce the need for transfusions, improve clinical outcomes and decrease healthcare costs.

In cardiac surgery, PBM should not be limited to intraoperative haemostasis, and it should be viewed as a comprehensive care package ranging from preoperative correction of anaemia to the implementation of strict postoperative protocols, including surgical excellence.

The updated guidelines of the *European Association for Cardio-Thoracic Surgery* and the *European Association of Cardiothoracic and Vascular Anaesthesia and Intensive Care* (EACTS/EACTAIC), launched in 2024, includes new recommendations to bring about changes throughout the perioperative period in cardiac surgery[6]:

1. PREOPERATIVE MANAGEMENT

- Early detection of preoperative anaemia and its causes
- Treatment of preoperative anaemia with oral or intravenous iron
- More precise assessment of bleeding risk
- Optimised management of antiaggregants and anticoagulants

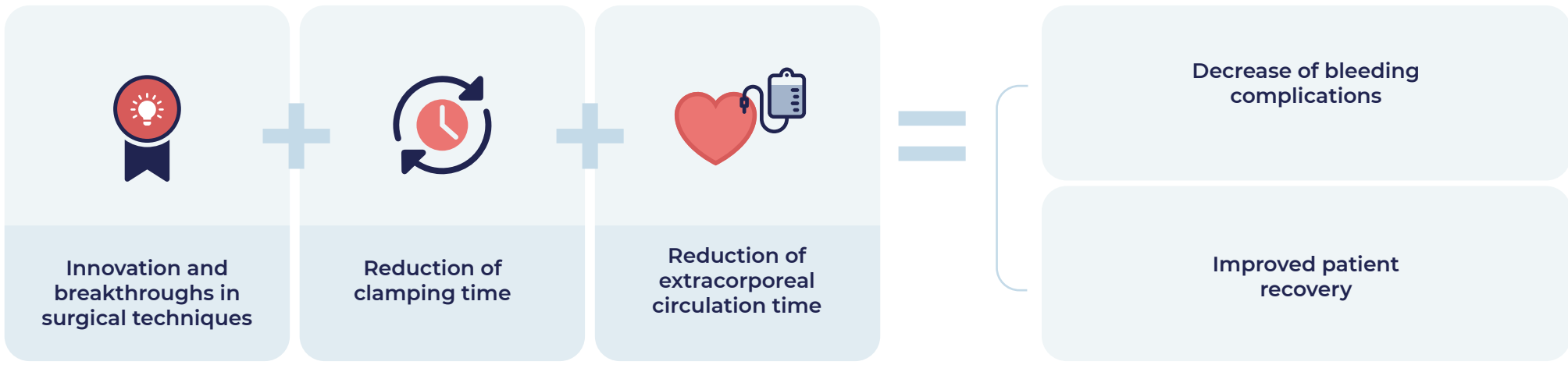
The goal during the preoperative period is to optimise the patient before the surgery in order to reduce the risk of anaemia and bleeding during the surgery.

- Correction of anaemia and iron deficiency.
- If there is enough time, increase the red blood cell count (with iron and erythropoietin).
- Management of anticoagulant and antiaggregant therapy, following the guidelines, in patients taking such medication.

2. INTRAOPERATIVE STRATEGIES

- Minimally invasive surgery whenever possible
- Multidisciplinary cooperation in the definition of the surgical strategy
- Improvement of extracorporeal circulation techniques
- Cell salvage and retrograde autologous priming as blood preservation strategies
- Optimisation of procoagulant interventions and use of blood products guided by point-of-care testing.

With regard to intraoperative strategies, the surgical technique is fundamental to successfully develop PBM:



It has been reported that prolonging extracorporeal circulation beyond 2-3 hours and aortic clamping beyond 60-90 minutes is associated with higher rates of acute kidney injury, stroke, prolonged ventilation and mortality.

In this context, the use of devices that reduce surgical times, such as the COR-KNOT® self-stitching mechanisms or the INNOVA-ELITE systems for high-definition videoscopy-guided aortic replacement, can be very useful and should be regarded as an integral tool within PBM strategies.

Another example is the use of hybrid aortic arch prostheses and thoracic endoprostheses (TEVAR), which can reduce the complications associated with the repair of the aortic arch and the descending thoracic aorta.

It is recommended that intraoperative transfusion algorithms be used, guided by viscoelastic tests that reflect the patient's haemostatic capacity[7].

3. POSTOPERATIVE MANAGEMENT

- Thoracic drainage
- Restart of the antithrombotic treatment
- Restrictive transfusion thresholds
- Venous thromboembolic disease prophylaxis

With regard to postoperative management, it is fundamental to understand that allogenic transfusions should be reserved as last-resort treatment, as in cardiac surgery even the transfusion of a single unit of packed red blood cells is associates with an increased risk of morbidity, complications and mortality[8].

PBM in cardiac surgery should be managed using a multidisciplinary approach throughout the preoperative, intraoperative, and postoperative periods. The choice of the right surgical techniques is also part of PBM strategies. In this context, transfusion should always be seen as a last-resort therapy measure.

KEY MESSAGES IN PBM GUIDELINES FOR CARDIAC SURGERY IN ADULTS:

RECOMMENDED	SHOULD BE CONSIDERED	NOT RECOMMENDED
• Institutional PBM programmes • Preoperative assessment of bleeding risk • Anaemia treatment • Limiting haemodilution • Optimising ECC priming • Prota:heparin ratio<1:1 • Antifibrinolytics • Restrictive transfusion thresholds • Multidisciplinary protocol to manage bleeding	• Supplementation with iron/EPO • PCC rather than FFP to revert Vit k antagonists • Cell saver, ultrafiltration • Normothermia, normo pH • Supplementing fibrinogen if there is bleeding and levels< 1.5 g • Desmopressin in platelet dysfunction • Platelet counts>50,000 • Early surgical exploration if bleeding	• Routine use of VET to predict bleeding • Preoperative transfusion in anaemic patients • Preoperative platelet transfusion • Preoperative andexanet in patients with DOACs • Routine use of topical sealants • Use of colloids in ECC priming • Prophylactic use of plasma, fibrinogen, desmopressin or recombinant factor VII to reduce bleeding

CSL Behring

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3. PBM IN BURNS

Patricia Guilabert

Los pacientes quemados presentan una fisiología especialmente dinámica y compleja que los hace únicos. En esta población de pacientes se produce una respuesta inflamatoria masiva, daño endotelial, incremento de la permeabilidad capilar, hemoconcentración inicial por hipovolemia y entrada en estado de shock, cuya resucitación agresiva con fluidos conlleva hemodilución.

1. In burn patients, haemoglobin levels do not necessarily provide an accurate reflection of tissue oxygen supply. Anaemia in these patients is multifactorial, and not exclusively associated with blood loss.

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	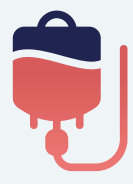		
Direct damage to red blood cells	**Hemodilution**	**Decrease in erythropoiesis**	**Pre-surgical blood loss**

ANAEMIA

REDUCED OXYGEN SUPPLY TO THE TISSUES

2. In burn patients, coagulation abnormalities are not always easily detectable, and the value of conventional coagulation tests is limited:

Abnormalities in prothrombin time (PT) and activated partial thromboplastin time (aPTTP) associated with acute burn-induced coagulopathy are not detected by viscoelastic testing.

Coagulopathy in burn patients is related to severity, not bleeding.

In burn patients, dynamic changes occur over time, with an evolution toward a hypercoagulability state.

3. It is important to consider the significant decrease in plasma FXIII levels experienced by patients with severe burns from the time of admission until 24 hours after surgery, possibly associated with haemodilution resulting from intensive fluid resuscitation. It must be remembered that FXIII stabilises the fibrin mesh that makes up the clot, maintains endothelial integrity and is essential for healing. FXIII levels in burn patients experience a significant decrease during the first 24 hours, and gradually rise again over time[9,10].

4. Burn patients present a pattern of coagulation abnormalities that is not clearly reflected in viscoelastic testing.

Given these characteristics inherent to burn patients, PBM should be approached using a multimodal strategy:

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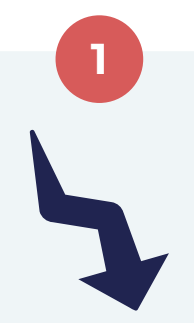			
Reducing hemorrhage	**Optimising erithropoiesis**	**Guided transfusion**	**Personalised Care**

THE GOAL IS TO IMPROVE CLINICAL OUTCOMES
MINIMISING TRANSFUSIONS AND RISKS FOR THE PATIENT

PBM should also be specifically tailored to burn patients, as many of the current strategies are extrapolated from other areas and patient profiles. In that regard, specific evidence must be generated for this population.

Currently, it is crucial to identify which strategies are genuinely useful to burn patients and which ones have not proven to be beneficial in this context[11–14]:

✓ WHAT WORKS	✕ WHAT CAN HELP	? WHAT DOESN’T WORK / IS UNCERTAIN
• Restrictive transfusion strategy • Reducing blood loss • Point-of-care-guided coagulation • Minimising iatrogenic losses	• Optimising erythropoiesis • Adequate nutritional support • Adjuvant surgical techniques • Cell salvage	• Liberal transfusion strategies • Fixed transfusion ratios (1:1:1) • Standard coagulation tests used in isolation • Therapies commonly used without clear evidence

Last, in burn patients it is important to set haemoglobin transfusion threshold of 7 g/dL (restrictive strategy) in those who are haemodynamically stable. However, clinical reality is usually more complex:

- The 7 g/dL threshold is not always applicable, particularly in cases of active bleeding, repeated surgery or haemodynamic instability. **7 is a reference, not a rule**.
- Besides haemoglobin levels, oxygen supply, tissue perfusion, and the patient's overall clinical context should be taken into account.
- Haemoglobin levels below 6 g/dL are indeed associated with worse clinical outcomes.

AREAS FOR FURTHER RESEARCH (MOVING FORWARD)

1. Hidden coagulation problems in these patients, which are not detected by standard laboratory tests and which may be clinically significant and associated with an increased risk of bleeding.

2. Interactions between resuscitation and haemostasis

3. Beyond haemoglobin. Haemoglobin does not mean O2 delivery—physiological assessment and monitoring support are required.

4. Specific PBM measures for burn patients, because currently used strategies are extrapolated from other scenarios.

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Iron

Moderator: Sigismond Lasocki, Elvira Bisbe

Friday, May 01, 2026

1. IRON AND THE HEART

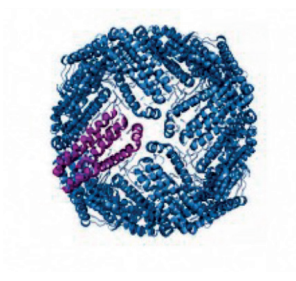
Mahir Karakas

Iron deficiency is a comorbidity in patients with heart failure (HF). The current guidelines of the *European Society of Cardiology* (ESC) recommend treatment with intravenous iron in symptomatic patients with HF and reduced or mildly reduced ejection fraction (< 50%) who have iron deficiency, with the aim of improving symptoms and quality of life and reducing the risk of hospitalization due to HF (evidences IA and IIA)[1].

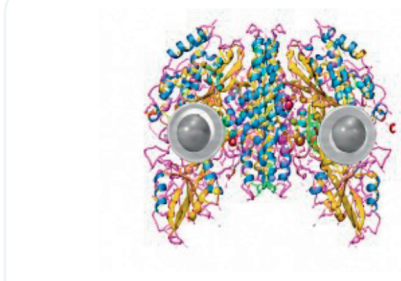
Iron deficiency has a "double effect": on the one hand, the reduction in haemoglobin compromises oxygen transport, on the other, it disrupts tissue utilisation of oxygen by reducing aerobic enzymes and diminishing oxygen utilisation and oxidative phosphorylation, thus reducing the generation of ATP, the energy molecule. This phenomenon is particularly relevant to the heart.

Consequently, iron deficiency is associated with a reduction in functional capacity, exercise intolerance and a decline in quality of life, even in the absence of overt anaemia.

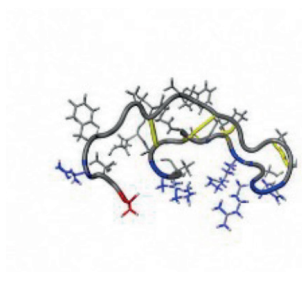
PARAMETERS FOR THE DEFINITION OF IRON DEFICIENCY IN CLINICAL TRIALS



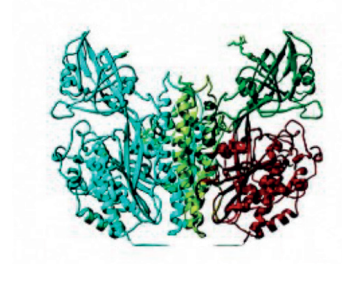
Ferritin



Transferrin saturation



Hepcidin



Soluble transferrin receptor

Definition of iron deficiency according to WHO in people over 4[2]:

- Serum ferritin < 15 µg/L in healthy subjects
- Ferritin < 70 µg/L if there is an infection or inflammation ➡ In this context, it must be taken into account that patients with heart failure usually present a state of subclinical chronic inflammation.

The classic definition of iron deficiency used in most HF trials has been the following[3-6]:

Ferritin ≤100 µg/L	**Ferritin 100–299 µg/L together with transferrin saturation (TSAT) <20%**

CLINICAL EVIDENCE DEVELOPMENT

The FAIR-HF study was the first clinical trial to demonstrate the efficacy of the intravenous administration of ferric carboxymaltose on the symptoms and quality of life in patients with HF and iron deficiency, regardless of the presence of anaemia[7]. In the subgroup of patients with baseline anaemia, the anaemia was resolved, while no significant changes were observed in non-anaemic patients.

Subsequently, the CONFIRM-HF study reported an improvement in functional capacity, as measured by the 6-minute walk test within 24 weeks after the intravenous administration of ferric carboxymaltose[8].

The AFFIRM-AHF study assessed the effect of intravenous ferric carboxymaltose in patients admitted for acute heart failure. A 21% decrease was observed in the combined rate of hospitalisations for HF and cardiovascular death versus placebo; however, this difference was not statistically significant[4]. The results were statistically significant in a secondary analysis that excluded the period following the outbreak of the COVID-19 pandemic, probably due to the loss of statistical power resulting from the interruption in follow-up visits.

A similar situation was observed in the IRONMAN trial, which assessed the efficacy of ferric derisomaltose. Although the overall analysis did not show a statistically significant reduction of hospitalizations due to HF and cardiovascular mortality, statistical significance was observed after excluding the period affected by the COVID-19 pandemic[3].

More recently, the HEART-FID trial assessed a hierarchical endpoint encompassing mortality, hospitalizations and functional capacity. Although a favourable trend was observed in all three variables, the differences were not statistical significance[5].

The FAIR-HF2 trial, the most recent to date, is a European, multicentre, double-blind, placebo-controlled study including over 1,100 patients. In this trial, ferric carboxymaltose was administered every four months until predefined safety criteria were met (Hb > 16 g/dL or ferritin > 800 µg/L). The study showed a non-significant 21% reduction in the combined endpoint of cardiovascular death or first hospitalization for HF. No significant reduction was either observed in the subgroup of patients with TSAT < 20%[6].

Finally, a meta-analysis including all six randomised clinical trials showed an overall 28% reduction in recurrent hospitalizations for HF and cardiovascular death at 12 months (RR 0.722; IC95 % 0.553–0.890). In the subgroup analysis, a significant interaction by sex was identified: the significant reduction in the risk of recurrent hospitalizations for HF and cardiovascular death associated with the administration of intravenous iron was significant in men, but not in women. In fact, the subgroups analyses in each individual trial have failed to demonstrate a consistent benefit in terms of prognostic endpoints in the female population.

Moderator: Sigismond Lasocki, Elvira Bisbe

Friday, May 01, 2026

2. IRON AND REHABILITATION

Elvira Bisbe

WHY IS IRON IMPORTANT?

Beyond its effect on haemoglobin, iron deficiency has a direct impact on energy production in the skeletal muscle and causes metabolic abnormalities which ultimately lead to fatigue.

1) Reduction in glycogen stores

2) Increase in lactate production

3) Reduces Krebs cycle activity

4) Reduces beta oxidation

5) Accumulation of toxic intermediate lipids

6) Reduction in OXPHOS efficiency (electron transport chain)

7) Reduction in ATP levels in the muscle

8) Increase in lactate production

9) Accumulation of toxic intermediate lipids

It has recently been reported in animal models that iron deficiency reduces the proliferation of muscle stem cells and results in smaller regenerative fibres and poorer recovery of muscle mass, leading to sarcopenia[9].

EVIDENCE ON IRON DEFICIENCY AND REHABILITATION

In a prospective observational study of 140 patients with acute ischaemic stroke of the middle cerebral artery, the prevalence of iron deficiency was 48% at baseline and rose to 77% after one year of follow-up.

- Hand grip strength and quadriceps strength were lower in patients with iron deficiency compares to those with normal iron levels.
- Muscle strength only improved in patients with no iron deficiency.

EFFECT OF IRON DEFICIENCY TREATMENT IN REHABILITATION

In a meta-analysis including over 3000 patients with HF and iron deficiency, the use of intravenous iron was associated with a decrease in hospitalizations and readmissions for HF[10]. Furthermore, intravenous iron was linked to an improvement in exercise capacity, quality of life, overall assessment of patients and functional class (NYHA). Modest/neutral effect on mortality.

The IVICA multicentre trial included 116 patients with colorectal cancer and anaemia. Unlike oral administration, treatment with intravenous iron administered two weeks before surgery improved the following parameters[11]:

- Quality of life in the preoperative period (EQ-5D-5L) and up to 3 months after surgery.
- Each and every one of the 11 quality of life items assessed before surgery.
- Anaemia, fatigue and FACT-An score at 3 months.

In orthopaedic surgery, a randomised trial compared ferric carboxymaltose with oral iron for postoperative anaemia after total knee replacement. Patients treated with ferric carboxymaltose reached haemoglobin levels > 12 g/dL more frequently than those treated with oral iron. Likewise, subgroups with Hb < 10 g/dL and ferritin < 100 ng/mL, or both conditions, showed a faster recovery of haemoglobin. Moreover, patients treated with intravenous iron scored higher in the daily activities domain of EQ-5D[12]. One of the limitations of the trial was the use of the 6-minute walk test in patients who had undergone knee surgery.

In another prospective randomised study evaluating iron isomaltoside in patients with postoperative anaemia following total knee replacement, the treatment managed to reduce postoperative anaemia, although it did not improve functional recovery. The authors suggested that the administration of iron 3-4 weeks before surgery could be a decisive factor.

Taking into account these results and those obtained in the 2022 Cochrane meta-analysis on the effect of intravenous iron in patients with iron deficiency but without anaemia, it is possible that quality of life is not the most appropriate endpoint to prove the efficacy of intravenous iron in rehabilitation. In this context, variables such as fatigue, physical function or maximum oxygen uptake could be more sensitive targets[13].

TAKE HOME MESSAGES

- The use of iron should not be limited to correcting haemoglobin levels
- Iron is important not just in anaemic patients for rehabilitation
- Iron deficiency is consistently associated with fatigue and poorer functional recovery, as well as reduced skeletal muscle regeneration
- The evidence that the treatment with iron improves rehabilitation outcomes remains limited and depends on the context
- The challenge is not whether iron is important, but to identify who benefits, when, and how to measure its impact on rehabilitation.

In short, iron deficiency has a relevant impact on fatigue and functional recovery. However, the evidence supporting the use of intravenous iron in this context remains limited, and so it is fundamental to identify what patients can actually benefit from the treatment and what is the optimal time for its administration.

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Friday, May 01, 2026

3. IRON AND THE BONES PHYSIOLOGY

Heinz Zoller

The bone is a dynamic tissue that adapts to physical activity, but it also has biological memory. It has been shown that part of the benefits for bone size and strength associated with physical activity during youth can be maintained throughout life[14].

The bone regeneration process depends on the balance between osteoclast-mediated resorption and the synthesis of bone matrix by osteoblasts, followed by its mineralization[15]. Essential to this process is the formation of the collagen triple helix, mediated by prolyl-4-hydroxylase, an enzyme that depends on iron and ascorbic acid[16].

Recent data suggest an association between abnormalities in iron metabolism parameters, such as transferrin saturation and ferritin, and a higher risk of bone fracture[17]. However, iron deficiency is not yet included in traditional tools for calculating fracture risk, such as FRAXplus.

HYPOPHOSPHATEMIA INDUCED BY INTRAVENOUS IRON

Treatment with intravenous iron is associated with a higher risk of hypophosphatemia. In the PREVENTT study, for instance, the administration of ferric carboxymaltose to treat anaemia prior to major abdominal surgery brought about a significant reduction of preoperative serum phosphate levels, and approximately 10% of patients developed hypophosphatemia. This relatively low incidence is likely related to variability at the time of preoperative iron administration. In the same study, serum phosphate concentrations below 0.65 mM were associated with a longer average hospital stay[18].

Hypophosphatemia associated with intravenous iron varies in incidence and severity depending on the formulation used. It is also important to consider the duration of hypophosphatemia in each patient.

- The incidence of fractures is more than double in patients treated with ferric carboxymaltose compared with ferric derisomaltose, regardless of factors such as age, osteoporosis, anaemia, or calcium levels[19].
- The incidence of osteomalacia is higher with ferric carboxymaltose than with ferric derisomaltose in humans[19].

This could be explained by the pharmacokinetics of both drugs: ferric carboxymaltose tends to accumulate more (approximately as much) on the trabecular surface than ferric derisomaltose in mice[19]. Furthermore, it has been reported that in mice, collagen production is lower with a ferric carboxymaltose treatment than without treatment or with ferric derisomaltose[19].

As for the treatment of hypophosphatemia induced by the administration of intravenous iron, a recent study showed that oral phosphate supplementation does not prevent hypophosphatemia induced by ferric carboxymaltose[20].

IN SUMMARY, IT IS CRUCIAL TO BEAR IN MIND THE FOLLOWING ASPECTS[21]:

The incidence de hypophosphatemia associated with ferric carboxymaltose is high.	**Some symptoms of hypophosphatemia may be mistaken for those of iron deficiency (fatigue, asthenia, weakness or shortness of breath).**	**It is difficult to predict the severity of hypophosphatemia in each patient at any given time.**	**For the time being, there is no effective treatment.**

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CSL Behring

Sculpture garden along the river - Coagulopathy

Moderator: Tina Tomić Mahečić, Konstantina Triantafyllopoulou

Friday, May 01, 2026

1. COAGULOPATHY MANAGEMENT STANDARDIZED: SOLUCIONES CREATIVAS SIN POCT

Tina Tomić Mahečić

The coagulation point-of-care testing technology market has grown significantly over the last few years. However, these tools currently remain underused, even in countries where *Patient Blood Management* (PBM) is widely implemented, such as Germany[1].

In general, lab tests are very useful diagnostic tools, and they are employed in roughly 70% of medical decisions, even though they only represent around 2% of healthcare expenditure[2]. However, over 90% of preoperative prothrombin time (PT) and activated partial thromboplastin time (aPTT) determinations are requested unnecessarily[3].

In general, conventional coagulation tests are not consistently associated with a higher bleeding risk in minor surgeries or scheduled major surgeries.

PT and aPTT may be normal in the presence of factor level deficiencies. Standard laboratory tests underestimate factor XIII and vWF. Additionally, artefacts during venipuncture can alter coagulation times.

An exception is PT, which may be related to bleeding risk in patients with advanced liver disease undergoing abdominal surgery.

Standard coagulation tests	• Shortened PT and aPTT have no clinical relevance • Prolonged PT and aPTT are usually related to congenital or acquired deficiencies • Time to obtain the result is too long
PT	• The effect of some highly relevant coagulation factors such as FXIII or von Willebrand (vWF) are not contemplated • *In vitro* determination, not very significant as to what happens *in vivo*
aPTT	• It can be prolonged by multiple causes with no clinical relevance • It can be normal in patients with mild bleeding disorders (von Willebrand) • It can be prolonged due to artefacts in venipuncture

CAN WE PREDICT WHAT WILL BLEED?

In the context of elective surgery, a structured bleeding anamnesis provides more clinical value than routine analytical screening.

There are specific tools to assess bleeding risk, such as the ISTH-BAT *(International Society on Thrombosis and Haemostasis Bleeding Assessment Tool)*, a validated bleeding history questionnaire designed to identify patients with hereditary bleeding disorders[4]. ISTH-BAT presents the following features:

- It has a high negative predictive value (> 98%), meaning that a negative result virtually rules out a clinically relevant bleeding disorder.
- It cannot predict by itself perioperative bleeding risk; therefore, in case of a positive result, supplementary studies should be conducted.
- It allows to effectively distinguish hereditary platelet disorders and it is useful to identify patients requiring specific analytical evaluation, once von Willebrand disease has been preliminarily ruled out[5].

Given that ISTH-BAT is not able to detect acquired coagulation disorders, as happens with trauma patients, in these cases clinical signs and specific tools must be used to predict the risk for massive transfusion.

When approaching these patients, it is fundamental to consider that hemostasis varies between tissues and organs *(vascular bed-specific hemostasis)*, due to the different local expression of procoagulant and anticoagulant factors.

BRAIN TISSUE	LUNG, PANCREAS OR UROGENITAL SYSTEM
• It can induce prothrombotic states through the release of procoagulant phospholipids, microvesicles, and vWF.	• They can release large amounts of tissue-type plasminogen activator (tPA), and favour hyperfibrinolysis and bleeding.

In regard to therapy management in coagulopathy and perioperative or trauma bleeding in absence of point-of-care testing, measures aimed at restoring homeostasis should be considered and applied in the following order[6,7]:

1. Basic conditions: Temperature, pH, Calcium, clinical history review to check whether the patient receives anticoagulants or antiaggregants.

2. Hyperfibrinolysis control

- Tranexamic acid may be administered without significantly increasing the thrombotic risk in surgery patients with various conditions[8], providing there are no specific risk factors, such as liver cirrhosis or history of thrombosis.

3. Favouring clot formation

- Administration of fibrinogen concentrate (30-50 mg/kg), since fibrinogen decreases earlier than other coagulation factors and platelets[9] and because, unlike other factors, it is a substrate.
- Administration of platelets, taking into account that platelet concentrate is the blood product most commonly associated with reactions[10]. The target is a count over 50,000 platelets and >100,000 in case of traumatic brain injury or with a coexisting platelet deficiency.

4. Increasing thrombin production

- Administration of prothrombin complex concentrate (20-40 UI/kg).

5. Administration of FXIII and FVII

- As a final intervention on the coagulation cascade, the administration of factor XIII and factor VII may be considered.

In summary, in patients with trauma-induced coagulopathy, haemorrhage control must be achieved as early as possible, using coordinated strategies at a prehospital, hospital, and transfusion level. Additionally, an early correction of the so-called trauma “lethal diamond” is essential, formed by acidosis, hypothermia, coagulopathy, and hypocalcemia[11].

“TIME IS THE ENEMY OF BLEEDING PATIENTS”

Sculpture garden along the river - Coagulopathy

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Friday, May 01, 2026

2. COAGULOPATHY MANAGEMENT INDIVIDUALISED (ROTEM/TEG/CLotPRO)

Dietmar Fries

Trauma- and sepsis-induced coagulopathy is not a uniform phenomenon. It comprises different phenotypes requiring specific therapy strategies. This variability exists both between different individuals and within the same patient along clinical evolution[12,13].

In this context, it is essential to consider the early decrease of fibrinogen during trauma haemorrhage and the subsequent need for an early assessment and correction of hypofibrinogenemia[14]. Among the different treatment options, fibrinogen concentrate is the most effective strategy:

- Replacement using cryoprecipitate achieves a faster correction than fresh frozen plasma[15].
- The FEISTY study demonstrated that fibrinogen replacement is achieved roughly 30 minutes earlier with fibrinogen concentrate than with cryoprecipitate[16].
- In the RETIC study, a strategy based on ROTEM-guided factor concentrates (fibrinogen, prothrombin complex concentrate, and FXIII) was associated with a 50% decrease in the need for massive transfusion when compared to a treatment based on fresh frozen plasma[17].
- The use of coagulation factor concentrates may explain the lower mortality rates observed in Austrian studies[17,18], compared to North American studies[19,20].

Blood product-based treatment allows for a more precise and individualized approach than whole blood transfusion, which poses several potential risks and issues:

Overtransfusion of unnecessary products	**Risk of complications: ARDS, among others[21]**	**Immune load**	**Risk of infections**	**Less useful life and more sensitivity to fibrinolysis[22]**	**Higher use of resources**	**Lack of sound evidence for many indications**

Whole blood is not the ideal solution, since not all haemorrhage cases require replacement of all blood products.

In this context, point-of-care tests are fundamental tools to individualize the haemostatic treatment. Unlike other diagnostic tests, they have been proven to significantly reduce mortality in trauma and heart surgery patients[23,24]. Moreover, different studies have shown that the empirical use of coagulation factors without functional monitoring does not improve clinical outcomes and may even increase thromboembolic complications[25,26]:

CRYOSTAT-2 study with cryoprecipitate[27]	**PROCOAG study with 4-factor prothrombin complex (4F-PCC)[28]**

As for tranexamic acid, it should not be administered indiscriminately to all trauma patients, but selectively, based on the fibrinolytic profile. In cases such as traumatic brain injury or multiorgan failure, hypofibrinolysis states are more common than hyperfibrinolysis. The PATCH-Trauma study, possibly because it did not specifically recruit hyperfibrinolytic patients, was not able to prove the efficacy of tranexamic acid administered in the prehospital setting[29]. Beyond an adequate indication, the time of administration of tranexamic acid is critical, since a delay in the administration is associated with a lower survival[30].

Recent European and German guidelines expressly recommend the addition of viscoelastic monitoring to transfusion algorithms[31–33]. Likewise, the DIVI German regulation considers these systems as part of the structural equipment recommended in advanced intensive care units[33].

In summary, rigid massive transfusion protocols should be avoided, and individualized strategies, guided by coagulation functional monitoring, should be adopted. Patients with a haemorrhage should only receive the blood products they really need, at the right time and in the right dose, in order to improve their clinical outcomes and to reduce complications associated to the transfusion treatment.

Furthermore, we should not forget that, once the haemorrhage has been corrected, antithrombotic prophylaxis must be implemented and monitored, because up to 50% of these patients present resistance to standard heparin doses.

Sculpture garden along the river - Coagulopathy

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Friday, May 01, 2026

3. DIC IN CRITICALLY ILL PATIENTS

Julien Demisell

The International Society on Thrombosis and Haemostasis (ISTH) defines disseminated intravascular coagulation (DIC) as an acquired syndrome characterized by the intravascular activation of coagulation with loss of localization arising from different severe conditions[34]. DIC represents the most advanced manifestation of coagulopathy and it is associated to multiorgan failure and death.

DIC is not a homogeneous entity and, depending on the underlying condition, a thrombotic or fibrinolytic phenotype may prevail[35]. In case of sepsis-related DIC, the thrombotic phenotype usually prevails.

- Sepsis affects 48.9 million people/year and over 20 million develop DIC[36].
- DIC is associated to a higher risk of complications and mortality[37,38].

Morbidity	Mortality	Severe acute kidney dysfunction

DIAGNOSIS OF DIC

Multiple diagnostic scales and biomarkers have been proposed for the diagnosis of DIC. Guidelines currently recommend a two-step diagnostic approach[39]:

1 SIC SCORE
(Sepsis-Induced Coagulopathy)

Evaluates sepsis-induced coagulopathy

2 CONFIRMATION WITH ISTH SCORE
(International Society of Thrombosis and Haemostasis)

Confirms the presence of DIC using the ISTH score

Platelets	PT/INR	Fibrinogen	D-Dimer

Limitations of DIC evaluation:

- Existence of multiple confusion factors in critical patients admitted to the ICU.
- Analytical alterations mainly detect late-stage changes, but not initial cellular events in the coagulopathy.

Because of this, and given that DIC is a dynamic process, septic patients must be continuously reassessed.

PATHOPHYSIOLOGY OF DIC

DIC is the result of immunothrombosis deregulation.

When compared to a healthy endothelium, with a protective, antithrombotic and antiinflammatory glycocalyx, in DIC we have a prothrombotic antifibrinolytic endothelium (fibrinolysis shutdown).

Tissue factor activation in endothelium and monocytes	Neutrophil activation, triggering endothelial damage and platelets	Loss of natural anticoagulants	Increase of plasminogen activator inhibitor (PAI-1) and fibrinolytic blockade

All of this leads to excessive activation of coagulation and hypofibrinolysis.

Neutrophil activation is currently put forward as a potential DIC biomarker, and there are ongoing studies aimed at evaluating its diagnostic and prognostic usefulness.

In sepsis, neutrophils are activated, and neutrophil NETosis and fluorescence appear, which may be the diagnostic criterion for sepsis-induced coagulopathy.

DIC TREATMENT

There are two main therapy strategies:

- Reducing coagulation activation using anticoagulants or thrombomodulin.
- Restoring fibrinolysis using plasma, plasma exchange or plasminogen.

1. Anticoagulants

Randomized clinical trials conducted over almost 20 years have failed to demonstrate a clear benefit of anticoagulants on sepsis-related mortality (OPTIMIST-TF pathway-, KyberSept -ATIII-, PROWESS-activated C Protein-)[40–42], probably due to several factors:

- Inclusion of heterogeneous populations, including patients with no DIC or with a haemorrhagic phenotype.
- Too late start of treatment.

2. Recombinant thrombomodulin (rhTM) (SCARLET TRIAL, fist randomized clinical trials with coagulopathy stratification in sepsis patients)

The efficacy of recombinant thrombomodulin has been assessed in patients with sepsis, cardiovascular dysfunction and/or respiratory condition and coagulopathy (INR > 1,4 and platelets 30–150 $\times 10^9$/L). rhTM was administered within 40 hours of inclusion in the study[43].

Although no significant reduction in mortality was observed within 28 days when compared to placebo, a separation of survival curves was actually confirmed, compatible with a potential clinical benefit in the patient subgroup still suffering from the coagulopathy at the time of administration. Around 20% of patients no longer presented a coagulopathy at that time. These findings suggest that both an adequate stratification of patients and the time of the intervention might be decisive for the therapy to be effective.

Furthermore, a post hoc analysis of the French cohort included in that trial suggested that patients with persistent sepsis-induced coagulopathy not receiving concomitant heparin may benefit from a treatment with rhTM[44].

3. Therapeutic plasma exchange

Plasma exchange has been shown to improve several pathophysiological and clinical parameters:

- Restoring balance between procoagulant and anticoagulant factors[44]
- Improvement of coagulation and endothelial protection[45]
- Increase of survival, both in adults and children[45,46]

4. Plasminogen supplementation

Plasminogen supplementation allows fibrinolytic capacity to be restored, which supports its potential therapeutic usefulness in sepsis-induced DIC. A recent study observed a non-significant reduction of mortality in the group treated with plasminogen (42%) versus the control group (60%)[47].

In summary, sepsis-induced DIC is a complex heterogeneous condition requiring a dynamic individualized approach. An early identification of the prevailing phenotype and an adequate selection of the therapy starting time may be key factors to improve the clinical outcomes.

CONCLUSIONS

- Early diagnosis of DIC is a challenge
- Identifying the right patient to administer the right treatment is key, and so the right scores must be defined or biomarkers must be used, such as fluorescence of neutrophil NETosis
- Treatment timing is fundamental for an optimal response
- New therapy goals must be developed:
- Anticoagulants?
- Restoration of plasminogen?

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The North American designers - SABM Session

Moderators: Sigismond Lasocki, Patrick Meybohm

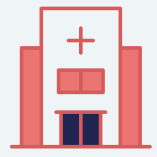
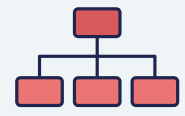
Friday, May 01, 2026

1. PBM IN THE US: CHALLENGES AND SUCCESSES

Linda Shore-Lesserson

Regardless of the definition used, the goals and challenges of *Patient Blood Management* (PBM) are shared globally and are tackled in the main international guidelines. In this context, PBM implementation remains one its main challenges[1]. The governments of some countries are very invested in this aspect of health: Western Australia, Romania, Germany, and Canada are some examples (and a source of envy).

The PBM measure package published by the *Society for the Advancement of Patient Blood Management* (SABM) includes the different obstacles identified in the United States for its implementation[2]:

1	2	3	4
			
Cultural and educational barriers, transfusion-focused medicine	**Lack of standardised guidelines and protocols**	**Limitations of infrastructure and logistical resources**	**Reluctance to change and need for multidisciplinary and institutional support**
Global	**Global**	**Infrastructure in the US**	**Hierarchy in the US**

Additionally, SABM, like other scientific societies, adhered to the 2012 Choosing Wisely campaign, an initiative of the *American Board International Medicine* (ABIM)[3] and issued recommendations focused on anaemia management:

1. Not performing elective surgeries without having previously diagnosed and treated anaemia.

2. Minimizing bleeding and using antifibrinolytics when indicated.

3. Ensuring the patient's informed consent, having previously discussed alternatives to transfusion.

Moreover, hospitals such as North Shore and others in the United States have promoted initiatives like including alerts in the electronic clinical history and warnings in prescription orders for blood products, including recommendations based on clinical guidelines during the prescription process. These strategies favour a better anaemia management and promote evidence-based transfusion practices. At the same time, they help reduce clinical variability and the number of transfusion units, thus improving clinical outcomes and reaching under 6% of requests for packed red blood cells versus all other requests for simple units.

In the United States, a transfusion-centered healthcare culture still prevails. However, in the last few years, there has been a significant increase in PBM education and the publication of guidelines and clinical algorithms:

- In 2021, the concept of PBM was first included in North American cardiac surgery guidelines[4].
- The *Society for Perioperative Assessment and Quality Improvement* (SPAQI) published in the last few years reviews on perioperative anaemia diagnosis and treatment, as well as other haemorrhagic disorders (2024 and 2025)[5,6].
- The *American Society of Anesthesiologists* (ASA) is planning to publish in 2026 new clinical practice guidelines focused on anaemia screening and treatment.

The United States healthcare system has experienced a remarkable transformation over the last 25-30 years:

1990	2000
***Fee for Service* model, providing incentives to carry out more procedures and services**	***Value-Based Care* models, based on value and capitation and focused on the patient**

In this context, incentives linked to the patient experience represent a relatively recent concept, while models based on procedures and services have historically posed an obstacle for PBM implementation.

An effective implementation of PBM requires the availability of sound data to prove their clinical impact. In this regard, further evidence must be generated, such as that brought about by a recent study published in Anesthesiology in 2025, including almost 31,000 patients and associating PBM with a reduction in complications after the surgery, during the hospital stay and in transfusion rates and indexes[7].

Besides the challenges inherent to the organization of the American healthcare system, there are two challenges shared by different countries[8–10]:

- The limited time available during the preoperative period.
- The need for an effective multidisciplinary cooperation.
- A successful PBM implementation will require data proving an improved evolution, shortening of hospital stays, cost reduction, and the best possible patient experience.

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Friday, May 01, 2026

2. CANADIAN EXPERIENCE: 25 YEARS OF PBM PROGRESS

Becky Rock

GENERAL CONTEXT AND HISTORIC EVOLUTION

1997	1998	2002
Krever research ➡ Analysis in blood supply safety problems in Canada.	Creation of ***Canadian Blood Services* (HEMA-Quebec)** ➡ National non-for-profit organization aimed at ensuring safety and preservation of blood products.	Development of **PBM provincial programmes** led by nursing teams.

DISTINCTIVE FEATURES OF THE COUNTRY AND THE CANADIAN HEALTHCARE SYSTEM

Canadian PBM cannot be understood without considering the country's specific features:

Second largest country in the world

10 provinces and 3 territories

Relatively low population (38 million), but socioeconomically very diverse

Indigenous communities, immigrants, rural population, elderly people, socioeconomically vulnerable groups.

In this context, PBM in Canada is presented not just as a clinical strategy, but also as a healthcare equity tool.

The Canadian healthcare system is decentralized and depends both on the federal government and the provinces and regional authorities. This structure creates a significant organizational and budgetary heterogeneity. Consequently, PBM funding and implementation level vary between provinces, regions and even hospitals.

PBM CHARACTERISTICS IN CANADA

- **Programmes led by nursing:** Nursing leadership has allowed to develop management models that are integrated, coordinated, consistent, efficient, and cost-effective.
- **Research and results:** Canada also has a sound PBM research tradition. Cooperation between researchers, clinicians and national suppliers of blood products has been fundamental to generate quality scientific evidence.

As a prominent example, the TRICC study *(Transfusion Requirements in Critical Care)* was the first one to show that restrictive transfusion strategies provided benefits in critical patients when compared to liberal strategies[11].

THE ONTraC MODEL

The ONTraC programme *(Ontario Nurse Transfusion Coordinators)* emerged from an innovative idea—having the nursing staff leading PBM coordination under medical supervision. This initiative was led by doctor John Fredman, Medical director at Saint Michael Hospital in Toronto. These are the its main features:

Nursing leadership
from the start

Steady funding
at province level

Data generation
reinforcing and improving clinical practice

25 Hospitals
permanently funded

Nursing staff leadership is focused on the programme implementation and coordination, as well as training and awareness-raising amongst professionals and gathering the generated data. The sites included in the programme have stable funding, regardless of any internal changes that may occur.

After over 20 years running, ONTraC has accomplished a significant reduction in the number of transfusions, hospital stays, and infection rates[12].

However, some provinces with a less developed PBM infrastructure present a lower use of blood products than Ontario. This fact probably reflects the influence of multiple factors and nuances, including demography, volume of surgeries, rurality, population characteristics, and distribution of blood products to smaller hospitals. Consequently, reality is more complex than the simplified idea that the implementation of a PBM programme is automatically translated into better clinical outcomes.

PBM IN OTHER CANADIAN PROVINCES

Nova Scotia

- Advanced program with 150 monthly referrals.
- Led by nurses with PhD and with diagnostic and prescriptive capacity in terms of anaemia and bleeding.

Alberta

- Among the lowest use of red blood cells in the country
- Long-term restrictive transfusion culture, with strong innovation.
- Multidisciplinary cooperation between services and referrals.
- Good access and data generation.

British Columbia

- Nursing-led model, with medical support and gradual development of a provincial framework.

Manitoba

- Model integrating PBM and transfusion safety in the same structure.

Saskatchewan

- Focus on the Enhanced Recovery After Surgery (ERAS) programme.

Quebec

- Emerging nursing-led models imported from Ontario.

In short, Nursing leads PBM in Canada

FUTURE CHALLENGES

Despite the progress made in the last few decades, the homogeneous and equitable implementation of PBM in Canada still faces several structural and organizational challenges:

1. Geography and accessibility:
Many remote communities still have problems to access treatments such as intravenous iron.

2. Equity and inclusion:
Inequalities persist in access to PBM by indigenous, rural, and migrant populations.

3. Irregular funding between provinces:
Coverage and resources allocated to PBM are still highly variable between provinces.

4. Infrastructure and data availability:
The availability of integrated data for national *benchmarking* is still limited.

5. Development of a PBM national framework:
It remains necessary to establish a homogeneous national framework facilitating PBM implementation and coordinated development throughout the country.

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Friday, May 01, 2026

3. DATA-DRIVEN PBM: USING ANALYTICS TO IMPROVE PBM IMPLEMENTATION

Matthew Warner

Current and future PBM requires robust information systems able to measure results and support clinical decision-making. Data analysis can be used to optimize PBM programmes and to prove their clinical and organizational impact.

Without data, PBM is just a concept, and it is difficult to get institutional support for its implementation.

WHAT TYPES OF DATA ARE RELEVANT FOR A PBM PROGRAMME?[13]

1. Basic level: ADMINISTRATIVE

It uses administrative data and allows to measure general indicators, such as the percentage of transfused patients, the prevalence of anaemia before elective surgery, or basic variables such as the length of the hospital stay and readmissions.

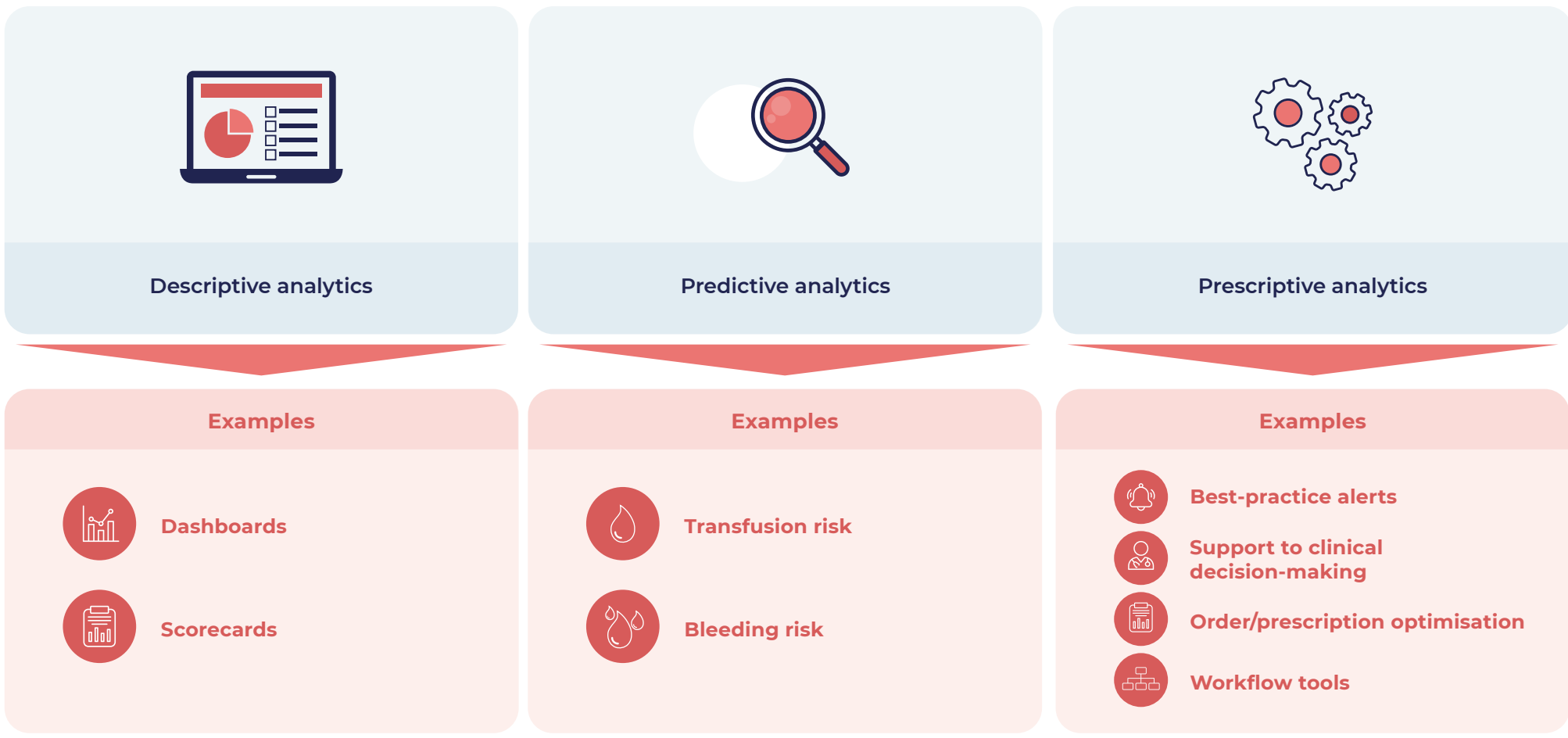
2. Intermediate level: ADMINISTRATIVE+LABORATORY+BLOOD BANK

It includes lab results and blood bank data, allowing the analysis of the number of transfused units per admission, transfusion patterns (ONE UNIT VERSUS CH MULTIUNITS), or the relationship between analytical parameters and transfusion.

3. Advanced level: ADMINISTRATIVE+LABORATORY+BLOOD BANCK+O.R.+E.R.+PHARMACY+ICU DATA

It integrates information from the O.R, E.R., ICU, pharmacy, and clinical systems, enabling the development of predictive models and support tools for clinical decision-making.

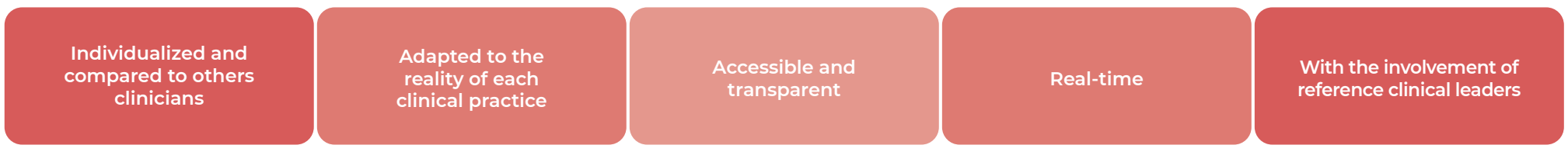
The data generated can be analysed in different ways:



Data analysis in the Mayo Clinic PBM programme is structured around five main areas. Next, some of them are described, together with examples of real-time monitored variables:

1. Use of transfusions:

- Use of packed red blood cells, plasma, platelets, and cryoprecipitates, as well as identification of clinical services with most utilization.
- Indicators of transfusion adequacy, such as the percentage of transfusions performed based on different haemoglobin thresholds.
- Data segmentation and comparison based on the type of professional, clinical service or healthcare context.
- Individualized information return systems for clinicians.



- At the prescribing level, alert integration in electronic prescription for patients rejecting transfusions or for prescriptions outside the recommended thresholds.

2. Anaemia management

- Preoperative anaemia consultation and treatment rates, as well as longitudinal follow-up from anaemia detection through correction or evolution of haemoglobin levels.
- Monitoring the use of intravenous iron in obstetrics and its association with improvements in haemoglobin levels.
- Identification of surgical patients due to undergo surgery with a high risk of bleeding.
- At the prescribing level, integration of alerts suggesting the referral of patients with preoperative anaemia for assessment and treatment.

3. Bleeding/coagulopathy

- Dynamic monitoring of ICU patients and tools to predict bleeding or impact on different organs.
- Development of predictive models to estimate bleeding risk using analytical parameters and clinical evolution of the patient over time.

4 and 5. Clinical outcomes and use of resources and costs

- Assessment of variables such as ICU admissions, readmissions after 30 and 90 days and length of hospital stay.
- Analysis of healthcare costs and estimation of savings associated with the implementation of the PBM programme.

In summary, data are an essential component of any PBM strategy, since they enable the identification of improvement opportunities, monitorization of indicators and demonstration of the clinical and economic value of the programme. For this information to be really useful, it must be presented in a way that is accessible and understandable to both clinical professionals and healthcare managers.

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