The impact of a restrictive transfusion trigger on post-operative complication rate and well-being following elective orthopaedic surgery: a post-hoc analysis of a randomised study

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Background. Peri-operative red blood cell transfusions have been associated with post-operative complications in patients undergoing elective orthopaedic hip or knee replacement surgery.

Materials and methods. We performed a post-hoc analysis of data extracted from a randomised study on transfusion triggers using pre-storage leucocyte-depleted red blood cells. Patients who were assigned to the most restrictive transfusion policy ("restrictive group") were compared with patients who were assigned to the most liberal policy ("liberal group"). End-points were red blood cell use, hospital stay, haemoglobin levels, post-operative complications and quality of life scores.

Results. Of 603 patients, 26.4% patients in the restrictive group and 39.1% in the liberal group were transfused (P =0.001). The rate of post-operative infections was lower, although not statistically significantly so, in the restrictive group than in the liberal group (5.4% *vs* 10.2%, respectively) as was the rate of respiratory complications (1.7% *vs* 4.9%, respectively), whereas hospital stay, cardiovascular complications and mortality rate were not different in the two groups. Quality of life scores were not associated with type of transfusion policy, the number of red blood cell transfusions or the transfusion status.

Discussion. A restrictive transfusion protocol was not associated with worse outcome and resulted in a lower transfusion rate compared to the liberal policy. Well-being (quality of life) was not associated with transfusion policy or with red blood cell transfusions.

Keywords: restrictive transfusion policy, complication rate, orthopaedic surgery, red blood cell transfusion, quality of life.

Introduction

Reports on the role of allogeneic red blood cell (RBC) transfusions, whether leucocyte-reduced or not, on post-operative infection rate in orthopaedic surgery are inconsistent[1-6]. Since many of these studies were observational or retrospective, there may have been a selection bias at the time of inclusion of the patients. We recently reported the intention-to-treat results of a randomised study among patients undergoing elective orthopaedic surgery which compared a new uniform, intentionally restrictive, transfusion policy with the standard hospital policy, with RBC use as the primary end-point[7]. No differences in RBC use were observed between the randomised arms because in one of the three participating hospitals the new uniform study trigger for blood transfusion turned out to be less restrictive than their standard trigger, which resulted in an increased RBC use with this new transfusion policy. Furthermore, there were no significant differences in post-operative complications between the original randomisation groups. In the current post-hoc analysis we investigated the effect of the most restrictive transfusion policy in all three participating hospitals on these outcome variables by pooling the patients who were randomised to the most restrictive trigger to a restrictive policy group and the patients who were randomised to the most liberal transfusion policy to a liberal policy group, thereby fully respecting the randomised nature of the data. This analysis was not performed originally, because presentation of the results was performed strictly according to the defined study protocol.

A second aim of the study was to evaluate the effect of the transfusion policy (restrictive or liberal) and of RBC transfusions on post-operative functional well-being by measuring quality of life (QoL) scores. Previously, we were unable to show any correlation between QoL scores

† passed away

and haemoglobin (Hb) levels in the early post-operative period in this cohort, but, as suggested by Wallis, Hb and transfusions should be disentangled and thus analysed separately in QoL evaluations[8,9].

Materials and methods

Establishing groups for the post-hoc analysis

In the original study, within each participating hospital, patients were randomised to either protocol A (new policy) or protocol B (standard policy)[7]. The new transfusion trigger was based on risk level (depending on age and co-morbidity) and uniform among the three participating hospitals (Appendix). The new protocol (A) was more restrictive than the standard policy (B) for two hospitals and the patients randomised to protocol A were labelled as "restrictive" and those randomised to protocol B as "liberal". In the third hospital, the new transfusion trigger was in fact more liberal than the hospital's existing standard policy. As a consequence, patients randomised to the new policy (protocol A) actually received more RBC transfusions and this group was now labelled as "liberal" whereas the group randomised to the standard policy (protocol B) was labelled as "restrictive". Only pre-storage leucocyte-depleted RBC units were used.

Outcome measures

The original primary outcome variable was RBC use[9]. Post-operative complications and QoL were secondary outcome measures and prospectively scored. Complications were categorised into infections, respiratory complications in terms of hypoxaemia (pneumonia was excluded, but was included as an infectious complication), neuropsychiatric, cardiovascular and haemorrhagic complications, mobilisation delay and mortality. Post-operative infections were pre-defined according to Centers for Disease Control (CDC) criteria[10]. All wounds were prospectively scored for possible infection at post-operative day 5 according to Gaine and co-workers[11]. Cases of unclassified hypoxaemia were further investigated by detailed chart review to investigate their relationship with RBC transfusions, for example transfusion-associated circulatory overload (TACO) or transfusion-related acute lung Injury (TRALI). QoL questionnaires were scored pre-operatively (time point T1) and on post-operative days +4 (time point T2) and +14 (time point T3), using the Functional Status Index (FSI), measuring functionality in daily living; a visual analogue scale (VAS) for fatigue; and the Functional Assessment of Cancer Therapy-Anaemia (FACT-An) subscale, measuring fatigue and other anaemia-related symptoms. All scores ranged from 1 to 100, with lower scores indicating better functioning. Follow-up ended at the outpatient clinic 14 days after surgery or at final discharge if the patient stayed in hospital longer than 14 days. Details of the original study and overall results have been reported previously[7,9].

Analysis and statistical methods

Continuous data are summarised as the mean and standard deviation (SD), or median and inter-quartile range (IQR) in the case of a non-normal distribution. A comparison of laboratory parameters and other numerical end-points (such as hospital stay and age) between groups was performed by a Student's *t*-test in the case of normal distributions and by the non-parametric counterpart (Mann-Whitney) in the case of non-normal distributions (e.g. RBC transfusions, hospital stay). When end-points were categorical, comparisons were made on proportions using the chi-square statistic or Fisher's exact test. A common (pooled) odds ratio was computed as an overall effect measure among the three hospitals since all tests for heterogeneity were non-significant ($P > 0.10$). RBC use of both groups was compared to verify that the restrictive group did indeed receive fewer RBC units (P value considered statistically significant: <0.05). Pearson's correlation coefficients with 95% confidence intervals (95% CI) were calculated between FSI, Fact-Anemia and VAS scores and number of RBC transfusions for time points T1, T2 and T3. If $r \geq 0.20$, scores at T2 and T3 were corrected for pre-operative scores of the FSI, Fact-An and VAS, and for peri-and post-operative variables (duration of surgery, surgical blood loss and post-operative complications) as possible confounders. Student's t-tests were used to compare the QoL scores with dichotomous variables (transfusion status: yes/no or type of transfusion policy: restrictive/liberal). If significant differences were found between means ($P < 0.05$), regression analysis was performed to further evaluate the association of FSI, Fact Anemia and VAS scores, correcting for possible confounders.

For the analysis of the post-operative endpoints we used Bonferroni's correction to adjust for multiple testing of seven variables (infections, respiratory complications (pneumonia excluded), neuropsychiatric, cardiovascular and haemorrhagic complications, mobilisation delay and mortality) (P value considered statistically significant: <0.01). Data were analysed using the SPSS statistical programme (version 15.0) for Windows (SPSS Inc, Chicago, Illinois, USA).

Results

Of 603 included patients, 299 were assigned to the restrictive group and 304 to the liberal group. The baseline characteristics (age, sex, type of surgery, co-morbidities, use of medication, pre-operative Hb) level) were balanced in both groups except for a history of chronic obstructive pulmonary disease (COPD) which was more frequent in the restrictive group (n =32; 10.7%) than in the liberal group (n =14; 4.6%) (P =0.005) (Table I).

Table I - Patients' baseline characteristics.

Parameter Numbers (%) or mean (SD)	Restrictive group[a] n=299	Liberal group[b] n=304	P-value
Females	190 (63.5)	211 (69.4)	0.13
Mean age (years)	70.2 (10.3)	70.7 (9.6)	
Mean weight (kg)	79.5 (13.4)	77.7 (13.1)	
Smoking	43 (14.4)	47 (15.5)	
Total hip replacement (THR)	166 (55.5)	173 (56.9)	
Total knee replacement (TKR)	113 (37.8)	111 (36.5)	
Revision of THR	16 (5.4)	18 (5.9)	
Revision of TKR	4 (1.3)	2 (0.7)	
Low risk[c]	12 (4.0)	14 (4.6)	
Intermediate risk[d]	81 (27.1)	80 (26.3)	
High risk[e]	206 (68.9)	210 (69.1)	
Rheumatoid arthritis	27 (9.0)	40 (13.2)	0.11
Chronic obstructive pulmonary disease	32 (10.7)	14 (4.6)	0.005
Mean pre-operative Hb (g/dL)	13.8 (1.4)	13.5 (1.3)	0.02
Mean pre-operative Hct (L/L)	0.41 (0.04)	0.40 (0.04)	

Legend
Percentages are within policy group. [a]restrictive group: patients assigned to the most restrictive transfusion policy; [b]liberal group: patients assigned to the most liberal transfusion policy; [c]low risk: patients younger than 50 years of age without risk factors; [d]intermediate risk: patients from 50 to 70 years of age without risk factors; [e]high risk: one or more of the following risk factors present: any heart rhythm other than sinus rhythm, unstable cardiac ischaemia (by history or electrocardiogram), myocardial infarction less than 6 months previously, heart failure, heart valve disease, ≥70 years old, serious peripheral arterial disease, including large vessel surgery (aortic aneurysm, peripheral vessels), cerebral arterial disease (history of cerebrovascular accident or transient ischaemic attacks), hypertension with left ventricular hypertrophy (shown on electrocardiogram/ echocardiogram), serious pulmonary disease, expressed as polyglobulinaemia (emphysema/pulmonary fibrosis), insulin-dependent diabetes mellitus.

Clinical end-points

The proportion of transfused patients was smaller (26.4%) in the restrictive group than in the liberal group (39.1%) (P =0.001), as was the median RBC use per patient (P =0.001) (Table II). No difference in hospital stay (P =0.23) was noted between the groups. Mean duration of surgery and median blood loss were comparable between groups (data not shown).

Infections occurred in 47 (7.8%) patients, of whom 16 were in the restrictive group (5.4%) and 31 in the liberal group (10.2%) (P =0.03). Pooled risk estimates were calculated for post-operative complications, which resulted in an elevated risk of infections (common OR =2.0, P=0.03) and respiratory complications (common OR =3.1, P =0.03) in the liberal group; however, neither was statistically significant after correction for multiple testing (P <0.01). Other post-operative end-points were also not different between the groups.

Table III shows that infections (mainly urine tract infections and wound infections) and respiratory complications occurred more often in transfused patients: respectively 66% (31 of 47) and 70% (14 of 20) of patients developing these complications had been transfused. Among the patients who developed infections, the median RBC use in the restrictive group was 0.5 units (IQR 0-2.0) whereas it was 2.0 in the liberal group (IQR 1.0-3.0) (P =0.08). Two patients had already been treated for a pre-existing infection (jaw and urinary tract infection, one in each group).

The median RBC use in patients with respiratory complications was 1.0 unit in the restrictive group (IQR 0-3.5) and 2.0 units in the liberal group (IQR 2-2.75) (P =0.49). Patients with post-operative infections or respiratory complications stayed in hospital significantly longer than patients without these complications -median hospital stay 12.0 (IQR 9.0-12.0) and 13.0 (IQR 10-17) days for patients with infections and respiratory complications, respectively- compared to 9.0 (IQR 7-10) in patients without these complications (P <0.001) (data not shown).

Of the group of 20 patients with respiratory complications, five were diagnosed as having TACO related to a RBC transfusion. Two patients suffered from bronchospasm with underlying obstructive pulmonary disease, three patients had respiratory insufficiency due to opiates and one patient had pulmonary embolism. Nine patients had unclassified hypoxaemia, of whom seven had received RBC transfusions. A detailed chart review of these seven patients further revealed two possible transfusion-related cases. One 73-year old male with a history of coronary artery bypass grafting, percutaneous transluminal coronary angioplasty and hypertension, had knee surgery and one post-operative RBC transfusion for a low Hb value of 9.2 g/dL, after

Table II - RBC use and post-operative clinical end-points by assigned transfusion policy group.

Clinical endpoints Numbers (%) or mean (SD)	Restrictive group[a] n =299	Liberal group[b] n =304	P	Common OR[c] (95% CI)
Numbers / proportion transfused (in %)	79 / 26.4	119 / 39.1	0.001	
By hospital:				
Hospital #1 (n =123)	31 / 50.8	34 / 54.8		
Hospital #2 (n =206)	21 / 20.8	32 / 30.5		
Hospital #3 (n =274)	27 / 19.7	53 / 38.7		
Median RBC use (U/patients) (IQR)	0.0 (0-1.0)	0.0 (0-2.0)	0.001	
Median LOHS (days) (IQR)[d]	9.0 (6.75-10.0)	9.0 (7.0-11.0)	0.23	
Hb day +1 (g/dL) (SD)[e]	10.6 (1.6)	10.3 (1.4)	0.02	
Hb day +4 (g/dL) (SD)	10.5 (1.2)	10.5 (1.2)	0.99	
Hb at discharge (g/dL) (SD)	11.4 (1.3)	11.4 (1.2)	0.99	
Infections	16 (5.4)	31 (10.2)	0.03	2.0 (1.1-3.8)
Cardiovascular complications	30 (10.0)	27 (8.9)	0.63	0.9 (0.5-1.5)
Respiratory complications	5 (1.7)	15 (4.9)	0.03	3.1 (1.1-8.5)
Neuropsychiatric complications	12 (4.0)	12 (3.9)	0.98	1.0 (0.4-2.2)
Haemorrhage	10 (3.3)	12 (3.9)	0.68	1.2 (0.5-2.9)
Delayed mobilisation	32 (10.7)	26 (8.6)	0.37	1.3 (0.7-2.2)
Mortality	0 (0)	3 (1.0)	0.25	
Composite complications[f]	93 (31.1)	110 (36.2)	0.18	1.3 (0.9-1.9)

Legend
[a]restrictive group: patients assigned to the most restrictive transfusion policy; [b]liberal group: patients assigned to the most liberal transfusion policy; [c]to estimate complication risk, a common odds ratio (OR) is calculated; [d]10 to 90% range of length of hospital stay (LOHS) (days): in restrictive group: 6.0 to 14.0 and in liberal group: 6.0 to 15.0; [e]10 to 90% range of Hb day+1 (g/dL): in restrictive group: 8.7 to 12.6 and in liberal group: 8.4 to 12.1; [f]patients could have more than one complication.
Mean LOHS was 9.6 (5.1) in the liberal policy group and 10.2 (7.4) in the restrictive policy group (95% CI of difference [-1.6, 0.4]; P =0.27). Mean RBC use was 1.00 (SD 1.6) in the liberal policy group and 0.64 (SD 1.4) in the restrictive policy group (95% CI of difference [0.12, 0.60]; P =0.003).

Table III - Infections and respiratory complications by assigned transfusion policy group in relation to transfusion status.

Clinical endpoints Numbers of patients (n)	Restrictive group (n =299) (n transfused: 79)	Liberal group (n =304) (n transfused: 119)	P-value
Infections (total number n =47)	16 (8)	31(23)	0.03
Urinary tract infection (UTI) (n =24)	8 (4)	16 (12)	
Wound infection (n =16)	6 (2)	10 (9)	
Of which deep prosthetic infection (n =6)	3 (1)	3 (3)	
Pneumonia (n =1)	0	1 (0)	
Systemic bacterial infection (n =3)	1[a] (0)	2 (1)	
Other (localised) (n =3)	1 (1)	2 (1)	
Of which pre-existing infection (n =2)	1 (1) Jaw	1 (1) UTI	
Respiratory complications (total number n =20)	5 (3)	15[d] (11)	0.03
Transfusion associated cardiac overload (TACO) (n =5)	2 (2)	3 (3)	
Bronchospasm in COPD (n =2)	1 (0)	1 (0)	
Respiratory insufficiency due to opiates (n =3)	0	3 (2)	
Pulmonary embolism (n =1)	0	1 (0)	
Unclassified hypoxaemia (n =9)	2 (1[b])	7 (6[c])	

Legend
[a]this patient also had a deep prosthetic wound infection; [b]this case was possibly transfusion-related (TACO); [c]one case was possibly transfusion-related (TRALI); [d]The liberal group was originally scored as having 16 patients with respiratory complications, however, after detailed chart review, one dyspnoeic patient suffered from a pyelonephritis and was misclassified into this group and is, therefore, now excluded. This specific case was already included in the group with infections.

which he developed heart failure (X-ray compatible with cardiac decompensation, possible TACO) that responded well to diuretics. The other was a 76-year old male patient with a history of coronary artery bypass grafting who received two RBC transfusions for a post-operative Hb value of 9.1 g/dL and developed transient hypoxaemia after transfusion, which required oxygen support but resolved uneventfully (possible TACO or TRALI, although a chest X-ray was not taken). A third 34-year old patient with a history of Still's disease had knee surgery followed by massive post-operative blood loss of 2 litres in the drains, with oliguria, dyspnoea and tachypnoea and a post-operative Hb of 9.1 g/dL. After the patient received 4 RBC transfusions to compensate for the blood loss, he recovered completely. In this case, the complication preceded the transfusion, and resolved after transfusion. Of the remaining four transfused patients with unclassified hypoxaemia a relationship with RBC transfusion could not be found, mainly because of lack of information in the charts. However, in all cases the hypoxaemia was mild and resolved completely without additional mechanical ventilation.

QoL and fatigue scores were not associated with type of transfusion policy (non-significant differences in mean scores between transfusion policy groups with P-values >0.05) or with number of RBC transfusions, except for FSI scores measuring daily activity which showed a significant, but weak correlation r =0.36 (P <0.001) with the number of RBC transfusions at time-point T2 (4 days post-operatively). However, this association disappeared after correction for the possible confounders pre-operative FSI score (T1), duration of surgery, surgical blood loss and post-operative complications, which lowered the r to 0.08 (P =0.085). Transfusion status (being transfused or not) was also significantly associated with the FSI score at T2, with better scores if not transfused, and with the VAS score at T2, the FSI score at T3 and the Fact-Fatigue score at T2 (mean scores between the transfused and non-transfused groups were statistically significant in all cases with P-values <0.001). After correction for the four possible confounders, the statistical significance was lost in all cases.

Discussion

In this post-hoc analysis, we compared a restrictive transfusion policy with a liberal policy and evaluated the clinical impact on post-operative complications and well-being. The restrictive transfusion policy resulted in an absolute reduction of 0.36 RBC unit per patient and a 31% relative risk reduction in the proportion of transfused patients (absolute decrease of 13% from 39% to 26%). This finding is in line with the findings of Carless and co-workers, who performed a meta-analysis of 17 randomised studies on transfusion triggers in a variety of groups of patients including those undergoing orthopaedic surgery and found an average relative risk reduction of 37%[12]. It is remarkable that even in hip fracture patients with underlying cardiovascular disease or cardiovascular risk factors, a restrictive transfusion trigger, as applied in the absence of symptoms of anaemia, is safe[13]. Although we found only an absolute reduction of 5% (from 36% to 31%) in the composite post-operative complication rates, the liberal group more often had infections and respiratory complications. The majority of post-operative infections and respiratory complications occurred in transfused patients in both groups. Estimated risks for these complications were respectively doubled and tripled in the groups assigned to the liberal transfusion trigger. However, if corrected for multiple testing (P <0.01), the significance between the groups was lost. A decreased infection rate with a restrictive transfusion policy was also found by Carless and co-workers, who analysed four randomised studies in which infection rate was reported, with a pooled risk ratio of 0.76 (95% CI 0.60 to 0.76). Two of those studies used leucoreduced RBC units[12].

The finding of an increased respiratory complication rate with a liberal transfusion policy has not been reported previously. Post-operative pulmonary morbidity has been associated with RBC transfusions in cardiac surgery[14]. In our dataset, detailed chart review of seven transfused cases with unclassified hypoxaemia revealed a possible transfusion-related complication in two, and in a third a complete recovery after being transfused. Given the lack of information (no chest x-rays) for the remaining four cases, we could not rule out a sub-clinical TACO or TRALI as a possible underlying cause of the hypoxaemia[15]. Despite the use of leucocyte-depleted RBC transfusions in both groups, patients assigned to a more liberal transfusion policy may have a higher incidence of post-operative infections and respiratory complications compared to patients assigned to a more restrictive transfusion policy. Although the study was not powered for the comparison of adverse transfusion events, these data suggest that use of a restrictive transfusion policy is important in blood management programs and could even be the first step to implement, aiming for improved outcome of patients.

In order to evaluate whether RBC transfusions contributed to well-being by separating the effects of transfusion from the effects of the need for transfusion, we correlated QoL scores to RBC use. The number of RBC transfusions and the transfusion status was, after correction for possible confounders, not associated with QoL or fatigue scores at any time-point. We may, therefore, conclude that neither the number of RBC transfusions nor the transfusion status was related to well-being or functioning in the immediate post-operative period. We previously found no effect of post-operative anaemia on QoL in this cohort, concordantly with Wallis

and co-workers, who did not find a correlation of SF-36 questionnaire scores and an in-house linear analogue QoL scale with Hb levels, and with Vuille-Lessard and co-workers, who compared Hb values with functional recovery and QoL in a cohort of 305 elderly patients after major arthroplasty, without finding a significant correlation in the immediate post-operative period. These results are, however, different from those of Conlon and co-workers, who reported that the changes in FACT-Anaemia and SF-36 scores, measured pre-operatively and 2 months after total hip arthroplasty, were associated with Hb values determined pre-operatively and 8 days post-operatively[9,16-18]. However, the latter end-point after the re-validation period was not addressed in our study.

This study has some limitations. First, the study was not powered to evaluate post-operative complications, since the prevalence of these complications is low, nor was it powered to evaluate the relationship between RBC use and post-operative functioning and well-being. Second, by reassigning the randomised groups to a "liberal" and "restrictive" group, the validity of the current "post-hoc" analysis might be disputed. However, since the allocation was still randomised, the inference and P-values are completely valid as if it were a randomised allocation from the start. The results from this study do, therefore, provide a higher level of evidence than data from prospective observational studies. Third, since post-operative anaemia was only moderate in our studied patients, we cannot extrapolate our findings to patients with more severe anaemia.

In conclusion, a restrictive transfusion policy was not associated with worse outcome and resulted in lower transfusion rates compared to a liberal transfusion policy. Moreover, a restrictive policy might even result in fewer infections and respiratory complications. QoL scores were not associated with the number of RBC transfusions or transfusion status, suggesting that these were not of influence on well-being and functioning in the immediate post-operative period in moderately anaemic patients.

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The Authors declare no conflicts of interest.

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Appendix

Transfusion policies from the original study protocol

Hb values were originally in mmol/L (e.g. 4.0/5.0/6.0 mmol/L) which is common use in the Netherlands.

PROTOCOL A: NEW, UNIFORM TRANSFUSION POLICY (all participating hospitals)

Low-risk group (patients <50 years of age)

Within 4 hours of surgery	*After 4 hours of surgery*
If Hb (g/dL) ≥6.4 g/dL: 0 RBC	If Hb (g/dL) ≥6.4 g/dL: 0 RBC
4.8 - <6.4: 1 RBC	5.6 - <6.4: 1 RBC
<4.8: 2 RBC	<5.6: 2 RBC

Intermediate-risk group (patients 50 ≤ age < 70)

Within 4 hours of surgery	*After 4 hours of surgery*
If Hb (g/dL) ≥7.2 g/dL: 0 RBC	If Hb ≥8.1 g/dL: 0 RBC
6.4 - < 7.2: 1 RBC	7.2 - < 8.1: 1 RBC
< 6.4: 2 RBC	< 7.2: 2 RBC

High-risk group[a] (patients ≥70 years of age) (see below)

Within 4 hours of surgery	*After 4 hours of surgery*
If Hb (g/dL) ≥8.9: 0 RBC	If Hb (g/dL) ≥9.7: 0 RBC
8.1 - <8.9: 1 RBC	8.9 - <9.7: 1 RBC
7.2 - <8.1: 2 RBC	8.1 - <8.9: 2 RBC
<7.2: 3 RBC	<8.1: 3 RBC

Legend

[a]High risk includes one or more of the following:
- any heart rhythm other than sinus rhythm;
- unstable cardiac ischaemia (by history or electrocardiogram);
- myocardial infarction in the preceding 6 months;
- heart failure;
- heart valve disease;
- age (from 70 years onwards);
- serious peripheral arterial disease, including large vessel surgery (aortic aneurysm, peripheral vessels);
- cerebral arterial disease (history of cerebrovascular accident or transient ischaemic accident);
- hypertension with left ventricular hypertrophy (shown on electrocardiogram/echocardiogram);
- serious pulmonary disease, expressed as polyglobulinaemia (emphysema/pulmonary fibrosis);
- insulin-dependent diabetes mellitus.

PROTOCOL B: STANDARD CARE TRANSFUSION POLICIES

***Hospital number 1 (University Medical Centre):**
- ***Peri-operative transfusion policy (day 0):***
  if Hb between 8.1 and 9.7 g/dL and dependent on blood loss: 1-2 RBC.
- ***Post-operative transfusion policy (from day 1):***
  if Hb <9.7 g/dL: 2 RBC, independently of age, risk status.

***Hospital number 2 (general hospital):**
- ***Peri-operative transfusion policy (day 0):***
  - I keep Hb >6.4 g/dL in case of age <60 years and ASA[a] class 1;
  - II keep Hb >8.1 g/dL in case of age ≥60 years and ASA[a] class 1, 2, 3;
  - III keep Hb >9.7 g/dL in case of ASA[a] class 4 or serious cardiopulmonary disease.

  Legend
  [a]American Society of Anesthesiologists
- ***Post operative transfusion policy (from day 1):***
  - I keep Hb >9.7 g/dL in case of co-morbidity such as: admission to intensive care unit or coronary care unit, uraemia, serious heart-, lung- or vessel disease;
  - II If no co-morbidity exists, the transfusion trigger is age-dependent:

Age (years)	Hb (g/dL)
>70	10.5
50-70	9.7
25-50	8.9
<25	8.1

***Hospital number 3 (general hospital):**
- ***Peri-operative transfusion policy (day 0):***
  if Hb <9.7 g/dL and dependent on (expected) blood loss: 2 RBC.
- ***Post operative transfusion policy (from day 1):***
  - I Patients with cardiac history:
    - if Hb < 9.7 g/dL: 2 RBC;
  - II Patients without cardiac history if symptoms of anaemia (nausea, dizziness, tachycardia, general malaise, pallor):
    - if Hb 7.2 g/dL – 8.1 g/dL: 2 RBC;
  - III If Hb ≤7.2 g/dL: 2 RBC.