

Perioperative Transfusion Strategies: A National Survey among Anaesthetists

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Abstract

A current concern in perioperative transfusion therapy is the balance between maintaining adequate haemoglobin level and yet avoiding unnecessary homologous blood transfusion. Strategies to minimise the perioperative use of homologous blood include redefining the traditional transfusion trigger of "10/30 rule", and the use of autologous transfusion therapy. Current recommendations for transfusion triggers advocate determining the "minimum acceptable haemoglobin level" for patients according to various other physiological or surgical factors. The current status of practice amongst anaesthetists in the abovementioned transfusion strategies was assessed using a national survey. An overall response rate of 59.4% was obtained. Results showed wide variation among respondents in their criteria used for preoperative and intraoperative transfusion. Recommendations on perioperative transfusion triggers made by various authors were also summarised. Autologous transfusion therapy was also not frequently practised—the reasons for this were identified. We concluded that in order to continually improve on the anaesthetic community's quality of perioperative care, continued education on the subject must be carried out. Certain practical issues also need to be addressed to facilitate the use of perioperative autologous transfusion therapy.

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Introduction

It has been estimated that almost 50% of all blood products are administered by anesthesiologists,¹ and that two-thirds of all red blood cell transfusions are given in the perioperative period.² This is not surprising as anaesthetists most frequently encounter clinical scenarios that require decisions on ordering blood transfusion in the perioperative period.

Clinicians have traditionally adopted the "10/30 rule"²⁻⁴ as the perioperative "transfusion trigger" for all patients, ie. to transfuse blood whenever the haemoglobin level is less than 10 g/dl or haematocrit (Hct) less than 30%. With increasing awareness of the possible complications of homologous blood transfusion, current trends in transfusion therapy favour strategies to minimise the use of homologous blood wherever possible. One such strategy is to redefine the transfusion trigger, departing from the strict universal 10/30 rule, while another is the use of perioperative autologous transfusion therapy.^{2,5,6}

Surveys on transfusion practices amongst anaesthetists^{1,7,8} have previously been conducted by various workers to establish a database for designing practical measures and educational programmes to promote the

judicious use of blood products. In a similar effort, this national survey was conducted amongst all anaesthetists to ascertain their: 1) perioperative transfusion triggers; 2) attitudes and practice of perioperative autologous transfusion therapy, in adult patients.

Materials and Methods

Study Population

The chosen study population included all qualified anaesthetists in Singapore who were either practising in government or restructured hospitals (subsequently referred to as "Institutional Anaesthetists"), or private hospitals (referred to as "Private Anaesthetists"). The final namelist was compiled from the membership list of the Singapore Society of Anaesthesiologists and from the staff roll of each government or restructured hospital.

In an attempt to obtain a high response, one of the authors (LS) visited each government or restructured hospital at least twice to personally conduct the survey amongst every anaesthetist present. The rest of the study population who could not be reached in that manner were surveyed by mail. The survey was closed after eight weeks.

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Questionnaire

The first part of the questionnaire aimed to ascertain the respondents' preoperative and intraoperative transfusion triggers. Three different preoperative scenarios were presented each involving an adult patient with a haemoglobin level deemed inadequate by the respondent. In the first scenario, the respondents were asked if they would order transfusion for this patient preoperatively when the surgery was purely non-urgent. This was to assess their tendency to administer blood when there was no surgical need to raise the haemoglobin level rapidly. They were then asked to indicate their transfusion triggers in the next two scenarios where the patient was scheduled for: 1) a more urgent elective surgery that had to be done as soon as possible (ASAP Surgery) and 2) emergency surgery (E Surgery) respectively. These more urgent scenarios ruled out the option of delaying surgery to allow for non-transfusional means of increasing the haemoglobin level. Intraoperative transfusion triggers were assessed by asking the respondents to indicate their criteria for administering blood transfusion during surgery.

The second part of the questionnaire inquired about the respondents' attitude, extent of practice, and the factors that hindered their practice of autologous transfusion therapy.

Results

Response Rate

One hundred and thirty anaesthetists were surveyed. Of these, 89% (67/75) of the institutional anaesthetists and 18% (10/55) of the private anaesthetists responded, giving an overall response rate of 59.2%.

TABLE I: PATTERN OF TRANSFUSION TRIGGERS OF RESPONDENTS FOR URGENT SURGERY

Pattern of transfusion triggers	Number (Percentage)	
	ASAP Surgery	E Surgery
1. Would not transfuse at all	4 (5.2%)	10 (12.9%)
2. Practicing strict 10/30 rule	4 (5.2%)	7 (9.1%)
3. Using Hb level as only criteria for transfusion but allows minimum acceptable Hb of < 10 g/dl	20 (26%)	20 (26%)
4. Transfusion based on single minimum acceptable Hb level but considers non-Hb factors	36 (46.7%)	35 (45.5%)
5. Different minimum acceptable Hb levels depending on the presence of non-Hb factors	13 (16.9%)	5 (6.5%)
Total (n = 77)	77 (100%)	77 (100%)

ASAP Surgery: surgery that needs to be done as soon as possible

E Surgery: emergency surgery

Hb: haemoglobin

Note: Within groups 2, 3 and 4, variations exist in the minimum acceptable Hb used by the respondents (ranging from 5 to 10 g/dl).

Transfusion in the Preoperative Period

Non-urgent surgery: When the patient was scheduled for non-urgent surgery, 66.2% of the respondents would order homologous blood transfusion if the haemoglobin level was deemed inadequate, whereas 33.8% of the respondents would not order transfusion immediately, but would delay the surgery, investigate and treat the anaemia first.

Urgent surgery: Given the more 'urgent scenario, an expected larger proportion of respondents (94.8% for ASAP Surgery and 87.1% for E Surgery) would now order homologous blood transfusion for patients with inadequate haemoglobin levels, and among these, there was a wide variation in their criteria for initiating transfusion. There were differences in what each considered as the preoperative "minimum acceptable haemoglobin level" (i.e. the minimum level under which transfusion would be initiated), and how "non-haemoglobin factors" (e.g. underlying medical condition, hypermetabolic and chronic anaemic states) would alter this minimum acceptable level. Table I describes the pattern of the respondents' practice in more detail. The non-haemoglobin factors indicated by the respondents are listed in Table II. The majority no longer practised the strict 10/30 rule, but a sizable proportion (31.2% in ASAP Surgery and 35.1% in E Surgery) still based their criteria for transfusion on a single haemoglobin level (with no reference to non-haemoglobin factors), of which many would consider levels of less than 10 g/dl (ranging from 9 to 5 g/dl) as the minimum acceptable level. Only a small proportion of respondents considered accepting different minimum haemoglobin levels in relation to the non-haemoglobin factors.

Transfusion in the Intraoperative Period

Wide variations also existed among the respondents' criteria for intraoperative transfusion. Slightly more than half (54.5%) of the respondents would initiate

TABLE II: NON-HAEMOGLOBIN FACTORS QUOTED BY THE RESPONDENTS

Non-haemoglobin factors quoted by respondents	
<i>Factors requiring higher minimum acceptable haemoglobin level</i>	
1. Poor ASA status	e.g. ASA III or IV
2. Cardiovascular disease	e.g. ischaemic heart disease, hypertension, low cardiac output states
3. Respiratory disease	e.g. chronic obstructive lung disease
4. Neurological disease	e.g. cerebrovascular disease, transient ischaemic attacks
5. Surgical factors	e.g. extensive surgery, anticipated massive blood loss
6. Old age	
<i>Factor allowing lower minimum acceptable haemoglobin level</i>	
1. Chronic anaemic states	e.g. Chronic renal failure

TABLE III: INTRAOPERATIVE TRANSFUSION TRIGGERS

Pattern of intraoperative transfusion triggers	Number	Percentage
Those who would transfuse if Hb decreases below		
10 g/dl	15	19.4%
9 g/dl	4	5.2%
8 g/dl	14	18.2%
7.5 g/dl	1	1.3%
7 g/dl	7	9.1%
5 g/dl	1	1.3%
Those who would transfuse if the absolute volume of blood loss is (without reference to Hb level)		
0.5 l	1	1.3%
1.0 l	2	2.6%
Replace volume for volume loss	2	2.6%
Those who would transfuse if the proportion of total blood volume loss is (without reference to Hb level)		
10%	11	14.3%
15%	7	9.1%
20%	11	14.3%
No response to question	1	1.3%
Total (n = 77)	77	100.0%

Hb: haemoglobin

TABLE IV: METHODS OF ESTIMATING INTRA-OPERATIVE HAEMOGLOBIN LEVEL

Methods quoted by respondents who based on the haemoglobin level as the intraoperative transfusion trigger (n = 42)		
Method	Number	Percentage
1. Blood sample for machine haemoglobin analysis	28	66.7%
2. Estimating from amount of blood loss	8	19.0%
3. Others	6	14.3%
Total (n = 42)	42	100.0%

transfusion based on the estimated haemoglobin level, i.e. if it was estimated to have decreased below a minimum acceptable level due to surgical bleeding. The rest of the respondents would initiate transfusion based on the proportion of total blood volume loss or on an absolute volume of blood loss without reference to the haemoglobin level (Table III). Respondents who based their decision on estimated haemoglobin level also had differing methods of estimation (Table IV).

Perioperative Autologous Transfusion Therapy

Attitude towards autologous transfusion therapy

Respondents were asked about their attitude and frequency of practice in the 2 types of perioperative autologous transfusion therapy:

1. Autologous predonation – patients predonate their blood several weeks before planned surgery. All except 1.3% of the respondents indicated that they would use this form of therapy for their patients if the conditions were appropriate.

TABLEV: EXTENT OF PRACTICE OF PERIOPERATIVE AUTOLOGOUS TRANSFUSION

Proportion of suitable patients given therapy	Percentage of respondents for	
	AP	ANH
0%	6.5%	14.3%
1 to 10%	70.2%	55.9%
11 to 20%	7.8%	7.8%
21 to 40%	3.9%	6.5%
41 to 50%	3.9%	2.6%
51 to 70%	1.3%	2.6%
71 to 90%	1.3%	2.6%
no answer	5.1%	7.7%

AP: autologous predonation
 ANH: acute normovolaemic haemodilution

TABLE VI: FACTORS HINDERINGTHEPRACTICEOFAUTOLOGOUS TRANSFUSION

Factors quoted by the respondents (n = 77)	Respondents	
	Number	Percentage
1. Too late to arrange for it during preoperative round	47	61.0%
2. Surgeons are responsible for arrangements	44	57.1%
3. Inadequate time due to long surgical list	33	42.9%
4. Need more information on administrative process	6	7.8%
5. The therapy process is too tedious	4	5.2%
6. Too impractical to administer the therapy	2	2.6%
7. Need more information on technique	1	1.3%
8. Others	6	7.8%

Note: Each respondent is allowed to quote more than one factors.

2. Acute normovolaemic haemodilution – autologous blood is collected immediately before surgery with simultaneous intravenous replacement of crystalloid or colloid solutions to maintain normovolaemia. 95% of respondents indicated that they would use this therapy for their patients if the conditions were appropriate, 3% would not and 5% were not sure.

Extent of the Practice of Autologous Transfusion

The respondents were asked to estimate the proportion of patients in their practice that were given perioperative autologous transfusion. Table V gives a breakdown of the number of respondents in relation to the proportion of patients that were given either type of therapy. The majority only administered the therapy in up to 10% their patients who were suitable for it. They were then asked to list the factors preventing; them from practicing autologous transfusion more extensively. Table VI gives a breakdown of the number of respondents quoting the various factors. The main factors cited for this low rate of practice centered on the technique’s tedious process versus the competing time demands of a busy surgical list. The other important factor was that arrangements for autologous predonation must be made by the surgeon during the patient’s surgical consulta-

TABLE VII: RECOMMENDATIONS ON MINIMUM ACCEPTABLE HAEMOGLOBIN LEVEL FROM VARIOUS SOURCES

Source	MA Hb	Non-Hb factors/Considerations
National Institute of Health Consensus Conference 1988 ²	<7 g/dl 7 g/dl >10 g/dl	acceptable in chronic anaemia usually require transfusion usually needs no transfusion
Robertie et al (1990) ¹⁰	6 g/dl 8 g/dl 10 g/dl	compensated chronic anaemia, healthy patients for haemodilution, patients for hypothermic cardio-pulmonary bypass surgery where >500 ml blood loss is expected, for well compensated ASA II and III patients in the intraoperative and postoperative period, for uncomplicated, stable cardiac surgical patients postop patients unable to increase cardiac output or regional blood flow to compensate for haemodilution, postoperative patients who have increased O ₂ demand or decreased cardiac reserve, patients >65 y old, patients requiring >48 h of mechanical ventilation
Carson and Willett (1993) ⁴	6 to 8 g/dl 10 g/dl	young patients, patients without systemic diseases, long life expectancy presence of cardiovascular, respiratory or neurological diseases, on Beta-blocker therapy, old patients, short life expectancy
Stehling and Simon (1994) ³	6 g/dl 7 g/dl 8 g/dl 10 g/dl	young, healthy patients with acute blood loss, patients with compensated chronic anaemia most individuals, even old patients mild to moderate systemic diseases patients unable to compensate for anaemia

MA Hb: minimum acceptable haemoglobin level; Hb: haemoglobin

Note: Normovolaemia must be maintained in all cases

tion, and not during the anaesthetist's preoperative round when it would be too late.

Discussion

Whether to increase the haemoglobin level of patients by red blood cell transfusion remains a perioperative dilemma faced constantly by anaesthetists. Defining a threshold for initiating transfusion therapy and an endpoint for that therapy is not always a simple task. Clinicians have traditionally adopted the "10/30 rule" as the transfusion trigger for all patients, but it is now recognised that this rule evolved more on the basis of tradition rather than scientific data.⁹

While it is accepted that the haemoglobin level of 10 g/dl (Haematocrit 30%) allows optimal tissue oxygen delivery (through the optimal balance between oxygen capacity and blood viscosity),^{10,11} extensive current data have shown that lower levels are still well tolerated by the majority of patients.^{2-4,12,13} In young and healthy individuals who develop acute anaemia from haemorrhage (thereby lowering oxygen carrying capacity per unit blood volume), adequate tissue oxygen delivery is still maintained through compensatory physiological mechanisms, provided that normovolaemia is maintained. These mechanisms include: increased cardiac output, improved microvascular flow due to reduced viscosity, increased 2-3, diphosphoglycerate and increased tissue oxygen extraction.^{4,9-11} Various authors

have demonstrated that young and healthy patients can safely tolerate haemoglobin levels as low as 6 g/dl,¹⁴⁻¹⁶ while patients with chronic anaemia (e.g. in chronic renal failure) can tolerate a level of 5 g/dl without adverse outcome.^{17,18} Haemoglobin level of 10 g/dl, however, would still be the minimum safe value for patients in whom optimal oxygen delivery is crucial. These include patients with an inability to increase cardiac output on demand (e.g. fixed cardiac output syndromes) and those with diseases more susceptible to hypoxia (e.g. ischaemic heart disease, respiratory diseases, cerebrovascular diseases).^{2-4,10-12}

Currently, it is widely accepted that the clinical decision to transfuse blood should not be based on a single haemoglobin or haematocrit value alone, but rather, one should determine the "minimum acceptable haemoglobin level" for a particular patient, and blood transfusion should be initiated if the patient's haemoglobin falls below that level. The determination of the minimum acceptable haemoglobin level is guided by a number of factors which may be termed as "non-haemoglobin factors". Based on the above principles and the extensive data now available, various authorities and authors have made recommendations on the minimum acceptable haemoglobin level for patients with different "non-haemoglobin factors" (summarised in Table III). Essentially, these recommendations subscribe to three sets of minimum acceptable haemoglobin levels. The

high level (10 g/dl) is reserved for patients who are unable to compensate for anaemia, the intermediate level (7 to 8 g/dl) for patients with mild systemic diseases and the low level (6 to 7 g/dl) for young and healthy patients with acute blood loss or patients with compensated chronic anaemia. It must be emphasized again that these are only applicable when normovolaemia is maintained.

The current concern for transfusion triggers is the balance between maintaining adequate haemoglobin levels and avoiding unnecessary transfusion. While it has always been recognized that minimising administration of homologous blood would reduce transfusion-related complications, promote blood conservation and lower health costs, the issue of "active avoidance of unnecessary transfusion" is gaining more significance due to the increasing risk of infection transmission through homologous blood.^{4,19} While patients may suffer the dire consequence of being infected due to unnecessary transfusion, healthcare providers must consequently face the increased medico-legal implications of "negligence in administering unnecessary transfusion".^{20,21} As opposed to the traditional "10/30 rule", the current recommendations (Table VII) define a more rational and substantiated basis for sound clinical practice.

This redefinition of transfusion triggers, together with the use of perioperative autologous transfusion therapy, are among the strategies employed to minimise homologous blood transfusion, a current trend in perioperative transfusion therapy aimed at minimising complications due to homologous blood usage and promoting blood conservation.

Steps in improving the transfusion practice of the anaesthetic community begin with a survey on each individual clinician's pattern of practice. Similar surveys conducted previously showed wide variations in practices, deficiencies in the indications for blood transfusion and possible over-utilization of blood among the respondents.^{1,7,8} In this survey the current recommendations (Table VII) formed the basis for evaluating the respondents' practice.

This survey showed that the majority of the respondents (66.2%) would order transfusion preoperatively even if there was no surgical urgency in increasing the haemoglobin level. As the survey questionnaire did not require a reason for the indicated practice, we can only speculate that perhaps the confidence in the Singapore Blood Transfusion Service's strict donor blood infection screening process, and the unwillingness to postpone operations have resulted in this keenness to order transfusion.

It was reasonable that a greater proportion of respondents would order transfusion preoperatively when

surgery was urgent and could not be delayed. The small proportion of respondents still practising the strict 10/30 rule compared well with the results of previous surveys. Kowalyshyn's survey⁷ in 1972 showed that 43.9% of 1249 institutions surveyed required a minimum haemoglobin level of 10 g/dl for elective surgery, while Stehling's survey¹ in 1987 showed a corresponding figure of 65% among 387 respondents. The consistent finding of all these surveys, including this one, was the great variation among the respondents' transfusion triggers. It was of concern that a significant proportion of our respondents (26%) based their decision on a single haemoglobin level of between 5 to 9 g/dl, which may not be adequate for certain groups of physiologically compromised patients, as discussed earlier. It was also of concern that only a small proportion of respondents considered accepting different minimum haemoglobin levels based on the non-haemoglobin factors.

As for intraoperative transfusion, Stehling's survey¹ found 48.8% of respondents basing their decision to transfuse on the proportion of blood volume loss alone, and 19% basing their decision on the calculated haematocrit level. We had a similar result of up to 45.5% of respondents still basing their decision on the volume or proportion of blood loss without reference to haemoglobin levels. Many authorities now agree that blood should only be transfused for the primary aim of elevating haemoglobin level (to augment oxygen delivery) and not as a therapy for hypovolaemia alone.^{3,6,9} In situations where bleeding has occurred but the haemoglobin level still remained adequate, hypovolaemia should be treated with crystalloid or plasma substitutes instead of blood. It is therefore reasonable to recommend that intraoperative transfusion should be initiated primarily to prevent the haemoglobin from decreasing below the patient's minimum acceptable level (Table VII) rather than for volume replacement. However, actual clinical practice basing on that principle may sometimes be difficult as surgical bleeding can be an unpredictable and dynamic event. To estimate the "allowable blood loss" before the haemoglobin decreases to the minimum acceptable level, we recommend the simple and practical formula which was described and verified by Gross:²²

$$V_L = EBV \times \frac{(H_O - H_F)}{H_{AV}}$$

where

V_L = allowable blood loss

EBV = patient's estimated blood volume

H_O = initial haemoglobin level

H_F = minimum acceptable haemoglobin level

H_{AV} = average of H_O and H_F

The application of this formula presupposes that

normovolaemia is maintained with simultaneous non-blood fluid replacement.

We further recommend that wherever clinically possible, the estimated haemoglobin level should be confirmed by machine analysis of the patient's blood sample before transfusion is initiated. This may significantly reduce inappropriate transfusion decisions (either over or under transfusion) especially when blood loss is great thus making haemoglobin estimation difficult even with Gross's formula. However, we must emphasise that haemoglobin level analysed in the midst of an acute ongoing haemorrhage may not reflect the true status, and must be evaluated together with the adequacy of non-blood volume replacement and the current rate of blood loss. It is worthwhile to mention that portable haemoglobin analyzers capable of instant bedside measurements are available commercially.

It would seem that there was still a lack of general awareness regarding the current data, concepts and recommendations on the variable haemoglobin requirements of different types of patients. This might not be too surprising as given the rapid and multi-faceted developments in anaesthesia in recent years, an old topic (but by no means unimportant) such as this might have taken the backseat. Initial steps to improve the awareness on this subject have been taken. The results of the survey and the underlying concepts and recommendations have been presented in the monthly educational meetings and annual scientific meetings of the local anaesthetic community. However, to effectively enhance persistence of the awareness, the anaesthetic community should explore the possibilities of setting up official guidelines in perioperative transfusion practices, in collaboration with other relevant specialists, e.g. haematologists and surgeons. The governing body of the postgraduate examinations should also include this as a compulsory subject in the examination preparatory courses. When put in place, the above measures would bring all levels of practising anaesthetists (specialists or trainees, institutional or private) into constant contact with current concepts and recommendations.

From Table VI, we gather that the major factors preventing the practice of perioperative autologous transfusion are largely organisational. The first step towards promoting higher rate of practice would be continued education to change attitudes among surgeons and anaesthetists regarding the need for its use. Besides the medical perspectives of disease prevention and blood conservation, doctors must be made aware that "negligently failing to use autologous blood" is now a medico-legal issue in the United States.²¹ Patients should also be educated regarding the benefits and availability of such therapy. It is inevitable that more work and time would have to be spent per patient for

such therapy, but both doctors and patients must achieve the attitudinal change to accept such a necessity. Other steps would include fostering cooperation among the surgeons, anaesthetists and the blood transfusion service to streamline the surgical listings processes thus facilitating arrangements for autologous predonation. Surgeons and anaesthetists should also cooperate in the area of acute normovolaemic haemodilution. Protocols should be drawn up collaboratively for the selection of surgical patients suitable for such therapy. These patients should be identified early by the surgeon, who in turn should initiate arrangements with the anaesthetist and operation room staff for adequate time, personnel and facilities to perform the haemodilution process.

Conclusions

This study revealed the wide variations among local anaesthetists in their perioperative transfusion triggers. Most respondents were agreeable to the use of autologous transfusion therapy but were hindered in their practice by various practical reasons. Evidently, there is the need for continued education regarding the latest recommendations in the multifactorial approach for decision making in transfusion, and for promoting autologous transfusion practice. This educational effort should be applied to both the qualified anaesthetists and trainees.

Besides continued education, practical measures should be implemented to enhance the cooperation among surgeons, anaesthetists and the Singapore Blood Transfusion Services to facilitate the use of both autologous predonation and acute normovolaemic haemodilution.

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