



# Blood Transfusions for Emergency Laparotomies in General Surgery

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**Purpose:** Decisions regarding perioperative blood transfusions are subject to clinical and laboratory factors. Blood transfusions are associated with increased risk of infection, sepsis, organ failure, and length of stay. Current guidelines on transfusions are based on elective settings. There is a paucity of data on blood transfusion use in emergency surgery. This study reviews the appropriateness of blood transfusions in patients undergoing emergency general surgical laparotomies.

**Methods:** Patients undergoing emergency general surgical laparotomies at Peninsula Health from January 2013 to May 2015 were reviewed. Hemoglobin (Hb) levels triggering transfusion and overall blood utilization were obtained. Transfusions were classified based on whether they were given pre-, intra- or postoperatively. Transfusions with Hb >80 g/L in the absence of bleeding or preoperative anemia were deemed 'inappropriate' as per Australian Blood Authority guidelines.

**Results:** Over the 29-month period, 368 patients underwent 398 emergency laparotomies. Blood transfusions were given to 102 patients (27.7%). These patients required 240 transfusion episodes. Patients were given a median of three units of blood. One hundred and sixty-six transfusions (69.2%) were postoperative. Forty-six transfusions (19.2%) were given with Hb >80 g/L in the absence of other indications, and were deemed inappropriate. Inappropriate transfusions occurred more frequently on the ward compared to ICU ( $p < 0.05$ ). Almost two thirds of inappropriate transfusions were given for Hb 80 ~85 g/L.

**Conclusion:** Nearly one in five patients received an inappropriate transfusion. More judicious use of blood products in emergency patients is required, especially on surgical wards. (*J Acute Care Surg* 2017;7:15-22)

**Key Words:** Blood transfusion, Surgery, Postoperative complications, Hemoglobin, General surgery

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## Introduction

Red blood cell transfusions are commonly used to improve the oxygen carrying capacity of blood in the perioperative setting. In situations with bleeding and coagulopathy, these transfusions have life saving potential. However, there is growing evidence that inappropriate blood transfusions increase morbidity and

mortality [1-4].

The risks of blood transfusions are well documented in international and national guidelines, including the Australian Blood Authority Guidelines [5,6]. Infectious and non-infectious complications, such as transfusion-related acute lung injury and transfusion-associated circulatory overload, are the leading causes of transfusion-related complications [4,7-9]. A number of case-

control and observational studies have also demonstrated an association between blood transfusions and poorer surgical outcomes, including increased length of stay, increased rates of postoperative infections, earlier cancer recurrence, and higher mortality after cancer surgery [2,3,10]. Furthermore, blood products are expensive, costing the Australian government \$547.10 million in the 2014 and 2015 financial year, from the transfusion of 796,978 units of blood products [7].

Several trials [8,11-13] have attempted to evaluate the impact of the restrictive use of blood transfusion. They have found equivalent or superior outcomes compared to more liberal use of blood transfusions in the elective surgical setting. Based on this growing pool of evidence, national and international guidelines recommend against the use of blood transfusions in patients with a hemoglobin (Hb) level above 80 g/L in the elective surgical setting. Despite this, studies have shown that transfusion practice vary significantly between institutions [6,10,14,15].

Emergency surgery is a significant proportion of a hospitals workload. However, there is a paucity of data on the use of blood transfusions in the emergency setting. Given the significant cost to the health system, and risks associated with improper use of blood transfusion, it seems timely to examine our current practice in emergency surgery. This is vital to improving prescribing, educating staff and promoting safe and appropriate transfusion practice.

In this study, we aim to review the usage of blood transfusions in patients undergoing emergency laparotomies in general surgery. We hypothesise that a significant proportion of patients are being transfused inappropriately at Hb levels over 80 g/L.

## Methods

We conducted a retrospective study to evaluate the utilization of blood transfusions in adult general surgical patients ( $\geq 18$  years old) undergoing emergency laparotomy from January 2013 to May 2015. Ethics approval for the study was granted from the Peninsula Health Research Ethics Committee (ref. no. QA15PH11).

### Patients

Patients were identified via operating theatre database, which

was queried to extract all emergency operations booked under general surgery during the study period. This was manually filtered to exclude all cases that did not involve an emergency laparotomy. Admission notes were then reviewed to identify patients who had a blood transfusion during their admission.

### Clinical data

Patient demographics details (age, gender, comorbidities, American Society of Anesthesiologists [ASA] status) and admission details (overall length of stay, intensive care unit [ICU] admission and time in ICU) were recorded. Hb level on admission, and Hb triggering transfusion were noted. Use of anticoagulants and international normalized ratio were recorded.

Blood transfusion details from patient records were extracted and analysed. Timing of transfusion was categorized as:

- Preoperative: if transfusion was commenced after the patient arrived in the emergency department and prior to induction of anesthesia.
- Intraoperative: if transfusion was commenced after induction of anesthesia and before the patient left the operating theatre.
- Postoperative: if transfusion was commenced after the patient left the operating room and before they were discharged from the hospital.

Hb trigger was defined as the lowest measured Hb that immediately preceded a blood transfusion. Each instance where units of blood were given was classified as an independent episode of blood transfusion.

As a secondary endpoint, in-hospital perioperative complications were identified through discharge summary entries. These included:

- Renal failure: defined as impairment in renal function necessitating renal replacement therapy.
- Cardiac failure: defined as need for inpatient angiography or other invasive intervention. This did not include patients who had raised troponins and only needed therapeutic anticoagulation without invasive intervention.
- Wound infection: defined as deep infections that required drainage percutaneously or in the operating theatre.
- Respiratory failure: defined as needing intubation and

invasive ventilation.

These outcome end points were chosen, as they were clearly objective, and easily extractable from all patient records.

### Classification of appropriateness of transfusion

Patients who had an emergency laparotomy for a bleeding-related condition were deemed as having ‘a bleeding episode’. We acknowledge that in acute blood loss, lab values may take time to change, and may even remain normal initially. Other evidence of end organ ischemia may be an indicator for transfusion, despite normal lab values. For these reasons, we classified any transfusion for bleeding-related episodes as appropriate.

Pre-existing anemia was classified as admission Hb <100 g/L. Pre-existing anemia is independently associated with an increased risk of morbidity and mortality [1,5,6,16]. Hence, all blood transfusions for patients who presented with pre-existing anemia were deemed appropriate. We acknowledge this categorization may be contentious, but feel that by considering these patient’s transfusions as appropriate, we would, if anything, underestimate the rate of inappropriate transfusion compared to a more restrictive view that pre-existing anaemia only with Hb <80 g/L be considered appropriate.

International and national guidelines such as the Australian Blood Authority state that “transfusion may be inappropriate for patients with a Hb >80 g/L” [2,5,6]. Accordingly, after the above considerations had been taken into account, transfusion episodes were deemed appropriate or inappropriate based on the Hb level that led to the transfusion.

In summary, any transfusion given for Hb <80 g/L, or in the presence of preoperative anaemia or active bleeding were classified as appropriate. Appropriateness of transfusions is summarized in Table 1.

### Statistical analyses

Continuous variables were expressed as mean±standard

Table 1. Criteria for appropriate transfusions

Hemoglobin <80 g/L in the absence of active bleeding
Preoperative hemoglobin <100 g/L
Active bleeding regardless of hemoglobin level

deviation for normally distributed data, and median (interquartile range, IQR) for non-normally distributed data. Student t-test or Mann Whitney U-test was used for significance testing. Ordinal and non-ordinal categorical variables were expressed as numbers (with percentages). Pearson chi-squared or Fisher exact test was used for categorical variables as appropriate. A p-value <0.05 was considered statistically significant. Data was analysed using IBM SPSS ver. 22.0 (IBM Co., Armonk, NY, USA) and Microsoft Excel 2011 (Microsoft, Redmond, WA, USA).

## Results

### Patient characteristics

A total of 1,791 emergency general surgical operations were identified during this 29-month period. Case selection is shown in Fig. 1. One hundred and two patients (27.7% of patients undergoing emergency laparotomies) were included in the analysis as they received transfusions with atleast one unit of packed red blood cells. These patients required a total of 240 episodes of

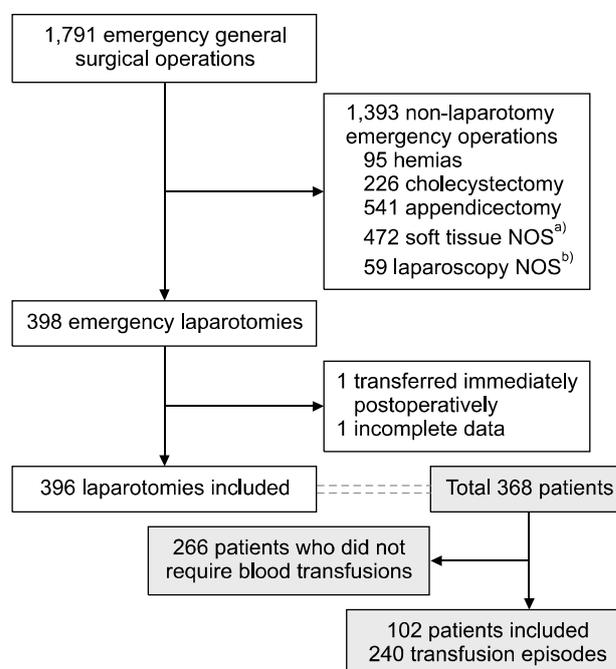


Fig. 1. Flowchart showing breakdown of emergency general surgery patients. <sup>a)</sup>Soft tissue debridement, abscess drainage, pilonidal, perianal, dressing changes. <sup>b)</sup>Laparoscopy for diagnostic purposes, drainage of bile, pus, blood. NOS: not otherwise specified.

blood transfusion.

Baseline data for these patients is shown in Table 2. The average age was 73 years old (IQR, 55~81 years). Patients in this cohort were generally very unwell; with a median ASA score of 3, and 87 patients (85.3%) required an ICU admission. The overall median length of stay was 20 days.

### Blood transfusion episodes

#### 1) Timing and amount of blood transfusions

Overall, 240 episodes of blood transfusions were utilized in 102 patients. More than two thirds of transfusions were administered during the postoperative period (69.2%, n=166), whilst just over a quarter (27.5%, n=66) were given preoperatively, the remainder (3.3%, n=8) were given intraoperatively (Fig. 2). Unsurprisingly, almost all patients (87.5%, n=7) requiring transfusion intraoperatively had acute bleeding emergencies requiring laparotomy. The median number of units of blood transfused per patient was 3 (2~5), with a median of 1 (range, 1~18) transfusion episode.

#### 2) Appropriate versus inappropriate blood transfusions

Fig. 2 shows the timing and appropriateness of blood transfusions. The majority of the transfusions (80.8%) were *appropriate*. The most common reason for an appropriate transfusion was a Hb <80 g/L (67.1%, n=161). There were six patients

Table 2. Clinicopathologic and transfusion characteristics of all patients in the cohort

Variable	Value
Total	102
Age (y)	73 (18~95)
Male gender	43 (42.2)
ASA score	3 (3~4)
Total LOS (d)	20 (2~274)
ICU admission	87 (85.3)
ICU LOS (d)	4 (0~92)
Total number of operations	1 (1~6)
Transfusion episodes per patient	1 (1~18)
Units transfused during admission	3 (1~42)

Values are presented as number only, median (range), or number (%). ASA: American Society of Anesthesiology physical status classification, LOS: length of stay, ICU: intensive care unit.

in total who were transfused because their preexisting Hb on admission was <10 g/L (and were considered to be chronically anaemic) prior to emergency laparotomy. Twenty-seven patients (11.3% of all transfusions) presented with a bleeding emergency and were transfused (considered appropriate, regardless of Hb value).

Forty-six (19.2%) transfusion episodes were deemed inappropriate (i.e., transfusion given with Hb >80 g/L, in the absence of bleeding or pre-existing anaemia).

#### 3) Associations with inappropriate blood transfusions

Of all inappropriate blood transfusions, thirty-six (78.2%) were given in the postoperative period, nine (19.6%) preoperatively and one (2.2%) was given intra-operatively (Fig. 2). Proportionally, inappropriate transfusions were highest postoperatively, accounting for 21.7%, compared to the preoperative (13.6%) and intra-operative (12.5%) setting. This was not a statistically significant difference (p=0.331) (Table 3).

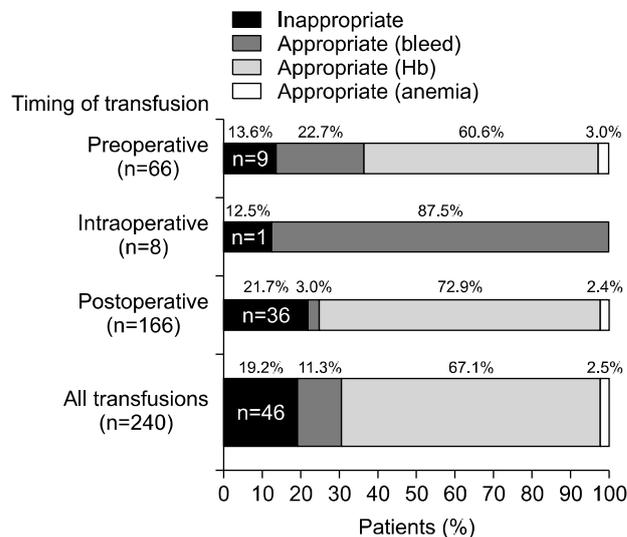


Fig. 2. Breakdown of transfusions into categories based on appropriateness, and according to timing of transfusion. Bars show data according to transfusions given pre-operatively (n=66, top bar), intra-operatively (n=8, second bar) and post-operatively (n=166, third bar), with all transfusion episodes represented by bottom bar (n=240). Transfusions considered appropriate were those given with hemoglobin (Hb)<80 g/L (“appropriate [Hb]”) or in the event of bleeding (“appropriate [bleed]”), or in patients with pre-existing anemia with presentation Hb<10 g/L (“appropriate [anemia]”). All other transfusions are considered “inappropriate.”

Table 3. Factors associated with appropriate vs. inappropriate blood transfusion per transfusion episode

Variable	Transfusion category		p-value
	Appropriate	Inappropriate	
Total	194 (80.8)	46 (19.2)	-
Trigger Hb (g/L)	75 (69~77)	84 (82~87)	<0.001
Age (y)	64 (51~79)	71 (54~81)	0.049
ASA score	4 (3~4)	4 (3~4)	0.648
Gender			0.176
Male	84.0	16.0	
Female	77.1	22.9	
Anticoagulation			0.737
No	80.6	19.4	
Yes	85.7	14.3	
INR	1.3 (1.2~1.4)	1.4 (1.2~1.5)	0.527
APTT	31 (28~39)	32 (27~38)	0.836
Timing			0.331
Preoperative	86.4	13.6	
Intraoperative	87.5	12.5	
Postoperative	78.3	21.7	
Admitted to ICU			0.656
No	77.3	22.7	
Yes	81.2	18.8	
Transfusion in ICU			0.009
In ICU	86.4	13.5	
Not in ICU	73.0	27.0	
Complications			0.650
Deep wound infection	18.0	15.2	
Renal failure	37.1	28.3	0.259
Cardiac failure	1.5	0	1.000*
Respiratory failure	6.7	6.5	1.000*
Any complication	48.5	39.1	0.254
Total LOS (d)	37 (18~93)	26 (18~66)	0.217

Values are presented as number (%), median (range), or percent only. Mann Whitney U-test and Pearson chi-squared test used for significance testing, unless otherwise stated.

Hb: hemoglobin, ASA: American Society of Anesthesiologists, INR: international normalized ratio, APTT: activated partial thromboplastin time, ICU: intensive care unit, LOS: length of stay.

\*Fisher exact test.

The ICU setting had a significant impact on the appropriate prescribing of blood products. The ICU had a significantly lower proportion of inappropriate transfusions compared to elsewhere (wards, emergency department, theatre) (27.0% vs. 13.5%,  $p < 0.05$ ) (Table 3, Fig. 3).

In addition, inappropriate transfusion episodes occurred in those who were a median of 7 years older than those who received an appropriate transfusion (median age 71 vs. 64 years,  $p=0.049$ ).

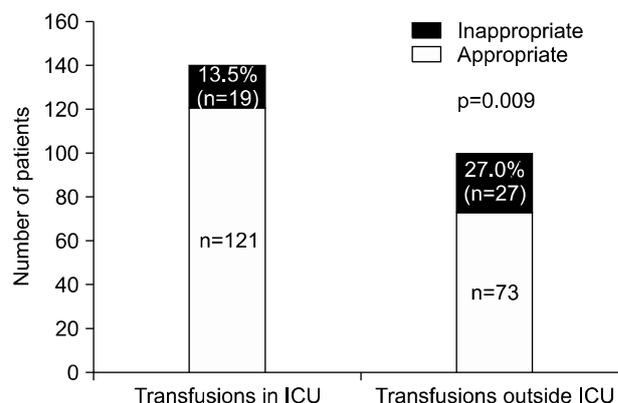


Fig. 3. Graph showing distribution of transfusions in intensive care unit and outside intensive care unit (emergency department, ward, operating theatre). ICU: intensive care unit.

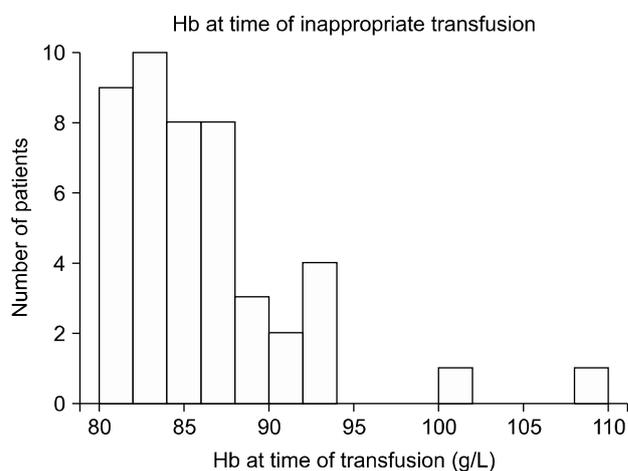


Fig. 4. Bar graph showing trigger hemoglobin for all inappropriate transfusions. Hb: hemoglobin.

Notably, there was no difference in gender, anticoagulation status, or length of operation between those with appropriate vs. inappropriate transfusion episodes. Furthermore, we found no difference in complications or length of stay between appropriate and inappropriate transfusion episodes (Table 2), although our study was not powered to detect this difference.

#### 4) Trigger Hb for inappropriate transfusions

Most inappropriate transfusions were given to patients with Hb levels only slightly above the recommended threshold (Fig. 4). Twenty-seven (58.7%) inappropriate transfusions were for a trigger Hb of 80~85 g/L. However, there were two (4.3%) transfusions given with Hb >10 g/L for unclear reasons, in

the absence of bleeding or pre-existing anaemia.

The majority of inappropriate transfusions occurred in the first two weeks after the operation, however 15.2% (n=7) occurred beyond two weeks of patients hospital stay. Despite review of patient records, it was unclear why these patients were prescribed transfusions beyond two weeks after the index operation.

## Discussion

Blood transfusion is a common therapeutic intervention with considerable variation in practice. This descriptive study confirms our hypothesis that a significant proportion of patients (19.2%) who receive blood transfusions in the emergency surgical setting do not satisfy any recommended criteria for transfusion. This indicates a potential over-utilization of blood, which could expose patients to needless associated risks.

There were some trends found in the patients who received inappropriate transfusions:

- Inappropriate transfusions occurred in older patients, which likely relates to increased comorbidities, perceived frailty and associated inability to sustain further physiological insult.
- Less inappropriate transfusions occurred in ICU. This may be due to closer monitoring and more advanced methods of assessing end organ perfusion. Consequently, ICU physicians do not have to rely only on Hb values, and may tolerate a lower Hb in a patient otherwise showing good perfusion.
- More inappropriate transfusions were given postoperatively. This is usually the time when the patient is recovering from the systemic inflammatory response syndrome and sepsis, and when perioperative complications most frequently occur.
- The trigger Hb seen in the majority of inappropriate transfusions was between 80~85 g/L in this study, suggesting that although prescribed outside of any known guidelines, the Hb level was taken into consideration, and is only moderately outside the range advised by authorities.

Blood transfusions have been shown in various studies to be an independent risk factor for increased nosocomial infections,

multiple organ failure, longer intensive care and hospital length of stay, increased complications and mortality [2,4,10,14].

Several national and international organizations have recommended the judicious or “restricted” use of blood transfusions to an Hb <80 g/L [5,6] due to the potential adverse effects.

It is important to note that these current guidelines are based on elective surgical settings. Minimal research has been done in the emergency setting, and subsequently, there are currently no guidelines for the use of blood transfusion in emergency surgical settings. Our data shows that in emergency general surgical laparotomies, almost 1 in 5 patients received blood despite being outside of these guidelines and may reflect a lower threshold to transfuse in patients undergoing emergency surgery. The Hb trigger for transfusion in an emergency setting needs to be specifically addressed in subsequent research and is an area lacking in the published literature. It may be reasonable to consider that a slightly higher threshold Hb may be appropriate to take into account regarding a patients already compromised physiological state secondary to their emergency presentation, although this is yet to be clearly defined.

Despite the guidelines specified for elective surgery, studies have shown that there is an over-utilisation of blood products in the peri-operative elective setting [17]. Most studies on patients in the intensive care, and patients presenting with acute coronary syndromes [11], have demonstrated worse outcomes after blood transfusions [1,5,10,18]. It is understandable that the higher acuity and potential for decline in most emergency surgical patients may lead the decision to transfuse at a higher Hb level. Compared to elective surgery patients, who are generally optimized pre-operatively, emergency patients are a much higher risk group from their presenting pathology-specific impaired physiological status. They are acutely unwell, often with sepsis, with increased potential for myocardial dysfunction, commonly on a background of multiple comorbidities, all resulting in increased perioperative physiological stress. Furthermore, they have to withstand a general anaesthetic, and undergo an emergency operation with potential for blood loss, followed by a postoperative stress response. This naturally creates a higher level of concern among medical staff, and could explain why there is a high rate of ‘inappropriate transfusions’ in our cohort.

However, there is a growing body of evidence showing that significant comorbidities should not be a deterrent to restrictive usage of blood, and need not mandate blood transfusions for a Hb level between 80~100 g/L. Some of this work has been undertaken in the emergency setting, albeit emergency orthopaedics and not general surgery. In the Functional Outcomes in Cardiovascular patients Undergoing Surgical hip fracture repair trial (FOCUS), 63% of the postoperative patients in the cohort had cardiovascular disease. There was, however, no difference in functional recovery, in-hospital myocardial infarction or congestive heart failure between patients having a liberal or restrictive blood transfusion strategy [12]. Similarly, in the Transfusion Requirement In Critical Care trial (TRICC) where 43% of patients had cardiovascular disease, mortality rates were identical in patients having a liberal or restrictive blood transfusion strategy [13].

The European Society of Cardiology has recently recommended withholding transfusion in patients with an acute coronary syndrome unless the Hb concentration drops to below 80 g/L [15]. The restrictive transfusion strategy (Hb <80 g/L) is further supported by the American Association of Blood Banks (AABB) [5] in patients with pre-existing cardiovascular disease. This suggests the potential for this lower Hb threshold (i.e., Hb <80 g/L) may also be applicable to the emergency surgical setting. Carson et al.[19] in a systematic review involving over 6,000 patients further reaffirmed this point by showing that patients receiving a liberal transfusion policy had a higher in hospital mortality and morbidity compared to a restrictive policy. A more recent systematic review by Holst et al.[20] confirmed the safety of and reduction in the number of units transfused to patients in the restrictive transfusion group compared to the liberal group.

This paper highlights the lack of evidence guiding blood transfusions in the emergency surgical setting, and shows that when recommendations from elective settings are applied to emergency surgical patient, almost 1 in 5 patients receive 'inappropriate' transfusions. In fact one could argue more patients actually received an inappropriate transfusion as we categorised transfusion for pre-existing anaemia for Hb <10 g/L as appropriate, and there is literature refuting this categorization in various emergency settings (orthopaedics, acute coronary syndrome as

outlined above), although not in general surgery to date.

Several limitations need to be considered when interpreting the data. All the data collected were retrospective, and thus open to recording and coding bias. The decision to transfuse a patient is usually multifactorial, guided by patient co-morbidities, clinical and biochemical parameters, and is unlikely to depend solely on a single Hb level. These factors may not be adequately captured or quantifiable in the clinical records.

In addition, we have commented on frequency of complications; however, this study has not been powered to show a difference in complication rate between groups.

In conclusion, in our institution nearly one in five patients received an inappropriate transfusion as defined by Hb levels of 80 g/L or above in non-bleeding patients who did not have pre-existing anaemia. It must be emphasised that this study serves to provide an insight into our transfusion practice, and does not serve to compare outcomes between interventions. There is increasing evidence that liberal blood transfusion does not lead to improved outcomes, but rather the opposite. Further prospective study is needed to compare blood transfusion use in emergency and elective general surgical setting, and assessing the difference in peri-operative outcomes and complications.

## Conflicts of Interest

No potential conflict of interest relevant to this article was reported.

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