BENCHMARKING TRANSFUSION ACROSS NEW ZEALAND

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April 2010

BACKGROUND

With its short shelf-life and dependency on altruistic donation, blood for transfusion is a scarce resource. Taken together with the small but present risks of transfusion, it is important that blood is used only when needed. Assessing appropriate use of blood is a challenge facing blood services and clinicians world-wide. A common approach is to audit a small sample of transfusions and extrapolate to all transfusion. Although audit can give a detailed snapshot, it is limited in its usefulness by the small numbers that can be assessed.

By comparing transfusion rates between individuals or institutions, a relative indication of the individuals or institution's performance can be obtained. This exercise, often called benchmarking, has been applied to various aspects of health care, such as cesarean section rates and post-operative infection rates. The Dartmouth Atlas[1] is an example of a highly developed form of benchmarking, founded following the discovery of wide variation in rates of surgery in the United States. As a guide to appropriateness, benchmarking has also been applied to transfusion[2,3]. In New Zealand this has been done previously by looking at transfusions per capita. But for this to be useful to the individual clinician and to influence his/her practice, a more refined tool is needed.

New Zealand Health Information Service (NZHIS) stores medical procedure codes as part of the National Minimal Dataset (NMDS) provided by all DHBs. The NMDS has been used to obtain mortality data[2] and has been used to derive intravenous immunoglobulin usage patterns[5]. To date it has not been used to obtain transfusion rates. Transfusion rates per procedure between DHBs have been sought by New Zealand clinicians by utilising data held by the DHBs. This has not been very successful yet. However NZBS stores the transfusion history of all patients transfused with blood issued by all but the very smallest of blood banks. By extracting data from the NMDS and NZBS databases and linking the two datasets, it is possible to derive transfusion rates per procedure for each DHB.

METHOD

Following ethics approval by the National Multi-Region Ethics Committee, the Chief Medical Advisors of all the District Health Boards were asked whether or not their DHBs wanted to participate in this study. 20 DHBs gave consent for inclusion in benchmarking; however in two cases this arrived too late for the request for information of NZHIS. Once consent had been obtained, NZHIS extracted a table of with DHB, NHI, and date of procedure and procedure code for all patients from 1 January 2002 until 31 December 2007 for patients undergoing the following procedure types:

- Coronary artery bypass
- Transurethral resection of the prostate
- Total abdominal hysterectomy
- Total hip replacement

NZBS extracted a table with NHI, data of transfusion and number of units transfused for all patients in the NZHIS table from the same period.

The two data sets were joined in a password-protected Microsoft Access database sitting on a secure, restricted (NZBS) network. Data was normalized according to standard database design. Each procedure was analysed without reference to the other procedure types. Where a patient had more than one procedure of the same type, procedures performed on the same day were grouped together, and subsequent procedures of the same type on the same patient were excluded if within seven days. Units of red cells and whole blood issued to the patient on the day of surgery and in the subsequent seven days were associated with each patient, surgery type, DHB and date of surgery.

Using the database, the numbers of procedures performed, the proportion of patients receiving blood and the number of units transfused per procedure were extracted for each DHB. Statistical analysis was performed using Microsoft Excel and the statistical package R.

The proportion of patients transfused was analysed by DHB using an Analysis of Means. This distributes the confidence intervals for each DHB around the overall mean, instead of the DHB's observed value, and then plots the observed value. If the observed value is outside the confidence intervals, that value is considered to be an outlier (figure 1). The units transfused to patients was graphed in a box and whisker plot to show the mean and standard deviations using R (figure 2).

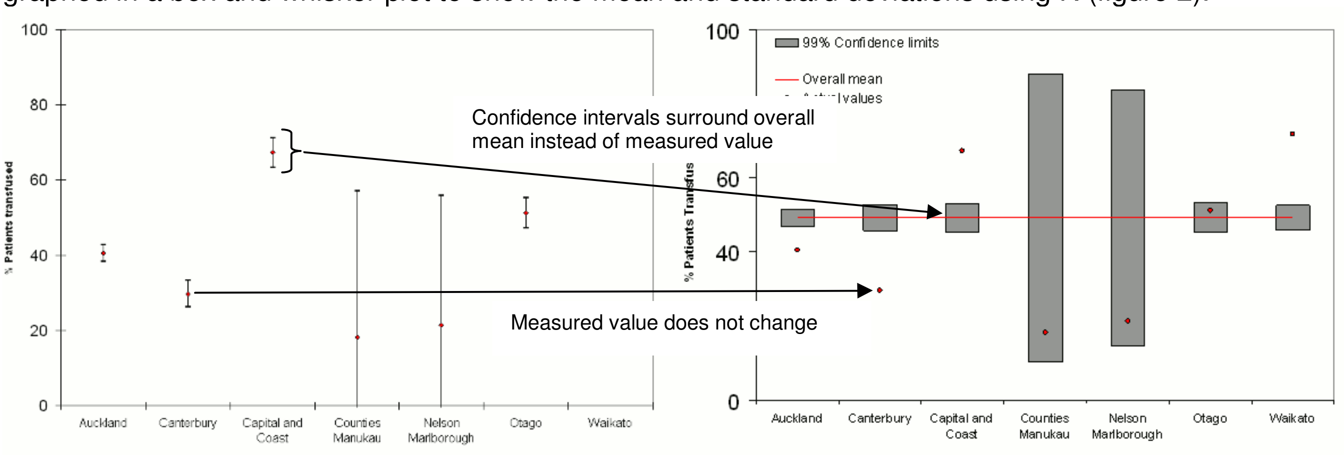

Figure 1. *Demonstration of the relationship between a standard plot showing confidence intervals, and an Analysis of Means plot.*

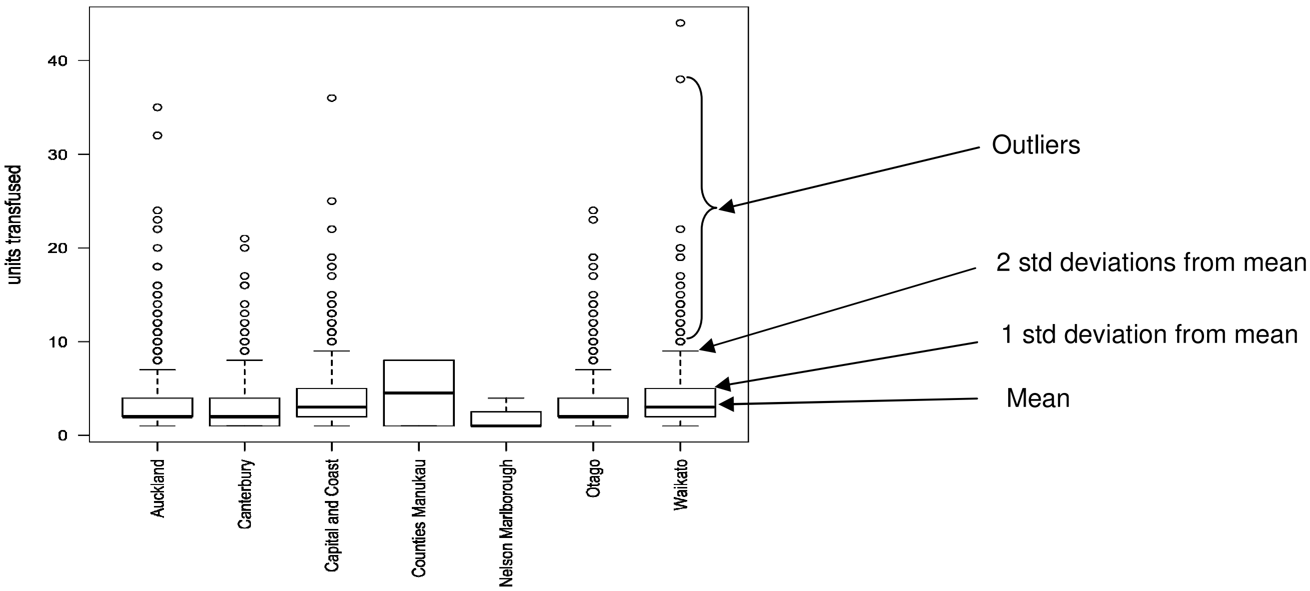

Figure 2. *Demonstration of the mean, standard deviation and outlier markers in the units transfused graphs.*

Preliminary analysis

An analysis of procedures of the same type more than seven days from the initial procedure was conducted to determine if the proportion of patients transfused was similar. This was to determine if the subsequent procedures were sufficiently similar and of sufficient number to warrant inclusion in the dataset. For coronary artery bypass and total abdominal hysterectomy, the data was statistically similar (Student's t test) but accounted for less than 0.3% of procedures and were excluded. For total hip replacements the proportion of patients transfused ceased to be statistically different only with an interval greater than 3.5 years. At this interval, the number of procedures amounted to only 0.9% of the total. In view of the significant differences up till 3.5 years, it was decided to exclude all subsequent hip replacements. Trans-urethral prostatectomy was the only procedure type where the proportion transfused was similar in subsequent procedures after seven days and where the number of subsequent procedures (4.2%) was felt to warrant inclusion in the analysis.

A comparison was conducted of the proportion of patients transfused between different specific procedure codes within the same type of surgery. This showed statistically significant variation for all four procedure types. It was therefore decided to choose the commonest procedure code for detailed analysis. The only exception to this was the decision to analyse total abdominal hysterectomies without bilateral salpingo-oophorectomies. Although-TAH-BSO was a slightly more common procedure than TAH (40% vs 38%), the distribution of TAH was more even across all eighteen DHBs than TAH-BSO.

As the transfusion data source was the NZBS blood management system, Progesa, any procedures occurring prior to implementation of Progesa at the local blood bank were excluded.

RESULTS

NZHIS identified 69,684 procedures in 54,283 patients in 18 DHBs (table 1) for the four types of surgery. Once the exclusions described previously had been applied, 33,921 were available for analysis. A detailed breakdown of the types of surgery by ICD-10 description is in appendix 1.

DHB	CABG	TAH	THR	TURP	Total
Auckland	3188	281	596	1324	5389
Bay of Plenty		190	1040	5	1235
Canterbury	1335	420	1914	1321	4990
Capital and Coast	1093	149	706	360	2308
Counties Manukau	11	127	692	82	912
Hawke's Bay		119	671	430	1220
Hutt Valley		164	456		620
Lakes		51	462		513
Mid Central		184	731	414	1329
Nelson Marlborough	14	150	569	298	1031
Northland		175	668	345	1188
Otago	1019	224	1132	455	2830
South Canterbury		191	515	219	925
Southland		136	511	389	1036
Tairawhiti		95	239	74	408
Taranaki		117	539	346	1002
Waikato	1468	523	1428	917	4336
Waitemata		378	1360	911	2649
TOTAL	8128	3674	14229	7890	33921

Table 1: *number of analysed procedures by DHB and type of surgery*

Four procedures were analysed in detail. These procedures are listed in table 2.

ICD10 code	Description	n
3565301	Total abdominal hysterectomy (without salpingo-oophorectomy)	3674
4931800	Total arthroplasty of hip, unilateral	14229
3720300	Transurethral resection of prostate	7890
3850000	Coronary artery bypass, using 1 LIMA graft	8128

Table 2: *ICD-10 code and description of procedures analysed*

Total Abdominal Hysterectomy

3,674 total abdominal hysterectomy procedures were analysed. 12.8% of patients were transfused and the geometric mean of units transfused to blood recipients was 3.43 units (range: 1-36).

The proportion of patients transfused, shown in figure 3, showed significant variation between DHBs (p<0.0001). Four of the eighteen DHBs were outliers for higher transfusion rates according to the analysis of means and only one was an outlier for lower transfusion rates. It should be noted that these results do not include transfusion prior to surgery, so DHBs where anaemic patients are topped up prior to surgery will appear better in this analysis than those DHBs that wait to see the patient's condition post-op before transfusing.

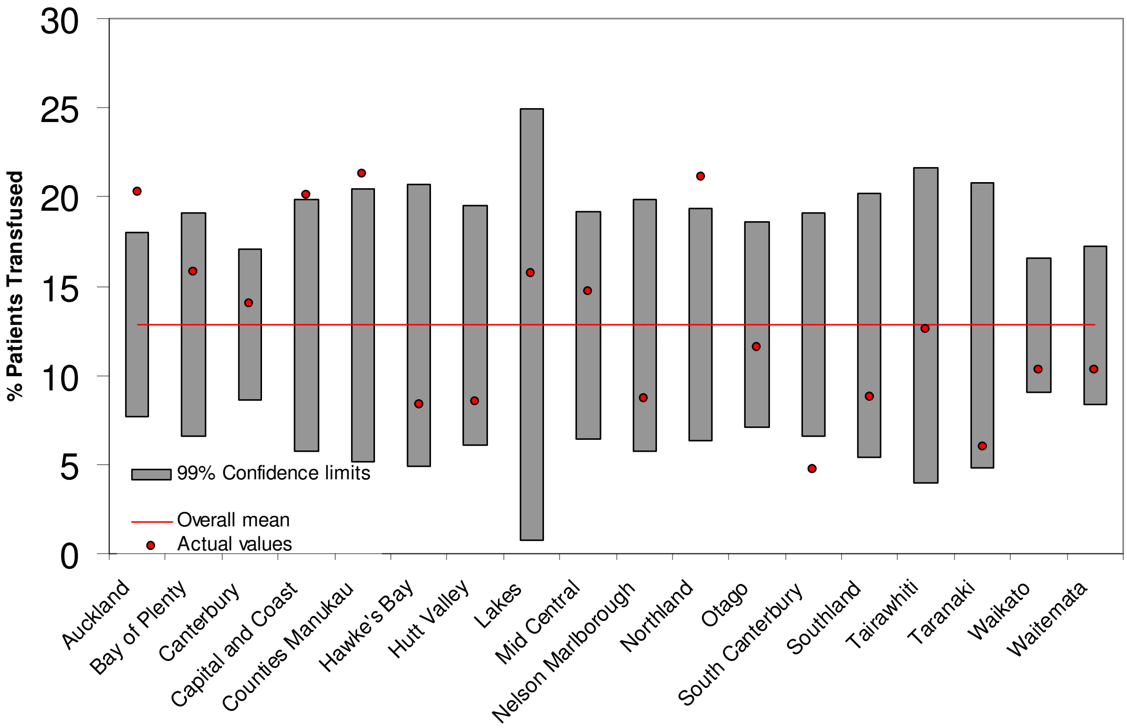

Figure 3. *Proportion of patients transfused after total abdominal hysterectomy with analysis of means showing outliers.*

The distribution of the number of units transfused to each patient is shown in Figures 4 and 5. Statistically significant variation was not seen across the DHBs (p=0.092, Kruskal-Wallis test).

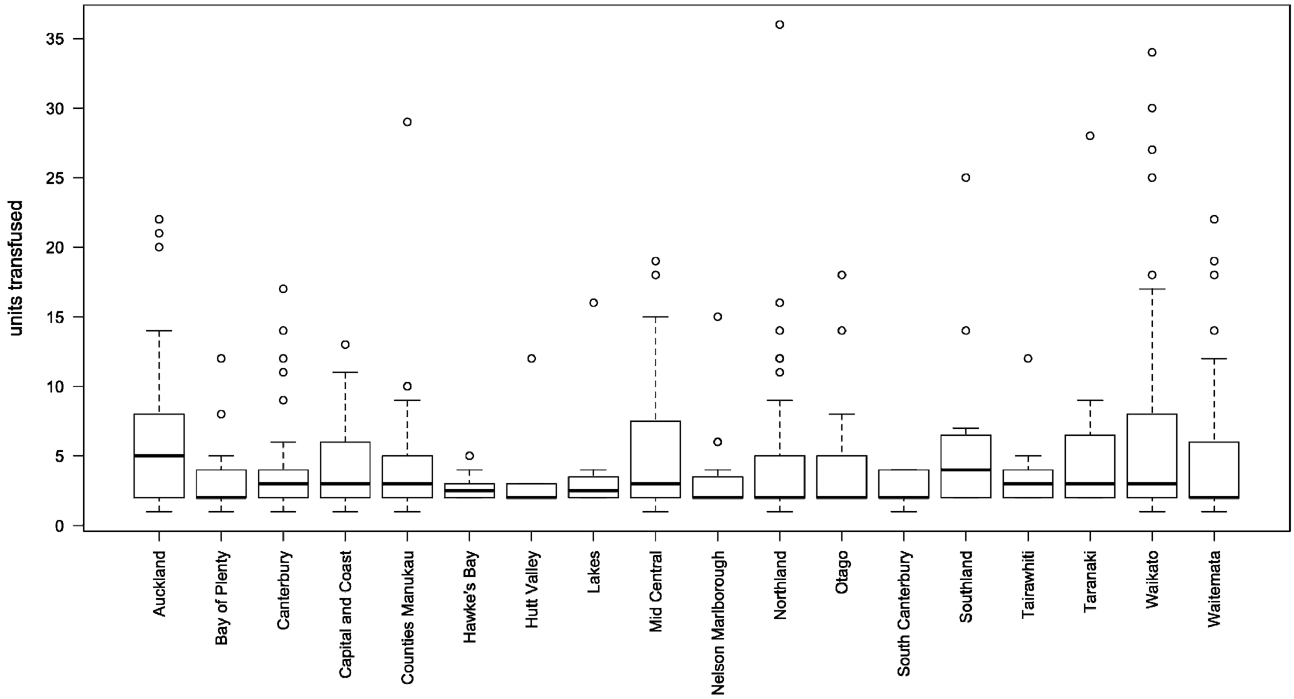

Figure 4. *Units transfused to patients receiving blood after total abdominal hysterectomy*

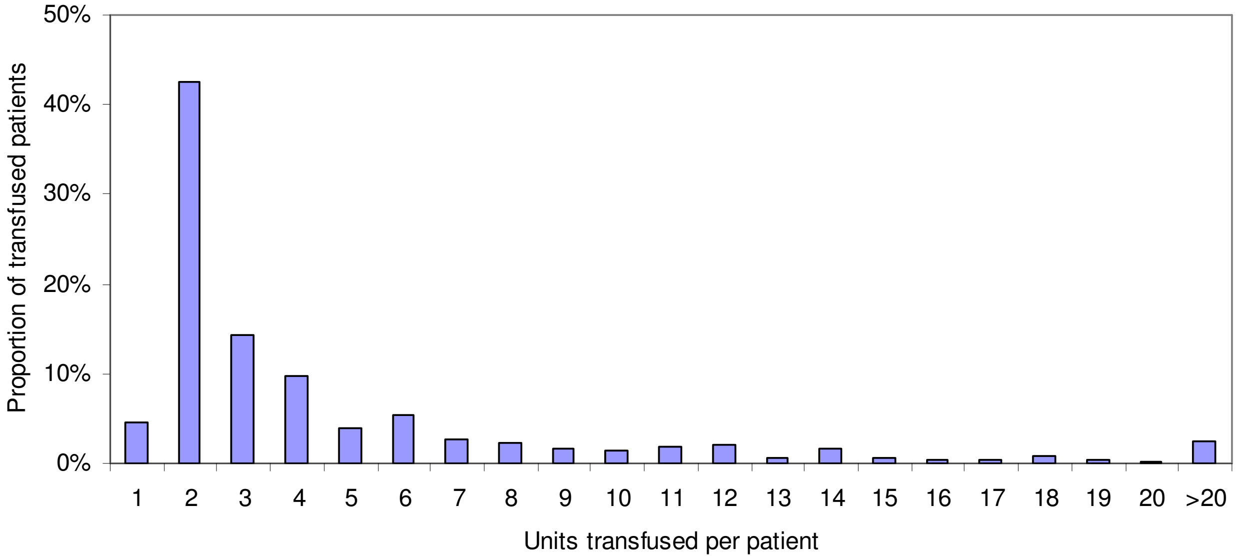

Figure 5: *Distribution of the number of total number of units transfused per patient against the proportion of patients receiving that number of units following total abdominal hysterectomy.*

Given that hysterectomies can be performed as an emergency procedure for post-partum haemorrhage, an analysis was conducted to separate premenopausal women from post-menopausal women, using an arbitrary cutoff of 50 years of age (figure 6). The difference in units transfused to women in the two groups was statistically different ($p < 0.025$, Kruskal-Wallis test). This is seen in the graph below where no women over fifty had more than 11 units compared with 11% of women under fifty years of age.

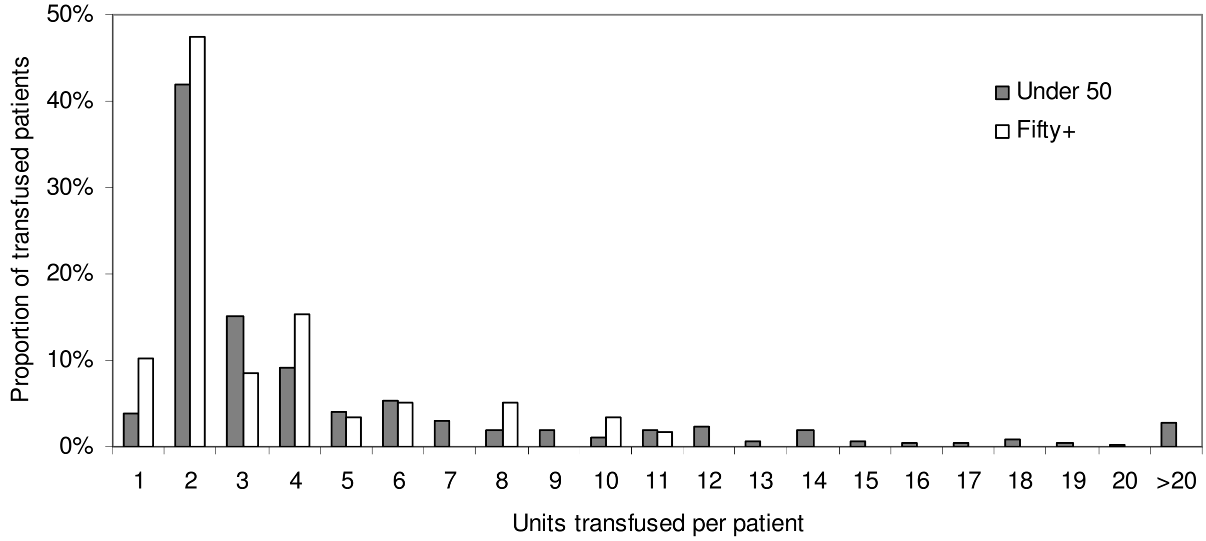

Figure 6. *Comparison of units transfused in women less than 50 vs. women 50 years and older*

Total Hip Replacement

14,229 total hip replacements were analysed. 30.6% of patients were transfused and the geometric mean of units transfused to blood recipients was 2.2 units (range: 1-21). The proportion of patients transfused, shown in figure 7, showed significant variation between DHBs ($p<0.0001$). Five of the eighteen DHB were outliers for higher transfusion rates according to the analysis of means and a further six were outliers for lower transfusion rates.

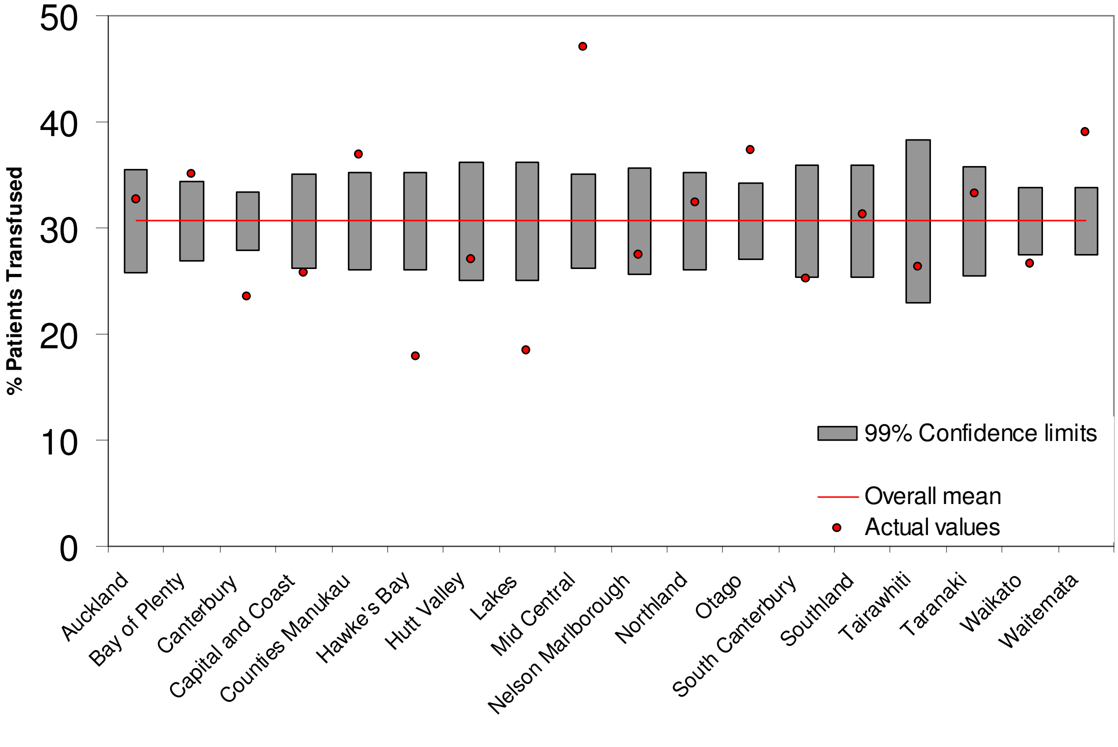

Figure 7. *Proportion of patients transfused after total hip replacement with analysis of means showing outliers.*

The distribution of the number of units transfused to each patient is shown in Figures 8 and 9. Statistically significant variation was seen across the DHBs (p<0.0001).

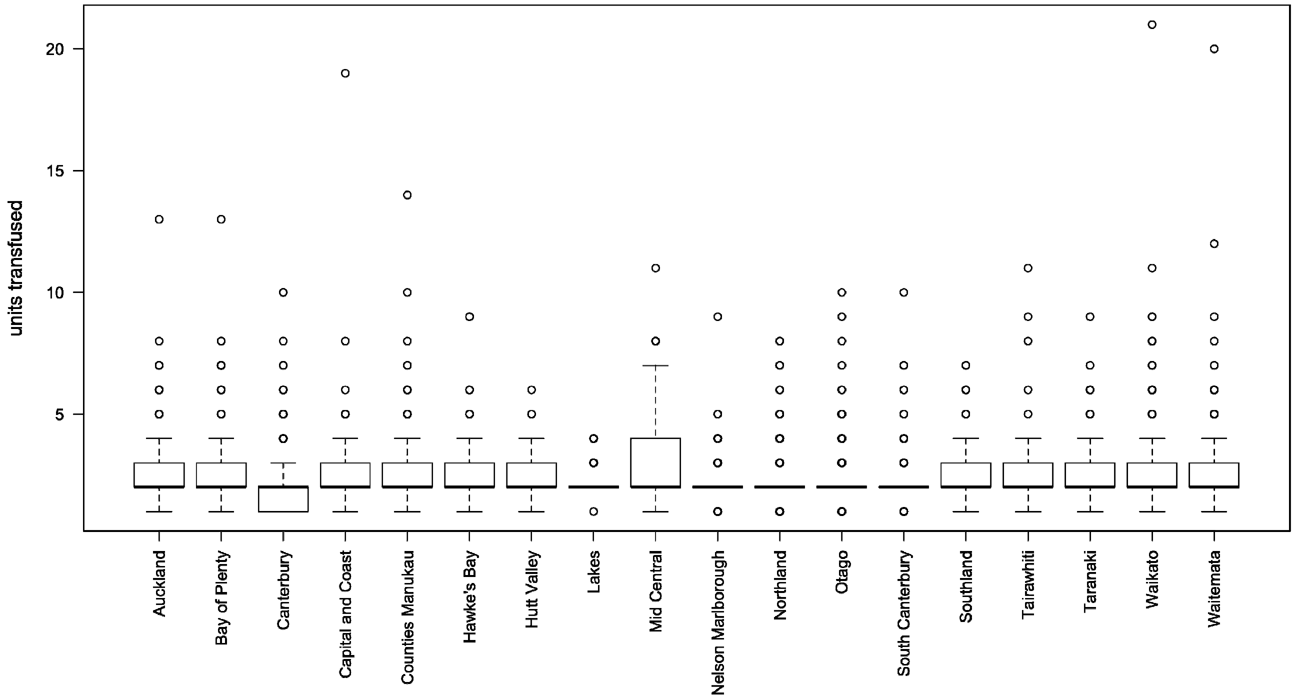

Figure 8. *Units transfused to patients receiving blood after hip replacement*

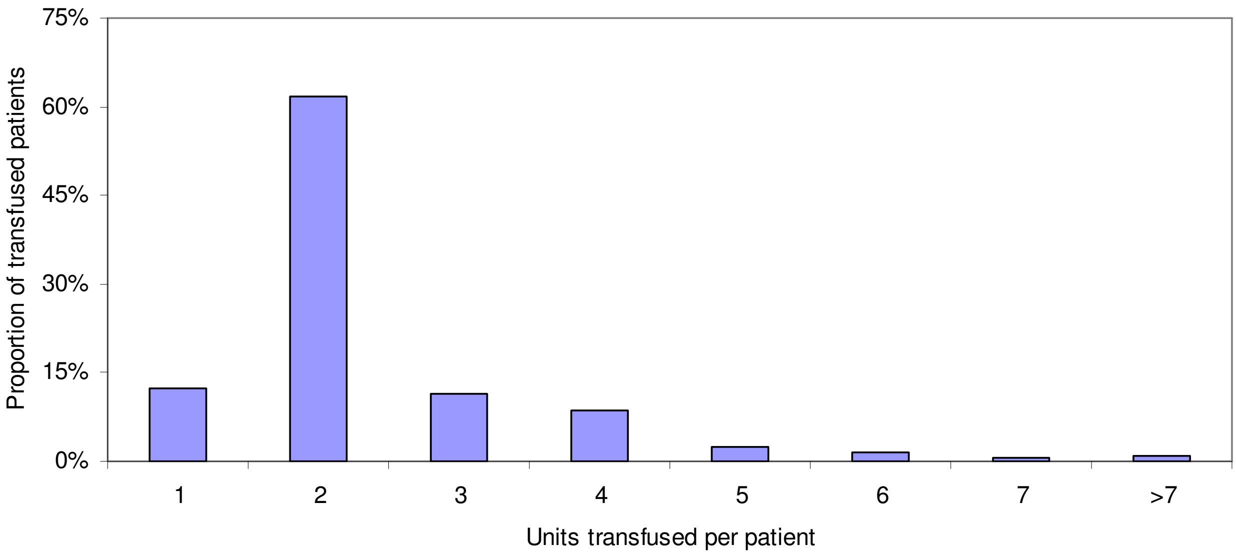

Figure 9: *Distribution of the number of total number of units transfused per patient against the proportion of patients receiving that number of units following total hip replacement*

Trans-urethral Prostatectomy

7,890 trans-urethral prostatectomies were analysed. 5.2% of patients were transfused and the geometric mean of units transfused to blood recipients was 2.3 units (range: 1-28). The proportion of patients transfused, shown in figure 10, showed significant variation between DHBs ($p<0.0001$). Only one of the sixteen DHBs was an outlier for higher transfusion rates according to the analysis of means with two outliers for lower transfusion rates. The distribution of the number of units transfused to each patient is shown in Figures 11 and 12 with no significant variation seen across the DHBs ($p=0.51$).

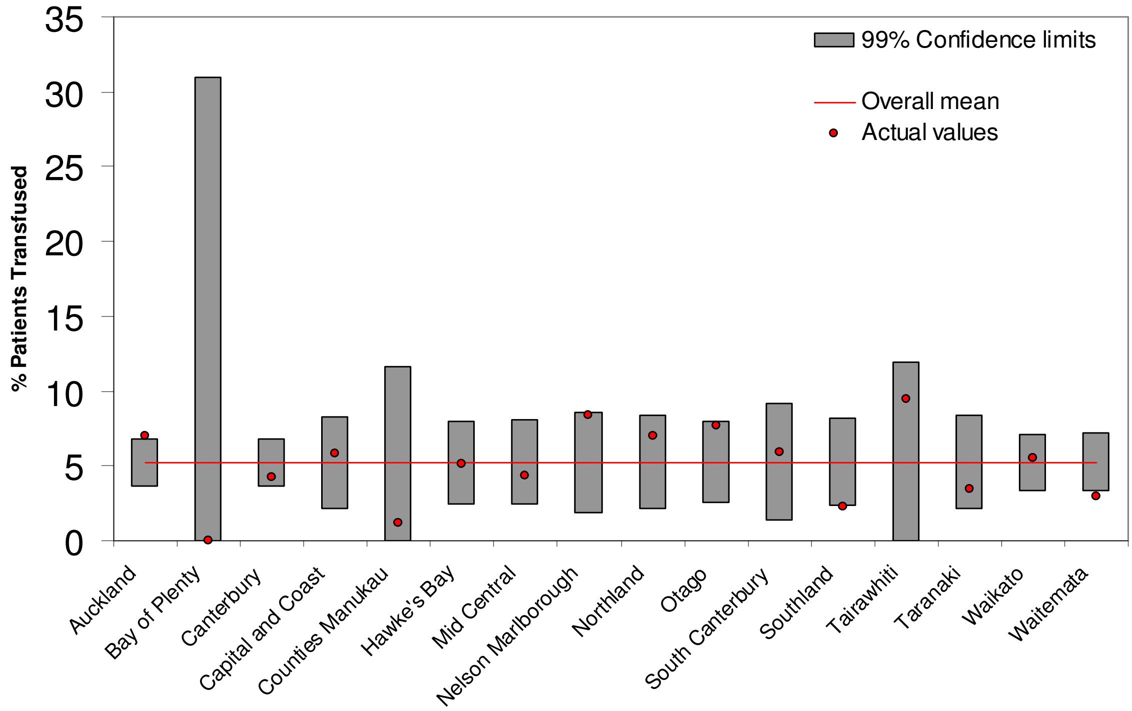

Figure 10. *Proportion of patients transfused after trans-urethral prostatectomy with analysis of means showing outliers.*

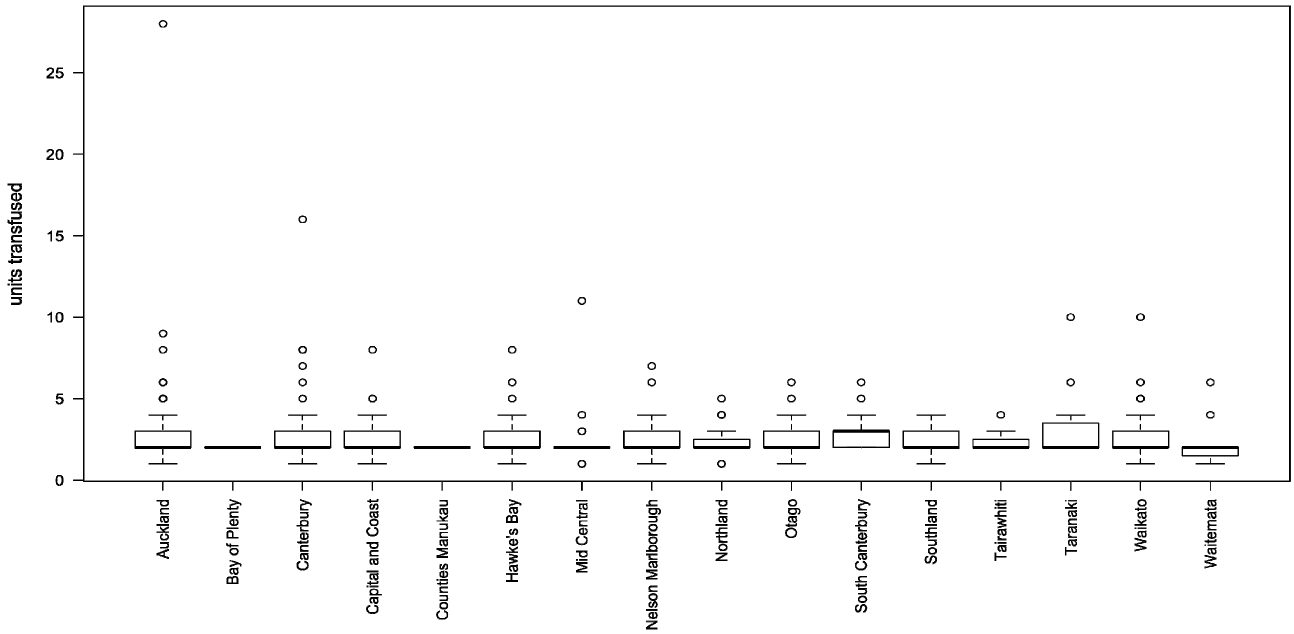

Figure 11. *Units transfused to patients receiving blood after trans-uretheral prostatectomy*

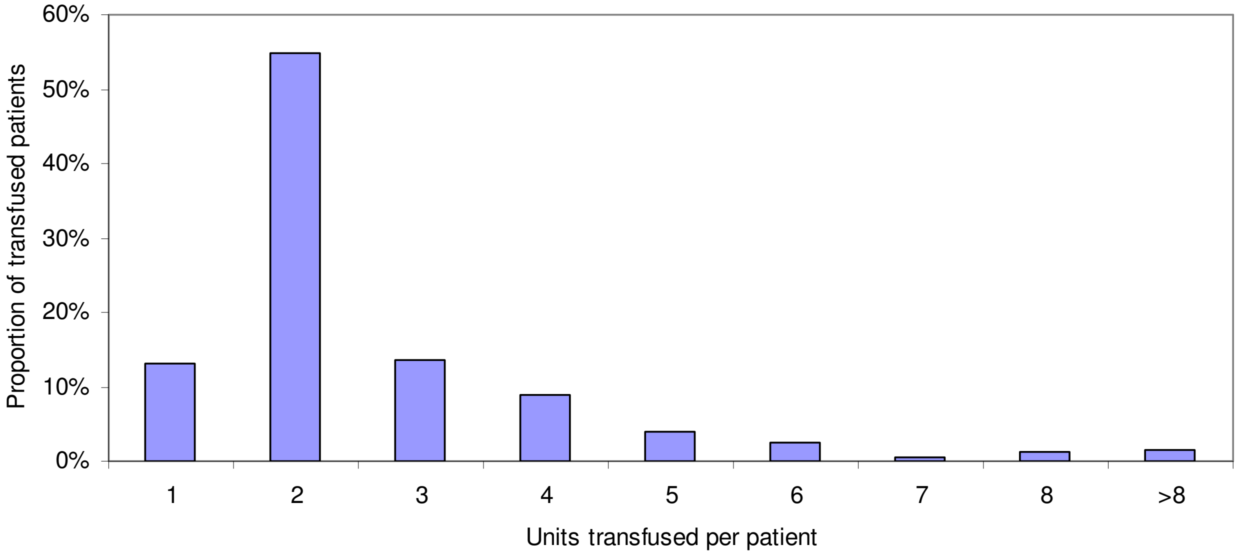

Figure 12: *Distribution of the number of total number of units transfused per patient against the proportion of patients receiving that number of units following transurethral prostatectomy*

Coronary Artery Bypass

8,128 coronary artery bypass procedures were analysed. 49.3% of patients were transfused and the geometric mean of units transfused to blood recipients was 2.8 units (range: 1-44). The proportion of patients transfused, shown in figure 13, showed significant variation between DHBs (p<0.0001). Two of the DHBs were outliers for higher transfusion rates according to the analysis of means with two outliers for lower transfusion rates. The distribution of the number of units transfused to each patient is shown in Figures 14 and 15. Statistically significant variation was seen across the DHBs (p=0.0002).

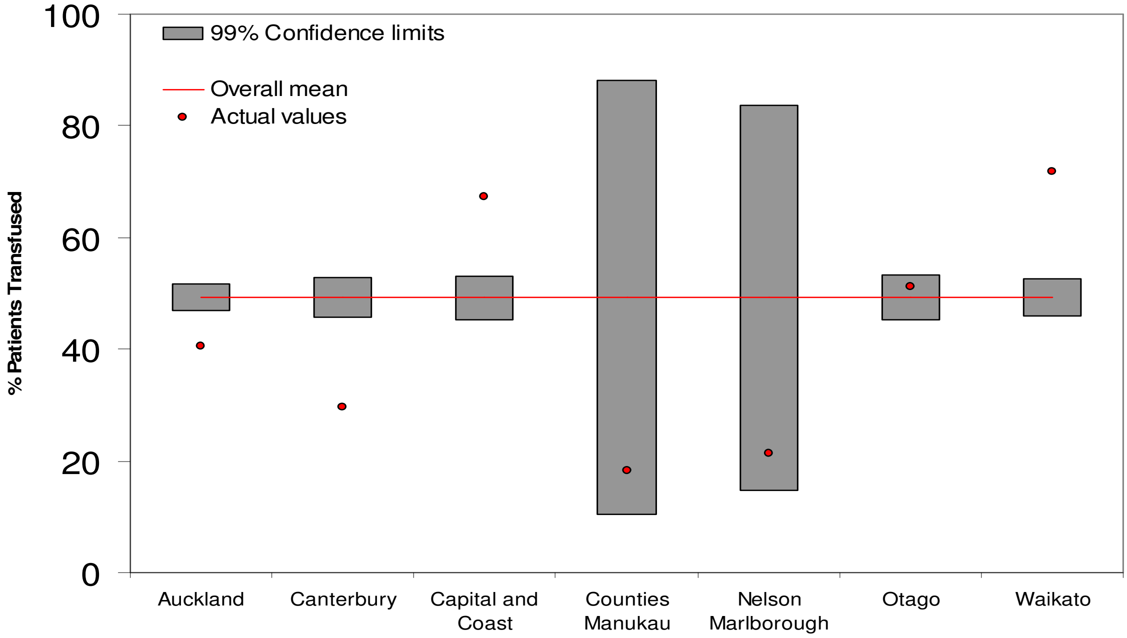

Figure 13. *Proportion of patients transfused after CABG with analysis of means showing outliers.*

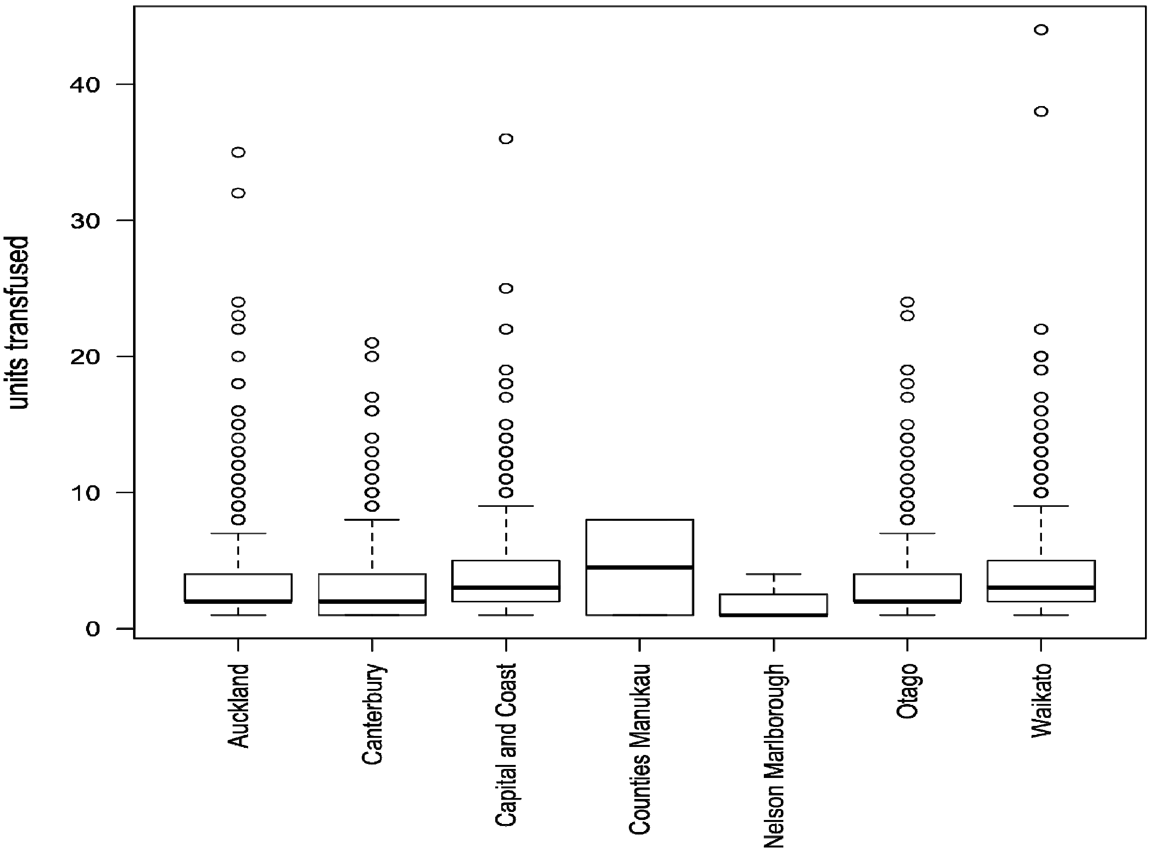

Figure 14. *Units transfused to patients receiving blood after coronary artery bypass grafting*

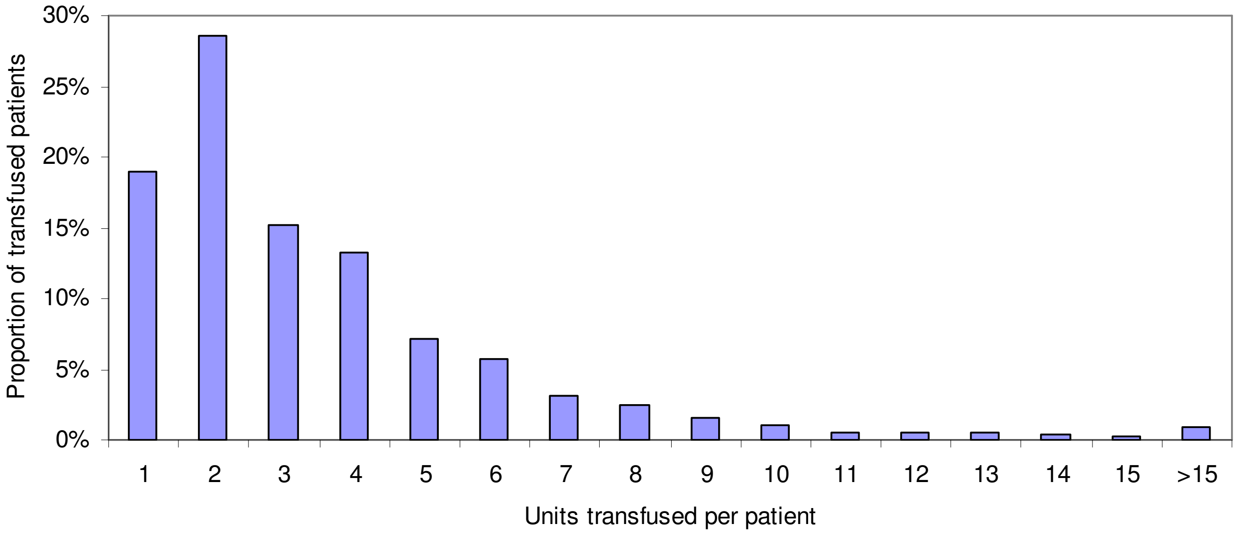

Figure 15: *Distribution of the number of total number of units transfused per patient against the proportion of patients receiving that number of units following coronary artery bypass grafting*

COMPARISON WITH PREVIOUS RED CELL AUDIT

In 2007/8, NZBS conducted an audit of red cell transfusion[6] in primary CABG, primary hip replacement, and total abdominal hysterectomy. Table 3 compares the proportion of patients transfused between the previous audit and this report. Although some outliers are noticeable, in part due to the small numbers in the audit (approximately 20 procedures of each type for each DHB), correlation between the audit and this study appears is good (Spearman's correlation co-efficient=0.835). Of note is that the audited patients undergoing hysterectomy had a significantly lower transfusion rate than in this study. This is possibly explained by the audit excluding complicated and emergency hysterectomies, such as those seen in malignancy and post-partum haemorrhage.

Surgery	DHB	Audit	Benchmark
CABG	Auckland	40%	41%
	Canterbury	38%	30%
	Capital & Coast	67%	67%
	Otago	70%	51%
	Waikato	40%	72%
Hip Replacement	Auckland	47%	33%
	Canterbury	27%	24%
	Capital & Coast	30%	26%
	Counties Manukau	18%	37%
	MidCentral	53%	47%
	Otago	36%	37%
	Waikato	25%	27%
Hysterectomy	Auckland	5%	20%
	Canterbury	5%	14%
	Capital & Coast	10%	20%
	Counties Manukau	14%	21%
	MidCentral	5%	15%
	Otago	0%	12%
	Waikato	0%	10%

Table 3: *Proportion of patients transfused in the previous audit and this benchmarking study by DHB*

DISCUSSION

This study looks at transfusion in four commonly performed procedures in eighteen DHBs over six years. This has shown significant variation in the proportion of patients transfused for each of the procedures. Further, the number of units transfused to patients showed significant variation across the eighteen DHBs in all three of the four operations. Trans-urethral prostatectomy was the only procedure where there was no statistically significant variation between DHBs.

Few would disagree that we all do our best to care for our patients. However when patients having the same procedure at DHB "x" are twice as likely to be transfused as those at DHB "y", we have to see if we can't learn from our peers to do better still.

If one group of patients is transfused more than another group, there are a number of possible explanations. The first possibility is that the patients in the second group were undertransfused. A recent audit[6] conducted by NZBS of 415 surgical procedures showed no cases of undertransfusion but did find 62% of patients were overtransfused. This suggests that differences between groups of patients are more likely to be due to some patients receiving more blood than any patients being undertransfused. Reasons identified in the audit for overtransfusion includes that the patients:

- were more anaemic at the time of surgery
- bled more from the surgery
- were transfused at a higher threshold haemoglobin level

There are a number of reasons why each of these reasons might apply to a particular patient group.

Firstly, anaemic patients may reflect a more socially deprived community, but also a failure to detect and treat the anaemia prior to surgery.

Secondly, patients may bleed more because of variation in surgical technique, thrombo-prophylaxis, adequate pre-op preparation (e.g. reversal of warfarin), or because the patients had more complex co-morbidities.

Thirdly, patients may be transfused at a higher threshold haemoglobin because of co-morbidities such as ischaemic heart disease or because of personal preference of the surgical team. One particular circumstance for transfusing at a higher haemoglobin threshold is the controversial belief that patients having hip replacements should have a haemoglobin level over 100g/L for optimal mobilization. The Focus trial[7] has been conducted to address this question but its results are not expected for another year.

Fourthly, patients with ischaemic heart disease may be perceived as needing transfusing at a higher threshold. However a subgroup analysis[8] of the TRICC study has shown restrictive transfusion policies are safe in most critically ill patients with cardiovascular disease and are recommended in such patients.

Lastly, it has been conventional wisdom for many years that single unit transfusions are inappropriate, and that a minimum of two units should be given if a patient needed transfusion. This is no longer current thinking. Transfusion is now aimed at treating a specific clinical problem, e.g. symptoms, and if one unit of red cells is all that is needed to correct the problem, then one unit is all that should be prescribed. Canterbury DHB had a very active programme promoting this concept, encapsulated in the phrase “Why use two when one will do”. With this in mind, it is interesting to look at the transfusion data for patients received following hip replacements (figures 7 & 8). Canterbury transfuse a lower proportion of patients than most DHBs and, noticeably, use single unit transfusion more often than other DHBs.

Each of these areas may explain differences between DHBs. Nevertheless, in each of these are also opportunities for DHBs to look at systems with a view to improvement.

The proportions of patients transfused for different procedures generated by this study are comparable with international publications[9,10,11,12,13,14,15,16,17]

- NZ hysterectomies: 12.8% vs USA data of 12.4%, 2.2% and 4.7% (Australia, benign disease only), 25.0% (Malaysia)
- NZ hip replacements: 30.6% vs 80.9% (USA), 57% (Australia), 30 falling to 20% (Scotland), 43% (Austria)
- NZ TURPs: 5.2% vs 11.6% (USA), 9% (Australia), 9.8% (Finland)
- NZ CABGs: 49.3% vs 49.8% (USA data not specific to CABG), 45% (Australia) and 80% (UK data not specific to CABG), 55% (Austria).

However the published data is now getting old, particularly the USA data. As a result it does not take into account the recent blood conservations trends to optimise patients pre-operatively, minimise intra-operative blood and restrict transfusion to those with symptoms or severe anaemia.

Some will inevitably ask what the data is for their particular operations. It was considered that the available data was not sufficiently robust in its ability to link patients to surgeons and that doing such a study nationally would be threatening and counter-productive. Such studies are more usually conducted within a single institution where surgeons can be part of the process from planning through to results.

Lastly, there is a natural response to data being presented that is not as good as the observer would have liked or believed. This ranges from rejection through rationalisation to questioning and acceptance (figure 16). The very nature of this report is comparative between DHBs and inevitably some surgeons will not like what they see. It is hoped that the data being presented is accepted for what it is, data with no preconceptions as to the cause of the differences. It is intended to promote reflection and discussion amongst colleagues about differences in practice and how to achieve the optimal outcome for patients.

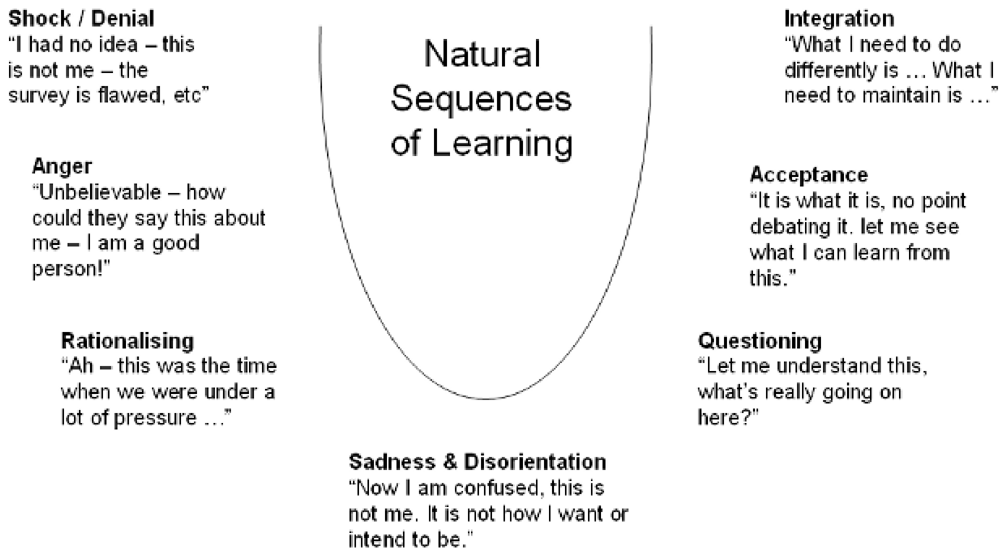

Figure 16. *Emotional responses in the natural sequences of learning*

In conclusion, this analysis has shown significant variation in the proportion of patients transfused for all four procedures, and the number of units transfused in three of the four procedures across the eighteen DHBs studied. While some of this may be due to variations in case-mix, much of the variation is likely to be due areas where DHBs could improve clinical practice.

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APPENDIX: *Detailed list of procedures with ICD10 code, the number of patients undergoing the operation (in parentheses) and percentage transfused by DHB*

Total Abdominal Hysterectomy	Auckland	Bay of Plenty	Canterbury	Capital and Coast	Counties Manukau	Hawke's Bay	Hutt Valley	Lakes	Mid Central	Nelson Marlborough	Northland	Otago	South Canterbury	Southland	Tairawhiti	Taranaki	Waikato	Waitemata	OVERALL
Abdominal hysterectomy with bilateral salpingo-oophorectomy (3565303)	13% (582)	15% (191)	17% (530)	20% (503)	6% (422)	6% (193)	11% (108)	21% (29)	18% (184)	5% (154)	8% (144)	13% (234)	7% (70)	5% (106)	14% (73)	7% (71)	15% (603)	13% (285)	13% (4482)
Abdominal hysterectomy with extensive retroperitoneal dissection (3566100)	38% (24)	50% (2)	29% (14)	60% (5)	25% (4)	0% (1)	-	100% (1)	83% (6)	-	-	38% (8)	-	0% (1)	50% (2)	-	100% (3)	-	44% (71)
Abdominal hysterectomy with radical excision of pelvic lymph nodes (3567000)	12% (66)	-	16% (50)	13% (48)	-	-	0% (1)	100% (1)	0% (4)	-	0% (1)	14% (36)	0% (1)	0% (1)	33% (3)	-	0% (8)	0% (1)	13% (221)
Abdominal hysterectomy with unilateral salpingo-oophorectomy (3565302)	18% (87)	24% (54)	13% (144)	17% (84)	6% (77)	7% (58)	7% (57)	19% (16)	20% (56)	4% (83)	20% (44)	12% (67)	10% (41)	2% (43)	19% (21)	17% (23)	12% (113)	10% (78)	13% (1146)
Radical abdominal hysterectomy (3566700)	43% (23)	100% (2)	30% (20)	44% (16)	-	0% (2)	-	100% (1)	100% (2)	33% (3)	-	50% (4)	-	-	50% (2)	25% (4)	44% (9)	-	42% (88)
Radical abdominal hysterectomy with radical excision of pelvic lymph nodes (3566400)	22% (59)	-	12% (58)	40% (15)	-	0% (1)	-	-	-	-	-	17% (23)	-	-	-	-	33% (3)	-	19% (159)
Subtotal abdominal hysterectomy (3565300)	32% (91)	29% (24)	14% (56)	26% (73)	15% (103)	8% (12)	11% (9)	50% (6)	17% (36)	3% (65)	14% (29)	15% (20)	6% (33)	7% (54)	0% (2)	7% (42)	47% (15)	19% (67)	17% (737)
Total abdominal hysterectomy (3565301)	20% (285)	15% (217)	14% (420)	17% (240)	9% (312)	6% (172)	7% (198)	12% (66)	15% (184)	7% (229)	18% (208)	12% (224)	5% (191)	8% (149)	11% (110)	6% (117)	10% (523)	10% (378)	12% (4223)

Transurethral Prostatectomy	Auckland	Bay of Plenty	Canterbury	Capital and Coast	Counties Manukau	Hawke's Bay	Hutt Valley	Lakes	Mid Central	Nelson Marlborough	Northland	Otago	South Canterbury	Southland	Tairawhiti	Taranaki	Waikato	Waitemata	OVERALL
Transurethral electrical vaporisation of prostate (3720302)	0% (1)	-	-	-	-	0% (1)	-	-	-	-	5% (100)	-	-	-	-	-	-	-	5% (102)
Transurethral needle ablation of prostate (3720301)	-	-	-	0% (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0% (1)
Transurethral resection of prostate (3720300)	7% (1368)	7% (15)	4% (1321)	7% (611)	1% (82)	4% (566)	-	-	4% (415)	5% (507)	6% (435)	8% (455)	6% (219)	2% (506)	7% (96)	3% (347)	6% (917)	3% (912)	5% (8772)

Total Hip Replacement	Auckland	Bay of Plenty	Canterbury	Capital and Coast	Counties Manukau	Hawke's Bay	Hutt Valley	Lakes	Mid Central	Nelson Marlborough	Northland	Otago	South Canterbury	Southland	Tairawhiti	Taranaki	Waikato	Waitemata	OVERALL
Excision arthroplasty of hip (4931200)	69% (45)	76% (33)	63% (30)	58% (24)	28% (69)	32% (25)	43% (14)	50% (12)	76% (25)	26% (19)	65% (17)	81% (26)	88% (8)	47% (19)	27% (11)	87% (15)	84% (50)	74% (31)	59% (473)
Hemiarthroplasty of femur (4752200)	38% (742)	42% (314)	36% (771)	27% (353)	11% (615)	15% (192)	30% (240)	24% (130)	41% (240)	19% (217)	26% (176)	52% (375)	31% (172)	31% (140)	37% (83)	29% (205)	25% (482)	39% (423)	31% (5870)
Partial arthroplasty of hip (4931500)	50% (8)	75% (4)	100% (1)	20% (5)	50% (4)	9% (11)	20% (10)	0% (1)	-	-	0% (3)	-	-	-	-	0% (1)	0% (1)	33% (3)	29% (52)
Revision of partial arthroplasty of hip (4934600)	51% (39)	42% (66)	40% (57)	41% (49)	25% (111)	11% (19)	50% (22)	26% (34)	68% (28)	12% (33)	53% (36)	54% (28)	67% (9)	19% (21)	29% (7)	61% (28)	48% (73)	67% (54)	42% (714)
Revision of total arthroplasty of hip (4932400)	68% (146)	70% (132)	39% (371)	56% (210)	32% (262)	24% (144)	52% (91)	44% (50)	63% (81)	29% (119)	67% (98)	73% (169)	63% (72)	65% (48)	59% (29)	65% (115)	68% (168)	75% (189)	54% (2494)
Revision of total arthroplasty of hip with anatomic specific allograft to acetabulum (4933900)	75% (4)	75% (4)	67% (3)	-	36% (14)	-	50% (8)	-	67% (3)	0% (1)	-	-	0% (2)	-	-	71% (7)	72% (25)	83% (6)	61% (77)
Revision of total arthroplasty of hip with anatomic specific allograft to acetabulum and femur (4934500)	100% (1)	100% (5)	-	100% (1)	0% (2)	-	0% (2)	-	100% (1)	0% (1)	-	100% (1)	-	100% (1)	-	100% (3)	100% (2)	86% (7)	78% (27)
Revision of total arthroplasty of hip with anatomic specific allograft to femur (4934200)	73% (15)	80% (5)	25% (4)	100% (1)	15% (13)	-	33% (3)	100% (1)	100% (2)	0% (2)	-	-	0% (1)	100% (3)	-	100% (1)	100% (9)	79% (14)	64% (74)
Revision of total arthroplasty of hip with bone graft to acetabulum (4932700)	56% (16)	88% (16)	67% (6)	100% (1)	25% (16)	67% (3)	67% (6)	50% (8)	90% (10)	29% (14)	33% (6)	71% (7)	67% (9)	50% (8)	0% (1)	65% (17)	71% (17)	53% (19)	58% (180)
Revision of total arthroplasty of hip with bone graft to acetabulum and femur (4933300)	100% (4)	100% (3)	100% (1)	0% (1)	0% (4)	-	75% (4)	-	100% (2)	0% (1)	0% (1)	50% (2)	-	50% (8)	-	100% (3)	0% (2)	88% (8)	64% (44)
Revision of total arthroplasty of hip with bone graft to femur (4933000)	80% (10)	83% (6)	50% (2)	50% (2)	17% (12)	0% (2)	50% (8)	-	78% (9)	14% (7)	-	80% (5)	100% (2)	42% (12)	-	50% (4)	75% (8)	88% (17)	59% (106)
Total arthroplasty of hip, bilateral (4931900)	0% (1)	73% (22)	51% (84)	72% (58)	32% (37)	0% (3)	71% (21)	50% (2)	75% (4)	60% (35)	50% (8)	88% (48)	50% (2)	0% (1)	-	100% (5)	27% (11)	71% (7)	61% (349)
Total arthroplasty of hip, unilateral (4931800)	34% (674)	35% (1319)	24% (2100)	26% (1136)	16% (1851)	13% (991)	22% (622)	17% (563)	47% (843)	18% (979)	28% (894)	37% (1261)	25% (587)	29% (627)	21% (322)	32% (610)	27% (1611)	39% (1532)	27% (18522)

Coronary Artery Bypass

	Auckland	Bay of Plenty	Canterbury	Capital and Coast	Counties Manukau	Hawke's Bay	Hutt Valley	Lakes	Mid Central	Nelson Marlborough	Northland	Otago	South Canterbury	Southland	Tairawhiti	Taranaki	Waikato	Waitemata	OVERALL
CABG using 1 epigastric artery graft (3850003)	100% (2)	-	0% (1)	67% (3)	-	-	-	-	-	-	-	-	-	-	-	-	100% (1)	-	71% (7)
CABG using 1 LIMA graft (3850000)	39% (3299)	-	30% (1341)	67% (1721)	18% (11)	-	-	-	-	21% (14)	-	51% (1020)	-	-	-	-	72% (1470)	-	50% (8876)
CABG using 1 other arterial graft (3850004)	50% (16)	-	0% (3)	73% (15)	-	-	-	-	-	-	-	0% (2)	-	-	-	-	50% (4)	-	53% (40)
CABG using 1 other material graft, not elsewhere classified (9020100)	100% (1)	-	100% (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100% (2)
CABG using 1 other venous graft (3849704)	50% (6)	-	0% (1)	61% (23)	-	-	-	-	100% (1)	-	-	33% (3)	-	-	-	-	-	-	56% (34)
CABG using 1 radial artery graft (3850002)	32% (1170)	-	20% (54)	54% (276)	0% (5)	-	-	-	-	-	-	62% (13)	-	-	-	-	66% (88)	-	37% (1606)
CABG using 1 RIMA graft (3850001)	32% (234)	-	22% (9)	63% (63)	25% (4)	-	-	-	-	-	-	50% (2)	-	-	-	-	82% (85)	-	48% (397)
CABG using 1 saphenous vein graft (3849700)	38% (791)	-	35% (294)	65% (375)	0% (3)	-	-	-	-	0% (4)	-	53% (163)	-	-	-	-	72% (355)	-	50% (1985)
CABG using 2 or more epigastric artery grafts (3850303)	-	-	-	100% (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100% (1)
CABG using 2 or more LIMA grafts (3850300)	36% (66)	-	31% (52)	51% (148)	0% (1)	-	-	-	-	-	-	50% (10)	-	-	-	-	64% (28)	-	45% (305)
CABG using 2 or more other arterial grafts (3850304)	0% (2)	-	0% (1)	33% (3)	-	-	-	-	-	-	-	100% (1)	-	-	-	-	100% (1)	-	38% (8)
CABG using 2 or more radial artery grafts (3850302)	31% (80)	-	22% (9)	56% (159)	100% (1)	-	-	-	-	-	-	64% (11)	-	-	-	-	72% (18)	-	49% (278)
CABG using 2 or more RIMA grafts (3850301)	0% (3)	-	-	28% (18)	-	-	-	-	-	-	-	-	-	-	-	-	100% (2)	-	30% (23)
CABG using 2 other venous grafts (3849705)	33% (3)	-	0% (1)	62% (29)	-	-	-	-	-	-	-	100% (3)	-	-	-	-	100% (2)	0% (1)	62% (39)
CABG using 2 saphenous vein grafts (3849701)	43% (1419)	-	29% (587)	70% (683)	33% (3)	-	-	-	-	38% (8)	-	54% (417)	-	-	-	-	74% (658)	-	52% (3775)
CABG using 3 other venous grafts (3849706)	-	-	-	50% (12)	-	-	-	-	-	-	-	40% (5)	-	-	-	-	100% (2)	-	53% (19)
CABG using 3 saphenous vein grafts (3849702)	44% (748)	-	28% (439)	71% (486)	-	-	-	-	-	0% (2)	-	51% (384)	-	-	-	-	79% (604)	-	55% (2663)
CABG using 4 or more other venous grafts (3849707)	-	-	-	100% (1)	-	-	-	-	-	-	-	100% (1)	-	-	-	-	-	-	100% (2)
CABG using 4 or more saphenous vein grafts (3849703)	43% (159)	-	35% (97)	81% (109)	0% (1)	-	-	-	-	0% (1)	-	52% (111)	-	-	-	-	80% (162)	-	59% (640)