Red Blood Cell Prospective Audit: Appropriateness of Use for Three Surgical Procedures in Seven New Zealand Hospitals

Final Report

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EXECUTIVE SUMMARY

BACKGROUND
New Zealand Blood Service (NZBS) supplies regular information to District Health Boards (DHBs) on red cell usage within New Zealand via the Demand Management Project. Although this provides retrospective information regarding overall red cell usage and the departments that request red cells, there is very little published information about the appropriateness of red cell usage in New Zealand. International studies have shown considerable variations in red cell usage and adherence to guidelines between countries, regions and from hospital to hospital.

AIM
A prospective audit of three common surgical procedures (first time coronary artery bypass graft, first time total hip replacement, and total abdominal hysterectomy) within seven main centres in New Zealand was undertaken to assess the appropriateness of red cell usage during the surgical procedure and the following post-operative period. Red cell usage was measured against the National Health and Medical Research Council (NHMRC) and Australian and New Zealand Society for Blood Transfusion (ANZSBT) guidelines. A secondary aim was to assess the usage of alternatives to blood transfusion employed by the audited institutions.

METHOD
Transfusion Nurse Specialists prospectively collected clinical, laboratory and transfusion data from a minimum of fifty operations per DHB at each of seven large District Health Boards in New Zealand. Transfusion data was collected from the time of admission until the patient was discharged, reached day seven, underwent repeat surgery or died. Details of pre-operative investigations and management of anaemia were also collected. Each transfusion was assessed by two Transfusion Medicine Specialists.

RESULTS
416 operations involving 415 patients were identified over the 10 month period. A total of 327 red cell units were transfused to 29% (n=119) of the patients. Transfusion rates showed significant differences between hospitals and surgical procedures. 84% patients had an appropriate indication for transfusion however 62% of patients were assessed as having been over-transfused. 69% of all units transfused were assessed as appropriate. 15% of all patients had low haemoglobin levels pre-operatively. Only a third of anaemic patients had been investigated and 14% of these were treated pre-operatively. Use of autologous blood collected in theatre or post-surgery was almost exclusively limited to cardiac surgery. Documentation of the indication for transfusion was recorded in 46% of transfusions.

COMMENT
The present audit is the first such audit to look at red cell usage within New Zealand Hospitals on a national basis involving different surgical procedures. This audit has identified several areas which could be responsive to education. These include:

- the optimum dose of red cells should be more closely assessed to avoid over transfusion
- routine prescribing of two red cell units should be avoided
- each site should investigate any barriers to implementing transfusion sparing techniques for e.g. cell saver or acute normovolaemic haemodilution
- each site should investigate strategies to improve identification and treatment of anaemic patients before their surgery
- documentation around blood transfusion, notably the indication for transfusion and blood loss in theatre, should be improved

INTRODUCTION

It is agreed that the transfusion of blood components has had a central role in modern medicine and transfusions undoubtedly save lives, but transfusions also carry risks of harm. Accordingly, the decision to transfuse needs to be a considered one and viewed similarly as with other risk/benefit decisions common in medical practice. Guidelines[1,2,3,4,5] are in existence to promote a consistent and evidence based approach that puts the patient's best interest first and reduces the pressure on blood supplies.[6,7].

New Zealand Blood Service (NZBS)[1] and the Royal Australian and New Zealand Colleges have endorsed the National Health and Medical Research Council (NHMRC) guidelines[2] for appropriate use of blood components that were published in October 2001. These guidelines were prepared after extensive consultation with specialist colleges and medical specialists in both Australia and New Zealand and a literature review of international studies and evidence.

As the most frequently prescribed blood component in New Zealand it is important to better understand how clinicians use this scarce resource and whether current transfusion practice meets published guidelines. International studies have demonstrated wide variations in transfusion practices not just between countries and regions but also between hospitals in the same region.[8,9] However, little has been published about red cell use in New Zealand or the extent to which alternatives such as autologous pre-donation and cell salvage are in use.

AIM

To investigate the appropriateness of red blood cell transfusion for three surgical procedures at Auckland, Counties Manukau, Waikato, MidCentral, Capital & Coast, Canterbury and Otago District Health Boards (DHBs).

The surgical procedures were:
- first time coronary artery bypass graft (CABG)
- first time total hip replacement (THR)
- total abdominal hysterectomy (TAH).

The three categories of surgery were "arranged" cases (elective, booked or non-emergency cases but including urgent and in-hospital acute) rather than emergency procedures.

METHOD

Data was collected prospectively by Transfusion Nurse Specialists (TNSs) at the above named sites on all patients undergoing one of the three defined procedures. Two sites (Counties Manukau and MidCentral) were unable to collect data from CABG procedures as these were not performed at these sites.

Access to surgery lists was arranged on a daily basis to enable TNSs to identify those patients who were booked for the three named surgical procedures.

Specific issues considered were:
- Was the indication and decision to transfuse appropriate, based on haemoglobin (Hb) result and clinical symptoms, and as measured against the NHMRC guidelines?
- Was the indication recorded in the notes?
- Was the correct dosage given, as measured against the NHMRC guidelines?
- What was the total number of units administered?

- Were pre and post* haemoglobin levels measured? (*post level taken within 24 hours)
- When were the red cells administered in relation to the surgery?
- Was autologous blood collected or transfused before, during or after surgery?
- Were there patients who did not receive red cells but upon review, might have benefited from a red cell transfusion?
- Was the timing of transfusion appropriate?

The audit observation period for transfusions commenced from the time of admission and concluded on day seven post-operatively, on discharge (if before day seven), on redo surgery, or on death of the patient whichever came first, for each of the three types of surgery. Patients with hereditary coagulopathies and paediatric patients were excluded from the audit. The lookback for pre-operative investigation of anaemia went back as far as four years.

A pilot study of data from ten operations was collected at each site and evaluated to confirm suitability for patient selection criteria, data collection processes and data evaluation processes. The process and data collection form was reviewed at the end of the pilot period and changes were made where necessary. A target was set of at least twenty operations for each of the three surgical procedures, per site.

Only the major hospital from each respective DHB was audited.

The following data was collected:
- Demographic data: This included the patient's initials, Progesa number, National Health Index number (NHI), age, gender, and weight* of recipient (*when documented).
- Product data: Date and time of transfusion, number of red cell units (if transfused), the number of fresh frozen plasma, platelets or cryoprecipitate units transfused during the observation period, date/time/type/volume of autologous collections and transfusions; red cells transfused in the month prior to admission.
- Clinical data: Clinical diagnosis, date/time of surgery, indication for red cells, duration and rate of bleeding (faster or slower than 1L/hour) or total amount of blood loss in peri-operative and post-operative periods, sign or symptoms of impaired oxygen transport, relevant co-morbidities, relevant medications (erythropoietin, haematinics).
- Records: Were the indication and the clinical condition necessitating transfusion recorded?
- Laboratory data: blood count, coagulation blood test results (INR, Fibrinogen, APTT, TEG), iron studies, B12 & folate levels. If a patient was anaemic on admission, blood count, iron studies, B12 & folate levels prior to the admission were also collected. Where readily available, point-of-care haemoglobin results were also collected.

The data was collated in a Microsoft Access database with restricted access, located on the NZBS internal network. Only the TNSs and the Transfusion Medicine Specialists (TMSs) directly overseeing the audit had access to the identifying data. No identifying data has been included in the audit report.

Criteria for assessing appropriateness of transfusion

Criteria for appropriate use of red blood cells during the audit was based upon the NHMRC guidelines[2] (table 1). It is noted in several guidelines that when deciding whether to transfuse red blood cells, the patient's haemoglobin level, although important, should not be the sole deciding factor. The patient's clinical condition, signs and symptoms of hypoxia, ongoing blood loss, the risk to the patient of anaemia as well as the risk associated with transfusion should be considered.

Table 1. *NHMRC Guidelines, 2001*[2]

Hb*	Considerations
< 70g/L	Lower thresholds may be acceptable in patients without symptoms and / or where specific therapy is available.
70 - 100g/L	Likely to be appropriate during surgery associated with major blood loss or if there are signs or symptoms of impaired oxygen transport.
> 80g/L	May be appropriate to control anaemia-related symptoms in a patient on a chronic transfusion regimen or during marrow suppressive therapy.
> 100g/L	Not likely to be appropriate unless there are specific indications

*The use of red blood cells for indications not listed in this table is unlikely to be considered appropriate as prophylaxis or therapy.

Specific factors to consider:[2]

- Patient's cardiopulmonary reserve - if pulmonary function is not normal, it may be necessary to consider transfusing at a higher threshold.
- Volume of blood loss - clinical assessment should attempt to quantify the volume of blood loss before, during and after surgery, to ensure maintenance of normal blood volume.
- Oxygen consumption - this may be affected by a number of factors including fever, shivering and anaesthesia; if increased then the patient's need for red blood cell transfusion could be higher.
- Atherosclerotic disease - critical arterial stenosis to major organs, particularly the heart, may modify indications for the use of red blood cells.
- Desired Hb - a transfusion of 4-5mL/kg (1 unit in a 60kg patient) will increase circulating Hb by about 10g/L.

Assessment of the appropriateness of the indication and dose was based on the criteria shown in table 2.

Table 2: *Method for assessing the appropriateness of the indication and dose*

Category	Criteria	Explanation
Appropriate indication for transfusion	At least one unit administered must be clinically appropriate, based on NHMRC guidelines.	If one unit was assessed as clinically appropriate, the patient needed transfusion
Appropriate dose	All units clinically appropriate	If one or more of the units administered were assessed as unnecessary, the patient was over-transfused and the dose was assessed as inappropriate.
Appropriate non transfusion	No units transfused and the patient was not under-transfused	Under- and non-transfusion was assessed by looking at the entire surgical episode.
Appropriate decision to transfuse or not transfuse	Combination assessment of appropriate indication for transfusion and appropriate non transfusion.	Patients with neither an inappropriate indication for transfusion nor an assessment of having been undertransfused, are assessed as having an appropriate decision.

Analysis and Reporting

Two NZBS TMSs reviewed the data to seek a consensus on the appropriateness of each red cell transfusion based on the NHMRC guidelines and the criteria and

considerations discussed above. The data was anonymised for both location and patient identifiers (initials, NHI number).

Following feedback from the seven respective DHB Hospital Transfusion Committees (HTCs) this report has been issued to the audited Hospitals and to the National Demand Management contacts.

RESULTS

415 patients were audited in the seven hospitals over 10.7 months. A total of 416 operations were included, with 119 (29%) patients transfused a total of 327 red cell units. 97% of cases reached the endpoints of either discharge or day seven post-surgery (appendix 1). All sites captured the minimum of fifty operations, performed at the DHB's main hospital. Two sites (Counties Manukau and MidCentral) were unable to collect data for CABG procedures as this surgery is not undertaken within the DHB. In all other sites, twenty cases per type of surgery were collected. One patient's operation was subsequently identified as having been duplicated in the database, resulting in only 19 hip replacements for Auckland.

The mean age of the 415 patients was 61 years (range: 24 –95 years), and 64% were female. The patient's weight was provided in 97% of cases (range by DHB: 92 – 100%) with an average weight of 81kg (range: 40 – 165). The distribution of cases is shown in table 3. The abbreviations CABG for coronary artery bypass grafting, THR for total hip replacement and TAH for total abdominal hysterectomy are used throughout.

Table 3: *Number of operations identified per site*

DHB	CABG	THR	TAH	All
Auckland	20	19	20	59
Canterbury	24	22	22	68
Capital & Coast	21	20	20	61
Counties Manukau	0	28	22	50
MidCentral	0	36	20	56
Otago	20	22	20	62
Waikato	20	20	20	60
Total	105	167	144	416

Overall, the patient group was transfused in 29% of cases (n=119), including pre-operative, intra-operative and post-operative transfusions (table 4). A breakdown by subtype of surgery is shown in appendix 2.

Table 4: *Proportion and number of operations where the patient was transfused by surgery type and site*

DHBs	CABG	THR	TAH	All	n
Auckland	40%	47%	5%	31%	18
Canterbury	38%	27%	5%	24%	16
Capital & Coast	67%	30%	10%	36%	22
Counties Manukau	-	18%	14%	16%	8
MidCentral	-	53%	5%	36%	20
Otago	70%	36%	0%	35%	22
Waikato	40%	25%	0%	22%	13
Overall	50%	35%	6%	29%	119

Appropriate transfusions

Each unit of red cells transfused was assessed by two Transfusion Medicine Specialists for appropriateness. This review considered the decision to transfuse, the indication for transfusion and whether the dose and number of units administered was appropriate.

The vast majority of patients were assessed as receiving or not receiving red cells appropriately (table 5). Of the 296 (71%) patients that did not receive red cells the clinical review confirmed they had not required a transfusion. With the possible exception of one patient from Canterbury, clinical review confirmed that no patient receiving red cells was under-transfused. 15 patients could not be assessed due to insufficient data (e.g. no post-op haemoglobin level).

Table 5: *Proportion and number of patients where an appropriate decision to transfuse or not transfuse was made*

DHB	CABG	THR	TAH	All	n
Auckland	90%	89%	93%	91%	54
Canterbury	100%	95%	100%	98%	67
Capital & Coast	90%	90%	95%	92%	56
Counties Manukau	-	89%	95%	92%	46
MidCentral	-	97%	100%	98%	55
Otago	90%	95%	100%	95%	59
Waikato	100%	100%	100%	100%	60
Total	94%	94%	98%	95%	397

The clinical indication for transfusion was considered as outlined in table 2. Using this approach, the majority of patients had an appropriate indication for transfusing red cells (table 6), but clinically significant variation existed between sites and surgery type. Some of this variation arises from the small number of transfused patients for some DHBs and types of surgery, particularly hysterectomies.

Table 6: *Proportion and number of transfused patients with an appropriate indication for transfusion*

DHB	CABG	THR	TAH	All	n
Auckland	75%	78%	0%	72%	13
Canterbury	100%	83%	100%	94%	15
Capital & Coast	86%	67%	50%	77%	17
Counties Manukau	-	40%	67%	50%	4
MidCentral	-	95%	100%	95%	19
Otago	86%	88%	-	86%	19
Waikato	100%	100%	-	100%	13
Total	89%	83%	63%	84%	100

Similar to the way the indication was reviewed, a patient was assessed as having received an appropriate dose of red cells if all of the red cells transfused were considered to be appropriate (table 7). The small number of patients for some DHBs and surgery types may have contributed to the variation seen. It is important to note that patients need to have an appropriate indication in order for the dose to be appropriate. Nevertheless, only 38% of patients were assessed as having received the correct dose, i.e. 62% were over-transfused.

Table 7: *Proportion and number of patients with an appropriate dose (where all units were assessed as appropriate)*

DHB	CABG	THR	TAH	All	n
Auckland	63%	44%	0%	50%	9
Canterbury	78%	33%	0%	56%	9
Capital & Coast	29%	0%	50%	23%	5
Counties Manukau	-	20%	33%	25%	2
MidCentral	-	16%	0%	15%	3
Otago	43%	13%	-	32%	7
Waikato	100%	40%	-	77%	10
Total	57%	22%	25%	38%	45

Looking at the red cell units individually, almost a third of all units administered were assessed as inappropriate (table 8). This is shown in greater detail in appendix 4.

Table 8: *Proportion of units transfused assessed as appropriate*

DHB	% Appropriate	Number of appropriate units	Total number of units transfused
Auckland	58%	22	38
Canterbury	81%	34	42
Capital & Coast	67%	45	67
Counties Manukau	66%	19	29
MidCentral	54%	28	52
Otago	70%	47	67
Waikato	91%	29	32
Overall	69%	224	327

283 patients had a post-operative haemoglobin level taken and were not transfused.

Comparison with the NHMRC guidelines

Pre-transfusion haemoglobin levels were recorded for all 327 units transfused, though the same pre-transfusion haemoglobin was frequently used for more than one transfused unit.

Using the pre-transfusion haemoglobin level, the transfusions were compared with the NHMRC guidelines for red cell transfusion (table 9).

Table 9: *Number of units transfused by pre-transfusion Haemoglobin and NHMRC guideline category*

NHMRC guideline category pre-transfusion haemoglobin	Units transfused (% of total)	Units assessed as appropriate	Ave hours between haemoglobin level and transfusion
<70 g/L	45 (14%)	96%	13.2
70-100 g/L	204 (62%)	62%	6.7
>100 g/L	78 (24%)	69%	185.1

Although the majority of transfusions met these guidelines, clinical review found that many transfusions meeting the NHMRC guidelines were inappropriate, and conversely some of those not meeting the guidelines were assessed as appropriate.

4% of the total units transfused to patients with haemoglobin level less than 70 g/L were considered inappropriate. These recipients had an appropriate indication but were considered to have been given more units then they required to correct their haemoglobin, i.e. they were over-transfused.

For the other two NHMRC categories, two thirds of patients appear to have been overdosed and one third had no indication for transfusion in each category.

Some of this discordance arises from the interval between pre-transfusion haemoglobin and the actual date and time of transfusion (figure 1), with surgery occurring between testing and transfusion in 21% of units administered. In other words, no post-operative pre-transfusion haemoglobin had been obtained to guide clinical decision making. This was most noticeable in those transfusions where the pre-transfusion haemoglobin was above 100 g/L.

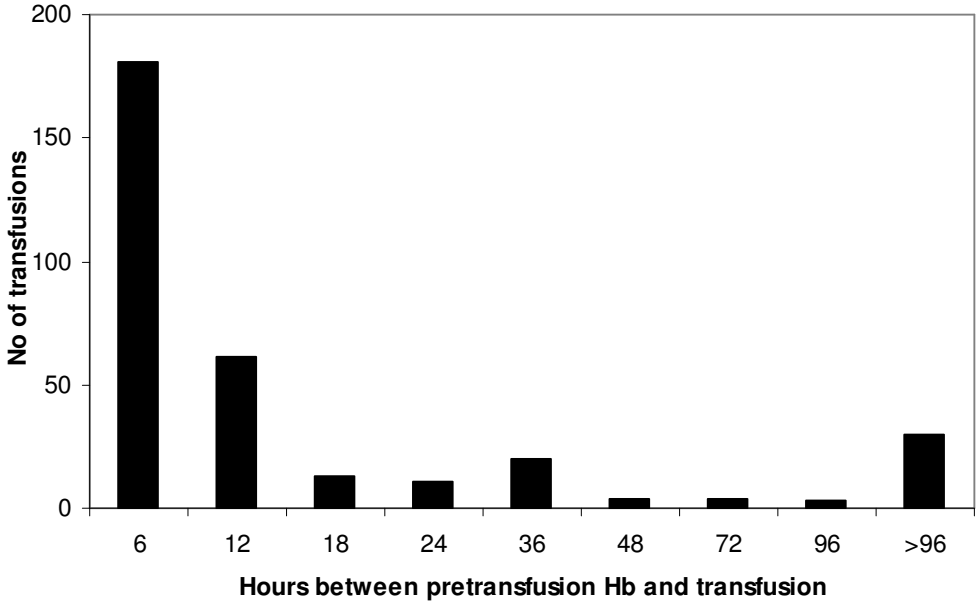

Figure 1: *Interval between pre-transfusion haemoglobin test and transfusion*

Units transfused on a single haemoglobin level

The commonest number of units transfused before the haemoglobin was rechecked was two units (figure 2).

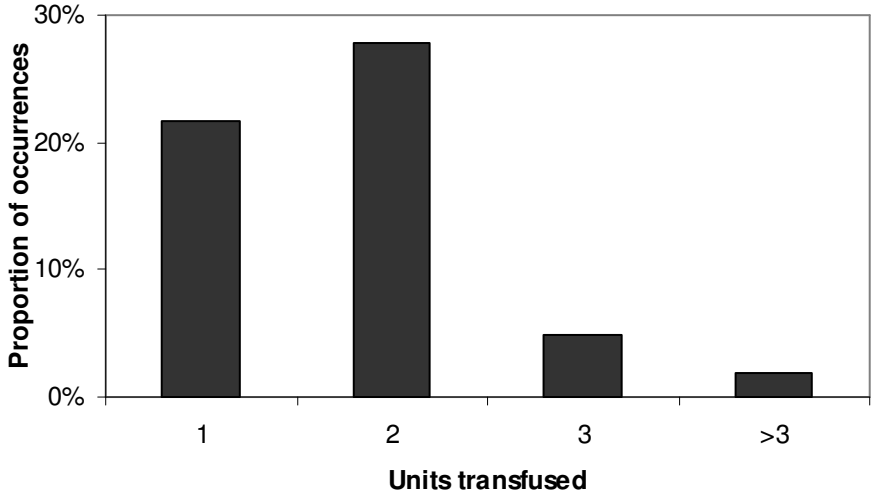

Figure 2: *Units transfused before haemoglobin rechecked*

The average number of units transfused before rechecking the haemoglobin was 1.8 (range: 1 - 6), with variation by site and surgery type (table 10). Point-of-care testing results were not available for most DHBs. Clearly if point-of-care testing was performed it would decrease the averages shown in the table below.

Table 10: *Average (and range) of units transfused before the haemoglobin was rechecked by site and surgery type*

DHB	CABG	THR	TAH	Overall
Auckland	1.3 (1 - 3)	1.5 (1 - 2)	3.0 (3 - 3)	1.5 (1 - 3)
Canterbury	1.6 (1 - 2)	1.6 (1 - 3)	2.0 (2 - 2)	1.6 (1 - 3)
Capital & Coast	1.9 (1 - 4)	1.6 (1 - 3)	2.5 (2 - 3)	1.9 (1 - 4)
Counties Manukau	-	2.6 (1 - 6)	2.0 (1 - 3)	2.4 (1 - 6)
MidCentral	-	2.3 (1 - 4)	2.0 (2 - 2)	2.3 (1 - 4)
Otago	1.6 (1 - 4)	2.1 (2 - 3)	-	1.7 (1 - 4)
Waikato	1.3 (1 - 2)	2.0 (1 - 3)	-	1.5 (1 - 3)
Overall	1.6 (1 - 4)	2.0 (1 - 6)	2.2 (1 - 3)	1.8 (1 - 6)

91% of all recipients had a post-transfusion haemoglobin level checked within 24 hours. (table 11).

Table 11: *Proportion and number of transfusions where a haemoglobin check was performed within 24 hours of the transfusion by DHB and type of surgery*

DHB	CABG	THR	TAH	Overall	n
Auckland	77%	95%	0%	82%	31
Canterbury	100%	89%	100%	95%	40
Capital & Coast	100%	100%	80%	99%	66
Counties Manukau	-	90%	100%	93%	27
MidCentral	-	86%	100%	87%	45
Otago	100%	74%	-	93%	62
Waikato	100%	50%	-	84%	27
Overall	98%	86%	80%	91%	298

Pre-operative anaemia

Haemoglobin levels were checked prior to surgery in all but four operations (four hip replacements at Counties Manukau DHB). Pre-operative haemoglobin levels were below the normal range for their local laboratory in 15% of cases (range: 5-32%) (table 12). The level of variation between DHBs and types of surgery was relatively low for this measure.

Table 12: *Proportion and number of patients with pre-operative haemoglobin level below normal range by site and surgery type*

DHB	CABG	THR	TAH	Overall	n
Auckland	15%	32%	20%	22%	13
Canterbury	25%	18%	14%	19%	13
Capital & Coast	5%	5%	15%	8%	5
Counties Manukau	-	18%	14%	16%	8
MidCentral	-	8%	25%	14%	8
Otago	25%	14%	5%	15%	9
Waikato	5%	15%	15%	12%	8
Overall	15%	15%	15%	15%	64

The proportion of patients investigated for anaemia with iron studies or similar investigations was low and showed noticeable variation between DHBs and surgery types (table 13).

Table 13: *Proportion and number of anaemic patients investigated for anaemia pre-operatively by DHB and surgery type*

DHB	CABG	THR	TAH	Overall	n
Auckland	33%	50%	50%	46%	6
Canterbury	0%	0%	67%	15%	2
Capital & Coast	0%	0%	33%	20%	1
Counties Manukau	-	40%	100%	63%	5
MidCentral	-	0%	60%	38%	3
Otago	0%	0%	100%	11%	1
Waikato	0%	67%	0%	29%	2
Overall	6%	28%	55%	32%	20

Similarly, anaemic patients treated with haematinics pre-operatively were low and showed noticeable variation between DHBs and types of surgery (table 14). Only one patient received erythropoietin pre-operatively, for end-stage renal failure.

Table 14: *Proportion and number of anaemic patients treated with haematinics pre-operatively by DHB and surgery type*

DHB	CABG	THR	TAH	Overall	n
Auckland	0%	17%	75%	31%	4
Canterbury	0%	0%	33%	8%	1
Capital & Coast	0%	0%	0%	0%	0
Counties Manukau	-	0%	0%	0%	0
MidCentral	-	0%	0%	0%	0
Otago	0%	0%	100%	11%	1
Waikato	0%	33%	33%	25%	2
Overall	0%	8%	27%	13%	8

Transfusion sparing techniques

A number of techniques are available to reduce the need for banked (allogeneic) blood to be transfused. These include cell salvage, drain reinfusion, acute normovolaemic haemodilution and return of pump blood. Almost all cases where such techniques were used occurred in cardiac bypass surgery, with cell salvage and return of pump blood widely used (table 15). The variation shown in the table does not allow for the proportion of patients operated on “off pump”.

Table 15: *Proportion and number of CABG patients receiving autologous shed blood collected in theatre by DHB and surgery type*

DHBs	CABG	n
Auckland	55%	11
Canterbury	75%	18
Capital & Coast	43%	9
Otago	90%	18
Waikato	85%	17
Overall	70%	73

Documentation of cell salvage is acknowledged to vary at some sites. In particular Capital & Coast do not document cell salvage in the patient notes until after discharge. It is likely that at Capital & Coast's percentage is a significant underestimate.

Waikato DHB also used acute normovolaemic haemodilution on four CABG patients (included in table above). One hip replacement performed at Canterbury DHB used drain reinfusion as an allogeneic transfusion sparing technique.

Haemoglobin levels on discharge

Post-operative haemoglobin levels were available for 96% (n=401) of patients. 14 of the patients without a post-operative haemoglobin had undergone hysterectomies. One patient had undergone a CABG but been returned to theatre soon after the CABG, thus reaching an audit endpoint before a post-operative haemoglobin level could be checked.

The mean haemoglobin on discharge is shown (table 16) for the 306 patients who were discharged on or before day seven (as opposed to dying, having repeat surgery or having an extended stay in hospital) and who had a haemoglobin level for inclusion.

Table 16: *Average discharge haemoglobin level for appropriately and inappropriately dosed patients by site and surgery type*

	Ave discharge Hb (g/L) where dose inappropriate				Ave discharge Hb (g/L) where dose appropriate			
DHB	CABG	THR	TAH	Overall	CABG	THR	TAH	Overall
Auckland	91	111	87	100	96	95	-	96
Canterbury	90	102	99	99	91	104	-	96
Capital & Coast	103	124	104	107	99	-	85	96
Counties Manukau	-	105	106	105	-	-	-	-
MidCentral	-	106	-	107	-	88	-	88
Otago	111	97	-	103	93	98	-	96
Waikato	-	100	-	100	88	104	-	93
Overall	102	105	99	104	94	97	85	95

Where no result is shown, either that type of surgery was not performed at the DHB, the dose did not meet the requirement for the column (appropriate or not) or there was no post-operative haemoglobin level. A number of factors could explain the variation seen, including the proportion of patients transfused, the interval between surgery and the last haemoglobin level, and the extent of blood loss at surgery. Small sample numbers is a significant confounding factor.

Timing of transfusion

66% of units were transfused within the first 24 hours post-surgery with a further 14% on the second day (figure 3). 9.5% of units were transfused between 9pm and 7am. Excluding the first 24 hours post-surgery, only 2.4% (n=8) of 327 units of red cells were transfused overnight.

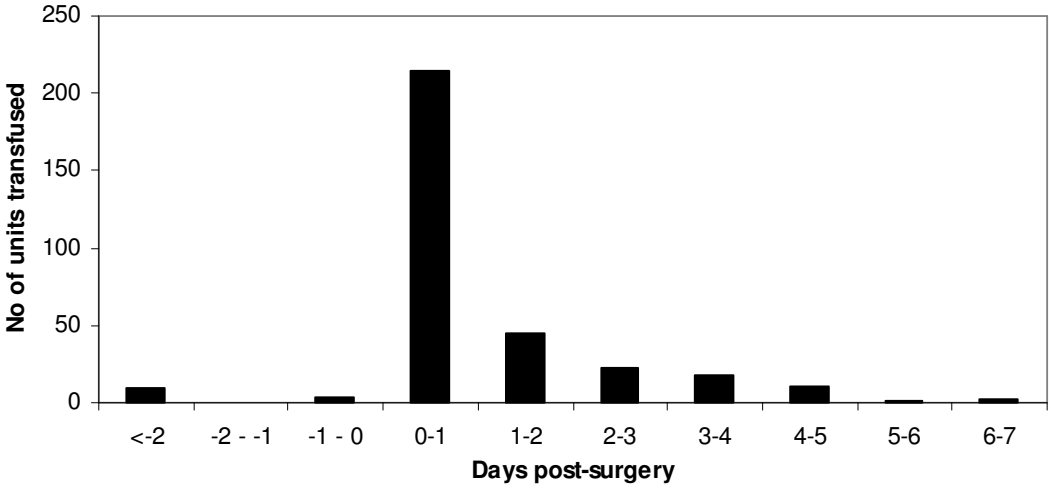

Figure 3: *Timing of transfusions in relation to surgery*

Five of the 416 patients were transfused a total of thirteen units pre-operatively. This is not generally recommended practice, and accordingly 62% were considered inappropriate on clinical review (table 17).

Table 17: *Patients receiving pre-operative transfusion by DHB and surgery type*

DHB	Surgery	No of patients	Units transfused pre-operatively	% of units appropriate
Auckland	CABG	1	3	33%
Auckland	THR	1	2	0%
Auckland	TAH	1	3	0%
Canterbury	TAH	1	2	50%
Capital & Coast	TAH	1	3	100%
Overall		5	13	38%

Documentation: Indication for transfusion

ANZSBT guidelines on the administration of blood[10] require, amongst other details, that the indication for the use of blood is recorded in the patient's case file. Of the 327 units transfused, the indication for transfusion was recorded in 46% of cases, with significant variation by DHB and type of surgery (table 18). Of the transfusions with no indication documented, 63% were considered appropriate upon clinical review. This compares with 75% for those transfusions where an indication was recorded.

Table 18: *Proportion (and number) of units transfused that had the indication for transfusion recorded in the notes by DHB and surgery type*

DHB	CABG	THR	TAH	Overall
Auckland	31% (13)	0% (22)	0% (3)	11% (38)
Canterbury	100% (22)	56% (18)	100% (2)	81% (42)
Capital & Coast	59% (49)	77% (13)	100% (5)	66% (67)
Counties Manukau	-	0% (21)	0% (8)	0% (29)
MidCentral	-	14% (50)	0% (2)	13% (52)
Otago	58% (48)	68% (19)		61% (67)
Waikato	64% (22)	60% (10)		63% (32)
Overall	63% (154)	30% (153)	35% (20)	46% (327)

Observations from Clinical Review

A number of observations were made by the two TMSs reviewing the cases:

- Blood loss in theatre was frequently not recorded or not available post-operatively in the notes.
- Post-operative haemodilution or sampling artefact was a factor leading to transfusion in a number of patients.
- Pre-operative transfusion for elective surgery was considered inappropriate.
- The lack of a post-operative pre-transfusion haemoglobin makes deciding whether a patient needs a transfusion difficult. It also makes reviewing the decision to transfuse difficult.
- Measuring iron studies or ferritin levels post-operatively has the potential to be misleading as both sets of markers are affected by the inflammatory response (serum iron falls, serum ferritin rises).
- Some orthopaedic units appeared to have a policy of transfusing to a level of 100 g/L to assist mobilisation. Consideration should be given as to whether this is evidence-based as current guidelines do not support such a practice.

AUDIT LIMITATIONS

Case matching between DHBs for severity or any other parameter was not attempted. Using the American Society for Anesthesiology physical status classification system (ASA scores), which crudely grades patients' health from 1 (normal) to 6 (brain dead), statistically significant differences in mean ASA scores were apparent between DHBs (appendix 3). Comparisons between DHBs are therefore unlikely to be statistically sound.

This audit provides only a snap-shot of activity over the audit period. Although the numbers of transfused patients for some sites and some types of surgery are small, the results highlight areas that individual DHBs may want to investigate in more detail to confirm or refute issues raised. A study underway benchmarking transfusion rates for particular types of surgery across a number of DHBs will provide a greater robustness for comparing transfusion rates between DHBs.

Point-of-care haemoglobin values were not always easily identified. Similarly the lack of availability of some theatre records (e.g. blood loss details) may have impacted on the assessment of appropriateness of transfusion.

There were seven Transfusion Nurse Specialists collecting data. This permitted a national audit to be performed, but an inherent problem with multiple collectors is variation in data collected. Efforts were made to reduce this by using a standard national data collection form and regular telephone and face to face meetings to clarify problems raised during the audit period.

The Transfusion Medicine Specialist review was conducted using the information provided by the audit. While key points were sought in the data capture, the data is inevitably not as complete as a full review of each patient's clinical record. This introduces a level of assumption into the assessment of appropriateness. Potential for bias exists, as the two specialists were actively involved in the management of some of the cases, although the data was blinded for location at the time of review.

Lastly, this audit did not assess clinical outcome other than limited surrogate markers such as haemoglobin level on discharge. While desirable, this would have added considerably to the complexity of the audit, and was beyond the resources available. Similarly, it was not possible to assess the morbidity or mortality prevented by

transfusions assessed as inappropriate. Assessments were therefore made in line with international best practice guidelines and clinical experience.

DISCUSSION

The present audit is the first multi-centre audit to look at red cell usage within New Zealand hospitals involving different surgical procedures. As such it provides a suitable baseline for clinicians to compare practice, and against which to measure future improvements.

The results from this audit show that 31% of all red cell units transfused were inappropriate. This compares with other studies showing rates of inappropriate transfusion ranging of 3% to 35%[11,12,13,14].

It appears the initial decision to transfuse was generally appropriate, with 84% of patients transfused receiving at least one transfusion assessed as appropriate, comparing well with an Australian study showing 79%[15]. However, in only 38% of patients transfused were *all* units transfused assessed as appropriate, indicating a significant level of over-transfusion. This is substantially more than an Australian study showing only 12%[15] patients were over-transfused, although methodologies were different.

Significant variation in transfusion practices was apparent across the country. For example, of patients having a CABG, the proportion receiving the correct dose (all units were assessed as appropriate) ranged from 29% to 100% per DHB. Likewise, the proportion of hip replacement patients receiving the correct dose, ranged from 0% to 44%.

It was pleasing to note that a pre-transfusion haemoglobin level was available for all units transfused, although in many cases no haemoglobin level was available between units. This is better than other similar studies showing 82%[16] and 97%[17] of cases had a pre-transfusion haemoglobin.

The NHMRC guidelines[2] are widely used when discussing appropriateness of transfusion. The majority of transfusions (76%) fell within the two NHMRC categories that suggest transfusion is likely to be appropriate (i.e. haemoglobin level < 100 g/L). The correlation between NHMRC category and clinical assessment of appropriateness, which took other factors into account, was strongest where the pre-transfusion haemoglobin levels were below 70 g/L. Above that cut-off the correlation was weaker. A significant part of this was the length of time between the haemoglobin measurement and the transfusion, with one in five haemoglobin measurements occurring before surgery and the transfusion at or after surgery, making the haemoglobin measurement a less robust measure of the patient's condition at the time of transfusion.

The majority of patients received at least two units before the haemoglobin level was rechecked. This may be due to the historical practice of prescribing a minimum of two units of red cells which was once considered best practice, however this is no longer the case.[18,19] Studies conducted in patients undergoing CABG have shown increased mortality and morbidity associated with red cell use in a dose dependent fashion[20]. Although the studies need to be confirmed, clinicians should use the absolute minimum number of transfusions required to obtain the relief of symptoms[11] and therefore for top-up transfusions, the patient's symptom control or haemoglobin level should be checked after each unit.

Some orthopaedic units have a policy of transfusing to a level of 100 g/L to assist mobilisation. Although there is some supporting literature[21,22,23] for this practice it is

considered controversial[24]. The large FOCUS trial[24] which aims to answer this question is still recruiting patients, with the report not expected for at least another two years. Careful consideration of the evidence is needed. A subsequent subgroup analysis[24] of the TRICC study has shown restrictive transfusion triggers appear to be safe in most critically ill patients with cardiovascular disease.

In monitoring the response to red cell administration, 91% of all transfusions had a post-transfusion haemoglobin level checked within 24 hours. This compares well with other studies showing results of 78%[16] and 96%[17], although like the pre-transfusion haemoglobin levels, the post-transfusion levels frequently applied to more than one unit transfused.

Transfusion sparing techniques such as cell saver, drain reinfusion and acute normovolaemic haemodilution varied between hospitals but were used almost exclusively in cardiac surgery. This is presumably because in hip replacements and hysterectomies, the volume of blood shed is typically small or inaccessible. Availability of documentation of the use of cell salvage in cardiac bypass surgery was identified as a problem in this audit, resulting in probable underestimation of the extent of their use.

Pre-operative anaemia was identified in 15% of patients. However only 32% of this group had any evidence of investigation into the causes of their anaemia. Not investigating anaemic patients misses an opportunity to detect serious incidental underlying pathology such as bowel cancer. Only 13% of anaemic patients were treated with haematinics. Anaemia is common in the elderly population and especially so in pre-operative patients. Around a third of these are readily treatable nutritional deficiencies (iron, B12, folate)[26]. Treating anaemia with haematinics is a much safer alternative to red cells. A low haemoglobin prior to surgery puts the patient at increased risk of receiving a transfusion. This problem is not confined to New Zealand[27], but nevertheless needs addressing.

Pre-operative transfusion for elective surgery is generally not an accepted practice. In many instances, safer alternatives, such as oral or intravenous iron supplements, are more appropriate, particularly prior to elective surgery. It was reassuring to see that only 1.2% (n=5) of patients received red cells (13 units) before their operation. However, eight of these units were considered inappropriate.

9.5% of the transfusions took place overnight (9pm – 7am). This compares well with a previous audit by this group in 2004 which showed 23% of units were being transfused overnight. 66% of the transfusions occurred within 24 hours of surgery, with a further 14% on the second day. Excluding the first 24 hours post-surgery when patients might be considered unstable, it was interesting to see that only 2.4% of the transfusions took place overnight. These cases appeared to have little rationale for being transfused overnight and it is worth re-iterating that transfusion overnight is more hazardous[28] as well as tiring for the patient.

Discharge haemoglobin values are often taken as surrogate markers for appropriateness of transfusion practice with high discharge haemoglobin levels a marker of inappropriate transfusion[13,14]. The results of this audit demonstrate that the average discharge haemoglobin value was 9g/L higher amongst the inappropriately transfused group compared with the appropriately transfused group, validating the assessment technique.

Although this is the last topic discussed, the first step in the transfusion process is the decision to use blood. The clinician responsible for this decision should be clear what s/he is trying to achieve and should document this[10,17]. In this audit, the indication was recorded in 46% of transfusions, less than in other studies which have shown over 60%[17]. A number of sites have commented that blood loss, cell salvage and other

pieces of transfusion-related information are not kept in the patient's notes, or may only be added to the patient's notes after discharge. This is a confounding factor both for audit and possibly also for post-operative management of the patient. It has been suggested that poor documentation correlates with inappropriate transfusion, and a trend towards this was seen in this audit[29].

RECOMMENDATIONS

This audit has identified several areas which could be responsive to appropriate education. These include:

- the optimum dose of red cells should be more closely assessed to avoid over transfusion
- routine prescribing of two red cell units to top patients up should be avoided
- each site should investigate any barriers to implementing transfusion sparing techniques for e.g. cell saver or acute normovolaemic haemodilution
- each site should investigate strategies to improve identification and treatment of anaemic patients before their surgery
- documentation around blood transfusion, notably the indication for transfusion, use of cell salvage and extent of blood loss in theatre, should be improved

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APPENDICES

Appendix 1: *Audit endpoints reached by surgery type and site*

DHB	Surgery	Day 7	Died	Discharged	Repeat surgery
Auckland	CABG	-	-	17	3
Auckland	THR	4	-	15	-
Auckland	TAH	-	-	19	1
Canterbury	CABG	11	-	11	2
Canterbury	THR	-	-	21	1
Canterbury	TAH	-	-	22	-
Capital & Coast	CABG	4	-	15	2
Capital & Coast	THR	5	-	14	1
Capital & Coast	TAH	2	-	18	-
Counties Manukau	THR	4	1	23	-
Counties Manukau	TAH	2	-	20	-
MidCentral	THR	8	1	27	-
MidCentral	TAH	3	-	17	-
Otago	CABG	12	-	8	-
Otago	THR	10	-	12	-
Otago	TAH	-	-	20	-
Waikato	CABG	14	-	6	-
Waikato	THR	4	-	16	-
Waikato	TAH	1	-	19	-
Overall		84	2	320	10

Appendix 2: *Proportion (and total number) of patients transfused by surgery subtype and site*

DHB	Auckland	Canterbury	Capital & Coast	Counties Manukau	MidCentral	Otago	Waikato	Overall
CABG (x1)	100% (1)		100% (1)	-	-		0% (1)	67% (3)
CABG (x2)	50% (2)	0% (2)	100% (5)	-	-	50% (2)	33% (3)	57% (14)
CABG (x3)	0% (4)	25% (8)	50% (10)	-	-	80% (5)	36% (11)	39% (38)
CABG (x4)	63% (8)	40% (10)	50% (4)	-	-	78% (9)	33% (3)	56% (34)
CABG (x5)	20% (5)	75% (4)	100% (1)	-	-	50% (4)	100% (2)	56% (16)
All CABG	*40% (20)*	*38% (24)*	*67% (21)*	-	-	*70% (20)*	*40% (20)*	*50% (105)*
THR unilat	47% (19)	27% (22)	14% (14)	19% (26)	50% (34)	36% (22)	25% (20)	33% (157)
THR bilat	-	-	67% (6)	0% (2)	100% (2)			60% (10)
All THR	*47% (19)*	*27% (22)*	*30% (20)*	*18% (28)*	*53% (36)*	*36% (22)*	*25% (20)*	*35% (167)*
TAH	5% (20)	7% (15)	20% (5)	22% (9)	5% (19)	0% (11)	0% (6)	7% (85)
TAH + BSO	-	0% (7)	7% (15)	8% (13)	0% (1)	0% (9)	0% (14)	3% (59)
All TAH	*5% (20)*	*5% (22)*	*10% (20)*	*14% (22)*	*5% (20)*	*0% (20)*	*0% (20)*	*6% (144)*
Overall	*31% (59)*	*24% (68)*	*36% (61)*	*16% (50)*	*36% (56)*	*35% (62)*	*22% (60)*	*29% (416)*

Appendix 3: *American Society for Anesthesiology physical status classification system (ASA scores) per DHB (1=normal, 6=brain dead)*

DHB	Score						
	Not provided	1	2	3	4	5	Mean
Auckland	4	4	17	20	14	0	2.8
Canterbury	9	7	26	14	11	1	2.5
Capital & Coast	6	5	21	22	7	0	2.6
Counties Manukau	0	5	39	6	0	0	2.0
MidCentral	2	8	32	12	2	0	2.1
Otago	21	4	19	15	3	0	2.4
Waikato	16	10	17	16	1	0	2.2
One way analysis of variance (ANOVA) of the means shows the groups are not the same ($p < 0.005$).							

Appendix 4: *Units transfused by NHMRC category and clinical appropriateness by site and surgery type*

DHB	Surgery	NHMRC guidelines category haemoglobin (g/L)	No of patients transfused	No of units transfused	No of units assessed as appropriate	Ave interval between Hb and transfusion (hours)
Auckland	CABG	<70	1	1	1	0.2
		70-100	8	12	8	2.3
	THR	70-100	7	15	9	6.1
		>100	4	7	4	3.4
	TAH	70-100	1	3	0	30.6
Canterbury	CABG	<70	6	12	12	1.7
		70-100	4	7	6	4.5
		>100	2	3	1	29.9
	THR	70-100	6	16	12	8.8
		>100	1	2	2	1421.8
	TAH	70-100	1	2	1	2.5
Capital & Coast	CABG	<70	4	10	10	0.6
		70-100	11	31	20	4.6
		>100	4	8	7	17.9
	THR	<70	1	3	2	5.8
		70-100	4	7	2	2.4
		>100	2	3	1	0.9
	TAH	<70	1	3	3	145.4
		70-100	1	2	0	9.4
Counties Manukau	THR	<70	1	6	6	0.3
		70-100	5	12	5	3
		>100	1	3	3	144
	TAH	<70	1	4	4	7.4
		70-100	1	1	0	3.6
		>100	1	3	1	75.1
MidCentral	THR	70-100	11	28	13	17.4
		>100	10	22	14	420.2
	TAH	>100	1	2	1	44.3
Otago	CABG	<70	1	2	2	11
		70-100	7	28	21	3.9
		>100	9	18	13	31.6
	THR	70-100	8	19	11	5.6
Waikato	CABG	<70	1	1	1	0
		70-100	8	16	16	1.1
		>100	3	5	5	19.3
	THR	<70	1	3	2	7
		70-100	3	5	3	4.4
		>100	1	2	2	23.8