

Red blood cell transfusion strategies and Maximum surgical blood ordering schedule

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ABSTRACT

Blood transfusion is one of the practices that is in vogue because it expands blood volume and purportedly improves the oxygen carrying capacity. Despite this supposed physiological benefit, paradoxically, both anaemia and transfusion are independently associated with organ injury and increased morbidity. Historically, transfusion was used to maintain blood haemoglobin concentration above 10 g/dL and a haematocrit above 30%. There is now a greater emphasis on interventions to reduce the use of transfusion as it is a scarce and expensive resource with many serious adverse effects. Institutional maximum surgical blood ordering schedule algorithm developed with data analysis and consensus of surgeons, anaesthesiologists and blood banks can reduce the overuse of blood. A PubMed search was performed with search words/combination of words 'erythrocyte transfusion, adverse effects, economics, mortality, therapy, therapeutic use and utilisation'. Search yielded a total of 1541 articles that were screened for clinical relevance for the purpose of this review.

Key words: Adverse effects, erythrocyte transfusion, erythrocyte transfusion/economics, erythrocyte transfusion/mortality, erythrocyte transfusion/therapy, therapeutic use, utilisation

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INTRODUCTION

Blood transfusion is performed for improvement in oxygen delivery (DO_2) at tissue level and to improve blood volume. Despite this supposed physiological benefit, paradoxically, both anaemia and transfusion are independently associated with organ injury and increased morbidity.^[1] Traditionally, the decision to transfuse red blood cells (RBCs) was based upon the '10/30 rule'; to maintain blood haemoglobin (Hb) concentration above 10 g/dL and a haematocrit above 30%.^[2] Reports of several series of patients who refuse blood transfusions demonstrate that a variety of major operations are tolerated without apparent major morbidity or mortality.^[3] The Agency for Healthcare Research and Quality reported that in 2007, blood transfusions were given in one in every ten hospital admissions in which a procedure was performed leading to 140% increase from 1997 in the USA.^[4]

This narrative review focuses on RBC transfusion with respect to physiological rationale, risks, complications

and the appropriate transfusion trigger for various conditions.

RATIONALE FOR TRANSFUSION

The efficacy of transfused RBC's may be related to three mechanisms, circulatory (volume) effects, rheological effects (blood flow/viscosity) and effects on oxygen transportation.^[2]

Circulatory volume expansion of RBC transfusions is immediate but is not usually recommended except for cases of trauma or surgical cases with massive blood loss as there is a risk of transfusion-associated circulatory overload.

Rheological effect on blood viscosity is an important factor for maintaining microvascular circulation. High haematocrit will cause an increase in viscosity and may compromise the microcirculation.

Oxygen (O_2) delivery rises with the rise in Hb (approximately 1 g/dL per unit of RBC transfused)

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and is often viewed as the main reason for giving blood.

Oxygen is carried in the blood from the lungs to the other organs predominantly bound to the haemoglobin group of Hb within the RBC. Negligible amount of oxygen is carried in plasma in a dissolved form. The sum of these two components makes up the total arterial oxygen content (CaO_2).

$$CaO_2 = (Hb \times 1.34 \times SaO_2) + (0.003 \times PaO_2)$$

(SaO_2 is the Hb oxygen saturation, [Hb] is the blood Hb concentration, and PaO_2 is the partial pressure of oxygen in arterial blood).

One gram of Hb carries 1.34 ml of oxygen as oxyhaemoglobin, and a factor of 0.003 determines the amount of oxygen carried dissolved in plasma.

Under normal physiological conditions, the amount of oxygen dissolved in plasma is negligible compared with the amount of oxygen that is bound to Hb.

The key issue in determining tissue oxygenation is the balance between the global DO_2 oxygen delivery (DO_2) and the global oxygen consumption (VO_2).

Oxygen delivery is a function of cardiac output (CO) and the arterial oxygen content (CaO_2)

$$DO_2 = CO \times CaO_2$$

VO_2 is global oxygen consumption and will depend on metabolic rate as well as ability of tissues to utilize oxygen.

$$VO_2 = CO \times (CaO_2 - CvO_2)$$

CvO_2 – total venous oxygen content.

Oxygen extraction ratio is the ratio of VO_2/DO_2 and is normally around 20-30%, allowing a significant safety margin. The rate of delivery normally exceeds consumption by a factor of four. Thus, if intravascular volume is maintained while bleeding and cardiovascular status is not impaired, DO_2 will remain adequate until the haematocrit falls below 10%. This is due to a compensatory increase in cardiac output, the rightward shift of the oxygen-Hb dissociation curve and increased oxygen extraction [Figure 1].

As a result of this sufficient reserve, initially despite a decrease in DO_2 , VO_2 is unaffected and remains

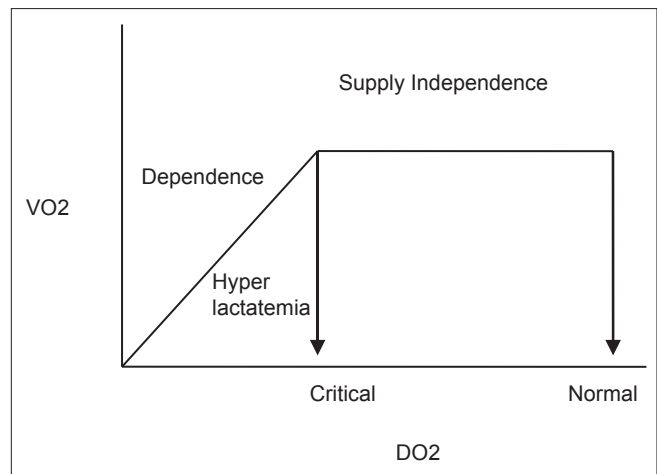


Figure 1: Oxygen delivery oxygen consumption relationship

stable (this is described as DO_2 -independence). However, as the DO_2 decreases and approaches VO_2 , a critical DO_2 point (DO_2 CRIT) is reached when the DO_2 is no longer sufficient to keep up with the VO_2 , resulting in a drop in VO_2 and development of tissue ischemia.

This DO_2 - VO_2 relationship gives us a rationale for using RBC transfusions in order to improve DO_2 to tissues, but this may not always be so. Using central venous oxygen saturation (SvO_2), a DO_2/VO_2 based target for RBC transfusion in septic patients has not shown benefit in two recent trials.^[5,6]

RATIONALE FOR AVOIDING TRANSFUSION

Observational studies have shown an association between anaemia and increased mortality, however, there is no clear data suggesting whether correction of anaemia will improve mortality.^[2] RBC transfusions result in an increase in Hb, but an immediate increase in DO_2 is not seen. The reasons for this transient inability of transfused RBC's to effectively deliver oxygen to the end organs may be explained by the effects of blood storage^[7] [Table 1].

Also, most patients with acute anaemia will increase tissue DO_2 by increasing cardiac output over a range of Hb concentrations. Other mechanisms for adaptation to anaemia include redistribution of blood flow to essential circulatory beds, increased coronary blood flow, increased oxygen extraction and increase in RBC 2,3-diphosphoglycerate.

The other rationale for avoiding RBC transfusions is due to the risks and complications of transfusion that are enlisted in the Table 2 below.^[8]

Table 1: Storage lesions

Biochemical changes	Increased levels of potassium, sodium, lactate, glucose, increased cytokines (IL-1 β , IL-6, IL-8, MCP1) Decrease in pH, ATP and 2,3-DPG depletion
Altered functionality	Increased RBC rigidity, reduced deformability Enhanced adhesion to endothelial cells Altered affinity to oxygen Reduced ability to bind and deliver NO
Organ injury	Inflammation Coagulopathy Impaired RBC-induced vasodilation Impaired oxygen delivery

RBC – Red blood cell; IL – Interleukin; MCP – Monocyte chemoattractant protein; 2,3-DPG – 2,3-diphosphoglycerate; ATP – Adenosine triphosphate; NO – Not other

Table 2: Risks and complications of RBC transfusions

Infection with transfusion-transmitted pathogens (e.g., viruses, bacteria, and parasites)
Allergic and immune transfusion reactions (e.g., 'immunologic transfusion reactions' and 'Transfusion-associated immune and non-immune-mediated haemolysis' and 'TRALI')
Volume overload ('TACO')
Massive transfusion leading to hyperkalaemia
Hypocalcaemia resulting from citrate toxicity
Hypothermia
Transfusion-mediated immunosuppression and increased risk of post-operative bacterial infection
Cancer recurrence in patients with colorectal cancer

TRALI – Transfusion-related acute lung injury; TACO – Transfusion associated circulatory overload; RBC – Red blood cell

The anaemia and blood transfusion in critical care (ABC) study, a large epidemiologic survey of 3534 patients in 146 western European intensive care units (ICUs) showed increased mortality rates (ICU and hospital) in transfused patients.^[9]

In view of this data and lack of clarity of appropriate transfusion trigger, a single pre-specified transfusion criterion is not justified as an indication for RBC transfusion.^[10]

RED BLOOD CELL TRANSFUSION TRIGGERS

Different transfusion thresholds have been studied in different patient populations.^[11-18] An appropriate transfusion trigger is defined as one which balances the benefit of treating anaemia and the risk of unnecessary transfusions.

Generally accepted terminologies include 'liberal strategy' with transfusion threshold Hb of 9-10 g/dL and 'restrictive strategy' with transfusion Hb thresholds of 7-8 g/dL.

Large randomized controlled trials (RCT's) studying liberal versus restrictive strategies for transfusion are relatively few and include select group of patients like critically ill patients, cardiac surgical patients, and elderly orthopaedic patients with cardiovascular risk.

EVIDENCE IN CRITICALLY ILL PATIENTS

Transfusion requirements in critical care [TRICC]^[11] trial was a multicentre randomised controlled clinical trial of transfusion requirements in critically ill patients. It enrolled 838 critically ill patients with euvolemia who after initial treatment had Hb concentrations of < 9.0 g/dl within 72 h after admission to the ICU. 418 patients were assigned to a restrictive strategy of transfusion, in which red cells were transfused if the Hb concentration dropped below 7.0 g/dL and Hb concentrations were maintained at 7.0-9.0 g/dL and 420 patients were assigned to a liberal strategy, in which transfusions were given when the Hb concentration fell below 10.0 g/dL and Hb concentrations were maintained at 10.0-12.0 g/dL. No difference in overall 30 days mortality in the two groups was seen but the 30 days mortality rates were significantly lower with the restrictive transfusion strategy in patients who were less acutely ill with an Acute Physiology and Chronic Health Evaluation II score of <20 and in patients who were <55 years of age. The authors concluded that a restrictive strategy of red-cell transfusion is at least as effective as and possibly superior to a liberal transfusion strategy in critically ill patients, with the possible exception of patients with acute myocardial infarction (MI) and unstable angina.^[11]

A recent RCT^[12] on 'lower versus higher Hb threshold for transfusion requirements in septic shock' (TRISS) patients did not find any difference in mortality at 90 days, rates of ischemic events and use of life supports.

EVIDENCE FOR ELDERLY ORTHOPEDIC PATIENTS WITH CARDIOVASCULAR RISKS

Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair (FOCUS) trial^[13] by Carson *et al.* looked at elderly patients with a history of risk factors for cardiovascular disease who were undergoing hip surgery. It randomised 2016 elderly patients to either restrictive or liberal transfusion strategies. The liberal transfusion group received immediate transfusion of one unit of packed

RBCs plus subsequent transfusions to raise the Hb level to > 10 g/dL whenever it fell below this level. The restrictive transfusion group received single unit transfusions only if they developed symptoms of anaemia (defined as chest pain, orthostatic hypotension, tachycardia unresponsive to fluid resuscitation, or congestive heart failure) or, in the absence of symptoms, when the Hb level fell below 8 g/dL. The study concluded that liberal transfusion strategy was not associated with improved outcomes (mortality, ability to walk independently, acute coronary syndrome and other complications) compared with a restrictive transfusion strategy. The restrictive transfusion strategy was however associated with a non-statistically significant higher risk of MI.

EVIDENCE FOR CARDIAC SURGICAL PATIENTS

Trials suggest that a restrictive transfusion strategy with an Hb threshold of 8 g/dL appears to be safe in patients undergoing cardiac surgery with cardiopulmonary bypass. The first trial by Bracey *et al.*^[14] randomly assigned 428 consecutive patients undergoing coronary artery bypass grafting to the post-operative transfusion either at a Hb < 8 g/dL, or at an institutional guideline of Hb < 9 g/dL. There was no difference in morbidity, mortality, or self-assessment for fatigue or anaemia between the two groups. Post-operative transfusion rates were significantly lower for the group with the lower transfusion threshold (0.9 vs. 1.4 RBC units/patient), amounting to savings of 500 RBC units per 1000 CABG. The second trial, 'transfusion requirements after cardiac surgery' TRACS^[15] randomized 502 consecutive patients who underwent cardiac surgery with cardiopulmonary bypass to a liberal or restrictive transfusion strategy (to maintain haematocrit at 30% or 24%) throughout surgery and the post-operative period. The primary outcome was a composite endpoint of 30 days all-cause mortality, cardiogenic shock, acute respiratory distress syndrome, or acute renal injury requiring dialysis or haemofiltration. There was no difference in this composite endpoint between the groups (10% liberal versus 11% restrictive). Independent of transfusion strategy, the number of transfusions correlated with clinical complications and death (hazard ratio 1.2 for each unit transfused).

Based on these trials, a restrictive transfusion threshold (i.e. to maintain the Hb above 8 g/dL or the haematocrit above 24%) appears to be safe in this population.

EVIDENCE IN HAEMODYNAMICALLY STABLE UPPER GASTROINTESTINAL BLEED

A single centre trial^[16] randomized 921 patients with acute upper gastrointestinal (GI) bleeding to a restrictive or a liberal transfusion strategy (transfusion threshold of 7 g/dL versus vs. 9 g/dL) and determined all-cause mortality at 45 days. Patients with massive bleeding, acute coronary syndrome, history of peripheral vascular disease or stroke, and Hb > 12 g/dL were excluded. All patients underwent emergent upper GI endoscopy within 6 h and were treated with endoscopic therapy as needed. When compared with the liberal transfusion threshold, the restrictive transfusion threshold in these bleeding patients resulted in a lower per cent of patients undergoing transfusion (49% vs. 86%) and fewer transfusions (mean 1.5 vs. 3.7 units) with fewer complications including rebleeding. The mortality from uncontrolled bleeding and also the all-cause mortality were lower in a restrictive group than liberal group.

Therefore a restrictive transfusion strategy may also be extrapolated to patients with bleeding from other sites (e.g. gynaecologic, trauma) who are haemodynamically stable, not at increased risk for complications (e.g. from unstable coronary artery disease) and who have access to rapid surgical intervention.^[16]

EVIDENCE IN PATIENTS WITH TRAUMATIC BRAIN INJURY

Experimental research studies as well as human observational and physiologic studies have shown that lower Hb concentrations are consistently associated with worse physiologic parameters and clinical outcomes; however, this relationship may not be altered by more aggressive use of RBC transfusions.^[17]

A small RCT^[18] ($n = 67$) evaluated restrictive versus a liberal transfusion strategy in patients with moderate to severe closed head injury following multiple trauma. Patients with Hb < 9 were included and randomized to a restrictive RBC transfusion strategy (Hb 7.0 g/dL and maintained between 7.0 and 9.0 g/dL) or a liberal strategy (Hb 10.0 g/dL and maintained between 10.0 and 12.0 g/dL). The 30 days all-cause mortality, presence of multiple organ dysfunction and changes in multiple organ dysfunction from baseline scores were similar between the restrictive and liberal transfusion groups.

SYSTEMATIC REVIEWS AND META-ANALYSIS FOR DIFFERENT TRANSFUSION TRIGGERS

The findings of a Cochrane collaboration meta-analysis (2012)^[19] which included 19 trials with a total of 6264 patients were as follows. Restrictive transfusion strategies reduced the risk of receiving a RBC transfusion by 39% (risk ratio [RR] 0.61, 95% confidence interval [CI] 0.52 to 0.72). The volume of RBCs transfused was reduced on average by 1.19 units (95% CI: 0.53-1.85 units). Restrictive transfusion strategies did not appear to impact the rate of adverse events compared to liberal transfusion strategies (i.e. mortality, cardiac events, MI, stroke, pneumonia and thromboembolism). Restrictive transfusion strategies were associated with a statistically significant reduction in hospital mortality (RR: 0.77, 95% CI: 0.62-0.95) but not 30 days mortality (RR: 0.85, 95% CI: 0.70-1.03). The use of restrictive transfusion strategies did not reduce functional recovery, hospital or ICU length of stay. The majority of patients randomised were included in good-quality trials, but some items of methodological qualities were unclear. There were no trials in patients with acute coronary syndrome.

Thus, this Cochrane meta-analysis^[19] supports the use of restrictive transfusion triggers in most patients, including those with pre-existing cardiovascular disease. As there are no trials, the effect of restrictive transfusion triggers in high-risk groups, such as acute coronary syndrome, needs to be tested in further large clinical trials.

In another meta-analysis,^[20] pooled results from three trials with 2364 participants were included. This meta-analysis showed that a restrictive Hb transfusion trigger of <7 g/dL resulted in reduced in-hospital mortality, total mortality, rebleeding, acute coronary syndrome, pulmonary oedema and bacterial infections compared with a more liberal strategy. Thus, in patients with critical illness or bleed, restricting blood transfusions by using Hb trigger of < 7 g/dL significantly reduces cardiac events, rebleeding, bacterial infections and total mortality.

Thus, overall the evidence supports the notion that restrictive transfusion strategies are at least as good as (and are likely to be better than) liberal transfusion approaches with regards to clinical outcomes of the patients, including those with cardiac conditions excluding acute coronary syndrome. While it seems that liberal RBC transfusions are more likely to cause

harm than benefit in the majority of patients, there may be a relatively small group of patients with acute coronary syndrome in whom the benefit of transfusion is likely to outweigh the harm.

TRANSFUSION THRESHOLDS RECOMMENDATIONS

Different societies^[21,22] have published RBC transfusion guidelines. The Hb level chosen in these guidelines are based on the results from clinical trials. It is also important to recognise that lower Hb thresholds have not been tested in most clinical settings and may be tolerated by many patients.

Table 3 illustrates the thresholds for different guidelines.^[23]

SUMMARY OF TRANSFUSION RECOMMENDATIONS

In general, the different guidelines^[3,10,21,22] have the common recommendation that transfusion is not indicated for Hb > 10 g/dL, but the lower threshold varies from 6 to 8 g/dL. The American Association of Blood Banks guideline recommendations^[22] for haemodynamically stable patients without active bleeding are mentioned in Table 4.

This guideline also emphasizes that the decision to transfuse should not be based only on Hb level but should incorporate individual patient characteristics and symptoms.

Clinical judgment is critical in the decision for RBC transfusion above or below the specified Hb threshold and will be directed by clinical situations like duration of anaemia, intravascular volume, extent of the surgery, the probability for massive blood loss and the presence of coexisting conditions such as impaired pulmonary function, inadequate cardiac output, myocardial ischemia, or cerebrovascular or peripheral circulatory disease.^[3]

Assessment of the post-transfusion Hb level can be performed as early as 15 min following transfusion, as long as the patient is not actively bleeding. Major exceptions to the use of a threshold of 7-8 g/dL are given in the Table 5.^[22]

MAXIMUM SURGICAL BLOOD ORDERING SCHEDULE

Introduction

Maximum surgical blood ordering schedule (MSBOS) is a scheduled list of a number of units of blood to

Table 3: Transfusion thresholds for guidelines from different societies

	CAP 1998	ASA 2006	STS 2007	SCCM 2009	SIMTI 2011	AABB 2012
Target population	General	Peri-operative	Cardiac surgery	Critically ill	Perioperative general	Hospitalised haemodynamically stable
RBC usually indicated (g/dL)	Hb<6	Hb<6	Hb<6 (Hb<7 in post-operative with risk of end organ ischaemia)	Hb<7 if ventilated, trauma or stable cardiac disease (Hb<8 if acute coronary syndrome)	Hb<6 (Hb 6-8 if risk factors present; Hb 6-10 if symptoms of hypoxia present)	Hb<7 in critically ill patients; Hb<8 in surgical patients, or patients with pre-existing cardiovascular disease; when symptoms are present
RBC rarely indicated (g/dL)	Hb>10	Hb>10	Hb>10	Hb>10	Hb>10	
Equivocal (g/dL)	Hb 6-10	Hb 6-10				Patients with acute coronary syndrome
Additional factors to be considered	Peripheral tissue oxygenation, clinical signs and symptoms, extent and rate of bleeding	Ischaemia, extent/ rate of bleeding, volume status, risk factors for hypoxia complications	Age, severity of illness, cardiac function, ischaemia, extent/rate of blood loss, SVO ₂	Volume status, shock, duration/extent of anaemia, cardio-pulmonary parameters	Rate of blood loss, risk factors, symptoms of hypoxia/ ischaemia	Symptoms like chest pain, orthostatic hypotension, unresponsive tachycardia, heart failure

RBC – Red blood cell; Hb – Haemoglobin; AABB – American Association of Blood Banks; ASA – American Society of Anaesthesiologists; CAP – College of American Pathologists; SCCM – Society of Critical Care Medicine; SIMTI – Italian Society of Transfusion Medicine and Immunohaematology; STS – Society of Thoracic Surgeons; SVO₂ – Mixed venous oxygen saturation. Adapted with permission from Shander *et al*

Table 4: AABB recommendations for RBC transfusion

Hb<6 g/dL – Transfusion recommended except in exceptional circumstances
Hb 6-7 g/dL – Transfusion generally likely to be indicated
Hb 7-8 g/dL – Transfusion should be considered in post-operative surgical patients, including those with stable cardiovascular disease, after evaluating the patient's clinical status (clinical considerations will include on-going loss)
Hb 8-10 g/dL – Transfusion generally not indicated, but should be considered for some populations (e.g., those with symptomatic anaemia, on-going bleeding, acute coronary syndrome with ischemia)
Hb>10 g/dL – Transfusion generally not indicated except in exceptional circumstances

AABB – American Association of Blood Banks; RBC – Red blood cell; Hb – Haemoglobin

Table 5: Exceptions to RBC transfusion threshold of 7-8 g/dL

Symptomatic patients may be transfused at higher Hb levels to treat symptoms (symptoms of anaemia requiring transfusion include symptoms of myocardial ischemia, orthostatic hypotension or tachycardia unresponsive to fluid replacement)
Patients with acute coronary syndromes, acute heart failures have not been adequately evaluated in clinical trials and may require higher thresholds for transfusion
Threshold-based transfusion is not appropriate for patients requiring massive transfusion. In haemodynamically unstable patients transfusion cannot be guided by Hb levels alone and often cannot await interval measurements of Hb
Transfusion in palliative care patients. Institution specific approaches are different for this indications

RBC – Red blood cell; Hb – Haemoglobin

be cross-matched for different elective surgical procedures. Friedman *et al.*^[24] proposed the concept of MSBOS as early as 1976. With increasing demand for this scarce natural resource, the concept of MSBOS has now been revisited in a number of studies. The advantages of MSBOS are enumerated in the Table 6.

Steps for implementation of maximum surgical blood ordering schedule

The implementation of MSBOS as explained in the 'guidelines for implementation of a MSBOS' – 'The British Committee for Standards in Haematology Blood Transfusion Task Force' are simplified into a step-wise approach as below:^[25]

Step-1

Differentiate surgical procedures into those requiring group and antibody screen only and those requiring grouping, antibody screen and cross-matching of blood.

Step-2

Retrospective hospital blood usage data analysis to evaluate the need of group and cross-match for list of commonly performed elective procedures. Cases with complications and exceptional massive transfusions are excluded. Data should be large enough to yield relevant conclusions. Presence of Anaesthesia Information Monitoring Systems with blood usage data will facilitate the collection of information.^[26]

Step-3

Evaluate the number of units transfused (T) and the number of units cross-matched (C) for specified elective surgical procedure. C/T ratio, transfusion probability and transfusion index for a specified elective surgical procedure is then determined.

C/T ratio = Number of units cross-matched/number of units transfused.

Table 6: Advantages of MSBOS

Reduction in unnecessary blood preparation and wastage due to expiry
Better availability of blood products for emergencies
Reduction in workload for the blood banks
Reduction in costs associated with process of unnecessary cross-match
MSBOS – Maximum surgical blood ordering schedule

Table 7: Problems with MSBOS

Transfusion needs are often subjective. Transfusion triggers are not applicable in acute blood loss scenarios
No fool proof method of blood loss estimation which drives transfusion
MSBOS doesn't take in to account specific pre-operative patients considerations
MSBOS needs to be institution specific
Failure of universal implementation across institute
Requires monitoring of compliance, periodic review for proper usage of blood products
MSBOS can't take in to account cancellations, intolerabilities or intra operative modifications in surgical techniques
MSBOS – Maximum surgical blood ordering schedule

Ideal value of C/T Ratio is 1. Higher values indicate that more number of blood unit's is cross-matched unnecessarily. However, a realistic C/T ratio of 2–2.5 can be indicative of significant blood usage.

Also, transfusion probability (%T) for a procedure can be determined as the number of patients transfused to number of patients cross-matched.

$\%T = \text{Number of patient transfused} \times 100 / \text{number of patients cross-matched}$.

A value of > 30 is considered as indicative of significant blood usage.

Transfusion index for a procedure is defined as the number of units transfused to number of patients cross-matched.

Transfusion index = Number of RBC units transfused/ number of patients cross-matched.

Step-4

Constructing MSBOS draft schedule using retrospective data. Elective surgical procedures are allotted to the 'only group and screen' category or to a 'group and cross-match' category.

For some elective surgical procedures such as hysterectomies, caesarean section, hernia repair, transrectal ultrasound-guided biopsy and biopsies, the chances of requiring transfusions are rare. In such

Table 8: Example of MSBOS

Procedures	Units
General surgery	
Breast biopsy	T/S
Colon resection	2
Exploratory laparotomy	T/S
Gastrectomy	2
Laryngectomy	2
Mastectomy, radical	T/S
Pancreatectomy	4
Splenectomy	2
Thyroidectomy	T/S
Orthopaedics	
Arthroscopy	T/S
Laminectomy	T/S
Spinal fusion	3
Total hip replacement	3
Total knee replacement	T/S
Obstetrics/gynaecology	
Abdomino-perineal repair	T/S
Cesarean section	T/S
Dilatation and curettage	T/S
Hysterectomy abdominal	T/S
Hysterectomy laproscopic	T/S
Radical hysterectomy	2
Cardiothoracic	
Aneurysm resection	6
Redo coronary artery bypass graft	4
Primary coronary artery bypass graft	2
Lobectomy	T/S
Lung biopsy	T/S
Vascular	
Aortic bypass with graft	4
Endarterectomy	T/S
Femoral-popliteal bypass with graft	2
Urology	
Bladder, transurethral resection	T/S
Radical nephrectomy	3
Prostatectomy, transurethral	T/S
Radical prostatectomy, perineal	2
Renal transplant	2

T/S – Type and screen; MSBOS – Maximum surgical blood ordering schedule

cases, only group and antibody screen approach is safe. The advantage of such an approach far outweighs any disadvantage like emergency requirement of blood products that is more often perceived than real.^[27] The advantage in terms of blood utilisation and cost has been well-established. It also leads to improved inventory control, which permits enhanced production of blood components and prevents obsolescence of blood.

Step-5

Pre-implementation consensus by stakeholders such as surgeons, anaesthesiologist and blood bank is important to ensure ease of implementation. Draft

has to be circulated to surgical and anaesthesia teams. Various factors are to be considered before deciding MSBOS. These include speed and ease of availability of blood products in case of emergency, complexity of procedures and select a group of patients for specified elective procedures.

Step-6

Implement the institution specific MSBOS. This includes the following steps:

- Induction of MSBOS
- Preparation of MSBOS cards
- Training of stakeholders.

Monitoring of compliance forms the part of Plan-Do-Study-Act cycle. Computerised blood ordering will help to systematically retrieve procedure-specific data.

Step-7

Regular reviews and revisions are done as necessary. MSBOS needs to be regularly updated as there can be changes or refinements in surgical procedures or blood conservation techniques.

Problems with MSBOS: The Table 7 enlists the problems with MSBOS.

Examples of MSBOS recommendations for different procedures and institutions from literature can be referred as a draft while developing institute specific MSBOS algorithm [Table 8].^[28]

SUMMARY

Institutional MSBOS algorithm developed with data analysis and consensus of surgeons, anaesthesiologist and blood banks can reduce the over ordering and wastage of blood.

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Source of Support: Nil, **Conflict of Interest:** None declared

Announcement

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12. Passport size photograph- one

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