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Patient blood management: A paradigm shift

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PATIENT BLOOD MANAGEMENT

INTRODUCTION

We are all contributors to the global burden of wasteful, but even more worryingly, dangerous and risky usage of blood and blood products. Some transfusions are administered in an effort to relieve the discomfort of the treating physician rather than for the needs of the patient. Accompanying a transfusion (whether appropriate or not) is it's associated costs, complications and risks which can be reduced by appropriate management of the patient's own blood. Many multicentre international studies have proven no or uncertain benefit of transfusions, and only a limited percentage of patients receiving transfusions showing any benefit[1]. In an attempt to improve the current usage of blood products, this booklet will outline some of the principles and concepts pertinent to optimizing the patient's own status with regard to their blood using a 3-pillar approach pioneered by Australian researchers as "Patient Blood Management."

DEFINITION AND CONTEXT

What is patient blood management?

It is more than just prudent transfusion of red blood cells. Patient blood management incorporates doing the best in the interests of the patient with regards to their own blood present within them. To this end, patient blood management uses a 3-pillar approach with the aim to individualise therapy to each patient using a multi-disciplinary approach to optimize the patient's own blood, pre-empt and minimize intra-operative blood loss and optimize the extent to which anaemia may be tolerated[2]. This ensures that all steps are in place to minimize the resort to a transfusion by pre-empting and optimizing the patient's blood system, long before a transfusion is even required by addressing modifiable risk factors.

According to the Australian Commission on Safety and Quality In Health Care[2]

1. Optimizing the patient's own blood incorporates identifying and addressing the medical conditions that may result in a blood transfusion e.g. iron deficiency or anaemia
2. Minimizing blood loss as part of the approach involves focussing on surgical skills that decrease blood loss
3. Optimizing tolerance of anaemia would involve a confidence of allowing the patients body to tolerate a certain degree of anaemia without resorting to a blood transfusion

As far as red cell transfusions go, generally the patient's own blood would be the best type. As such, the patient's own blood should be viewed as a unique and valuable resource that should be conserved and appropriately managed. This is the first step in safer blood management practices for the patient[2].

Further rationale for patient blood management incorporates that altruistically donated blood is a precious, unique and expensive resource[3] that is held in trust, and that it will only be used for treatment when evidence exists for likely benefit, possible harm will be reduced and alternatives are unavailable[5].

All patients should be managed with this standard of care and not just those undergoing surgical or medical interventions at high risk of significant blood loss.

Adverse clinical outcomes are associated with a triad of independent risk factors in patients undergoing surgery: anaemia, haemorrhage and transfusion[5]. The three-pillar matrix of patient blood management (PBM) was designed to assess this triad. The reality is that many patients would not even get close to the transfusion trigger or a critical hypoxia level if the first 2 pillars have been adequately addressed[10].

Additionally, the shift in practice lends to the consideration of alternatives to red cell transfusion.

Improvement of patient outcomes is the primary aim of patient blood management. Other desirable side effects include minimizing or evading transfusion of red blood cells and decreasing health-related costs, however these are secondary to patient outcomes[5].

DRIVERS FOR THE PARADIGM SHIFT FROM PRODUCT-FOCUSSED GUIDELINES TO PATIENT-FOCUSSED BLOOD MANAGEMENT (PBM)[10]

- The World Health Assembly resolved to take on the patient blood management concept in 2010 and urged the 189 member states of the United Nations to sustainably administer its recommendations
- The Australian National Blood Authority is the first country to effectively tackle implementation of this innovative approach
- Donor blood safety is an additional factor that is driving the paradigm shift, not only with the risk of HIV, Hepatitis C and B from blood transfusion, but also the risk of infection transmission of numerous developing and resurfacing pathogenic organisms in the blood pool. The risk is that there is a substantial amount of pathogens known which aren't routinely being tested for, and some of these pathogens (e.g. prions and dengue) carry a potential for stark adverse clinical outcomes
- Chronic and seasonal blood shortages are further drivers towards patient blood management. The widening gap of supply and demand imbalance is brought about by an aging population with a faster growing old age segment, especially in the developed world[10]
- The increasing price tag of blood transfusions is also a motivator to move toward patient blood management strategies. Cost evaluations have demonstrated that the transfusion cost is close to almost 5 times the cost of acquisition due to the intricate logistics, laboratory facilities, nursing and physician time, administration work and additional services[10] (in addition to the potential for error at each step of the way). The costs of adverse outcomes also have to be factored into the cost calculation of blood transfusions

BENEFITS OF APPROPRIATE MANAGEMENT USING THE PBM APPROACH[2]

- managing conditions that may result in a transfusion, so that transfusions are solely performed when suitable
- improved patient outcomes[7] measured by fewer patient adverse events, earlier recovery and reduced hospital stays
- decreased patient exposure to allogeneic blood transfusions and its associated risks including, but not limited to, allergic and immunologic complications, infectious risks and errors from administration (incorrect blood transfused)

THREE-PILLAR APPROACH OF PATIENT BLOOD MANAGEMENT

1) **Optimize erythropoiesis and red cell mass**

Pre-operative anaemia

Despite the plethora of sophisticated diagnostic methods and a good scientific understanding of mechanisms, this common finding is managed poorly in general. It is mild in most circumstances and its importance per se with regard to unfavourably affecting clinical outcomes with a lack of confounders is questionable[5].

A deficiency in the quality or number of red blood cells can be classed into haemorrhagic, haemolytic or ineffective erythropoiesis causes. Iron deficiency due to blood loss or inadequate diet, chronic diseases, infection and medication side effects make up the most common pre-operative causes[2].

Preoperative anaemia is proven to be *independently associated* with a higher risk of mortality and morbidity as well as increased hospital length of stay[7] in a dose dependent manner. Evidence points to a causal relationship rather than an associative relationship[10]. It also increases the chances of transfusion of red blood cells with its own inherent risks. Patients' pre-surgery clinical status can be improved, and post-surgery morbidity, mortality and length of stay in hospital can be reduced with appropriate management of pre-operative anaemia prior to elective surgery[7]. Evidence also points to those patients with preoperative anaemia receiving a preoperative transfusion have worse outcomes than those with preoperative anaemia not undergoing a transfusion[16].

Of assistance to manage anaemia would include establishing the diagnosis of anaemia, determining if it's related to the patient's current condition and if it can be corrected. Even though some forms of anaemia cannot be prevented (red cell production failure), others can be prevented and managed (e.g. blood loss and dietary deficiency). Most forms of anaemia can be corrected within 2-3 weeks without a red cell transfusion, provided there isn't a primary condition affecting bone marrow or an influence subduing function of the marrow. In the case of urgent surgery, red cell transfusion may be necessary, but anaemia may recur in the post-operative period. If anaemia is corrected in the short term with a red cell transfusion, the cause of the anaemia will require follow-up or the anaemia needs to be monitored to ensure its resolution as a transfusion can temporarily dampen the stimulus for the marrow to respond to appropriate therapy to correct the cause of the initial anaemia.

Haematinic options available to use where appropriate include iron, folate, vitamin B_{12} and erythropoietin. Allogeneic transfusions should solely be considered when other options are unavailable[5].

With the use of red blood cell (RBC) transfusion being in no way innocuous, analysis has shown minimal or, for certain populations, zero evidence to confirm that there is benefit to patients from transfusion except in extreme or acute bleeding scenarios[10].

Blood transfusions have demonstrated their association with the following adverse outcomes:[5,10]

- Increased morbidity [due to cerebral and cardiac ischaemic events, bacterial infections including septicaemia, venous thromboembolism, impaired renal function, acute lung injury, systemic inflammatory response syndrome, multisystem organ failure]
- Increased mortality
- Increased hospital length of stay
- Increased intensive care unit (ICU) admissions

Optimal haematocrit[5]

- Oxygen transporting ability of the blood (including oxygen-carrying, -delivery and –unloading capacity) is better measured by haemoglobin, total red cell mass, and red cell membrane structure and function rather than the haemoglobin concentration, although the latter is used from a peripheral venous sample in most studies of restrictive blood transfusion protocols. The information above should be interpreted in conjunction with measurements of the patient's cardio-pulmonary function and individual organ microcirculation and function. Due to ease of measurement of a peripheral blood sample haemoglobin concentration and clinical correlation, these are generally used in the real world scenario. It is for this reason that the clinician must have high up on their list the various factors that can influence the haemoglobin concentration in deciding whether to tolerate a patient's anaemia or to administer a transfusion:

- *Gender:* females have lower reference ranges and lower blood volumes compared to men and are further likely to receive a transfusion compared to males[11,12]
- *Age:* altered thirst and autonomic nervous system responses lead to significantly altered blood volume regulation mechanisms. Aging is accompanied by a decrease in total blood volume and a blunted response of the capability of the adrenergic system of older patients to react and adjust to environmental encounters and medical interventions
- *Pregnancy:* the main change is increased total blood volume and increase of both red cell mass as well as plasma volume (plasma volume proportionally greater than red cell mass, leading to reduced blood viscosity and haemodilution)
- *Aerobic fitness:* fit patients often present with lower haemoglobins with a poor relationship between total red cell mass and haemoglobin concentration measured in peripheral blood and – commonly called “sports anaemia”
- *Altitude:* acute hypoxic stress of altitude commonly results in plasma volume contraction due to a form of stress polycythaemia. Acute hypoxia initially results in increased sympatho-adrenal activity noticeable as an increase in cardiac output, constriction of veins, redirection of blood volumes to the central compartments and subsequent haemoconcentration
- *Physiologic and pathophysiologic adrenergic stress:* plasma volume contraction with resulting haemoconcentration is caused by the acute haematological stress response leading to polycythaemia due to activation of the adrenergic system as seen in the flight/fight response. This can either be physiological due to hypoxic conditions present within the environment or due to psychological stress or also secondary to an array of diseases including acute hypoxia, acute neurological catastrophes (e.g. subarachnoid haemorrhage or strokes), respiratory failure, atrial tachycardia, acute coronary syndromes and phaeochromocytoma. This stress response must be recognised as even though the red cell mass remains unchanged, the haemoglobin concentration can have major fluctuations and this may be misinterpreted as dehydration with a high haemoglobin or blood loss due to a sudden drop in haemoglobin.
- *Acute phase response, anaemia of injury and chronic disease:* this response is preceded by cytokine release and is an expression of host defences and healing processes after an insult. The haemostatic system (coagulation factors and platelets) are primed and haemoconcentration in the course of the acute haematological stress response take place in reaction to a perceived or real insult. This response is contrasted with the acute phase response, which is accompanied by haemodilution, which assists the fluidity of the blood and ensuring microcirculatory flow is maintained – possibly to assist with delivery of inflammatory and subsequent healing responses. Anaemia of chronic disease follows as the acute phase progresses to a more chronic phase. This is not a primary diagnosis, but rather a secondary response considered normal to an inflammatory or infectious condition that should not be “corrected”

- *Medications:* venodilators and venoconstrictors do not have a clinically significant effect on fluctuations of haemoglobin level or changes in red cell mass
- *Diabetes:* venous haematocrit is commonly within reference ranges despite a substantial reduction in total red cell mass and blood volume
- *Cigarette smoking:* smoking patients in general have a haematocrit level higher than that of non-smokers. Plasma volume contraction is frequently the source. Acute habit changes, especially stopping during hospital admission or in relation to elective surgical procedures, will cause changes in haemoglobin level

2) Minimizing blood loss

Taking an in depth history from the patient is a rewarding exercise likely to yield discovery into clinically significant haemostatic disorders – e.g. menorrhagia, easy bruising or joint/muscle swelling after minor trauma, bleeding related to previous surgical and dental procedures, excessive bleeding with major trauma and epistaxis[7]. Further interrogation into the patients' medication history may reveal the consumption of pre-operative aspirin and aspirin containing-compounds, NSAIDs, chronic steroid use, platelet inhibitors, warfarin, oral antithrombin or Xa anticoagulants or low molecular weight heparin.

Some of the strategies available to the peri-operative clinicians include normovolaemic haemodilution, intra-operative blood recovery and reinfusion, deliberate hypotension, microsampling, component sequestration, point-of-care testing, appropriate positioning, topical haemostatics, use of improved surgical techniques, maintaining normothermia, and using fibrin sealants. Considering the post-operative period, anaemia is of highest concern within an intensive care unit[4]. Before physiological reserves within the patient are lost, expectation, prompt diagnosis and management of haemorrhage should be instituted as soon as possible. Cell salvage can also be performed on blood drained and recovered from wounds. Further options available to the post-operative treating physician include optimizing erythropoiesis, preventing and treating anaemia and blood loss as well as consideration of hyperbaric oxygen therapy. Blood usage audits within the post-operative period serve a two-fold purpose of reducing inappropriate blood component usage as well as supporting transfusion of the correct constituent at the correct period to the correct patient.

Due to failing to proactively assess haemostasis and risk of haemorrhage combined with sub-optimal surgical and anaesthetic management of bleeding during the intra-operative period, poor attention to the management of haemostasis is a common occurrence[5].

3) Physiological tolerance of anaemia

There exists a poor tolerance of mild to moderate anaemia in the short term. Even though literature is present associating anaemia with poor outcome in certain circumstances, supporting the notion that correcting anaemia with red cell transfusion improves clinical outcomes lacks evidence[5,16].

Insight gained from the management of Jehovah's Witness (JW) patients reveal that the body is able to tolerate a degree of anaemia as evidenced by equivalent or better clinical outcomes in surgeries where transfusions are considered integral for successful patient outcomes[5]. Research into restrictive transfusion strategies has been ignited by the demonstration of such outcomes in this specific patient population group. A case controlled study in Jehovah's Witness patients compared to those accepting blood transfusions in elective cardiac surgery revealed that JW patients had a higher pre-operative haemoglobin level, bled less intra-operatively and had post-operative haemoglobin levels that were higher. These findings may point to a difference in the standard of care received.

Table 1 – Summarized Three-pillar approach with 9 field matrix incorporating pre-, intra- and post-operative periods[5,10]

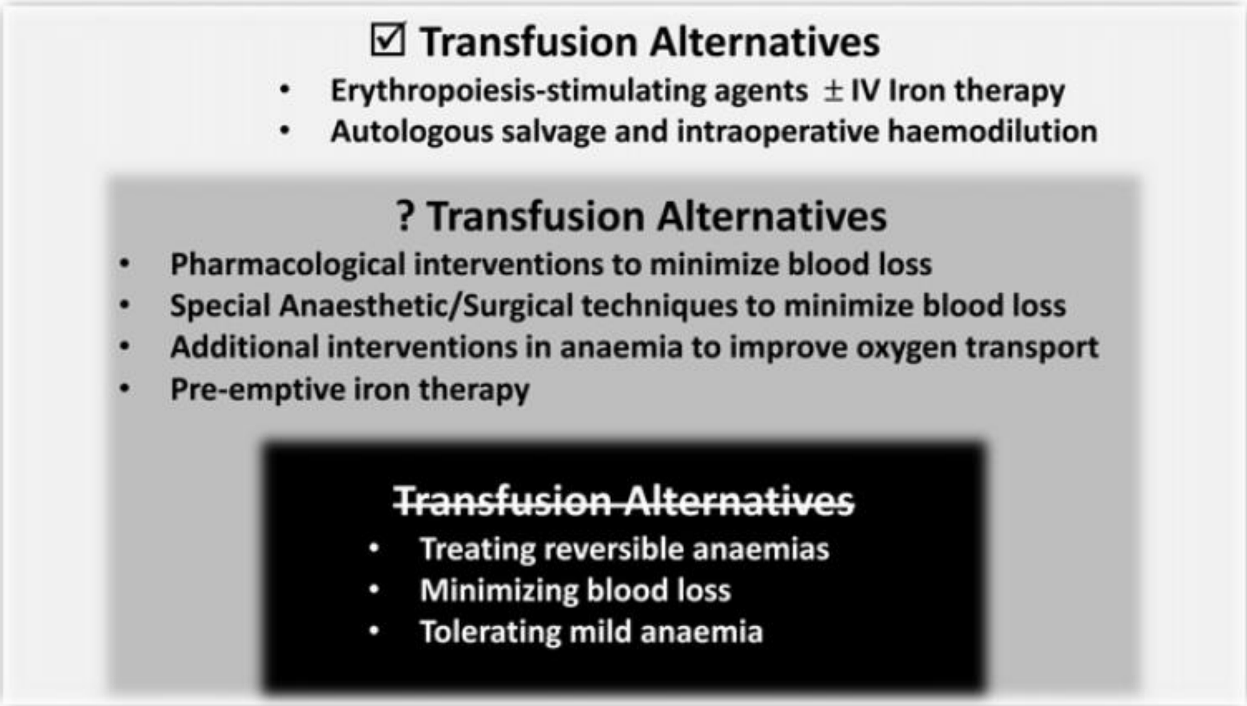
1ST PILLAR: - optimize erythropoiesis and red cell mass	**2ND PILLAR:** - minimize blood loss and bleeding	**3RD PILLAR:** - harness and optimize physiological reserve of anaemia
PRE-OPERATIVE		
- Detect anaemia - Identify underlying disorder(s) causing anaemia in a timely manner - Manage disorder(s) - Refer for further evaluation if necessary - Treat suboptimal iron stores/ iron deficiency/ anaemia of chronic disease/ iron-restricted erythropoiesis - Treat other haematinic deficiencies - Optimize haemoglobin - Consider pre-operative erythropoeisis-stimulating agents if nutritional anaemia is ruled out or treated - Note: anaemia is a contraindication to elective surgery	- Identify, manage and treat bleeding/ bleeding risk - Minimizing iatrogenic blood loss/ phlebotomy - Review medication (antiplatelet and anticoagulation treatment) - Procedure planning and rehearsal - Consider pre-operative autologous blood donation in selected cases	- Assess/ optimize patients physiological reserve, risk factors and bleeding history - Compare estimated blood loss with patient-specific tolerable blood loss - Formulate patient-specific blood management plan using appropriate blood conservation modalities to minimize blood loss, optimize red cell mass and manage anaemia - Optimize cardiopulmomnary function - Restricive transfusion strategies
INTRA-OPERATIVE		
- Time surgery when erythropoeisis and red cell mass has been optimized	- Meticulous haemostasis and surgical/ anaesthetic techniques - Blood-sparing surgical techniques - Anaesthetic blood conserving strategies - Acute normovolaemic haemodilution - Maintain normothermia unless specifically indicated - Autologous options – cell salvage, haemodilution - Avoid coagulopathy - Pharmacological/ haemostatic agents	- Optimize cardiac output - Optimize cardiopulmonary function - Optimize ventilation and oxygenation - Restrictive transfusion strategies

POST-OPERATIVE		
- Manage nutritional or correctable anaemia and iron deficiency (e.g. avoid folate deficiency, iron-restricted erythropoiesis) - Manage medications and potential interactions that can causes anaemia (e.g. an ACE inhibitor) - Stimulate erythropoiesis if necessary	- Vigilant monitoring and management of post-operative bleeding - Patient warming/ maintain normothermia, unless hypothermia specifically indicated - Autologous blood salvage if appropriate - Minimizing diagnostic blood sampling/ phlebotomy - Haemostasis/ anticoagulation management - Prophylaxis of upper gastrointestinal haemorrhage where appropriate - Avoiding other secondary haemorrhage - Minimize infections by treating promptly - Be aware of adverse medication effects	- Tolerance of anaemia - Maximize oxygen delivery - Minimize oxygen consumption - Avoid/treat infections promptly - Restrictive transfusion strategies

ALTERNATIVES TO BLOOD TRANSFUSIONS

It is important to appreciate that patient blood management is not a substitute for red cell transfusion. It is a sound, evidence-based clinical practice and should be standard of care afforded to all patients, not just those patients with risk of significant blood loss[5].

Figure 1 *– Standard of care versus transfusion alternatives*[5]



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RECOMMENDATIONS FOR IMPLEMENTATION

Table 2 *- Grading of recommendations*[9]

GRADE A	Body of evidence can be trusted to guide practice
GRADE B	Body of evidence can be trusted to guide practice in most situations
GRADE C	Body of evidence provides some support for recommendation(s) but care should be taken in its application
GRADE D	Body of evidence is weak and recommendations must be applied with caution

The recommendations to assist with implementation of a successful patient blood management programme include establishing a committee that works above and beyond the transfusion committee and that is staffed by "champions" that want to advance the PBM practices within the institution[8]. This approach would require a multi-disciplinary patient blood management program in the peri-operative field. Although not an essential recommendation (Grade C), its implementation will be of benefit.

The aim is to have all patients scheduled for surgery assessed as soon as possible to synchronize the scheduled surgery with optimization of the patients' haemoglobin level and iron stores. A reasonable time frame of 3-4 weeks prior to scheduled surgery or cancellation/delay of surgery if feasible for optimization is a prudent approach. This would encourage a pre-operative anaesthetic assessment of such patients, ideally at a pre-anaesthetic assessment clinic where a plan of management can be made. To ease the evaluation and assist with screening and assessment, checklists for certain types of surgery can be devised. The use of intravenous iron and erythropoietin should also have appropriate guidelines for its use in the institution. Institutional policies in place will also go a long way in assisting with appropriate management of patients by having guidelines in place regarding delay or cancellation of surgery unless adequate levels of RBC and iron stores are in place for specific patient populations or types of surgery.

Pre-operative anaemia

In every patient scheduled for surgery, it is imperative that preoperative anaemia is picked-up, assessed and treated to minimize transfusion of red cells which might be associated with increased risk of mortality, morbidity, hospital length of stay and ICU length of stay (Grade C)[7].

Iron and erythropoiesis-stimulating agents (ESA)

There is Grade B evidence for the recommended use of preoperative oral iron treatment in surgical patients at risk of or presenting with iron-deficient anaemia. For patients with presenting with preoperative iron deficient anaemia where an ESA is indicated, it is essential to be administered together with iron therapy (Grade A)[9]. There is also further Grade B evidence to show that early treatment with oral iron has no clinically effective properties in patients with postoperative anaemia and the routine use cannot be recommended in this setting. In patients scheduled for surgery with suboptimal iron stores (ferritin <100mcg/L) and in whom a significant loss of blood is anticipated (defined as "blood loss of a volume great enough to induce anaemia that would require a transfusion"), they ought to receive iron therapy preoperatively. Iron alone should be used as the treatment if the patient present with depleted iron stores or iron deficiency anaemia. Erythropoietin-stimulating agents may be indicated for patients with anaemia of chronic disease (sometimes called anaemia of inflammation). Evidence in the literature points to benefit of use of erythropoietin in the critically ill patient[17]. The use of oral iron agents has a time restriction – it is an ill-advised option should the scheduled surgical procedure require to be undertaken in less than 6 weeks. Further, absorption restrictions may also play a role depending on the comorbidities of the patient and their daily medication schedule e.g. acid reducing agents, non-steroidal anti-inflammatory drugs, hormonal therapy and malabsorption conditions. In these cases, oral iron agents may be insufficient and intravenous iron therapy should be considered if oral agents were not instituted 6-12 weeks prior to the scheduled surgery date. Consideration can also be given to instituting a 6-week trial of oral iron therapy, and if this fails, one can resort to intravenous iron therapy. When undergoing an administration of erythropoietin-stimulating agents, it is important to order intravenous iron prior to its administration and also following its administration. The use of oral iron therapy during erythropoietin-stimulating agent use is inappropriate. Sufficient iron stores need to be readily available and accessible before the institution of exogenous erythropoietin-stimulating agent therapy.

Haemostasis management

Therapy with clopidogrel should be discontinued at least 5 days prior to surgery where possible in patients scheduled for CABG with or without CPB (OPCAB) (level of recommendation Grade C). Aspirin can be continued until scheduled surgery. The decision to stop clopidogrel therapy in patients who are planned for noncardiac surgery electively or other invasive procedures should be taken by a multidisciplinary team approach in order to weigh up and balance the bleeding risks versus thrombotic events in the best interest of the patient. Further, particular assessment is mandatory in patients that have sustained a recent cerebral infarction or have received a drug-eluting stent inside of 12 months or a bare metal stent in the preceding 6 week period. Therapy should be discontinued 7-10 days prior to surgery if the decision has been taken to stop therapy[9]. Adherence to current guidelines is required regarding specific management in patients scheduled for elective noncardiac surgery or other invasive procedures and whom are on warfarin therapy. It is rational not to discontinue low dose aspirin therapy in patients undergoing noncardiac surgery, however in neurosurgery and intra-ocular surgery, further evaluation may be required (Grade C). To reduce blood loss and subsequent transfusion, elective orthopaedic surgical patients should stop NSAID therapy preoperatively (Grade C) in a timely manner that reflects the pharmacology of the relevant agent. Warfarin can be continued in patients scheduled for cataract surgery, upper gastrointestinal endoscopy without biopsy or colonoscopy without biopsy, arthocentesis and minor dental procedures (Grade B). A well designed program for optimal patient blood management will have in place a list of agents taken by patients preoperatively that may need to be stopped at a specific time frame as well as guidelines covering the use of certain nutritional supplements or complementary medicines in certain patients that need to be stopped in preparation for surgery. Further guidelines should also be instituted concerning referral to a specialist for transitional medication regimes in certain instances in anticipation of elective surgery (e.g. oral anticoagulation transitioning to LMWH therapy).

Blood conservation strategies

- Hypothermia must be actively prevented (Grade A recommendation)
- The patient must be positioned in such a manner both during and after surgery so as to reduce excess venous pressure at the site of surgery
- Controlled (or deliberate) hypotension (targeting a mean arterial pressure of 50-60mmHg) can be considered for patients when substantial blood loss is anticipated during major joint replacement or radical prostatectomy, considering risks of blood loss and maintaining perfusion of vital organs (Grade C)
- In adult patients undergoing surgery where blood is expected to be substantial, acute normovolaemic haemodilution should also be considered (Grade C) in accordance with local

guidelines specifying patient selection with inclusion and exclusion criteria, choice of replacement fluid, vascular access, volume of blood withdrawn, blood storage and handling and timing of re-infusion

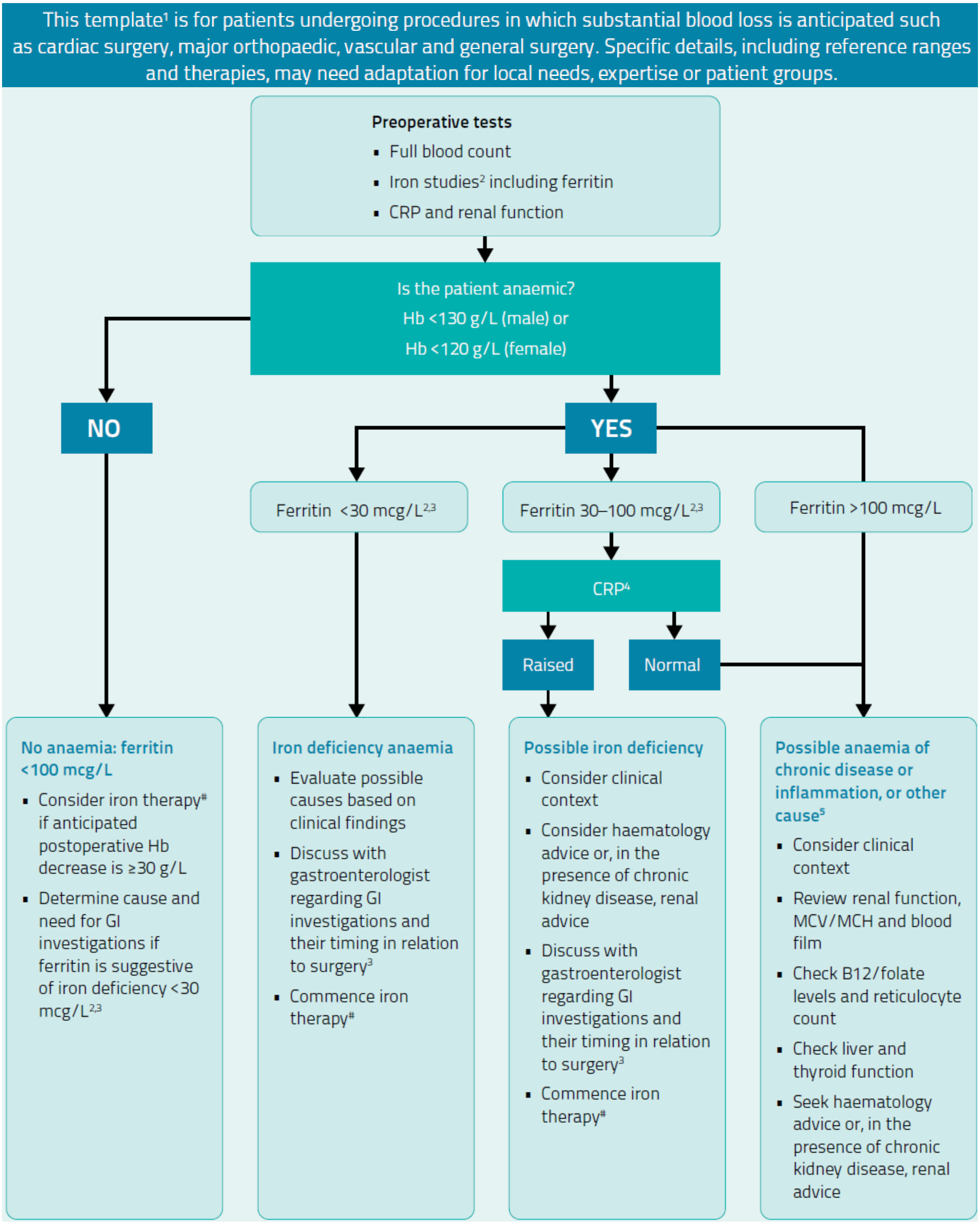
- In accordance with locally available guidelines on its use, red cell recovery techniques in the intra-operative period is also recommended for adult patients undergoing surgery with anticipated significant blood loss (Grade C)
- Thromboelastography to analyse haemostasis should also be considered for adult patients subject to cardiac surgery and other massive transfusion procedures (Grade C)
- Intravenous tranexamic acid use is recommended for adult patients undergoing surgery with anticipated substantial blood loss. The recommendation is Grade A for cardiac surgery, and Grade B for noncardiac surgery[9]
- The routine implementation of desmopressin is not supported in adult patients scheduled for surgery with anticipated significant blood loss due to the uncertainty of risk regarding stroke and mortality
- Postoperative red cell recovery ought to be considered for patients undergoing total knee arthroplasty or cardiac surgery (Grade C)

Appropriate transfusion practices

- Triggers for blood component transfusion
    - An assessment of the patients' clinical status should be made in deciding whether a patient requires transfusion of RBC rather than relying on a dictated transfusion "trigger" alone. It may be unsuitable to transfuse patients postoperatively with a haemoglobin level of >8g/dL, with no evidence of acute cerebrovascular or myocardial ischaemia
    - When the haemoglobin level is >10g/dL, RBC transfusion is not indicated. Consideration should be given to patients in the setting of acute cerebrovascular or myocardial ischaemia with a postoperative haemoglobin level of 7-10g/dL – reassessment of its clinical efficacy after transfusion of a single unit of RBC is appropriate in this setting
    - The use of a transfusion trigger haemoglobin value of 7g/dL or patients with symptoms of anaemia as a restrictive blood transfusion strategy has not been demonstrated to be associated with increased morbidity or mortality and is considered safe[18], with some exceptions:
        - the Myocardial Ischaemia and Transfusion (MINT) trial suggests a higher trigger for red cell transfusion[19]
        - No benefit for a higher transfusion trigger has been demonstrated in:
            - Patients with hip fractures[21]
            - Critically ill patients[18]
            - Patients with traumatic brain injury (there is a consensus statement stating a level of 8g/dL, however this is not evidence based)[18]
    - Patients with a documented platelet count of $>50x10^9$/L or INR<2 can generally withstand invasive procedures without severe bleeding, however there may be circumstances where even lower platelet counts or higher INR's can be tolerated
    - In patients at risk undergoing intraocular, intracranial and neuraxial procedures, specialist guidance or haematology advice is suitable. This is also applicable to patients with severe thrombocytopaenia or coagulopathy
    - Institutions should have readily available policies and guidelines which are updated in accordance with published literature
- Fresh frozen plasma (FFP)
    - There is a Grade B recommendation that the use of FFP prophylactically in cardiac surgery is unsupported. Resorting to thromboelastometry prior to its use is the preferred process

- Platelets
    - Similar to FFP use, resorting to thromboelastometry prior to its use is the preferred process rather than the prophylactic administration of platelets after cardiac surgery
- Recombinant activated factor VII (rFVII)
    - Due to on-going concerns regarding its risk profile with regard to adverse thrombotic events, the routine therapeutic use of rFVII prophylactically is not recommended (Grade C). Consideration to its use may be appropriate in perioperative patients with life-threatening bleeding following traditional measures, including using antifibrinolytics, surgical haemostasis, and appropriate blood component therapy have proved inadequate. Institutional policies should be in place to guide its access and use

Figure 2 *- SUGGESTED ALGORITHMIC APPROACH [9]*



Iron therapy

Oral iron in divided daily doses. Evaluate response after 1 month. Provide patient information material.

IV iron if oral iron contraindicated, is not tolerated or effective; and consider if rapid iron repletion is clinically important (e.g. <2 months to non deferrable surgery).

NOTE: 1 mcg/L of ferritin is equivalent to 8–10 mg of storage iron. It will take approximately 165 mg of storage iron to reconstitute 10 g/L of Hb in a 70 kg adult. If preoperative ferritin is <100 mcg/L, blood loss resulting in a postoperative Hb drop of ≥30 g/L would deplete iron stores.

In patients not receiving preoperative iron therapy, if unanticipated blood loss is encountered, 150 mg IV iron per 10g/L Hb drop may be given to compensate for bleeding related iron loss (1 ml blood contains ~0.5 mg elemental iron)

Abbreviations

CRP = C-reactive protein

GI = gastrointestinal

Hb = haemoglobin

IV = intravenous

MCV = mean cell/corpuscular volume (fL)

MCH = mean cell/corpuscular haemoglobin (pg)

Footnotes

1 Anaemia may be multifactorial, especially in the elderly or in those with chronic disease, renal impairment, nutritional deficiencies or malabsorption.

2 In an anaemic adult, a ferritin level <15 mcg/L is diagnostic of iron deficiency, and levels between 15–30 mcg/L are highly suggestive. However, ferritin is elevated in inflammation, infection, liver disease and malignancy. This can result in misleadingly elevated ferritin levels in iron-deficient patients with coexisting systemic illness. In the elderly or in patients with inflammation, iron deficiency may still be present with ferritin values up to 60–100 mcg/L.

3 Patients without a clear physiological explanation for iron deficiency (especially men and postmenopausal women) should be evaluated by gastroscopy/colonoscopy to exclude a source of GI bleeding, particularly a malignant lesion. Determine possible causes based on history and examination; initiate iron therapy; screen for coeliac disease; discuss timing of scopes with a gastroenterologist.

4 CRP may be normal in the presence of chronic disease and inflammation.

5 Consider thalassaemia if MCH or MCV is low and not explained by iron deficiency, or if long standing. Check B12/folate if macrocytic or if there are risk factors for deficiency (e.g. decreased intake or absorption), or if anaemia is unexplained. Consider blood loss or haemolysis if reticulocyte count is increased. Seek haematology advice or, in presence of chronic kidney disease, nephrology advice

For more information on the diagnosis, investigation and management of iron deficiency anaemia refer to Pasricha SR, Flecknoe-Brown SC, Allen KJ et al. Diagnosis and management of iron deficiency anaemia: a clinical update. Med J Aust, 2010, 193(9):525–532.

Disclaimer

The information above, developed by consensus, can be used as a guide. Any algorithm should always take into account the patient's history and clinical assessment, and the nature of the proposed surgical procedure.

ROLE OF THE ANAESTHETIST[5]

The usage of the three-pillar matrix in routine daily clinical practice will be influenced by:

- surgical and medical context
- age and sex of the patient
- time frame for managing the primary clinical problem – urgent vs. emergent vs. elective
- reversibility and treatability of the primary disease

- presence of co-morbidities
- availability and costs of alternatives to blood transfusion and
- specific preferences of patients

Pursuing responses to the following questions will delineate a perioperative management plan tailored to each patient[5]

1. Is the anaemia related to the patient's current condition?
2. Is the anaemia correctable in the short term and by what means?
3. If the anaemia is not correctable is transfusion appropriate?
4. What effect may anaemia have on the current anaesthetic and surgical management of the patient?

Our role to embracing the concept of patient blood management includes, but is not limited to:

Pre-operatively

1. Have protocols and guidelines in place on appropriate referrals to a pre-anaesthetic clinic for evaluation of those patients with pre-operative anaemia (or those at risk for blood loss peri-operatively that may be of significant magnitude to require a blood transfusion):
    a. certain types of surgery at high risk of significant blood loss
    b. patient comorbidities that increase their amount of blood loss
    c. patient consumption of drugs that increase risk of bleeding
2. Aim to identify such patients and manage with any of the following options as appropriate:
    a. oral haematinic therapy (iron/folate/b12)
    b. intravenous iron therapy
    c. preoperative autologous transfusion
    d. erythropoietin-stimulating agents
    e. red blood cell transfusion (use a restrictive strategy)
3. Planning of procedure to estimate blood loss and to schedule surgery with timing of optimal patient haematocrit

Intra-operatively

1. Institute measures to decrease the amount of red cell mass lost:
    a. deliberate hypotension
    b. acute normovolaemic haemodilution
    c. avoid coagulopathy:
        i. maintain normothermia
        ii. use of bedside coagulation tests and administering relevant component therapy as required
    d. tranexamic acid use
    e. use of cell salvage techniques
    f. avoid excess pressure at surgical site
2. Maintain optimal cardiopulmonary function

Post-operatively

1. Monitor those at risk for anaemia to identify timeously
2. Cell salvage of blood draining from wounds
3. Consider haematinics and erythropoietin-stimulating agents
4. Be aware of and avoid medication interactions causing anaemia
5. blood usage audits to ensure transfusions are appropriate
6. Tolerate anaemia
7. Monitor for and treat infections promptly
8. Minimizing phlebotomy

CONCLUDING REMARKS

With the stark number of inappropriate blood transfusions and its inherent risks that occur on a daily basis without due consideration of appropriate management of the patient’s own blood volume, it is prudent to adopt an approach of patient blood management rather than blood-product management. With the pioneered approach of the Australian National Blood Committee adopted by resolution of the World Health Organization, we hope this will set the tone for other countries to follow suit in improving patient outcomes and reducing healthcare costs by addressing modifiable risk factors for a transfusion long before a transfusion even becomes necessary. This is where patient blood management holds its superiority over appropriate blood-product management.

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