A SURVEY OF BLOOD AND BLOOD COMPONENT USAGE AMONGST SOUTH AFRICAN ANAESTHETISTS IN TEACHING HOSPITAL PRACTICE

Dissertation submitted to the University of Cape Town

for

M.Med(Anaesthesia)

by

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ACKNOWLEDGEMENTS

I would like to thank **Professor M.F.M. James**, Head of the Department of Anaesthetics, Groote Schuur Hospital for his advice and for allowing me time to complete this study. I would also like to thank the **Heads of the Anaesthetic Departments of the Teaching Hospitals** who allowed me to use their Academic Meetings to obtain good returns for my Questionnaire. These were:

Professor T. Ungerer, University of the Orange Free State
Professor J. Couper, Medunsa
Professor A.D. Rocke, University of Natal
Professor J. Hugo, University of Pretoria
Professor W. van der Merwe, Stellenbosch University
Professor D.F. Morrell, University of the Witwatersrand (Johannesburg General Hospital)
Professor D. Moyes, University of the Witwatersrand (Baragwanath Hospital)

To **Hoechst Pharmaceuticals, SABAX and Keatings Pharmaceuticals** for financial assistance towards travel and accommodation and who has made possible the extension of the survey into a National one.

To **Shirley Green** many thanks for all the hours on the word processor typing at amazing speed whilst attempting to decipher my writing.

Finally, to my wife, **Louise**, without whose support and encouragement I would have abandoned the project long ago, now that I have time, I promise I'll try and fix the sitting room light!

Signed

Gordon Irving
March, 1990

INTRODUCTION

INTRODUCTION

It is claimed that the first blood transfusion took place in 1492 when the dying Pope Innocent VII was given blood from three young men, with fatal results for all four. Most reliable records suggest the first transfusions were stimulated by **Harvey's** description of the circulation in 1628. **Jean Denis (1667)** of Montpellier appears to have been the first to transfuse blood from animals to humans and **Lower** did the same later in the year. In 1818 a desperate **James Blundell** gave blood successfully to a woman, near death with an acute post partum haemorrhage. Blood was collected from an onlooker into a primitive apparatus. Anticoagulation and the 33% risk of ABO incompatability was not known.

Nowadays most anaesthetists accept that blood and its products will be readily available whenever he or she needs them. In South Africa in 1988 over 700,000 units of blood were transfused. The average turn round for a unit of blood is 8-10 days in the Western Province Blood Transfusion Service and anaesthetists are probably responsible for at least 50% of all red cell products used. Unfortunately it has been stated that the anaesthetist often has little knowledge of the problems associated with the collection of blood, its preservation, fractionation, distribution and the ways in which it can be used. (**Marshall and Bird, 1983**). It was to assess the knowledge and transfusion practices of South African anaesthetists that the following survey was undertaken.

METHOD

The survey consisted of a 22 question Questionnaire with 63 part questions (Appendix 1) was completed prior to a lecture on blood component therapy given at the academic meetings of the Anaesthetic Departments at eight principle teaching hospitals in South Africa. These hospitals were Groote Schuur Hospital, Cape Town; King Edward VIII Hospital, Durban, Johannesburg General Hospital and Baragwanath Hospital, Johannesburg; J.G. Strijdom Hospital, Johannesburg; Garankuwa Hospital (serviced by Medunsa), Pretoria; and the Libertas Hospital, Bloemfontein. Tygerberg Hospital Anaesthetic Department and the remainder of the Western Cape membership of the South African Society of Anaesthetists (SASA) were sent the Questionnaire by post.

RESULTS (see separate page)

The results are annotated in the text according to answers given by area:

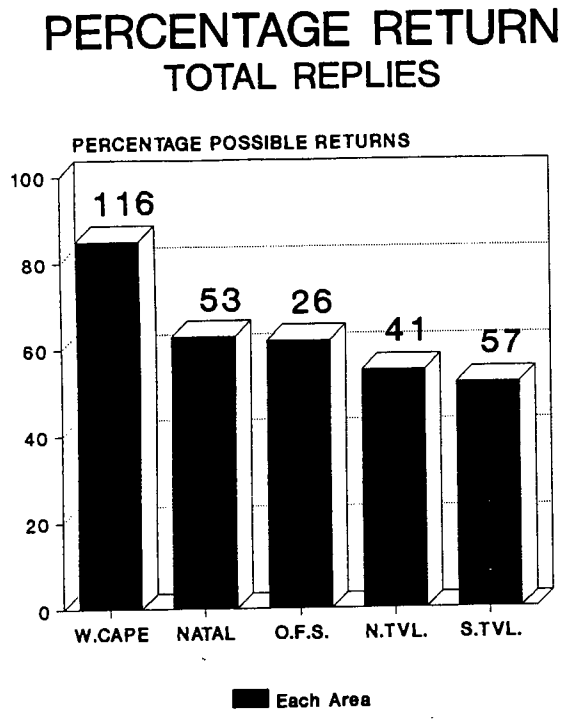
Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		

The separate columns for NTvl and STvl were due to the author not being able to determine which hospital they worked at, although the area had been stated. There were 6 respondents in these columns.

The answers were also annotated according to the years of anaesthetic experience of the respondents; 1-5 years; 6-20 years or more than 20 years.

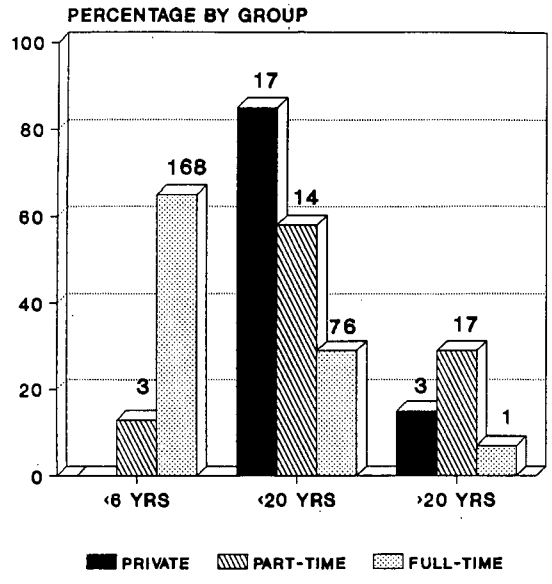
Answer	1-5		6-20		>20	
	No	%	No	%	No	%

Three hundred and thirty one replies were collected. 315 from anaesthetists in full-time teaching hospital practice, and 16 from practitioners with part-time appointments.



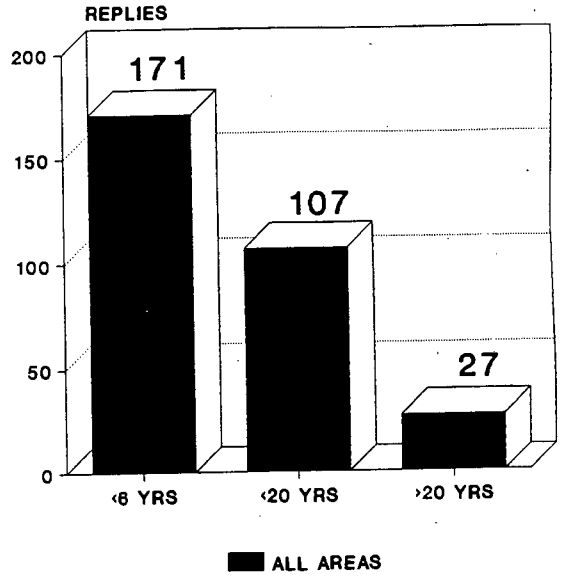
Note that the returns included 84% of the total number of anaesthetists in teaching hospitals of the Western Cape, 63% of Natal, 62% of the Orange Free State, 55% of Northern Transvaal (Pretoria and Medunsa) and 51% of the Southern Transvaal (Johannesburg General & Baragwanath)

ANAESTHETIC POST EXPERIENCE IN YEARS



Note that the majority of those respondents with 6-20 years experience were in full time private practice.

ANAESTHETIC TIME TOTAL REPLIES



Note that 171 of the respondents had less than six years anaesthetic experience; 107 had less than 20 years and 27 had more than 20 years.

COMMENT

A 63 % overall reply rate for a five page detailed Questionnaire is considered by most researchers to be a very good return for a survey. The probable reason for the good return was that a lecture entitled "The Blood and Blood Component Therapy in the Peri-operative Period" was given by the author of the survey at the Department's weekly Academic Meeting. The attending anaesthetists were requested to fill in the Questionnaire prior to the lecture and did not have recourse to books or discussion. This is unlike postal surveys of Anaesthetists' practices such as reported by **Stehling et al (1987)** and **Kowalyshyn et al (1972)**. To try and 'capture' those anaesthetists who were not present at the lecture, Questionnaires were left for them with the Department's Secretary. The detailed hand-out of the lecture was only given to those who had completed the Questionnaire and then only two to three weeks after the lecture. However, this small number of respondents would have been able to look up the correct answers in the text books, if they were so inclined, as in any postal survey.

The returned Questionnaires were individually scrutinised and, where the answer had been technically filled in incorrectly, e.g. two answers marked where only one answer was asked for, that question was marked as spoilt and not analysed further.

Results were entered onto an ISM compatible personal computer, using DBase IV and Harvard Graphics as the statistic and graphic software programmes.

CHAPTER ONE

PRE-OPERATIVE ASSESSMENT

* **Minimal Pre-operative Haemoglobin**

* **Maximum Pre-operative Haemoglobin**

MINIMAL ACCEPTABLE PRE-OPERATIVE HAEMOGLOBIN LEVELS

Survey Question

For a non-emergency, asymptomatic patient on average, what is your minimum pre-operative haemoglobin level which you consider to be adequate for elective minor surgery?

a) No requirement if blood volume considered normal ☐

b) 8g/100ml ☐

c) 10g/100ml ☐

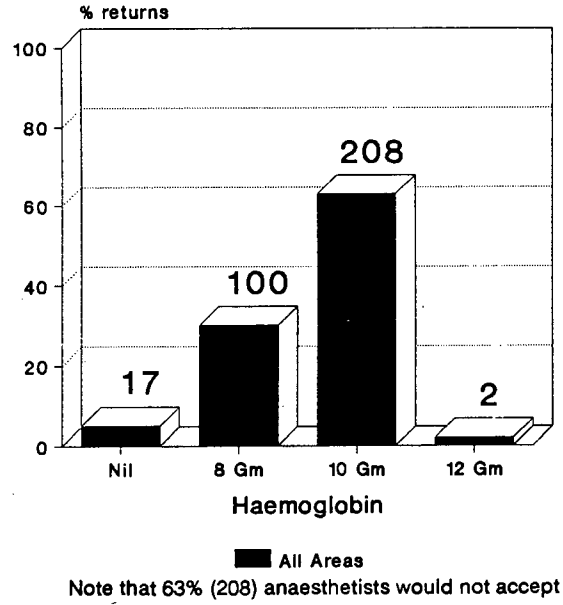
d) 12g/100ml ☐

RESULTS

Minimum Haemoglobin

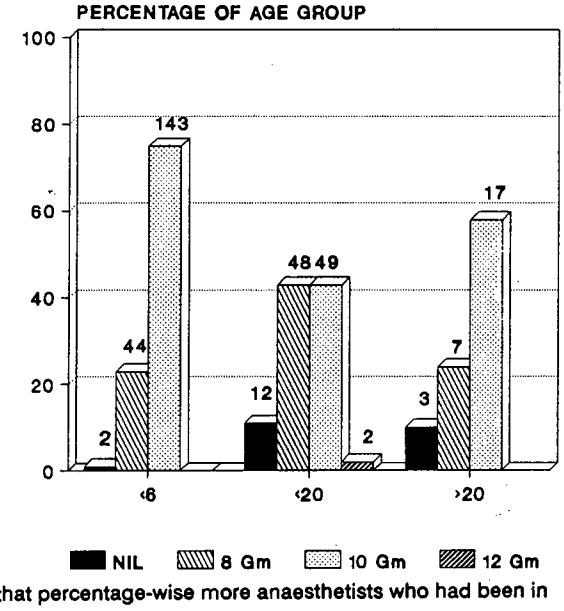
Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
Spoilt																	5	2
N/A																	1	
Nil	9	6	3	6					1	4	1	8	3	11			17	5
8gm	56	37	23	43					2	8	5	39	7	21	2	8	100	30
10gm	83	54	27	50		3	22		25	89	7	54	18	64	23	92	208	63
12gm	2	1															2	0.6

MINIMUM HB..
PRE-OP.REQUIREMENTS



Note that 63% (208) anaesthetists would not accept a lower haemoglobin than 10mg/dl for an asymptomatic patient booked for an elective minor operation.

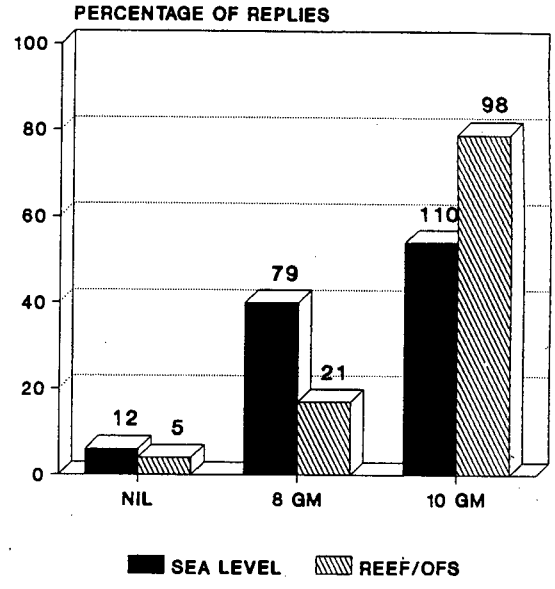
MINIMUM HB
PRE.OP.REQUIREMENTS



Note that percentage-wise more anaesthetists who had been in in practice less than six years and more than 20 years chose 10gm/dl as compared to 8gm/dl. Those anaesthetists in practice between 6 and 20 years were equally divided as to choosing 8 or 10mg/dl.

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
Spoilt						
N/A						
Nil	2	1	12	11	3	10
8gm	44	23	48	43	24	
10gm	143	75	49	43	17	56
12gm			2	2		

MINIMUM HB.
REPLIES BY ALTITUDE



Note that when analysed according to area, with Natal and Western Cape designated as sea level and the Orange Free State (OFS) and the Transvaal as altitude, a greater percentage of those practising at higher altitudes used 10gm/dl as their lower pre-operative haemoglobin limit.

The figure of 10gm/dl as a minimal pre-operative acceptable haemoglobin was partially confirmed by question 4c:

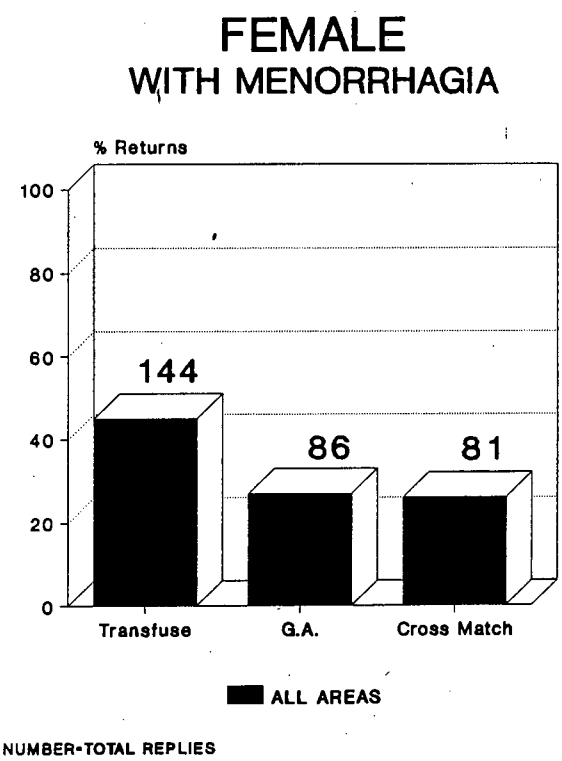
What course of action would you take in the following cases:

	Transfuse Pre-op	Administer General Anaesthetic	Require Blood Cross Matched
30 year-old female with menorrhagia for a D & C, haemoglobin 8,5g/100ml	☐	☐	☐

Female

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	15	
Spoilt																	7	2
Transfuse	71		22		1	2	12		14		4		13		5		144	45
GA	39		14			3	5		5		5		7		8		86	27
X match	32		14				6		8		4		7		10		81	26

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
Spoilt						
Transfuse	87	47	39	46	18	69
GA	42	23	40	37	4	15
X match	52	28	26	24	3	12



Note that 45% (144) of respondents would transfuse pre-operatively a 30-year-old female with menorrhagia for a D & C with a haemoglobin of 8,5gm/dl and 26% (81) would ask for blood to be cross-matched.

DISCUSSION

In the past surgical anaesthetic practice has been guided by the belief that a minimum acceptible haemoglobin level of 10g per 100ml was important in providing safe anaesthesia (**Gillies 1974, Rawstron 1970**). Less than the "magic 10g" or a haematocrit of less than 30% was taken as indicating the need for red blood cell transfusion. This concept was based on calculations which suggest oxygen availability to the tissues and organs might be impaired when haemoglobin values are less. However, these calculations did not include: appropriate corrections for cardiac output; oxygen extraction; or alterations in the haemoglobin affinity for oxygen by physiological adaptations such as a rise in 2, 3 diphosphoglycerate (2, 3 DPG), which shifts the oxygen haemoglobin dissociation curve to the right.

Evidence suggests that the haemoglobin level a given person will tolerate before becoming symptomatic depends on many factors. Cardiac output does not increase dramatically in healthy humans until the haemoglobin decreases to 7g% and then there is a linear increase as the haemoglobin falls further to 2g% (**Varat et al 1972**), as long as the fall in haemoglobin is slow enough to allow the blood volume to remain normal. However, an acute loss of only 30% red cell mass will result in hypovolaemic shock (**Linman, 1968**) and hypovolaemia on its own is deliterious to tissue perfusion both in patients with normal haemoglobin levels and in those with anaemia. Thus, acute anaemia due to blood loss needs to be treated aggressively with intensive monitoring and a low haemoglobin in these patients should be assessed differently from those patients who present with a chronic anaemia and presumed normal blood volume.

Chronic Anaemia

Most patients who are anaemic on presentation for elective surgery have a chronic anaemia, generally caused by nutritional deficiency, chronic bleeding disorders, chronic illness or the cause may be multifactorial. Various compensations for the decreased oxygen carrying capacity associated with chronic anaemia include:

1. Vasodilation of tissue vessels
   Vasodilation is thought to be due to the decreased viscosity because of the lowered haematocrit and not due to the decreased oxygen carrying capacity. This may increase tissue oxygenation of the organs. The decrease in after load due to the vasodilation also causes an increase in cardiac output when the haemoglobin is reduced to less than 7g%. This was shown by **Murray & Escolar (1968)** who replaced a fraction of the normal haemoglobin with methaemoglobin and noted that the cardiac output remained the same. However, when red blood cells were withdrawn and replaced with plasma giving an oxygen carrying capacity equivalent to the met haemoglobin model but with a decrease in the hematocrit and viscosity, cardiac output increased considerably.

2. 2, 3 Diphosphoglycerate (2, 3 DPG) Levels
   The level of 2,3 DPG in the red blood cells is increased considerably in anaemia shifting the oxygen haemoglobin dissociation curve to the right. Thus a 50% reduction of circulating haemoglobin only results in a 27% decrease of oxygen availability at tissue level. This is due to a direct effect on oxygen binding to deoxyhaemoglobin and an indirect effect secondary to a decrease of intracellular pH (**Benesch & Benesch 1967**).

3. Increased organ blood flow
   The blood flow to individual organs is increased by varying degrees. In the heart as long as the coronaries are healthy the increase is proportional to the elevation of cardiac output. Early studies in chronically anaemic dogs and humans showed additional coronary vessels and collaterals may form over a period of weeks (**Eckstein 1955, Zoll et al 1951**).

Cerebral blood flow is increased although oxygen delivery to the brain is slightly decreased. This is associated with a small but significant decrease in brain oxygen consumption (**Varat et al, 1972**).

Hepatic and renal blood flow are both increased in anaemia provided the circulating blood volume and cardiac output is increased (**Varat et al, 1972**).

Symptoms of anaemia

In an otherwise healthy patient as anaemia becomes more severe, symptoms become more marked (**Linman, 1968**). Mild anaemia (9-11%) may cause only pallor and tachycardia. With a further fall to 7 or 8g% dyspnoea of exertion occurs. At a haemoglobin of 6g% most patients complain of weakness. A haemoglobin of 3g% causes the patient to complain of dysnoea at rest and at a haemoglobin of 2-2,5g% congestive cardiac failure frequently occurs. Symptoms of anaemia occuring at higher haemoglobin levels should be treated vigorously as it indicates cardiac problems e.g. ischaemic heart disease, shunting in the lungs or heart or a hyperdynamic circulation e.g. in thryotoxicosis.

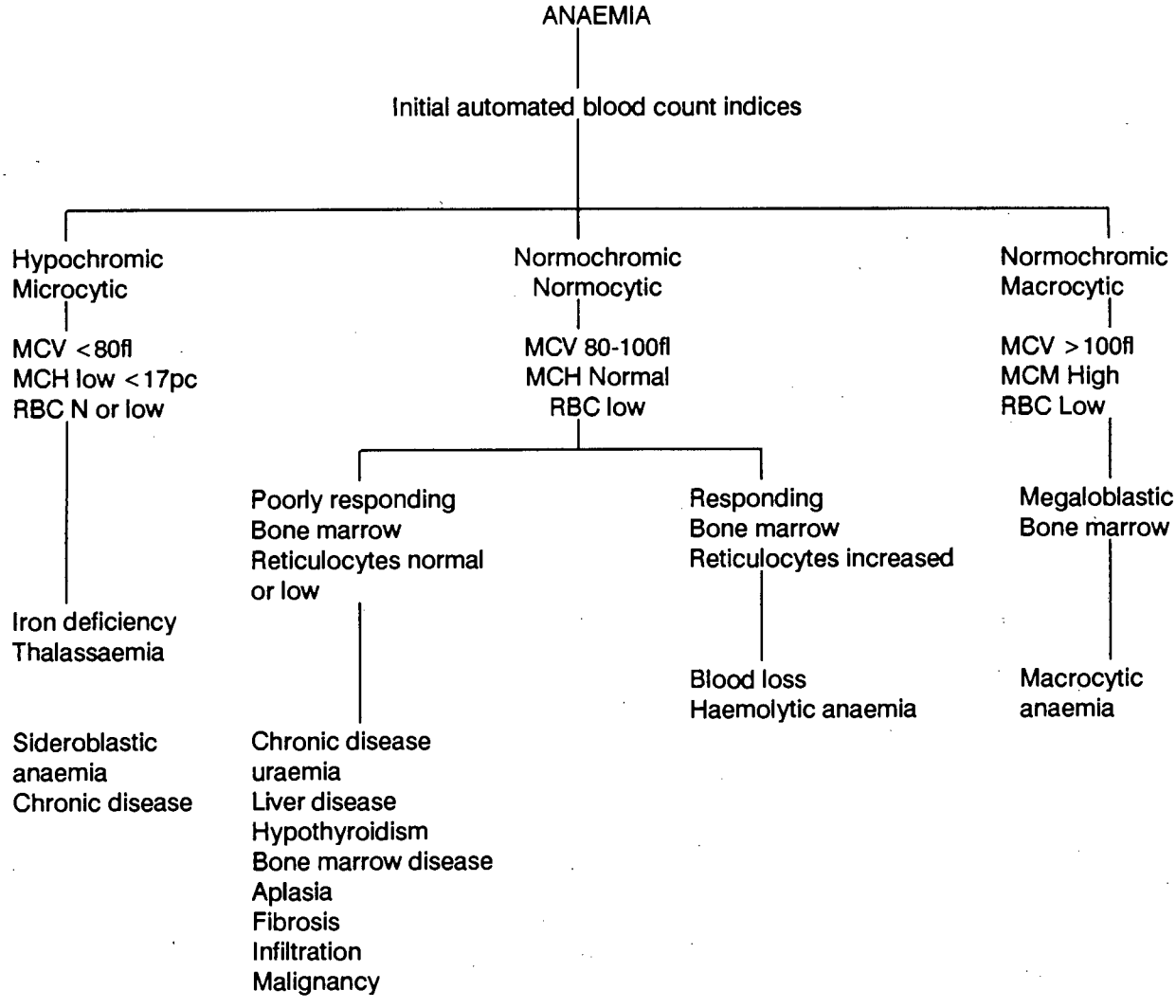
In cigarette smokers, in whom a significant fraction of haemoglobin is combined with carbon monoxide, a haemoglobin level of 8,6g% was necessary to prevent symptoms at rest and 10,7g% was needed for strenuous exercise. This was contrasted to healthy non-smokers in whom the critical symptomatic levels were 7,5g% and 9,5g% respectively (**Scott 1975**).

Age also affects the level of haemoglobin fall necessary to cause symptoms. Children appear to be remarkably resistant to the effects of anaemia, whereas the elderly may not tolerate even minor reductions in haemoglobin level (**Varat et al, 1972**).

Diagnosis of the Anaemia

Grindon et al (1985) suggest that patients with a haemoglobin of less than 8g% without symptoms of hypovolaemia or hypoxia should be investigated for a nutritional reason for their anaemia, such as iron deficiency, pernicious anaemia, intestinal malabsorption or hereditary haemolytic anaemia.

The common causes of anaemia can be summarised below (**Isbister & Pittiglio, 1988**):



However the cause of the anaemia may be multifactorial and the response to therapy may need to be assessed prior to a final diagnosis. Inappropriate blood transfusion is not only hazardous but may delay response to definitive therapy by suppressing the bone marrow response.

Anaesthetic Implications

The cause of the anaemia should have more than a passing, academic interest to the anaesthetist due to other organ systems which may be affected, for example, liver impairment due to malnutrition. The fact that many other systems including the immune system are affected by iron deficiency may delay or compromise recovery. Also liver, renal or thyroid disease can have a profound effect on the anaesthesia if these disorders are unrecognised in the pre-operative assessment.

If the cause of the anaemia is an infective process, sub acute bacterial endocarditis should be excluded, as in these patients all but the most urgent of surgical procedures must be postponed because of the high peri-operative morbidity and mortality risk.

Therapy of Nutritional Anaemias (Isbister & Pittiglio, 1988)

If the anaemia is due to malnutrition and the operation can safely be postponed it is safer to treat the anaemia and operate with the anaemia corrected.

Iron Deficiency

The treatment of iron deficiency requires the regular delivery of iron to the upper small bowel until the haemoglobin level is normal. Following this, a longer period of less intense iron therapy is necessary to replete the body's iron stores.

The rate of erythropoiesis is intimately connected to the stimulus for red cell production i.e. degrees of anaemia and the presence of other nutritional or suppressive factors which may impair the response. Normal bone marrow has the potential to produce at six times the normal rate and thus utilize as much as 120mg of iron a day. Thus, if the patient can tolerate a high iron intake (4-5mg/Kg/day of elemental iron) three times a day, a maximal response of approximately 100ml of new red cells each day results in a haemoglobin rise of 1-2g/week. Because of gastrointestinal intolerance it is wise to build up to this dose gradually. However the marrow of a patient with severe iron deficiency anaemia needs time to "wind-up" and produce red blood cells. So a delay of up to 7-10 days may occur before a rise in haemoglobin is noted.

It is unusual to see a reticulocyte count of more than 12% in a resolving iron deficiency anaemia, in contrast to a severe megaloblastic anaemia where responses as high as 60% may be observed.

Failure or delay in response to therapy suggests either -
Noncompliance
Incorrect diagnosis
Multifactorial anaemia
Continued blood loss
Inappropriate iron therapy e.g. single dose or delayed release
Gastrointestinal malabsorption
Suppressive effects on bone marrow response and iron absorption by initial blood transfusion.

Pre-operative transfusion and oxygen carrying capacity

If pre-operative transfusion is believed necessary, ideally one to two days should be allowed for the volume shifts to normalise and the transfused blood to regain normal 2, 3 DPG levels and restore the oxygen release to normal (**Allen & Allen**). However with the introduction of ADSOL (Mannitol, 750mg/100ml; glucose 2000mg/100ml; adenine 27mg/100ml and NaCl 900mg/100ml) to packed red blood cells 2, 3 DPG is better preserved and within several hours after transfusion the haemoglobin oxygen carrying capability will have normalised. It has been reported that ADSOL; (a) maintains at least 50% of original ATP values by day 35 or beyond; (b) minimises haemolysis to less than 0,5% at day 35 or beyond; (c) provides at least 75% post transfusion recovery of red cells and (d) allows for relatively simple manufacturing methods while providing a stable solution under current standard storage practice (**Heaton et al, 1984**). Blood transfusions should be given slowly especially in patients with cardiac insufficiency. If there is a risk of cardiopulmonary embarrassment a diuretic may be given concurrently with the transfusion.

Effects of anaesthesia and oxygen carriage

Anaesthesia may increase shunting in the lung due to vasodilation of hypoxically restricted pulmonary vessels thus diminishing total oxygen uptake. In clinical practice, however, patients are given high inspiratory oxygen concentrations. This, together with the fact that General Anaesthesia reduces the oxygen requirements of the body as a whole, and specifically those of the heart (**Theye & Michenfelder, 1975**), means that most adequately ventilated patients have arterial oxygen tensions far greater than when they are awake and breathing room air.

Morbidity of anaemia in the peri-operative period

Mild anaemia, itself, is not associated with peri-operative morbidity or poorer surgical healing. The frequency and severity of post-operative infections is also not increased in anaemia (**Consensus Statement on Peri-operative Red Cell Transfusion, 1989**). Similarly, in non-uraemic patients no relationship has been demonstrated between anaemia and increased bleeding times. However there are no controlled studies on the relationship of anaemia to delayed recuperation or increased hospital stay.

Optimal haematocrit values

The haematocrit value at which peak oxygen transport occurs has been reported to be as low as 30% in a theoretical study on dogs and as high as 40-45% in other studies on dogs (**Richardson & Guyton, 1959, Hint 1968**). However a study of critically ill post-operative patients (**Czer & Shoemaker, 1978**) found a maximum survival rate in those patients who had a haematocrit between 27 and 33%. They suggested the optimum haematocrit level was in the peri-operative period about 33%.

Optimal pre-operative haemoglobin levels

It would seem reasonable that evolution would select the haemoglobin level that would allow an animal the greatest chance of survival following injury. However, the decision to transfuse patients should not be made on laboratory values alone but must take into account various clinical factors including: the patient's symptoms; the duration of anaemia; level of the anaemia; the intravascular volume; the extent of the operation; the ability of the surgeon and the probability of surgery causing significant blood loss; the presence of co-existing conditions such as impaired lung function, impaired cardiac output, myocardial ischaemia and cerebrovascular or peripheral circulatory disease; and the possibility of the formation of HLA cytoxic antibodies. The latter is important in terminal renal failure where the presence of antibodies will make a suitable donor more difficult to find.

The optimal haemoglobin level will be different for each patient. No single measure can replace good clinical judgment. However, current internationally reported experience suggests that healthy patients with haemoglobin levels of 10/dl or greater seldom require peri-operative transfusions. Whereas those with acute anaemias and haemoglobins of less than 7g/dl will frequently require transfusions (**Consensus Conference on Peri-operative Red Cell Transfusion, 1989**). During the pre-operative visit by the anaesthetist an acceptable haemoglobin level for the patient should be calculated based on the abovementioned clinical factors. This should be the level which one allows the patient to bleed down to in the peri-operative period whilst replacing blood with clear fluids (crystalloids or colloids).

A postal survey by **Stehling et al (1987)** of transfusion practices amongst anaesthesiologists in the USA showed similar trends to those found in the present survey. 65% of respondents required patients to have a pre-operative haemoglobin of 10gm/dl for elective surgery (63% in South African survey). This is similar to a survey by **Kowalyshyn et al (1972)** in which 88,1% of anaesthetists at 1,249 institutions required a haemoglobin greater than 9,0gm/dl and 43,9% required that the level be higher than 10gm/dl.

CONCLUSION

The survey suggests that fixed haemoglobin levels are used as cut offs for pre-operative acceptance of the patient's fitness for anaesthesia amongst the majority of South African anaesthetists surveyed. Whilst the actual acceptable haemoglobin pre-operatively will vary from different areas and with different patients, a more critical look should be taken at pre-operative haemoglobin levels. To transfuse unnecessarily based on fixed cut off levels without cognizance of the cause, symptoms, or type of surgery contemplated is expensive at best and at worst may cause serious harm to the patient. An important clinical role the anaesthetist has to be able to fulfill is to assess if a proper work up of the anaemic patient has been completed or whether postponement for correction of the anaemia is indicated.

MAXIMUM PRE-OPERATIVE HAEMOGLOBIN LEVELS

Survey Question

For a non-emergency case, on average, what is the maximum pre-operative haemoglobin level above which you would suggest postponing the operation?

a) No maximum requirement ☐

b) 17-18g/100ml ☐

c) 18g-19g/100ml ☐

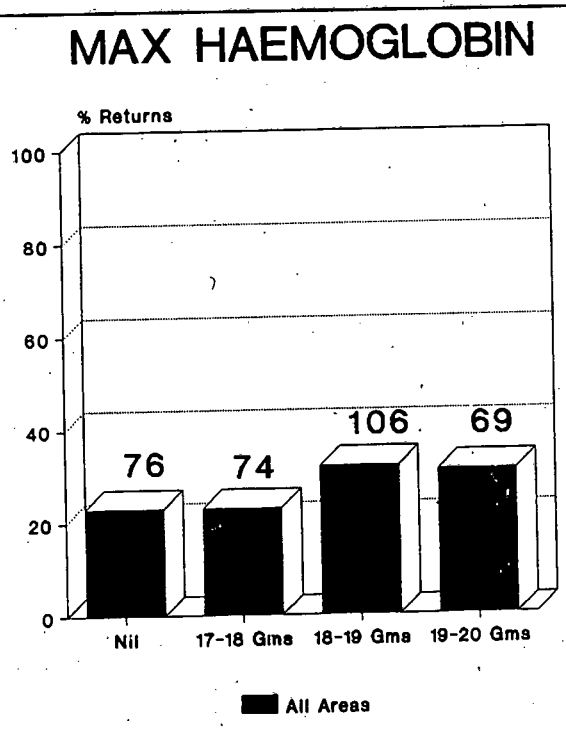
d) 19-20g/100ml ☐

RESULTS

Maximum Haemoglobin

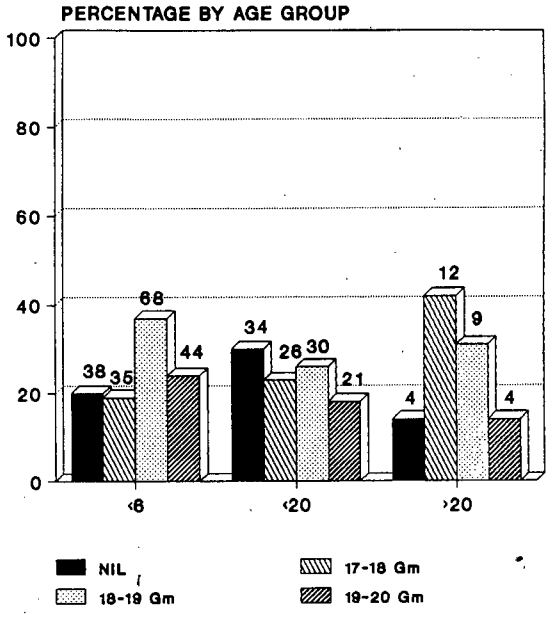
Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	4	
Spoilt																	4	1
Nil	24	16	15	28	1	1	10	40	11	40	1	8	8	31	5	20	76	23
17-18gm	38	25	13	25		2	3	12	3	11	1	8	5	19	9	36	74	23
18-19gm	63	41	14	26			9	36	4	15	5	39	7	27	4	16	106	32
19-20gm	28	18	10	19		2	2	8	9	33	5	39	6	23	7	28	69	21

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
Spoilt						
Nil	38	20	34	30	4	14
17-18gm	35	19	26	23	12	42
18-19gm	68	37	30	26	9	31
19-20gm	44	24	21	19	4	14



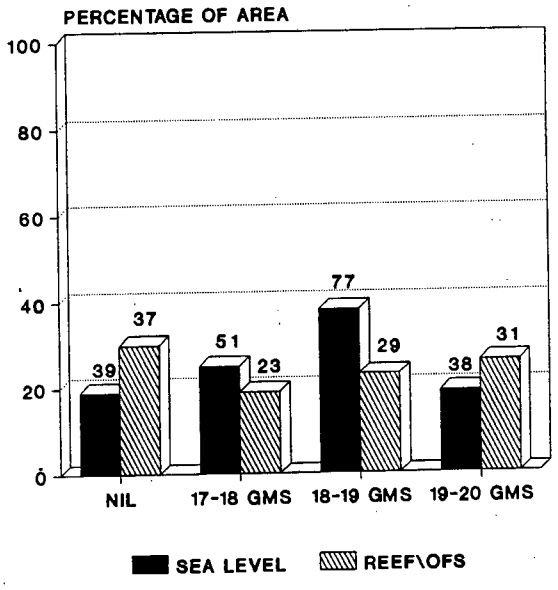
Note that 23% (74) of respondents stated their maximum pre-operative haemoglobin requirement was 17-18gm/dl.

MAX.HAEMOGLOBIN



Note that a higher percentage (42%) of those with more than 20 years anaesthetic experience would suggest postponing a case when the haemoglobin was 17-18 gm than those with less than 6 years experience (19%) or those with 6 to 20 years experience (23%).

MAX.HAEMOGLOBIN
REPLIES BY ALTITUDE



Note that there is no statistical difference between the percentage of respondents at either sea level or at altitude (Reef & OFS) choosing each of the maximum haemoglobin levels.

DISCUSSION

There is continued debate in relation to the upper reference range for the haemoglobin level. There does, however, appear to be agreement that a haemoglobin above 17g/dl in a male and 16g/dl in a female requires an explanation and should be considered as a significant risk factor for vascular disease (**Isibister, 1986**).

The polycythaemias can be divided into three groups (**Isibister, 1986**):

1) Polycythaemia Rubra Vera or primary polycythaemia: a stem cell disease of clonal origin characterised by an increased production not only of RBC's but also of granulocytes and platelets.

2) Secondary Polycythaemia: a complication of a variety of disorders in which an increased production of erythropoietin leads to an increased RBC mass.

3) Relative Polycythaemia (stress polycythaemia, spurious polycythaemia) due to plasma volume contraction.

Polycythaemia Rubra Vera (PRV)

This is a myeloproliferative disease in which there is increased activity of erythropoiesis with varying degrees of granulopoietic and megakaryocytic proliferation. The disease gradually progresses to a "spent" phase with myelofibrosis and myeloid metaplasia in the majority of patients. The disease is clonal in nature and has the potential for acute leukaemic transformation in as many as 25% of patients.

Clinical Features:

History:
PRV typically occurs in patients over the age of 40 years. Clinical features include hyperviscosity and hypervolemia, haemostatic impairment (epistaxis, GIT haemorrhage), pruritus (especially after heat exposure), thrombotic events, gout and peripheral vascular insufficiency.

Examination:
Patients are typically plethoric with signs of hyperviscosity, hypertension (30%), splenomegaly (75%) and hepatomegaly (35%).

Laboratory Features:

Full Blood Examination:
Usually polycythaemia is present with normocytic normochromic red cells unless iron deficiency has supervened; leukocytosis in 75% of cases; thrombocytosis in 50% and a reduced ESR.

Bone Marrow:
Bone marrow aspirate and biopsy may help by demonstrating hypercellularity with panhyperplasia, reduced iron stores and increased reticulin.

Other Haematological Investigations:
Leukocyte alkaline phosphatase score (LAP), vitamin B12 and B12 binding proteins are elevated, ferritin and folate are commonly low. Abnormal platelet function may be found.

Biochemistry:
Hyperuricaemia is common and LDH may be elevated due to ineffective erythyropoiesis.

Management:

With treatment, the mean survival of patients with polycythaemia is 10 to 15 years. In the past the majority of patients died from thrombotic events secondary to the hyperviscosity and factors inducing hypercoagulability. Initial treatment must be directed towards correcting hyperviscosity followed by a programme for long-term control of the disease. Therapy must be individualised as some patients can be controlled with minimal therapy whereas others require more definitive, regular marrow suppressive medications.

Initial Control of Hyperviscosity:

Phlebotomy has always been the mainstay of therapy. As the red cell mass may be markedly increased, large volumes of blood may need to be removed before the haematocrit is reduced to an acceptable level. The importance of adequate intravascular volume replacement to maintain normovolaemia, especially in elderly patients, is crucial. Any sudden reduction in perfusion pressure may have additional detrimental effects on microcirculatory flow which is compounded by hyperviscosity or large vessel stenosis. If only a single unit of blood is being removed at any one time crystalloid is usually adequate for volume replacement; but if larger volumes are being removed colloid replacement is desirable. The use of low molecular weight dextran is commonly advocated because of its rheological effects in improving microcirculatory flow.

Thrombocytosis commonly occurs following venesection and this may arouse considerable alarm. It is unlikely that this is a reactive thrombocytosis as the disease process is autonomous. It is more likely that the increase in circulating platelets is an indication of platelet mobilization from the microcirculation as sludging is relieved by the haemodilution. Antiplatelet therapy is desirable if the platelet count is elevated (aspirin and dipyridamole). However, if the platelet levels are markedly elevated specific suppressive therapy is necessary (*busulphan* or radioactive phosphorous).

Long-term Therapy:

Over 10% of patients with polycythaemia vera may suddenly develop *acute non-lymphocytic leukaemia*. The interval until onset of acute leukaemia is usually less than 5 years for patients developing acute leukaemia after chlorambucil and 6 to 10 years for patients developing acute leukaemia after radio active phosphorus.

Failure to treat patients with polycythaemia vera results in a median survival of less than 2 years, primarily because of fatal thrombosis or haemorrhage. Cumulative survival does not differ significantly for patients treated only with repeated phlebotomy or patients treated with radio active phosphorus.

The decision whether or not to manage a patient with phlebotomy alone or phlebotomy followed by a myelosuppressive agent depends on assessment of a patient's risk for an early thrombotic event. One approach to treatment may be summarised as follows:

1) Initial isovolaemic phlebotomies at 2- to 3-day intervals to reduce RBC mass.

2) Management by continued phlebotomy alone in the patient under the age of 50 years unless findings arousing concern of incipient thrombosis are present - platelet count over 700,000 per μL plus a history of an earlier thrombotic event, angina, or neurologic symptoms suggestive of transient episodes of cerebral ischaemia. If myelosuppression is needed, hydroxyurea, which is an antimetabolite and therefore may have less risk for inducing secondary leukaemia than an alkalating agent or ^{32}P, may be the best agent to use **(Isibister, 1986)**.

3) Myelosuppressive therapy with hydroxyurea or with ^{32}P (whose long-term effects are known and a single intravenous injection may control the disease for months) in the patient between the ages of 50 and 80 years if one believes that the likelihood of a thrombotic episode within the ensuing 5 years is substantial. (Uncontrollable itching may be another indication for myelosuppressive therapy.)

4) Administration of ^{32}P after initial phlebotomies to most patients over age 70, because of the known increased risk for arterial thrombotic disease in the elderly.

Anaesthetic Implications of PRV:

Spontaneous thrombotic and haemorrhagic complications can occur even without surgery. These events increase precipitously when the haematocrit is more than 54%. **Wasserman and Gilbert (1964)** reported on a series of 68 patients who had primary polycythaemia vera who underwent 81 operations. Twenty-eight operations were performed on uncontrolled polycythaemic patients (haemoglobin more than 16g% or haematocrit values more than 52%). These patients had a complication rate of 79% with a 43% morbidity and 36% mortality. By comparison, 53 operations performed on controlled (haemoglobin less than 16g%, haematocrit less than 52%) polycythaemic patients had a 23% complication rate with only 5% being fatal. Those patients who had been controlled and had a normal blood count for more than four months had a complication rate of only 5% with no deaths, in contrast to those who had a short (1 week to 4 months) or immediate (0-7 days) control. These latter groups had a complication rate of 45% and 42% respectively with a 15% mortality.

Sixty-five percent of the complications consisted of haemorrhage leading to 69% of the deaths. Thirty-seven percent of these bleeds were in the late (more than 48 hours) post-operative period. Thrombosis caused 32% morbidity and was associated with haemorrhage in 15%. The authors recommended effective and long term control of polythaemic vera patients where possible, prior to any elective procedure.

Secondary Polycythaemias:

Polycythaemia Secondary to Hypoxaemia:

Any condition causing intermittent or chronic reduction in arterial oxygen saturation will stimulate the erythropoietin system, resulting in a reactive erythroid hyperplasia in the bone marrow. It is not essential to demonstrate hypoxaemia on a random blood sample to suspect this type of secondary polycythaemia. The maximum hypoxic stimulus may occur at other times, especially at night and sleep studies may be necessary. The possible causes of hypoxaemia causing polycythaemia are:

1) Low barometric pressure (altitude dwellers)
2) Cyanotic heart disease and other right-to-left shunts
3) Pulmonary disease
4) Hypoventilation syndromes
5) Sleep apnoea.

Polycythaemia Secondary to Tissue Hypoxia:

There are several conditions where there is defective release of oxygen to the tissues. This stimulates erythropoietin production. This can occur in chronic carbon monoxide poisoning either from smoking or environmental exposure. Not only does carbon monoxide make some haemoglobin unavailable for oxygen transport, but the remaining functional haemoglobin has an increased oxygen affinity. Carboxyhaemoglobin measurements should be made at the times of peak exposure. An uncommon cause of secondary polycythaemia is seen in families with congenitally abnormal high affinity haemoglobins where the haemoglobin dissociation curve can be shifted markedly to the left. These are sometimes called "Llama" haemoglobins as their oxygen dissociation curve is similar to that of high-altitude-dwelling mammals.

Polycythaemia Secondary to Inappropriate Erythropoietin Production:

On rare occasions polycythaemia may be the presenting symptom of an underlying erythropoietin-produced tumour or of renal pathology. Renal ischaemia, cysts and hydronephrosis as well as hypernephroma may be responsible. Other non-renal erythropoietin-producing tumours include: hepatomas, uterine myomas and cerebellar haemangiomas. Certain endocrine diseases, such as Cushing's syndrome, phaeochromocytoma and androgenizing states, may also be associated with polycythaemia. A condition of over-production of erythropoietin has also been identified, explaining some cases of "idiopathic erythrocytosis".

Anaesthetic Implications:

Secondary polycythaemia that is due to a physiologically appropriate response, i.e. a response to tissue hypoxia does not appear to be associated with an increased thrombotic element. However the primary disease causing the polycythaemic response needs to be assessed carefully from the anaesthetic risk point of view e.g. chronic obstructive airways disease. The physiologically inappropriate response e.g. secondary to a neoplasm, cerebellar haemangioma, polycystic kidneys or phaeochromocytoma carries an increased anaesthetic risk if the pathology is not recognised. This is especially true with phaeochromocytomas.

Polycythaemia due to Plasma volume contraction : Relative polycythaemia:

It is becoming increasingly recognised that in the majority of patients with mild polycythaemia the underlying mechanism is a contraction of the plasma volume. This is due either to a salt and water deficit, capillary leak of protein-rich fluid or a contraction of the venous capacitance volume. This causes compensatory reduction in plasma volume to maintain normal central cardiac filling pressures and volumes.

Dehydration and Salt Deficit:

Plasma volume contraction secondary to water and/or salt depletion is usually due to excessive losses with inadequate intake, but disorders of thirst control may be responsible. Therapeutic dehydration is commonly used in order to treat or prevent oedema formation in vital organs, especially the central nervous system and lung. Over zealous therapy will severely contract the plasma volume and haemoconcentrate the blood with detrimental effects. Constant maintenance of adequate peripheral perfusion pressure is essential in the presence of severe haemoconcentration.

Chronic Disorders of Osmoregulation:

Disorders of osmoregulation and the thirst mechanism may cause severe dehydration, plasma volume contraction and polycythaemia. The syndrome particularly occurs in elderly patients who may or may not have recognisable neurological disease resulting in chronic hypodypsia and dehydration. These patients have intact osmoreceptors and appropriate vasopressin responses, but the message is not communicated to the thirst centre, so the patients will unknowingly allow themselves to become dehydrated despite the ready availability of water.

Diuretics:

Acute and chronic diuretic therapy may both cause plasma volume contraction and polycythaemia. The administration of diuretics to patients for the first time is particularly likely to result in sudden plasma volume reduction and associated haemodynamic consequences.

Hypoxic States:

Rapid ascent to high altitude may be associated with the development of a syndrome of headache, insomnia, nausea, irritability, oliguria and sometimes life-threatening pulmonary oedema and coma. This acute mountain sickness, although initiated by a low inspired oxygen tension, has a complex pathophysiology of which an important component is polycythaemia with hyperviscosity and microcirculatory failure. Maintenance of hydration is of crucial importance. This is well known to climbers who drink copious amounts to achieve "gin clear" urine.

Stress Polycythaemia (Gaisbock's Syndrome):

It is not strictly correct to give this syndrome the status of a disease as many different disorders have been included under a multitude of different synonyms. **Gaisbock** originally described a group of patients with polycythaemia and hypertension (polycythaemia hypertonica) with splenomegaly. Some of these patients may have had polycythaemia rubra vera. With the introduction of red cell mass and plasma volume measurements it became clear that there were patients with relative polycythaemia due to plasma volume contraction and various terms were introduced to cover this entity, including chronic relative erythrocytosis, benign erythrocytosis, spurious polycythaemia, pseudopolycythaemia and stress polycythaemia. As well as psychological stress and hypertension other causes include obesity, vascular occlusive disease, excess alcohol intake and cigarette smoking. Several theories have been proposed relating polycythaemia to stress and the most tenable one at present is the increased venous tone theory. This theory suggests chronically raised catecholamine levels which cause venoconstriction and centralise the blood volume. In order to maintain normal cardiac filling pressures and volumes the plasma volume contracts.

Cigarette Smoking:

The association between smoking and polycythaemia has been recognised for many years, but it is only in the last decade that there has been a clearer understanding of the pathophysiology. Until recently it was assumed that pulmonary disease with arterial hypoxia was necessary for polycythaemia to develop. However it has been found that most heavy smokers with polycythaemia have normal arterial oxygen tension. Red cell mass and plasma volume studies have revealed several different patterns. Some patients have clearly elevated total red cell mass, but the majority have a significant plasma volume contraction with minimal or no increase in red cell mass. In some patients both parameters are within the normal range, but the plasma volume is at the lower limit and the red cell mass is at the upper limit.

When plasma volume contraction is present, the effects of smoking on the haematocrit are relatively quickly reversible. Cessation of smoking may lead to the haemoglobin falling 1g/dl or more in a matter of 24 hours. It is a common observation in the coronary care unit that many patients are mildly polycythaemic on admission with the haematocrit returning to normal in the days following admission to the unit. This is commoner in smokers, but recent diuretic therapy, dehydration or stress may also be incriminated.

Anaesthetic Implications:

The increased viscosity which occurs in association with plasma volume contractions is not only likely to impair oxygen transport to the tissues, but may set up a series of viscous cycles in the microcirculation ultimately culminating in thrombosis. Thrombosis may also occur at other sites of vascular narrowing (e.g. atheroma or spasm). Thus the patient is more at risk of a coronary thrombosis or cerebral vascular accident especially if blood flow is further compromised by a fall in blood pressure. Hypotension is unfortunately a common occurence when anaesthesia is induced in the presence of unexpected plasma volume depletion. Thus intravenous fluids should probably be 'up and running' in any patient suggestive of secondary polycythaemia prior to the induction of anaesthesia.

Diagnostic Approach:

The evaluation of a patient with an elevated haemoglobin and haematocrit may be simplified by focusing initial attention on two questions:

1) Is there an obvious chronic hypoxia, for example, chronic obstructive pulmonary disease? If so, further haematologic study is rarely indicated.
2) Is there evidence suggestive of proliferation of other cell lines besides the RBCs, for example:
   a) An enlarged spleen on physical examination.
   b) A high WBC and platelet count. If so, the patient possibly has polycythaemia vera and further work up is directed toward confirming that diagnosis prior to any anaesthetic because of the increased risks involved for any operation.

If both of these questions are answered negatively, the haematocrit is between 54% and 60%, and the patient smokes, ideally one should try to convince the patient to stop smoking and observe the haematocrit over the next few weeks. If the value falls to normal, the diagnosis of polycythaemia secondary to smoking is established. If an elevated haematocrit persists, RBC mass, plasma volume and arterial oxygen saturation should be measured.

If the RBC mass is elevated and arterial oxygen saturation is reduced, one's attention turns to tracking a less obvious cause for arterial hypoxaemia. If RBC mass is elevated but arterial oxygen saturation is not reduced, one needs to:

1) Rule out a cause for intermittent arterial hypoxaemia (e.g. sleep apnoea).
2) Measure p50 to screen for impaired oxygen release from haemoglobin.
3) Perform an ultrasound examination of the kidneys to look for evidence of an erythropoietin-producing renal lesion (e.g. a renal tumour or renal cysts).
4) Measure the metabolic breakdown products of catecholamine release e.g. VMA to rule out phaeochromocytoma.
5) Consider the possibility of an unusual presentation of polycythaemia rubra vera without evidence in the peripheral blood of increased proliferation of granulocytic or megakarycocytic cell lines. Measuring plasma erythropoietin by radioimmunoassay will distinguish a patient in whom the level is not elevated from a patient with secondary polycythaemia in whom the level is elevated. Unfortunately, this assay is still not generally available, and one is usually limited to looking further for evidence of granulocytic and megakaryocytic hyperplasia by:
   a) Examining a histology section of the bone marrow for evidence of increased myeloid activity and megakaryocytic hyperplasia.
   b) Measuring serum vitamin B_{12} and unsaturated B_{12} binding capacity.

Other surveys of Maximal Pre-operative Haemoglobin Levels:

Kowalyshyn et al (1972) conducted a postal survey on the maximal acceptable pre-operative haemoglobin levels of 1903 Anaesthetic Departments in the USA. There was a 66% return (1249 replies). The survey revealed that 39,9% (499) of the institutions had no maximum requirement; 0,1% (12) stated less than 17gm/dl; and 8% (92) stated 19-20gm/dl. This survey was conducted amongst Anaesthetic Departments and not individual anaesthetists as was the present South African survey. This included a lack of awareness in the increased risk of peri-operative morbidity of the polycythaemic patient.

CONCLUSION

Only 23% (74) of South African respondents implied they would be concerned by pre-operative haemoglobin levels above 18gm/dl. This indicates a lack of awareness that polycythaemia may significantly affect the peri-operative morbidity and mortality. Polycythaemia is particularly relevant where there is no obvious physiological cause such as chronic hypoxia. The affect of altitude on the normal acceptable maximal haemoglobin level needs to be investigated.

CHAPTER TWO

PRE-OPERATIVE BLOOD ORDERING

* **Cross Matching**

* **Maximum Surgical Blood Ordering Schedules**

* **Practical Examples:**

  Baby for hernia repair

  Sickle Cell patient for arthroscopy

  Chronic renal failure patient for AV fistula

PRE-OPERATIVE ORDERING : CROSS MATCHING

Survey Question

An average of how many units of blood would you cross-match for the following procedures? Assume it is an elective procedure in a patient with a normal haemoglobin pre-operatively.

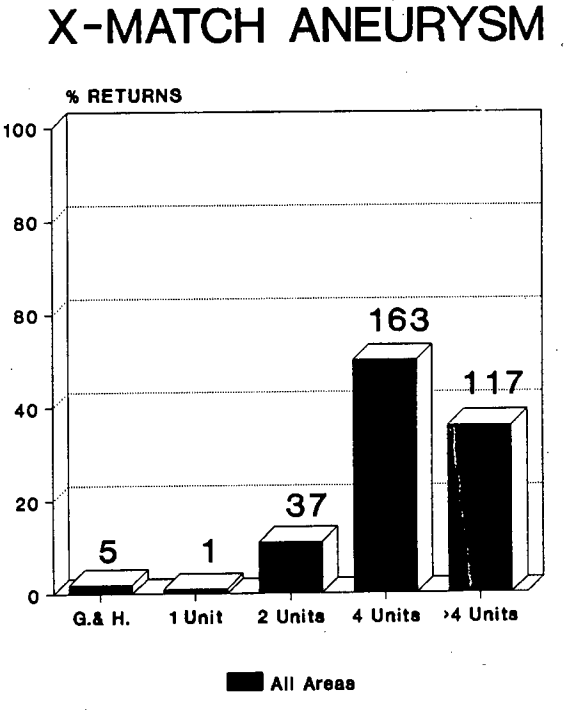
	*Group & Hold	1 Unit	2 Units	4 Units	More than 4 Units
Abdominal aneurysm resection	☐	☐	☐	☐	☐

RESULTS

X match Abdominal Aneurysm

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	4	
G & H			1				4										5	2
1 units							1										1	
2 units	9	6	2	4		1	12	46	9	33	2	15	2	7			37	11
4 units	79	52	43	14	1	3	6	23	16	59	10	77	12	44	13	54	163	50
> 4 units	64	42	26	49		1	2	8	2	7	1	8	12	44	9	37	117	36
Spoilt																	24	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
G & H	2	1	3	3		
1 unit	1					
2 units	16	9	17	15	4	14
4 units	106	57	43	38	13	45
> 4 units	59	32	47	42	12	42
Spoilt						



The GSH recommended MSBOS advises five units to be cross-matched.

Note that 86% (280) of respondents would cross-match four or more units for an abdominal aneurysm resection

Survey Question

An average of how many units of blood would you cross-match for the following procedures? Assume it is an elective procedure in a patient with a normal haemoglobin pre-operatively.

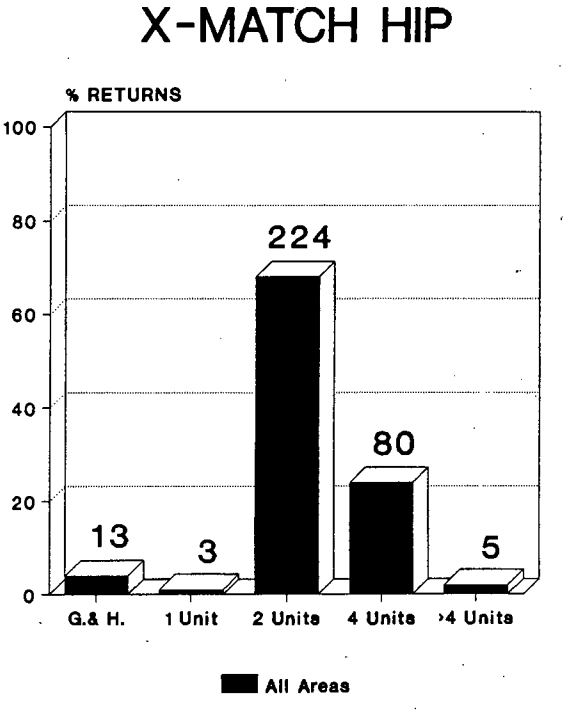
	*Group & Hold	1 Unit	2 Units	4 Units	More than 4 Units
Total hip replacement	☐	☐	☐	☐	☐

RESULTS

X match Hip replacement

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	3	
G & H	3	2	5	10			1	4	1	4	1	8	1	4	1	4	13	4H
1 units	2	1											1	4			3	1
2 units	112	73	28	53	1	4	21	81	22	82	10	77	10	37	16	67	224	68
4 units	34	22	18	34		1	3	12	4	15	2	15	11	41	7	29	80	24
4 units	2	1	1	2									2	7			5	2
Spoilt																	5	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
G & H	6	3	5	4	2	7
1 unit	2	1			1	3
2 units	133	71	73	64	18	62
4 units	40	21	33	29	7	24
> 4 units	4	2			1	3
Spoilt						



Note that 68% (224) of respondents would cross-match two units for a total hip replacement.

The MSBOS recommendation of GSH advises Group & Screen only.

Survey Question

An average of how many units of blood would you cross-match for the following procedures? Assume it is an elective procedure in a patient with a normal haemoglobin pre-operatively.

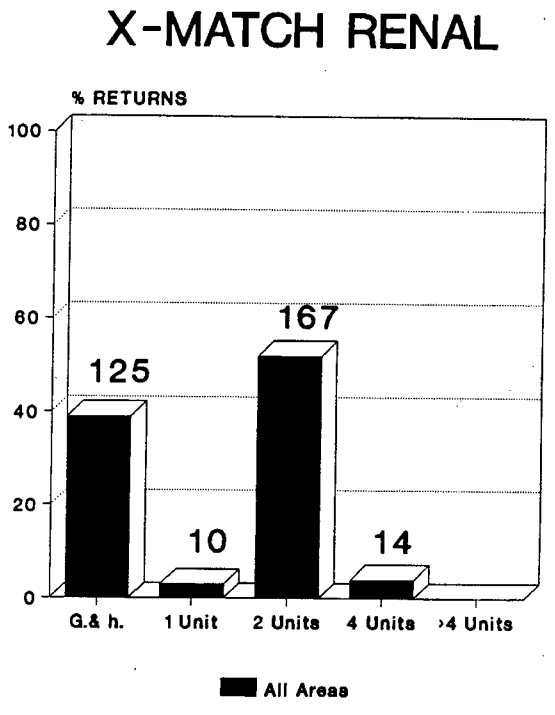
	*Group & Hold	1 Unit	2 Units	4 Units	More than 4 Units
Nephrectomy	☐	☐	☐	☐	☐

RESULTS

X match Nephrectomy

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	11	
G & H	72	48	14	27	1	3	10	42	8	30	3	23	8	32	6	25	125	39
1 unit	4	3					2	8	2	7	1	7			1	4	10	3
2 units	64	44	34	65			2	40	8	33	16	60	7	54	17	68	167	52
4 units	5	3	3	6			2	8	1	4	2	15			1	4	14	4
> 4 units	1	1															1	
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
G & H	54	29	55	51	16	62
1 unit	8	4	1	1	1	4
2 units	108	58	50	46	9	35
4 units	12	6	2	2		
> 4 units	1					
Spoilt						



Note that: 52% (167) of respondents would cross-match two units for a nephrectomy.

The MSBOS recommendations of GSH advises two units be cross-matched.

Survey Question

An average of how many units of blood would you cross-match for the following procedures? Assume it is an elective procedure in a patient with a normal haemoglobin pre-operatively.

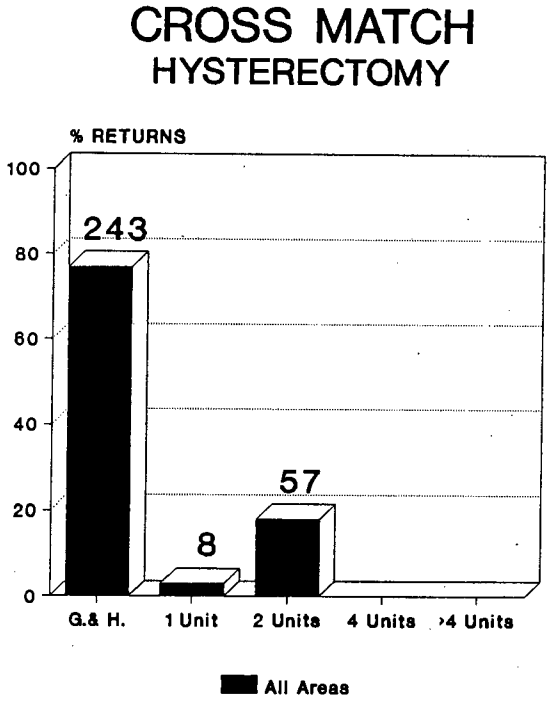
	*Group & Hold	1 Unit	2 Units	4 Units	More than 4 Units
Hysterectomy (Vaginal, Abdominal)	☐	☐	☐	☐	☐

RESULTS

X match Hysterectomy

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	17	
G & H	125	85	35	67	1	4	20	87	23	85	6	46	17	71	12	50	243	77
1 unit	4	3	1	2			2	9							1	4	8	3
2 units	14	10	14	237		1	1	4	4	15	7	53	7	30	9	38	57	18
4 units			1	2													1	
> 4 units																		
Spoilt																	7	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
G & H	138	75	91	85	15	63
1 unit	6	3	2	2		
2 units	37	20	11	10	8	33
4 units	1					
> 4 units						
Spoilt						



Note that 77% (243) of respondents would Group and Hold blood for an elective hysterectomy.

The MSBOS recommendations of GSH advises Group & Hold only.

Survey Question

An average of how many units of blood would you cross-match for the following procedures? Assume it is an elective procedure in a patient with a normal haemoglobin pre-operatively.

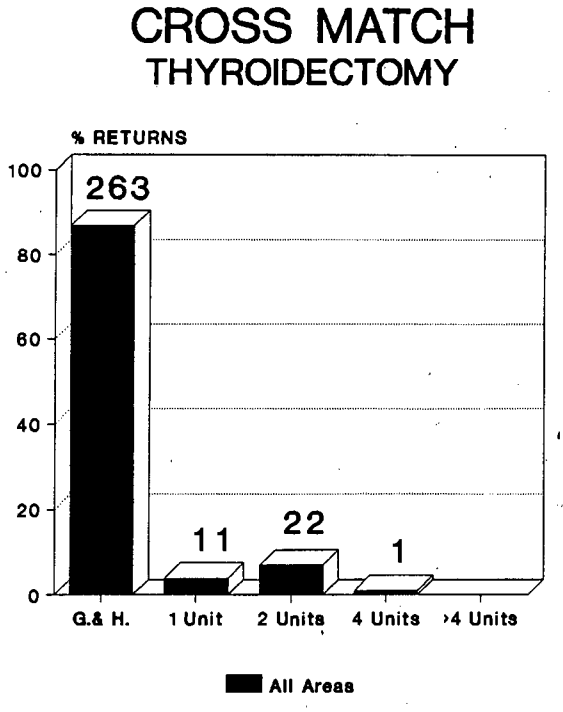
	*Group & Hold	1 Unit	2 Units	4 Units	More than 4 Units
Thryoidectomy	☐	☐	☐	☐	☐

RESULTS

X match Thyroidectomy

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	29	
G & H	123	87	45	88		5	22	100	23	89	10	83	19	83	16	70	263	87
1 unit	3	2	1	2					2	7			1	4	4	17	11	4
2 units	11	8	5	10					1	4	2	17	2	9	1	4	22	7
4 units	1	1															1	
> 4 units																		
Spoilt																	7	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
G & H	151	83	94	93	17	77
1 unit	7	4	1	1	3	14
2 units	19	11	3	3	1	5
4 units	1					
> 4 units						
Spoilt						



Note that 87% (263) of respondents would Group and Hold blood for an elective thyroidectomy.

The MSBOS recommendations of GSH advises Group & Hold only.

Survey Question

An average of how many units of blood would you cross-match for the following procedures? Assume it is an elective procedure in a patient with a normal haemoglobin pre-operatively.

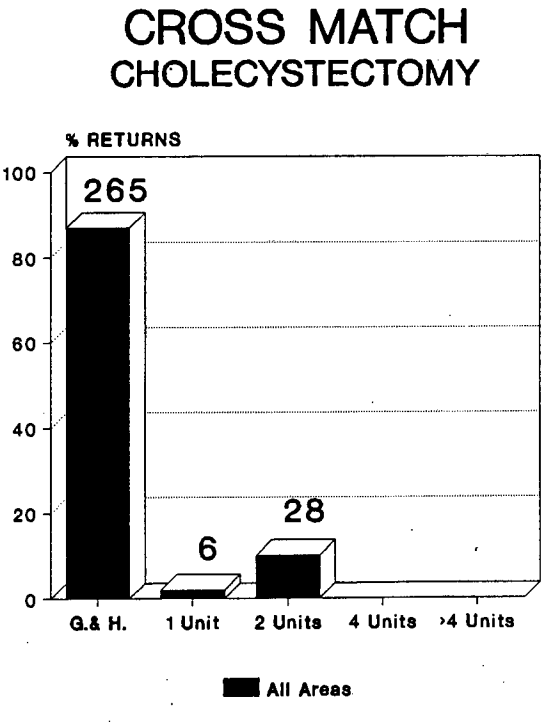
	*Group & Hold	1 Unit	2 Units	4 Units	More than 4 Units
Cholecystectomy	☐	☐	☐	☐	☐

RESULTS

X match Cholestectomy

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	29	
G & H	129	91	41	82		5	22	100	23	89	9	75	19	83	16	70	265	87
1 unit	2	1							2	8	1	8	1	4			6	2
2 units	7	5	9	18					1	4	2	17	2	9	7	30	28	10
4 units																		
> 4 units																		
Spoilt																	5	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
G & H	154	85	92	91	19	86
1 unit	5	3			1	5
2 units	21	12	6	6	1	5
4 units						
> 4 units						
Spoilt						



Note that 87% (265) of respondents would Group and Hold blood for an elective cholecystectomy.

The MSBOS recommendations of GSH advises Group & Screen only.

Survey Question

An average of how many units of blood would you cross-match for the following procedures? Assume it is an elective procedure in a patient with a normal haemoglobin pre-operatively.

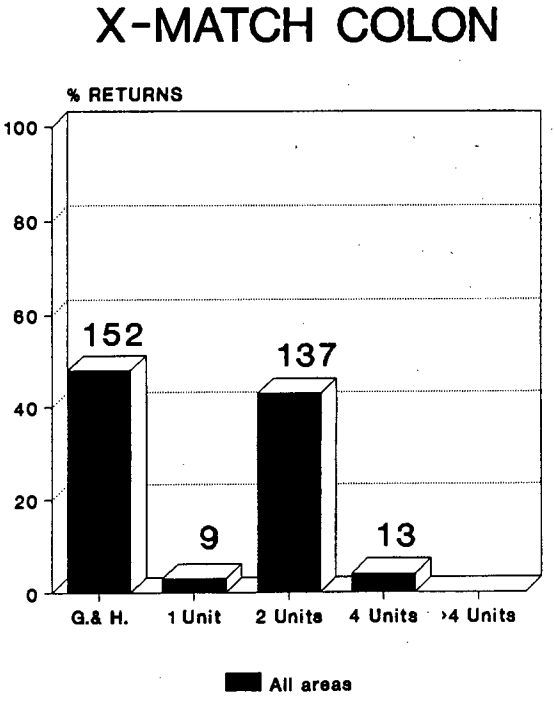
	*Group & Hold	1 Unit	2 Units	4 Units	More than 4 Units
Colon resection	☐	☐	☐	☐	☐

RESULTS

X match Colon resection

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	17	
G & H	70	48	25	50	1	5	18	70	13	48	6	46	7	29	7	30	152	48
1 unit	4	3	1	2					2	7			1	4	1	4	9	3
2 units	66	45	19	38			8	31	10	37	7	54	13	54	14	61	137	43
4 units	5	3	3	6					2	7			3	13			13	4
> 4 units																		
Spoilt																	5	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
G & H	91	50	52	48	9	36
1 unit	7	4	1	1	1	4
2 units	77	42	48	44	12	48
4 units	5	3	6	6	2	8
> 4 units						
Spoilt						



48% (152) amd 43% (137) would Group and Hold or cross-match two units respectively for an elective colon resection.

The MSBOS recommendations of GSH advises three units to be cross-matched.

DISCUSSION

PERI-OPERATIVE CROSS MATCHING

Peri-operative transfusion ordering policies are littered with personal, often unsubstantiated practices. These have resulted in (1) excessive blood requests (**Rouault & Gruenhagen 1978, Lee & Lachance 1980, Friedman 1979, Mintz et al, 1976**). 2) Over transfusion. This has been defined as transfusions resulting in a pre-operative haematocrit exceeding 36% or an intra-operative or post-operative haematocrit exceeding 33% (**Tartter & Barron, 1985**). 3) The reconstitution of whole blood (i.e. the concomitant transfusion of red blood cells and FFPs) (**Blumberg et al, 1986**) and 4) The under use of autologous blood (**Toy et al, 1987**).

Ideally the ratio of cross-matched to transfusion ratio (C:T ratio) should be 2,5-1 or less in hospitals with a full range of clinical services (**Friedman, 1979**). A high C:T ratio indicates a large number of units are cross-matched but are never used. This means that more units have to be kept and more units become out-dated. The cost of a cancelled cross-match is also significant (W.P.B.S. charge 1989 R52-00 per unit). To achieve low C:T levels many institutions in the USA have employed maximum surgical blood ordering schedules and type and screen procedures. As a result of instituting these measures **Lee & Lechancel (1980)** reported a decrease of 49% in cross-matches for surgical procedures and a reduction of C:T ratio from 6,5 to 3,2 within one year. Within six months of implementing type and screen procedures at Los Angeles County Hospital, the number of cross-matches decreased by 33% and daily blood inventories were cut from the 450-500 unit range to 300-350 units (**Rouault & Gruenhagen, 1978**).

Routine Blood Transfusion Procedure:

Although 21 different blood group systems have been identified on the RBC membrane, the antigens of only two of these blood group systems - the ABO system and the Rh system - are typed prior to a blood transfusion. The ABO system is typed because each person has naturally occurring plasma antibodies to antigens of the ABO system that he or she does not possess. The Rh system is typed to determine the presence (Rh positive) or absence (Rh-negative) of the D antigen, which is highly immunogenic. Donor and recipient RBCs should be of the same type in these two systems.

The antigen composition of the other, less immunogenic blood group systems is not routinely determined, since this would involve an impossible commitment of time, personnel, and scarce reagents. Instead, one establishes that the recipient's serum contains no antibodies that react *in vitro* with antigens on the donor RBCs. Although this protects against an acute haemolytic transfusion reaction, it does not prevent immunization of occasional patients to foreign antigens on donor cells, with formation of serum antibodies that then increase the difficulty of obtaining compatible blood for later transfusion.

Group and Hold (Group & Screen)

This consists of ABO and Rhesus typing by conventional methods plus a screen for unexpected antibodies. This latter test is performed by mixing a pure suspension of selected red blood cells possessing the most common blood group factors with the potential recipient's serum. It takes the same time (± 1 hour) as a major cross-match. If an antibody is detected during the screen it is further identified by testing with commercial reagent erythrocytes. Donor units are also screened against the recipient's blood.

Blood administration following a negative antibody screen is 99,99% safe as regards having an incompatible transfusion (**Boral & Henry 1977, Boral et al 1979**). **Boral and Henry (1977)** estimated that the chance of having haemolytic reaction following the administration of typed but uncrossed-matched blood with a non-reactive screen was 1 in 12,500,000 units.

Technique of performing a cross-match and antibody screen:

The crossmatch and antibody screen must be carried out under conditions that will detect 1gM antibodies, 1gG antibodies, and cell bound complement components. The tests are carried out as follows:

1) An approximately 5% suspension of RBCs in saline is incubated with serum at both room temperature and 37°C and examined for agglutination. Agglutination means that an 1gM antibody has reacted with the RBCs. This may occur if:
   a) An error of ABO typing has been made.
   b) The serum contains a cold agglutinin with a thermal amplitude that extends to temperatures of clinical significance.
2) The above incubations are repeated but with the addition of two drops of a concentrated albumin solution to the mixtures. The increased protein concentration reduces the electrostatic forces separating the RBCs, which facilitates the agglutination of RBCs that have become coated with an IgG antibody.
3) An indirect anti-human globulin (Coombs') test is performed. A 5% suspension of RBCs is incubated with the serum, separated by centrifugation, washed thoroughly, and then reacted with a "broad-spectrum" anti-human globulin (Coomb's) serum. The anti-human globulin serum will agglutinate the RBCs if IgG, complement, or both have bound to the RBCs during their initial incubation with the serum.

Group and Hold techniques are not a substitute for cross-matching (**Stehling, 1982**) but should rather be used when the probability that the patient may require blood during the operation is remote. If a Group and Hold has to be converted to a cross-match urgently during surgery, the first portion of a full cross-match, taking 3 minutes, is completed and the required number of units is rushed to theatre. If there is less urgency a full cross-match taking one hour should be performed.

CONCLUSION

The present survey indicates that there is a large degree of consent as to blood ordering practices for relatively common 'cold' procedures. There will obviously be regional variations dependent principally on the surgical skills available.

Stehling et al (1987) conducted a postal survey of 389 anaesthetists in the USA asking the same questions regarding cross matching.

	USA Survey No. of Units Mean ± SEM	**Present SA Survey No. of Units Mean**
Abdominal aneurysm	4,5 ± 0,13	4,5
Total Hip replacement	2,9 ± 0,06	2,55
Nephrectomy	2,2 ± 0,06	1,31
Hysterectomy	1,3 ± 0,05	0,41
Thryoidectomy	97 ± 0,05	0,20
Cholecystectomy	0,7 ± 0,04	0,21

As can be seen from the above comparison the South African respondents were more reticent about cross matching blood for most of the listed procedures. However details of the cross match to transfusion ratios of the blood banks need to be examined before one can infer the smaller number of units cross matched by the present respondents are optimum or not.

PRE-OPERATIVE BLOOD ORDERING : MAXIMUM SURGICAL BLOOD ORDERING SCHEDULES (MSBOS)

Survey Question

Does your hospital have a Maximum Surgical Blood Order Schedule? (i.e. recommendations for maximum blood ordering for elective operations)

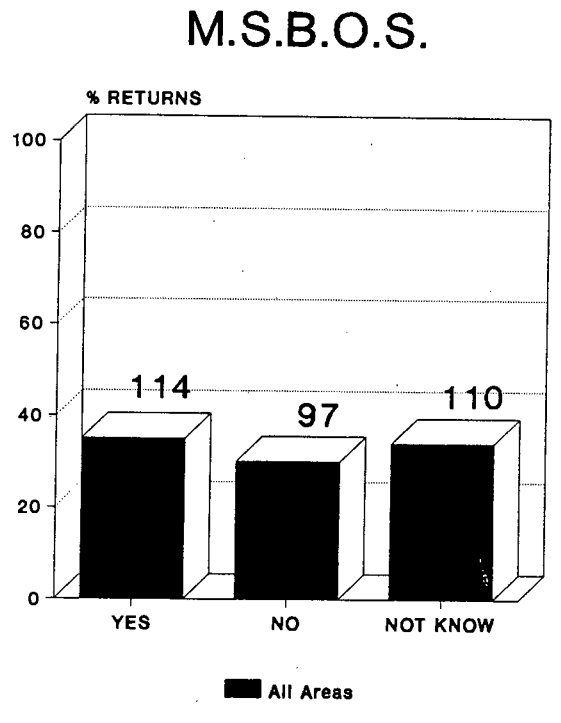
Yes **No** **Don't know**

RESULTS

MSBOS

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	8	
Yes	22	14	27	54	1		16	64	14	52	7	54	18	69	9	38	114	35
No	87	57	4	8					1	4	2	15	2	8	1	4	97	30
Not know	41	27	19	38		5	9	36	12	44	4	31	6	23	14	58	110	34
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
Yes	52	28	47	42	16	59
No	53	28	37	33	6	22
Not know	82	44	24	22	4	15
Spoilt						



Note that 34% (110) of respondents did not know if the hospital had a MSBOS.

DISCUSSION

Optimum blood ordering

Maximum Surgical Blood Ordering Schedules (MSBOS) consist of a list of the recommended maximum number of units of blood which should be cross-matched pre-operatively for most commonly performed surgical procedures. Although guidelines differ slightly between institutions, the recommendations of several groups are very similar (**Stehling 1982, Rouault & Gruenhagen 1978, Friedman 1979**). The Groote Schuur Hospital group MSBOS is included in the appendix. If more blood than recommended is ordered there should be a system whereby the Blood Bank contacts the doctor involved for the reason for the abnormal request.

Employing an MSBOS effectively has been recommended to reduce the following: Total blood inventory, total number of cross-match procedures, out-dating of blood, laboratory expenses, expense to patients, and clerical and technical errors.

In order for such a system to run effectively it is recommended that a hospital transfusion committee be set up (**Stehling 1978, Grindon et al 1985, Giovenetti et al 1988**). This committee should be made up of all major departments utilising blood products. They should set standards of transfusion practices and review cases where pre-operative orders do not agree with the recommended schedule. These standards should be reviewed periodically as new information becomes available. The committee should have several functions:

1. To assess the adequacy of blood supply and be able to institute corrective action for serious deficiencies.

2. To compare actual transfusion practices to the recommended standards and where they are different to assess whether they are due to the practices of a Department, group of physicians or even one physician. Corrective methods will, obviously, differ in each case, but education should be the principle method of change.

3. To review the frequency of transfusion transmitted diseases.

4. To review the efficacy of blood and component therapy e.g. by haematocrit or post-transfusion platelet counts.

CONCLUSION

Over one third of anaesthetists did not know whether or not their Department had recommended MSBOS's. Even many of those who answered that their area had or had not recommendations were incorrect, for example only 14% of the Western Cape area which has MSBOS's knew they did; 57% thought they did not.

This indicates a lack of Departmental communication where blood transfusion guidelines are concerned. This is a fundamental educational question which needs to be urgently addressed by individual Departments.

PRE-OPERATIVE BLOOD ORDERING : PRACTICAL EXAMPLES

Survey Question

What course of action would you take in the following cases:

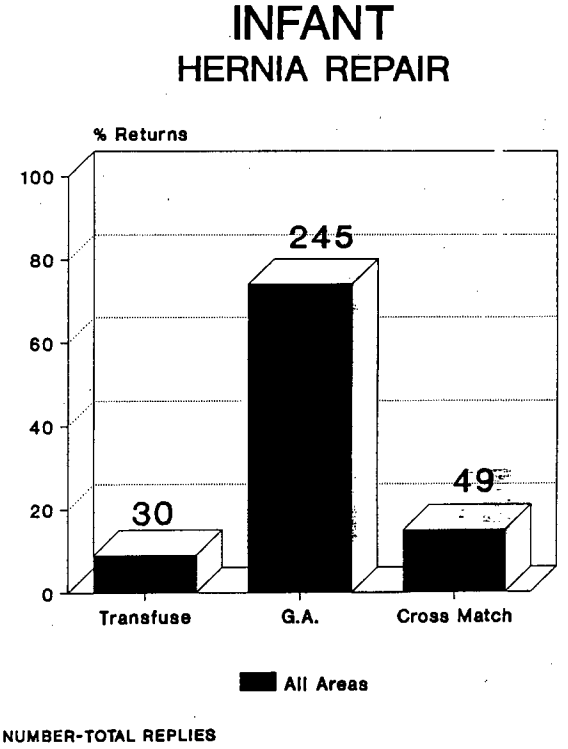
	Transfuse Pre-op	Administer General Anaesthetic	Require Blood Cross Matched
A healthy three-month-old patient for hernia repair haemoglobin 9,2g/dl	☐	☐	☐

RESULTS

Baby

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	1	
Spoilt																	7	2
Transfuse	9		3				3		6		4		2		3		30	9
GA	123			43		1	4	13		14		6		21		20		245
X match	21		4				8		7		2		5		2		8	15

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
Spoilt						
Transfuse	24	13	4	4	2	7
GA	126	66	99	87	21	75
X match	35	18	10	9	4	14



NUMBER-TOTAL REPLIES

Note that 9% (30) of respondents would transfuse the baby pre-operatively and 15% (49) would have blood matched.

DISCUSSION

A term infant has a mean cord haemoglobin of 16,5g/dl and a few hours after birth a mean venous haemoglobin concentration of 19g/dl due to loss of plasma volume. Erythropoeisis almost stops for several weeks after birth and the haemoglobin level may fall to about 9.5g/dl at nine weeks of age in a full-term infant. It then rises gradually to 11-12g/dl at the first year of life. In premature infants the haemoglobin may fall even lower with means of 9.4g/dl ± 1,0 at 10 weeks (**Gorton & Cross, 1964**(. **Oski & Stockman, 1974** state that apparently healthy premature infants weighing 1,2Kg or less show average haemoglobin levels of 8,9g/dl between six and eight weeks. Values of 7g/dl are frequently seen without recognisable haematological or other disease.

Thus the three-month-old baby with a haemoglobin of 9,2g/dl has a normal haemoglobin for its age. The procedure of hernia repair does not usually require blood and so both cross-matching and transfusion are unnecessary.

Although 24% of respondents stated they would transfuse (9%) or cross-matched (15%) this may have been due in part to inexperience. Twenty-four out of 30 who would transfuse and 35 out of 49 who would cross-match had been in anaesthetic practice less than six years and may not have had exposure to paediatric anaesthesia.

Stehling et al (1987) in their postal survey of 389 anaesthetists in the USA found 2,6% would transfuse pre-operatively, 91,7% would administer a GA and 21,7% would require blood to be cross-matched. These results are similar to the South African findings remembering that a postal survey allows references to be consulted regarding the normal haemoglobin for a three-month-old baby.

CONCLUSION

With the exception of some of the less experienced anaesthetists the use of blood components as investigated by this question was satisfactory.

Survey Question

What course of action would you take in the following cases:

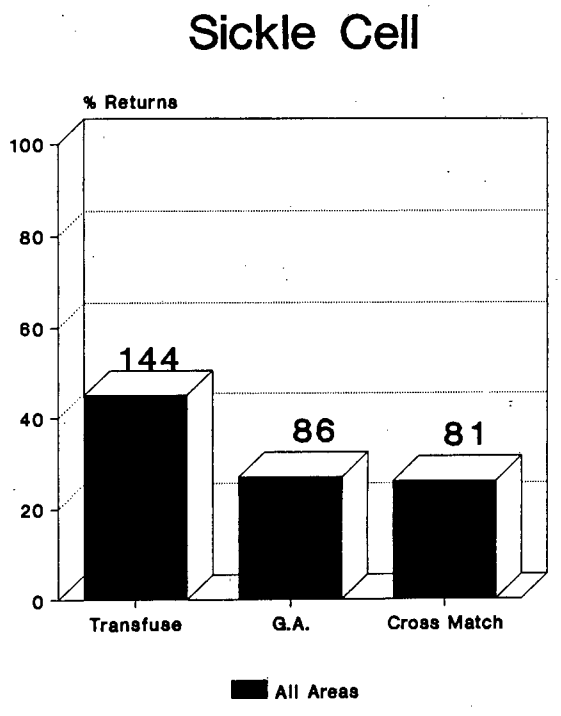
	Transfuse Pre-op	Administer General Anaesthetic	Require Blood Cross Matched
15 year-old male with sickle cell anaemia for arthroscopy of the knee, haemoglobin 7,5g/100ml	☐	☐	☐

RESULTS

Sickle Cell

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	15	
Spoilt																	7	2
Transfuse	71		22		1	2	12		14		4		13		5		144	45
GA	39		14			3	5		5		5		7		8		86	27
X match	32		14				6		8		4		7		10		81	26

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
Spoilt						
Transfuse	87	47	39	36	18	69
GA	42	23	40	37	4	15
X match	52	28	26	24	3	12



Note that 45% (144) would transfuse pre-operatively 27% (86) would administer a GA and 26% (81) would require blood to be cross-matched.

DISCUSSION

Sickle Cell Disease

Sickle cell disease represents an inherited group of disorders ranging in severity from the usual benign sickle cell trait to the debilitating and often fatal sickle cell anaemia (**Lessin & Jensen, 1974**). All the varients of sickle cell disease have various qualities of haemoglobin S. Haemoglobin S differs from normal adult haemoglobin A by the substitution of valine for glutamic acid at the sixth position on the Beta chain of the haemoglobin molecule. Confirmation of the presence of haemoglobin S depends on electro-phoretic studies.

Sickle cell anaemia is present when patients are homozygous for haemoglobin S. Approximately 0,3% to 1% of the Black population of the United States are homozygous for haemoglobin S, with a further 8-14% having the sickle cell trait which may cause sickling with hypoxia.

The presence of hypoxia results in the deformation of the erythrocytes into sickle shapes which form long aggregates causing infarctive areas. In addition the sickle shape damages the erythrocyte membrane leading to their rupture and chronic haemolytic anaemia. In the steady state haemoglobin concentrations are 5g/dl to 10g/dl. Thus the sickle cell patient in the question has an acceptable haemoglobin (7,5g/dl) for this disease.

The need for pre-operative transfusion is determined by the severity of co-existing anaemia and the magnitude of the proposed operation. The goal of pre-operative infusion of erythrocytes is to increase the concentration of haemoglobin A to at least 40%. The hazards of transfusion include depression of the hyperactive bone marrow and increased blood viscosity.

Goals in the management of anaesthesia include:

1) Avoidance of acidosis due to hypoventilation
2) Maintenance of optimal oxygenation including supplementary oxygen if a regional technique is employed
3) Prevention of circulatory stasis due to improper body positioning or the use of a tourniquet
4) Anticipation and rapid correction of hypotension
5) Maintenance of intravascular volume by intravenous infusion of crystalloid solutions
6) Maintenance of normal body temperature to prevent vasoconstriction and stasis of blood flow.

Thus, the correction of a mild to moderate anaemia for an arthroscopy is less important than being aware of the above goals of anaesthesia. Anthroscopy without a tourniquet has been shown to be surgically as equally as effective (**Stein & Urbaniak, 1980**).

Stein & Urbaniak (1980) undertook a 17 year review of tourniquet procedures involving 29 tourniquet applications to 21 patients with sickle cell disease. They found no differences between the incidence of complications of sickle cell patients and that in a randomly selected control population. They concluded that the use of a tourniquet was not contra-indicated in sickle cell patients. However if a tourniquet is used, it would be prudent to exsanguate the limb carefully.

There does not appear to be statistics regarding the incidence of sickle cell anaemia in South Africa. However on personal questioning, most anaesthetists have never anaesthetised a case, so the incidence must be very infrequent. This probably accounts for the low proportion of anaesthetists (27%) who answered the question correctly i.e. proceed with a general anaesthetic.

Stehling et al (1987) in their survey in the USA, where the incidence is 0.3-1% for the black population, showed only 60,5% would administer a GA whereas 40,8% would transfuse pre-operatively (compared to 45% S. Africa) and 44,4% would require blood to be cross-matched (compared to 26% S. Africa). This was a postal survey where the respondents had the advantage of being able to refer to text books.

CONCLUSION

The knowledge of the normal haemoglobin for a person suffering from sickle cell anaemia is, not surprisingly, poor amongst South African Anaesthetists. However, it also may indicate either poor logical thought procedures when considering a patient with a chronic anaemia of known aetiology for an operation where there is no blood loss, or it confirms that most South African Anaesthetists have a firm cut off figure for the lower limit of haemoglobin before elective minor surgery.

Survey Question

What course of action could you take in the following cases:

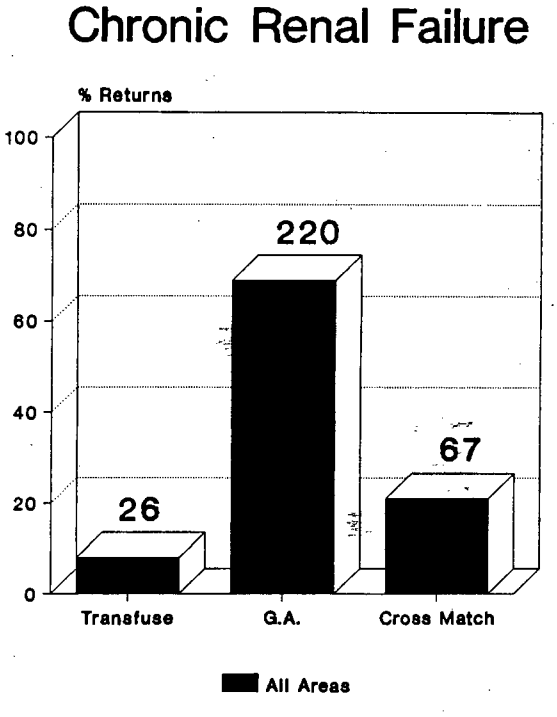
	Transfuse Pre-op	Administer General Anaesthetic	Require Blood Cross Matched
45 year-old male with end stage renal disease for creation of an arterio-venous fistula in the arm, haemoglobin 6g/100ml.	☐	☐	☐

RESULTS

Renal

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	12	
Spoilt																	8	3
Transfuse	16		2				1		3		2		1		1		26	8
GA	99		40		1	2	19		16		6		20		17		220	69
X match			9			3	4		8		2		6		5		67	21

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
Spoilt						
Transfuse	17	9	4	4	5	20
GA	116	63	90	80	15	58
X match	47	26	17	15	3	12



Note that only 8% (26) of respondents would transfuse pre-operatively and 21% (67) would require blood to be cross-matched.

DISCUSSION

Chronic Renal Failure

Normochromic, normocytic anaemia occurs in almost all patients with chronic renal failure who have plasma creatinine concentrations greater than 3,5mg.dl^{-1}. The degree of anaemia often parallels the degree of chronic renal dysfunction but remains relatively constant after end-stage renal failure has occurred.

Haemoglobin concentrations in the range of 5g.dl^{-1} to 8g.dl^{-1} are hallmarks of chronic renal failure. Decreased erythropoietin production in the presence of elevated blood urea nitrogen levels is the most likely explanation. Also survival time for erythrocytes is shortened about 50% in the presence of chronic anaemia reflecting an increased erythrocyte membrane fragility. These two factors together with an increased tendency for menorrhagia and gastrointestinal bleeding cause anaemia.

The anaemia is well tolerated because of its slow onset and pre-operative transfusions are not routinely indicated. The decreased oxygen carrying capacity is compensated for by increased tissue blood flow, and a right shift of the oxygen haemoglobin curve, resulting in increased release of oxygen due to increased 2:3 Di-phosphoglycerate and metabolic acidosis. Because of the risk of creating HLA antibodies which makes tissue compatability matching for a suitable donor harder, most anaesthetists would accept a much lower haemoglobin in these patients before transfusing.

The postal survey by **Stehling et al (1987)** revealed a poorer knowledge of the use blood products in the patient suffering from chronic renal failure, when compared to the present survey. The same question was answered; transfuse pre-operatively 20,2% (compared with 8% S. Africa) administer general anaesthetic 54,5% (compared with 69% S. Africa) and cross-match 61,5% (compared with 21% S. Africa).

CONCLUSION

Most respondents accept a low haemoglobin level (6gm/dl) in a patient with end stage renal failure. This is at variance with the previous questions relating to pre-operative acceptable minimal haemoglobin levels where most anaesthetists used 10gm/dl as their lower level. This must add further to the debate regarding safe minimal haemoglobin levels.

Cross-matching for a relatively bloodless procedure was again excessive (21%), although 47 out of 67 respondents had less than six years anaesthetic experience and so inexperience may be a factor.

CHAPTER THREE

BLOOD TRANSFUSION DURING OPERATION

* Assessment of Blood Loss
* Replacement of Blood Loss
* Incorrectly Labelled Blood

BLOOD REPLACEMENT : ASSESSMENT OF LOSS

Survey Question

Which methods of blood loss assessment do you usually employ during major abdominal surgery?

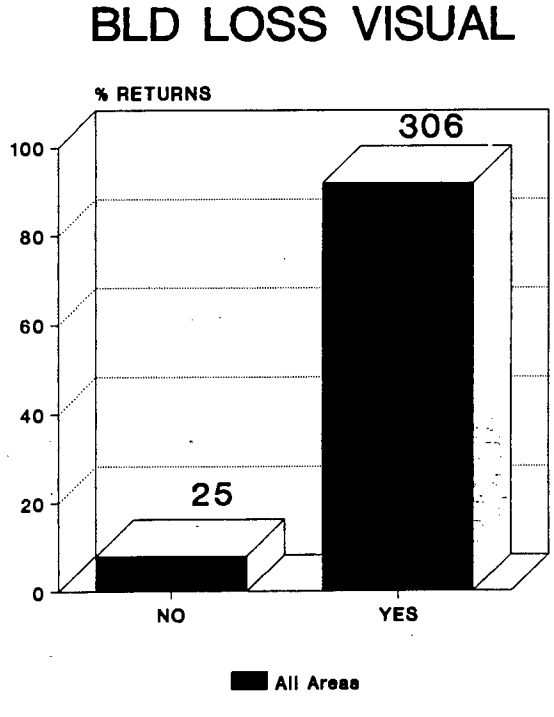
Visual estimation ☐

RESULTS

Blood loss visual

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
No	4	3	12	23	1		4	15	3	11	1	8					25	8
Yes	150	97	41	77		5	22	85	24	89	12	92	28	100	24	100	306	92

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	12	6	10	9	3	10
Yes	176	94	104	91	26	90



Note that 92% (306) of respondents visually assess blood loss.

Survey Question

Which methods of blood loss assessment do you usually employ during major abdominal surgery?

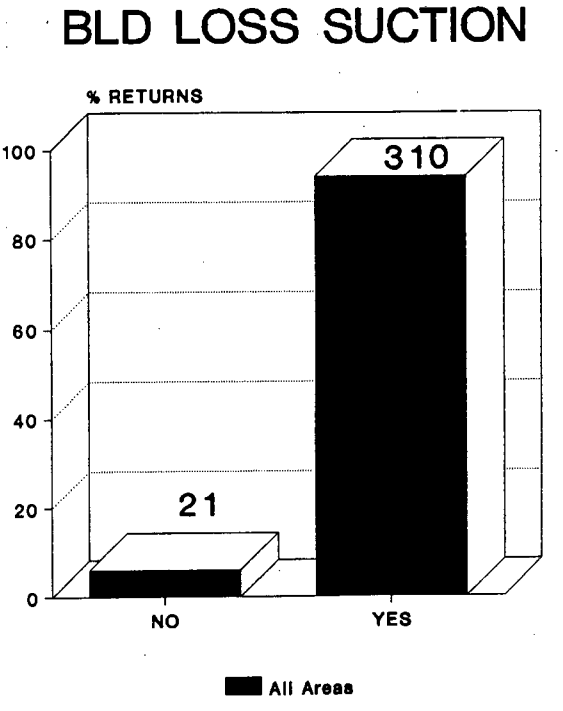
Measuring suction bottles ☐

RESULTS

Blood loss Suction

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
No	9	6	4	8	1		2	8	2	7					3	13	21	6
Yes	145	94	49	92		5	24	92	25	93	13	100	28	100	21	88	310	94

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A	11	6	6	5	4	14
No	177	94	108	95	25	86
Yes						



Note that 98% (310) of respondents do take note of suction bottle measurement in estimation of blood loss.

Survey Question

Which methods of blood loss assessment do you usually employ during major abdominal surgery?

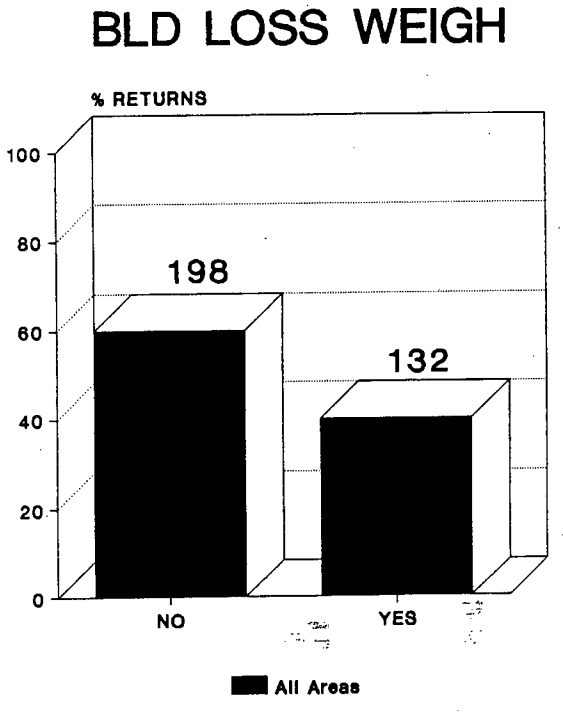
Weighing swabs ☐

RESULTS

Blood loss weighing

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
No	114	74	12	23	1	4	10	39	14	52	7	54	12	43	24	100	198	60
Yes	39	25	41	77		1	16	62	13	48	6	46	16	57			132	40
Spoilt																	1	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	126	67	57	50	15	52
Yes	62	33	56	49	14	48
Spoilt						



Note that 60% (198) of respondents do not weigh swabs to estimate blood loss.

Survey Question

Which methods of blood loss assessment do you usually employ during major abdominal surgery?

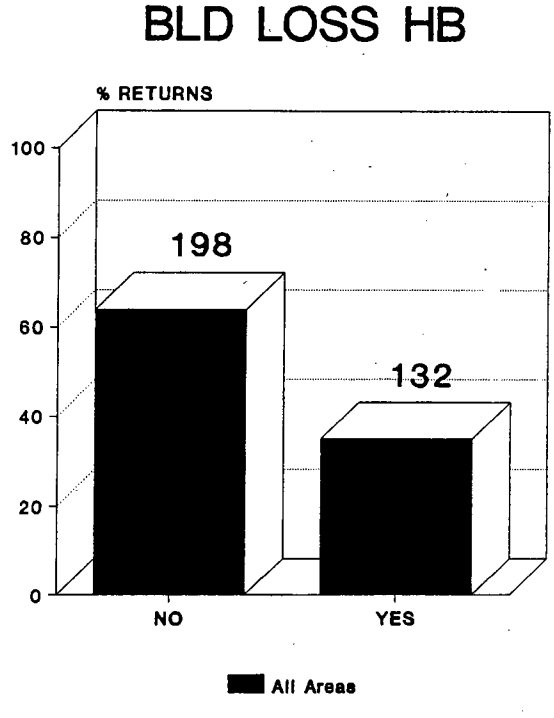
Serial haemoglobin estimation ☐

RESULTS

Blood loss serial Hb

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
No	97	63	37	60		1	11	42	25	93	11	85	19	68	12	50	213	64
Yes	55	36	16	30	1	4	15	58	2	7	1	8	9	32	12	50	115	35
Spoilt																	2	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	118	63	73	64	21	72
Yes	69	37	40	35	7	24
Spoilt						



Note that 64% (213) of respondents do not use intra-operative haemoglobin measurements when estimating blood loss.

Survey Question

Which methods of blood loss assessment do you usually employ during major abdominal surgery?

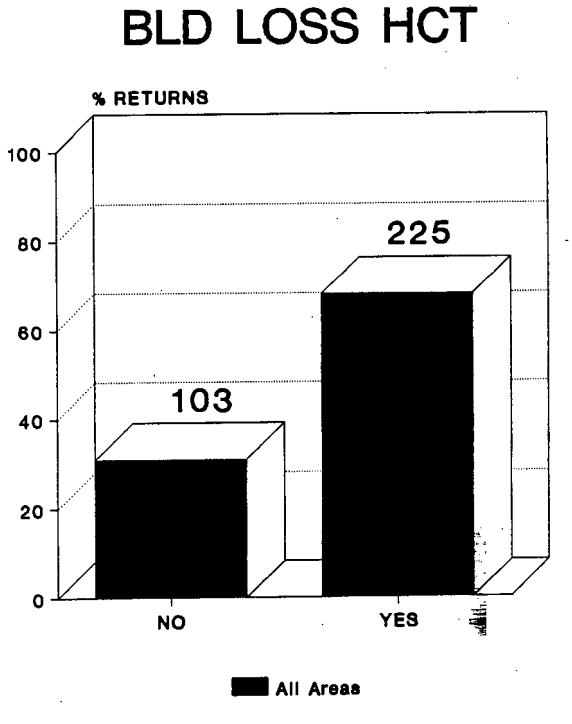
Serial haematocrit (PCV) estimation ☐

RESULTS

Blood loss Serial HCt

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
No	34	22	15	28		5	11	42					16	57	22	92	103	31
Yes	118	77	38	72	1		15	58	27	100	12	92	12	43	2	8	225	68
Spoilt																	1	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	47	25	44	39	14	48
Yes	140	75	69	61	14	48
Spoilt						



Note that 68% (225) of respondents do use serial haematocrit estimations when calculating intra-operative blood loss.

DISCUSSION

The assessment of blood loss during major surgery involves the use of all the anaesthetists experience and perceptions. Thus he should look at the swabs, the drapes, any blood spillage onto the floor and bleeding into the operation site. In the survey 92% of respondents stated they did so. The suction bottles should be marked with graduations so that blood collected in them can be estimated with allowance made for any washings. In the survey 94% of respondents stated they did so. Weighing the swabs may be misleading if dampened swabs are used (common in abdominal surgery) and weighing the drapes can only occur when the operation is over. Thus weighing of swabs if often only done where even a small amount of blood loss is significant, such as in paediatric surgery. In the survey only 40% of respondents indicated they weighed swabs. There was no allowance made for paediatric and non-paediatric anaesthetists in the Questionnaire.

A similar question was asked by **Stehling et al (1987)** in their survey or 389 anesthesiologists in the USA. 87,9% used visual estimation (S.A. survey 92%) 94,6% measured contents of the suction bottle (S.A. survey 98%) 48,3% weighed sponges (S.A. survey 40%) 45,2% used serial haemoglobin/haematocrit (S.A. survey 35-68%).

Serial haematocrit even more so than serial haemoglobin estimations, are extremely important in accurately following the blood loss during the operation. It was therefore disappointing that 32% and 64% of respondents neither used serial haematocrit nor haemoglobin estimations respectively. The inference must be they use a fixed volume loss for their indications for blood transfusion. This hypothesis was investigated in the following survey question.

BLOOD TRANSFUSION : REPLACEMENT OF BLOOD LOSS

Survey Question

During an operation NOT normally requiring blood replacement which of the following best describes your approach? (Tick only one)

a) Replace when blood loss is, or will be, by the end of the procedure 10% of estimated blood volume: ☐

b) Replace when blood loss is, or will be, by the end of the procedure, 20% of estimated blood volume ☐

c) Allow the patient to bleed to a haematocrit of 30% before transfusing: ☐

d) In adults administer blood only if more than one unit is required ☐

e) Administer blood only if vital signs change e.g. blood pressure drops or pulse rate increases significantly ☐

RESULTS

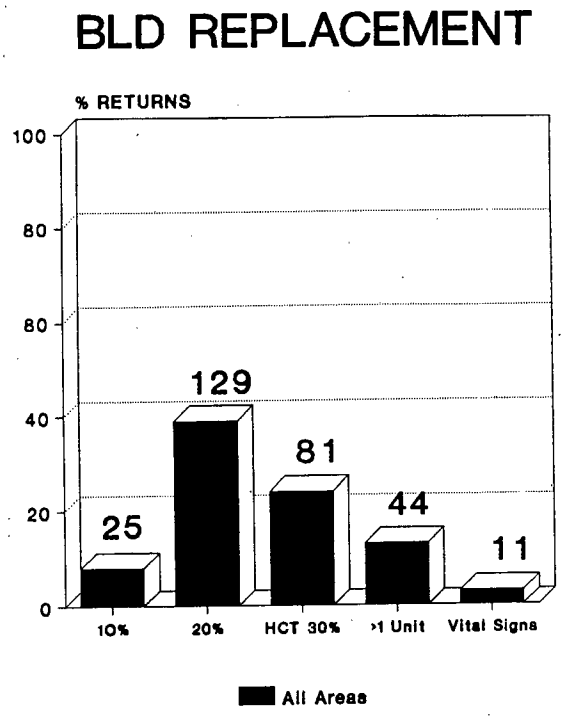
Blood Replacement

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	1	
10%	11	7	4	7			4	15	1	3			3	11	2	8	25	8
20%	56	36	24	44	1	4	11	42	7	26	4	31	9	32	13	54	129	39
HCt 30	44	29	12	22		1	3	12	11	41	5	39	2	7	3	13	81	24%
>1 unit	25	16	7	13					3	11	3	23	4	14	2	8	44	13
Vital signs	4	3	3	6			1	4			1	8	2	7			11	3
Spoilt																	42	13

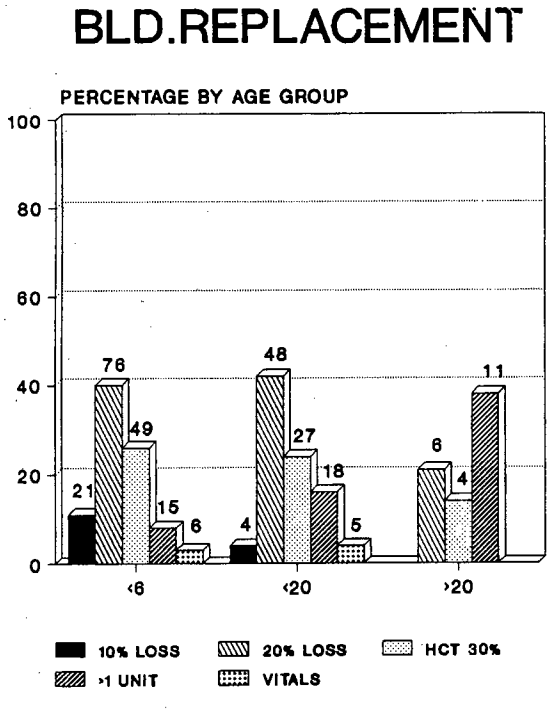
RESULTS (contd):

Blood Replacement (contd.):

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A	21	11	4	7		
10%	76	40	48	42	6	21
20%	49	26	27	24	4	14
HCt 30	15	8	18	16	11	38
>1 unit	6	3	5	4		
Vital signs						
Spoilt						



Note that only 24% (81) of respondents replied that they would use a haematocrit of 30%.



- Note that percentage-wise more experienced anaesthetists, (>20 years) used more than one unit loss as their main criteria for blood replacement.

DISCUSSION

Most healthy patients can sustain acute blood losses of 30% of their blood volume and require replacement only with clear fluids **(Stoelting et al, 1988)**. **Czer and Shoemaker (1978)** reported that the maximal survival rate in critically ill patients occurred at a haematocrit of between 27 and 33%. Because of differences in pre-operative haemoglobin levels and physical status it would seem logical to have a policy of blood transfusion based on a measured value as opposed to a fixed volume loss which may be difficult to measure accurately. The simplest and most accurate theatre test at present available which can be applied in the theatre is the measurement of haematocrit. Using serial haematocrit estimations with an end point before transfusing of 30% (haemoglobin of 10g/dl) as long as there is no clinical contraindications, is a logical method of assessing when to start blood replacement. At a haematocrit of 30% there is favourable rheological blood flow properties and oxygen transport to the tissues is not compromised. Vital signs changing can be caused by many factors, not only blood loss, such as drugs given, surgical interference with venous return and myocardial depression.

CONCLUSION

The majority of anaesthetists surveyed (63%) used a blood volume loss of 10-20% as their indication for blood replacement. Translated into practical terms this must result in a major cause of over-transfusion of blood. Serial haematocrit estimations should be used routinely to assess the need for blood replacement.

BLOOD TRANSFUSION : INCORRECTLY LABELLED BLOOD

Survey Question

Within the last five years have you ever received incorrectly labelled blood (wrong patient or wrong folder number)?

Yes No

If **Yes** - how many times over the last 5 years?

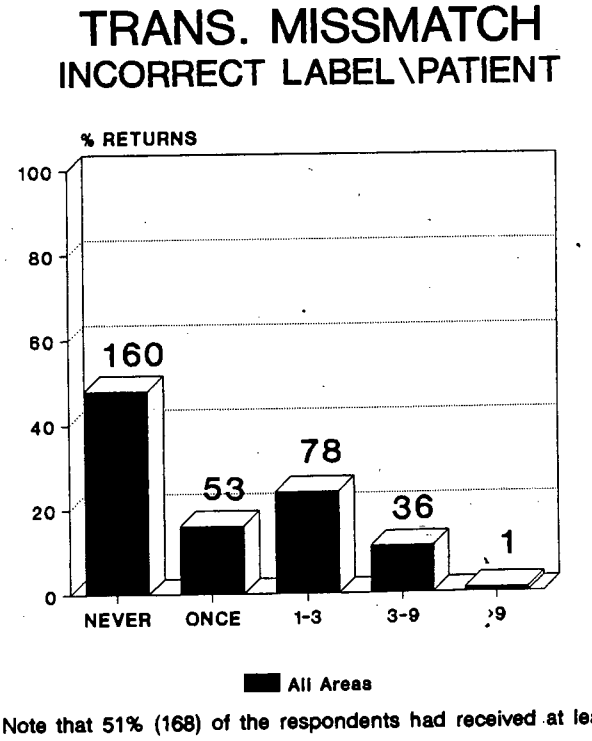
Once ☐ < than 3 ☐ 3-9 times ☐ more than 9 times ☐

RESULTS

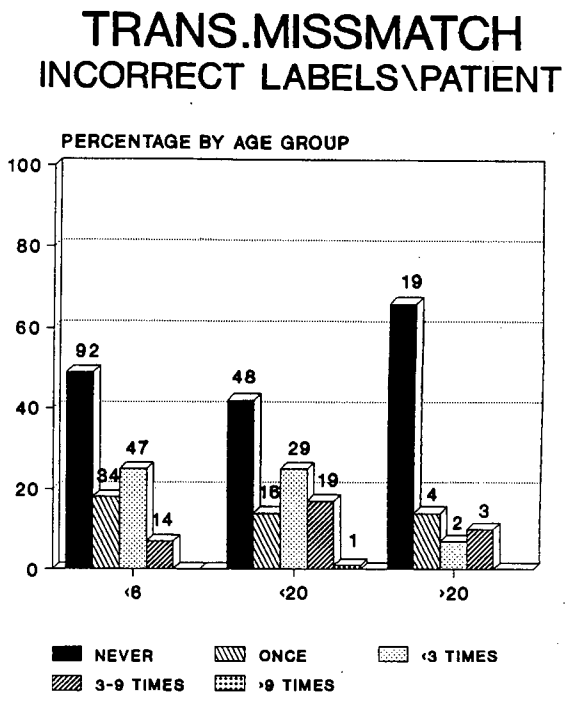
Wrong Transfusion

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
Never	105	68	20	37	1	1	8	31	8	30	6	46	5	18	6	25	160	48
Once	23	15	13	24			7	27	7	26	2	15	1	4			53	16
1-3	18	12	14	26		2	7	27	11	41	4	31	9	32	13	54	78	24
3-9	7	5	4	7		2	3	12	1	4	1	8	13	46	5	21	36	11
>9	1																1	
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
Never	92	49	48	42	19	66
Once	34	18	16	14	4	14
1-3	47	25	29	25	2	7
3-9	14	7	19	16	3	10
>9			1	1		
Spoilt						



Note that 51% (168) of the respondents had received at least one unit of incorrectly labelled blood within the last five years.



Note that there appears to be no significant increase in the percentage of transfusion mismatches received and length of anaesthetic experience.

DISCUSSION

Incorrectly labelled blood

Myhre (1980) reported on fatalities associated with blood transfusion in the USA between 1976 and 1979. There were 113 reported fatalaties out of 11,8 million units of blood transfused (a fatality rate of 0,00023% or approximately 1 in 100,000).

In forty-seven cases clerical error was at fault due to mislabelling of blood samples or cross-match records interchanged in the laboratory. **Koepke (1971)** looking at transcribing errors reported a rate of 4,6% when blood bank technologists were asked to copy eleven digit numbers from one side of a survey report to another. In thirty-one fatal cases the wrong unit of blood was given to the patient. Thus sixty-five percent of fatalities were due to misidentification of the patient, sample, or unit of blood. Laboratory errors were eight and included incorrect typing of the blood or undetected antibodies.

CONCLUSION

There was an alarmingly high percentage (51%) of anaesthetists surveyed who had incorrectly labelled blood, either wrong patient or wrong folder number, within the last five years. This makes it vitally important that no matter what the urgency the blood is checked carefully before being transfused.

CHAPTER FOUR

BLOOD PRODUCT KNOWLEDGE

* Basic Knowledge, Haemoglobin Elevation by Transfusion
* Haemophilia
* Transmission of infection
* Suppression of immunity
* Costs

BLOOD KNOWLEDGE

Haemoglobin Elevation

Survey Question

On average in patients with anaemia how much would you expect one unit of blood to raise the haemoglobin?

a) 0,5g/100ml ☐

b) 1g/100ml ☐

c) 1,5g/100ml ☐

d) Don't know ☐

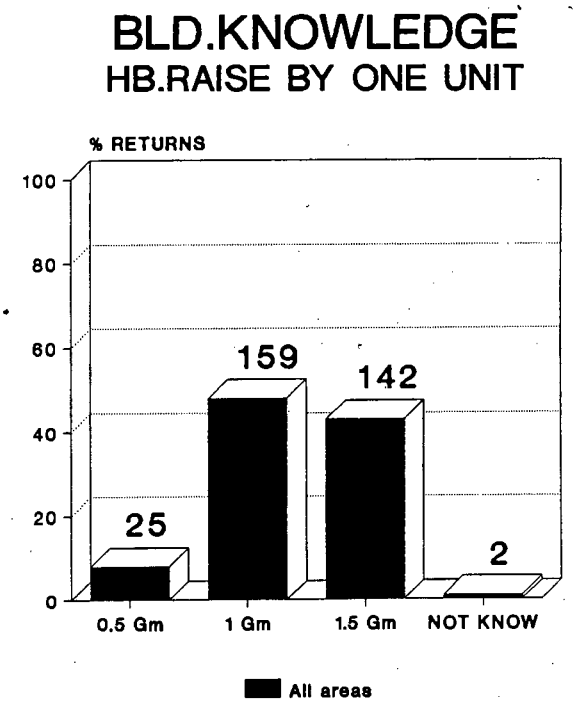
RESULTS

Raise Haemoglobin

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
0,5	12	8	5	9			3	12	4	15					1	4	25	8
1gm	84	55	26	50			7	27	13	49	4	31	15	54	10	48	159	48
1,5	54	35	22	42	1	5	16	62	9	33	9	69	13	46	13	54	142	43
Not know	1										1						2	.6
Spoilt																	2	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
0,5gm	17	9	8	7		
1gm	72	38	67	59	18	62
1,5gm	96	51	38	33	10	35
Not know						
Spoilt						

Note that 48% (159) replied that one unit of blood raised the haemoglobin level by 1g/dl.



DISCUSSION

One unit of whole blood contains approximately 450ml of blood and 63ml of preservative, 6ml/Kg body weight of whole blood will raise the haemoglobin concentration by 1g/dl **(Mollison, 1972)**. In the text books by **Dripps et al (1988)** and **Scurr and Feldman (1982)** it is stated that one unit of whole blood or packed cells increases the haemoglobin level by 1g/dl.

CONCLUSION

Less than 50% of respondents were aware of how much one unit of blood raised the haemoglobin level. This shows poor basic knowledge of blood transfusion.

BLOOD KNOWLEDGE : HAEMOPHILIA

Survey Question

A haemophiliac (Type A) presents for an elective dental clearance under general anaesthetic. What is the minimal level of Factor VIII you would consider necessary prior to operation?

a) More than 25% ☐

b) More than 50% ☐

c) More than 75% ☐

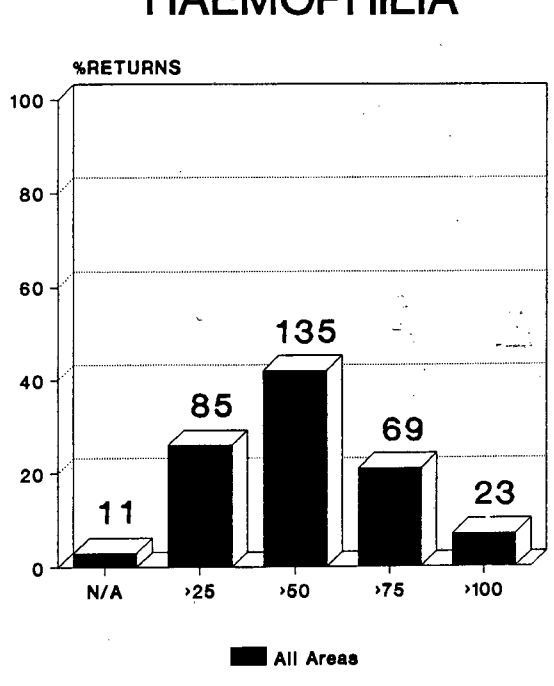
d) 100% ☐

RESULTS

Haemophilia

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	11	
>25	45	30	13	24		1	3	12	9	35	1	32	5	19	8	36	85	26
>50	58	39	27	50		3	10	39	13	50	5	42	8	30	11	50	135	42
>75	31	21	6	11	1	1	7	27	3	12	5	42	13	48	2	9	69	21
>100	9	6	4	7			6	23	1	4	1	8	1	4	1	5	23	7
Spoilt																	10	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
	10		1			
	45	25	34	30	6	21
	8	45	43	38	11	38
	38	21	23	20	8	28
	12	7	9	8	2	7



Note that 42% (135) of respondents replied that the Factor VIII level should be 50% or above for a dental clearance.

DISCUSSION

Haemophilia

Classical haemophilia (Type A) results from deficient synthesis of Factor VIII:C, while the Von Willebrand portion of the molecule is normal. Application of recombinant DNA technology with cloning of the protein has shown that most patients have a parallel decrease in Factor III:C, together with its antigen, whereas less than 10% may have a biologically defective molecule, with normal antigen, but marked reduction in coagulant activity **(Jacobs, 1989)**. The gene encoding the protein is carried on the X chromosome and all daughters of involved males are carriers in contrast to offspring from a mother who carries the trait, where half the sons will have haemophilia and half the daughters will transmit the genetic abnormality. The incidence of Factor VIII deficiency is estimated to be 1:10,000 to 1:24,000 births **(Ellison, 1977)**.

Clinically the bleeding pattern varies widely and correlates with the level of Factor VIII coagulant activity. Thus, the more severe disorders where the value is less than 1% of normal, present early in life with spontaneous haemarthoses and deep tissue bleeding. At levels of 1-5% there is typically childhood bleeding associated with trauma. With values of 15-20% more substantial trauma such as minor surgery or dental extraction reveal abnormal bleeding. With higher levels of Factor VIII the patient remains asymptomatic until major trauma or surgery are followed by severe bleeding.

When a deficient factor is infused into a patient the volume required depends on: patient size; desired elevation in level of deficient factor; and preparation potency. Survival of the transfused factor *in vivo* shows a characteristic double exponential curve in which the early rapid disappearance represents equilibration with the extravascular space and the later slower disappearance with natural degredation, which is accelerated in the presence of fever or infection **(Britten & Salyman, 1966)**. To prevent excessive bleeding with operations the actual replacement is calculated to accomplish minimal levels in excess of that needed to permit partial saturation of the extravascular stores and to allow for intravascular decay with a reasonable booster schedule.

Factor VIII:C is usually given as cryoprecipitate or heat treated lyophilised concentrate to achieve desired haemostatic levels. The following equation can be used to calculate the dose required:

Dose (units of Factor VIII:C) = (0,01) (%Factor VIII increment) (plasma vol. of patient in mls)

Cryprecipitate generally contains 100 units/bag. Commercial concentrations will carry this information on the label. The biological equilibration is 12 hours and therefore, after a loading infusion, a 12 hour replacement is adequate in the absence of inhibitors. About 10% of haemophiliac patients have an inhibitor where Factor VIII replacement fails to achieve the expected level. Haemorrhage in these circumstances is life threatening and needs to be managed in association with an experienced haematologist **(Jacobs, 1989)**. After transfusion the patient should have a normal activated partial thromboplastin time (aPTT), a measure of the intrinsic coagulation system.

For dental extraction a single infusion to raise the Factor VIII level above 50% is required, followed by the fibrinolytic inhibitor epsilon aminocaproic acid, at a dose of 100mg/Kg for 10 days. This will obviate the need for further Factor VIII replacement **(Jacobs, 1989)**.

For major surgery it is common to infuse sufficient Factor VIII to raise the level to 80-100% and then give boosters every 12 hours to maintain levels above 50% for 10-14 days.

CONCLUSION

Although 28% (92) of respondents required unnecessarily higher levels of Factor VIII pre-operatively and 26% (85) respondents stated too low a level, most haemophiliacs in South Africa would have been worked up for the procedure by a haematologist. Also, being an elective case, this would have allowed the anaesthetist who was unsure of the required level of Factor VIII required to check it in a text book.

The results do however point to a poor knowledge of certain blood disorders and peri-operative transfusion requirements.

BLOOD COMPONENT KNOWLEDGE : INFECTION TRANSMISSION

Survey Question

What risk do the following blood products have of carrying transmissable disease when compared to one unit of whole blood?

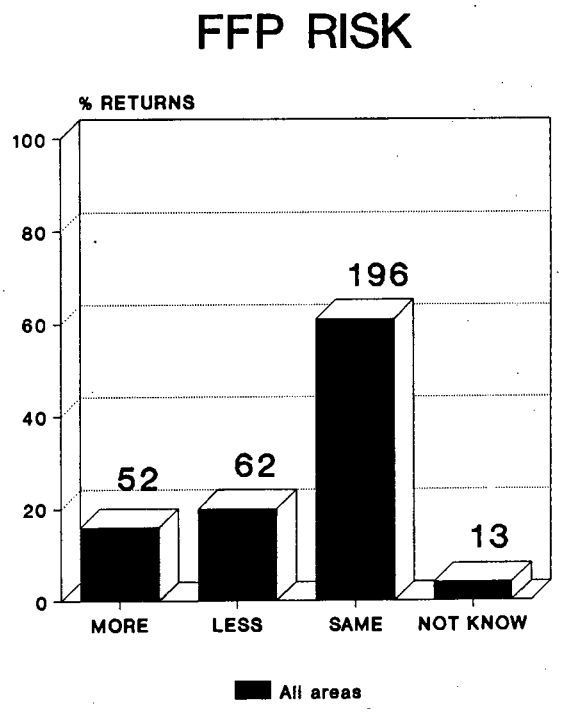
	More Risk	Less Risk	Same Risk	Don't Know
a) Unit of fresh frozen plasma (FFP)	☐	☐	☐	☐

RESULTS

FFP Risk

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	9	
More	26	17	16	31			2	8	2	8	1	8	3	12	2	8	52	16
Less	22	14	6	12		1	5	21	9	35	4	31	5	19	10	42	62	20
Same	99	65	28	54	1	4	15	63	14	54	8	62	17	65	10	42	196	61
Not know	6	4	1	2			2	8	1	4			1	4	4	2	8	13
Spoilt																	1	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
More	27	15	23	20	3	11
Less	44	24	11	10	7	26
Same	106	58	76	67	13	48
Not know	4					
Spoilt						



Note that 35% (126) of respondents did not know FFP carries the same risk of transmission of infection as blood.

Survey Question

What risk do the following blood products have of carrying transmissable disease when compared to one unit of whole blood?

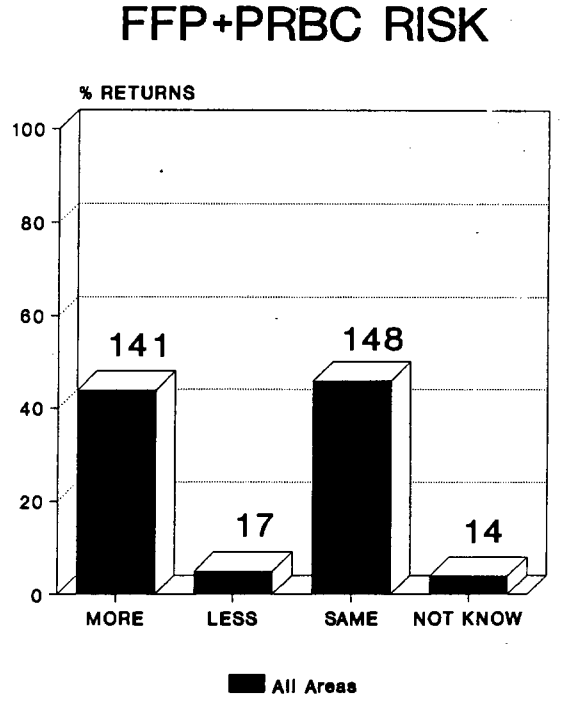
	More Risk	Less Risk	Same Risk	Don't Know
1 Unit FFP plus 1 Unit pre-packed red blood cells	☐	☐	☐	☐

RESULTS

FFP + PRBC risk

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	12	
More	82	54	27	54		2	8	32	4	15	2	17	10	37	6	26	141	44
Less	2	1	2	4			4	16	7	27			2	7			17	5
Same	62	41	18	36	1	2	12	48	13	50	10	83	14	52	60	70	148	46
Not know	6	4	2	4		1	1	4	2	8			1	4	1	4	14	4
Spoilt																	1	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
More	72	40	60	54	10	37
Less	9	5	5	5	3	11
Same	92	51	46	41	9	33
Not know						
Spoilt						



Note that 56% (179) of respondents did not know that 1 unit of FFP plus 1 unit of packed red blood cells carry a higher risk of transmission of disease than 1 unit of whole blood. This is because when given out by the Blood Bank these products will almost certainly not come from the same donor.

Survey Question

What risk do the following blood products have of carrying transmissable disease when compared to one unit of whole blood?

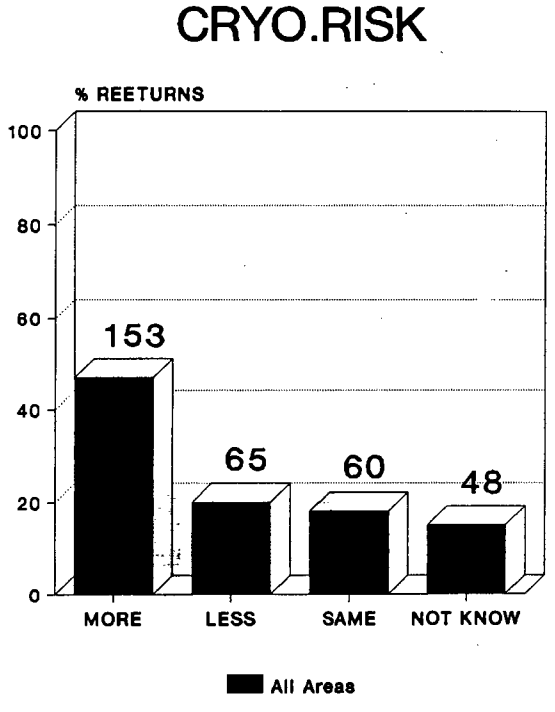
	More Risk	Less Risk	Same Risk	Don't Know
1 Unit Cryoprecipitate (AHF 500 units)	☐	☐	☐	☐

RESULTS

Cryo. risk

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	6	
More	81	53	28	53		3	9	35	7	27	3	25	14	52	8	33	153	47
Less	26	17	11	21		1	6	23	7	27	2	17	6	22	6	25	65	20
Same	29	19	3	6	1	1	9	35	7	27	3	25	3	11	4	17	60	18
Not know	17	11	10	19			2	8	5	19	4	33	4	15	6	25	48	15
Spoilt																	1	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
More	76	41	68	60	8	29
Less	40	22	15	13	9	32
Same	39	21	18	16	3	11
Not know	31	17	11	10	8	29
Spoilt						



Note that 53% (173) of respondents did not know cryoprecipitate (AHF 500 units) because it is a pooled product carries more risk of transmission of infection than one unit of blood.

Survey Question

What risk do the following blood products have of carrying transmissable disease when compared to one unit of whole blood?

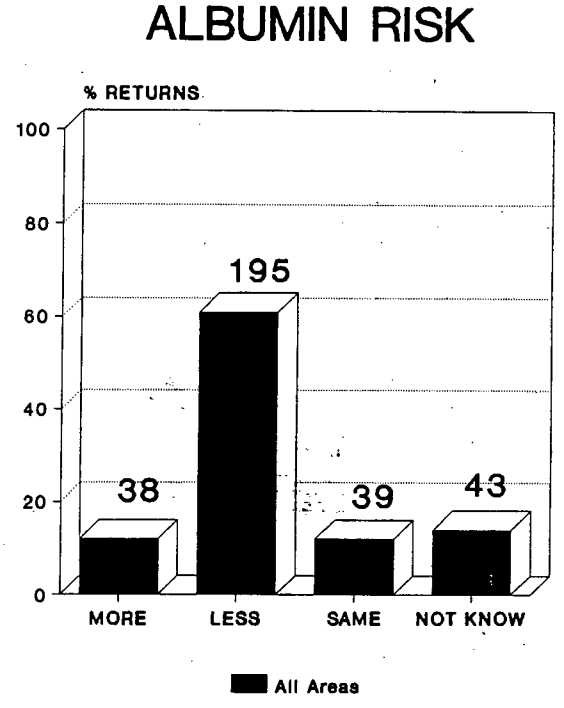
	More Risk	Less Risk	Same Risk	Don't Know
100ml Albumin	☐	☐	☐	☐

RESULTS

Albumin risk

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	14	
More	21	14	8	15		1			1	4	1	8	4	15	2	9	38	12
Less	90	60	25	48	1	3	21	84	23	89	5	42	14	54	13	59	195	61
Same	18	12	8	15			1	4	1	4	4	33	4	15	3	14	39	12
Not know	20	13	9	17		1	3	12	1	4	1	8	4	15	4	18	43	14
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
More	16	9	20	18	1	4
Less	114	63	61	55	19	68
Same	23	13	14	13	3	11
Not know	24	13	15	14	5	18
Spoilt						



Note that 49% (120) of respondents did not know that albumin carries less risk of infection transmission than blood. In fact because it is filtered fractionated and pasturised albumin carries no risk of disease transmission.

DISCUSSION

The possibility of transmissable disease being carried in a unit of blood or blood product exists in all countries no matter how careful and stringent the precautions and testing.

Transmission of Infection

1) Bacterial:
Bacterial contamination of blood products is rare in modern blood banking practice. The greatest danger of bacterial contamination appears to be with platelet transfusions because of their storage at 20-24°C. This is the reason why platelets are not usually taken back by the blood bank once issued.

2) Viral:
Virus contamination remains today the main form of transmitted infection. If an infective agent is present in the blood of a donor at the time of donation the consequence of transfusing that blood will depend on the nature of the agent. The incubation period for clinical signs and symptoms varies depending on the infective agent and signs and symptoms may be delayed many years.

3) Human Hepatitis Virus: All blood products except albumin solution and gamma globulin can transmit hepatitis. Pooled plasma products have an obviously higher risk than products prepared from single donors. The usual incubation period for transfusion induced hepatitis is 50 to 60 days, with a range of from 2 weeks to 6 months.

   At least four types of hepatitis have been recognised: type A, type B, a type referred to as Non-A, non-B, and the delta virus. Cytomegalovirus may also cause hepatitis (and accounts for 1-5% of post-transfusion hepatitis).

   Type A hepatitis is rarely transmitted by transfusion because the viraemia is so brief that the chance of an asymptomatic viraemic individual donating blood is small.

   The incidence of non-A, non-B hepatitis virus may be less high as 1 in 100 units, in the U.S.A. and until recently was difficult to test for. However, recent development (**Time Magazine, 1989**) of a test for non-A, non-B virus should markedly decrease this frequency if it is brought into widespread practice. Hepatitis B has been tested for since 1971 and mandatory testing has reduced the incidence of post-transfusion hepatitis B to about 2%. In 1988 the Western Province Blood Transfusion Service (WPBTS) had two reported cases of Hepatitis B and three cases of non-A, non-B due to blood transfusions.

   The delta virus is a defective virus that requires the helper function of the hepatitis B virus to replicate. When a patient positive for hepatitis B surface antigen is infected with delta virus, the superinfection can convert a previously mild hepatitis B carrier state into a severe, progressive hepatitis.

   Most patients developing hepatitis do not become jaundiced and escape notice unless transaminase values are measured so many transfusion related cases of hepatitis will go undetected and unreported. Nevertheless, in 20% of patients the hepatitis will progress to cirrhosis.

   Thus non-A, non-B hepatitis and hepatitis B viruses are a major risk of transfusion therapy.

4) Human immunodeficiency virus (HIV): In the United States the estimated risk is 1 in 40 000 to 1 in 100 000 units. However, the consequences of HIV infection may take many years before damage to the immune system allows opportunistic diseases to cause the extremely high mortality of Aids (Acquired Immune Deficiency Syndrome). As it is the antibodies to HIV which are tested for, it is possible that a donor, recently infected for the first time with HIV, may be in the so-called "window free zone" and prove negative on testing. This zone lasts until antibodies are formed some months or even years later. It is now known that some subjects infected with HIV never seroconvert and go on to develop AIDS still HIV negative. At present there is no test which can detect seronegative HIV carriers. Up until April, 1989 in South Africa there were ten cases of HIV positive cases associated with transfusions. These included nine haemophiliacs some of whom are thought to be HIV positive as a result of transfusions of commercial factor concentrates imported from the United States prior to 1985 when the routine testing for HIV antibodies was instituted.

5) Human T Cell Lymphotropic Viruses (HTLV 1 and 2): **Cohen et al (1989)** reported that although the risk of HTLV 1 transmission is small, about 0,024% per unit of blood transfused, it is still eight times higher than the risk of Human Immuno Deficiency Virus (HIV) transmission.

   HTLV I and II viruses occur in a low but not negligible frequency amongst donor populations in the United States. HLTV 1 is a retrovirus which has been associated with tropical spastic paraparesis, also called HTLV-1 associated myolopathy and adult T-cell leukaemia/lymphoma. The virus may be dormant for 20-30 years in an affected individual with only 1-2% develop clinical disease.

   Tropical spastic paraparesis is a slowly progressive neurological disease that causes weakness in the legs and lower body and leaves half its patients unable to walk. The virus is believed to be passed through sexual contact, via the placenta as well as via contaminated blood products.

   HTLV-II appears to cause a milder immunodeficiency disease than HIV-I.

   Screening tests recommended for HTLV-I antibodies will add up to $2.80 per unit in the USA. This does not include the cost of confirmatory assays, discarded units, counselling donors or tracing recipients who may receive blood later found to be infected with HTLV I.

6) Cytomegalovirus: Latent cytomegalovirus is present in circulating WBC's of a substantial proportion of donors and infection is readily transmitted by blood transfusion. Serum cytomegaloviral antibody titres rise at least fourfold in about 30% of post-operative patients given a large number of transfusions during surgery. A few patients develop an infectious mononucleosis-like syndrome. Immuno-compromised patients may develop severe or even fatal post transfusion, cytomegalovirus septicaemia.

   The W.P.B.T.S. had one reported transfusion related cytomegalovirus infection in 1988.

7) Others, including parvovirus and Epstein Barr virus, which have been linked with the syndrome of Myalgic Encephalopathy (M.E.)

Other Transfusion Transmitted Diseases:

Malaria:
The Plasmodium parasites have been known to remain in the body for years after the initial attack. If a specific diagnosis was not made, the donor is potentially dangerous. The parasite may be absent initially in the peripheral blood but present in the bone marrow making detection of the potentially dangerous donor difficult. Plasmodium vivax does not survive longer than 96 hours in blood stored at 4°C. However, Plasmodium malariae and Plasmodium falciparum survive indefinitely under the usual conditions of blood storage. Platelet concentrates have also been implicated in malarial transmission.

In 1988 one case of transfusion related malaria was reported in the W.P.B.T.S.

Syphilis:
There is an extremely low incidence of transfusion-induced syphilis. This is due in part to the low incidence of syphilis amongst voluntary blood donors. Any donor giving a history of syphilis is rejected regardless of the outcome of a serological test for syphilis. Any serologically positive blood is also rejected. The problem lies in identifying the dangerous donor who has been exposed to syphilis but has not yet developed a chancre, secondary syphilitic lesions or a positive serologic reaction. However, treponema pallidum is killed when blood is stored at 4°C for 96 hours or when plasma is stored and frozen. This is thought to eliminate much of the danger from the use of serologically negative blood containing organisms.

Isolated transmission of other microorganisms are reported, brucellosis, trypanosomiasis, toxoplasmosis, visceral leukmaniasis, and Rocky Mountain Spotted Fever.

Graft-versus-Host Disease:
Graft versus host disease has been reported after blood tranfusions in children with various primary immunodeficiency states, after interuterine or exchange transfusions of neonates with haemolytic disease of the newborn and after transfusion of adult with myelosuppression and immunodeficiency secondary to chemotherapy for haematological malignancies. Irradiating stored blood with 1,500 to 3,000 rads before administration prevents graft-versus-host disease by inactivating lymphocytes without impairing the function of RBC's, granulocytes or platelets.

CONCLUSION

Blood and blood products are not safe from the risk of disease transmission and, as knowledge of the slow acting viruses such as HIV and HTLV I and II increases even more circumspection needs to be taken before they are transfused. The fact that the respondents assessed the risk of infection transmission incorrectly for: FFP 35%; Albumin 49%; Cryoprecipitate 53% and for FFP plus packed red blood cells 56% shows a serious flaw in the education of those South African anaesthetists surveyed.

Less than 50% of the respondents gave the correct responses to the risk of transmission of infection by blood. This shows a serious flaw in the anaesthetists' knowledge.

BLOOD KNOWLEDGE : IMMUNITY SUPPRESSION

Survey Question

Please answer the following questions **True** or **False** or **Don't know**:

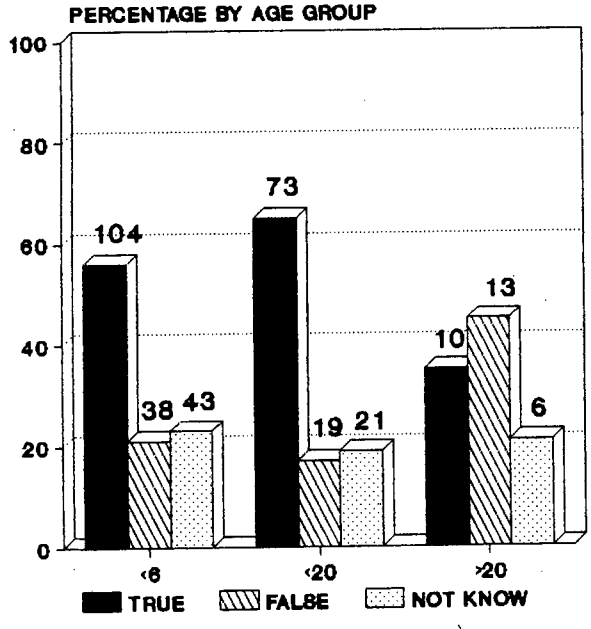
	True	False	Don't know
Blood transfusions worsen the prognosis in certain cancers being operated upon (Colon, Breast, Lung, Sarcomas)	☐	☐	☐

RESULTS

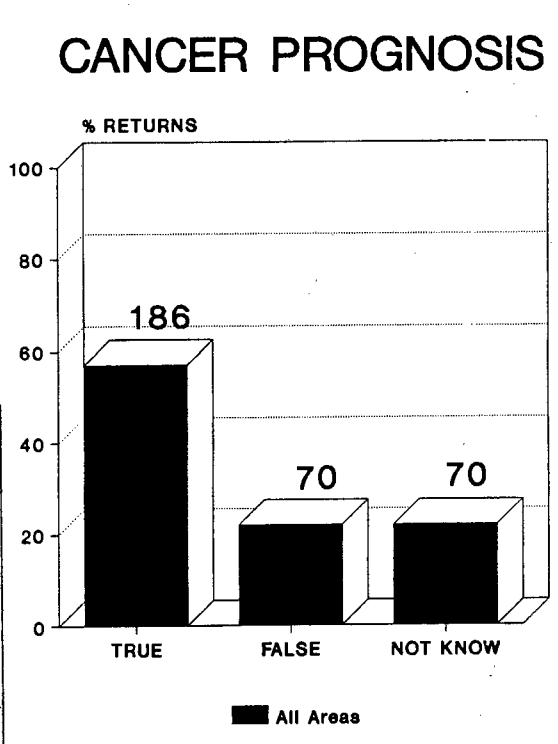
Cancer Prognosis

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	7	
True	75	49	28	53	1	4	18	72	14	52	7	64	21	75	18	78	186	57
False	39	26	12	23		1	1	5	8	30	3	27	5	18	1	4	70	22
Not know	39	26	13	25			6	24	5	19	1	9	2	7	4	17	70	22

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A	104	56	73	65	10	35
True	38	21	19	17	13	45
False	43	23	21	19	6	21
Not know						



Note that the anaethetist with the most experience (>20 years) percentage-wise appeared to have the poorest knowledge.



Note that 57% (186) of respondents replied that blood transfusion worsened the prognosis in certain cancers.

Survey Question

Please answer the following questions **True** or **False** or **Don't know**:

	True	False	Don't know
Blood transfusions improve long-term renal transplant survival rate	☐	☐	☐

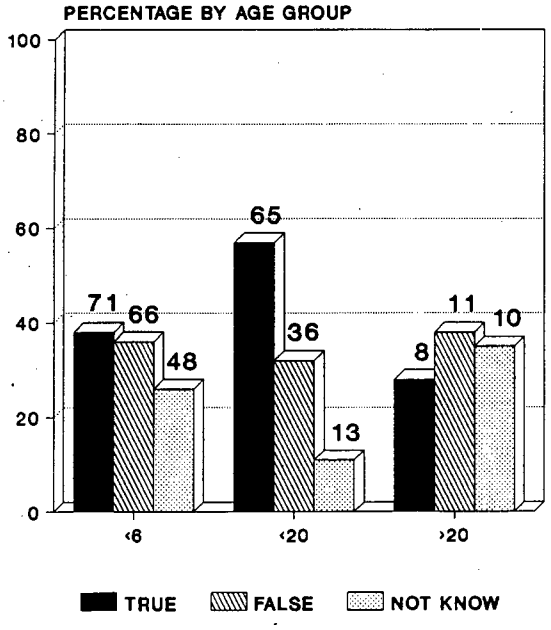
RESULTS

Renal Transplant Survival

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	5	
True	65	43	24	45	1	2	14	56	15	56	5	42	12	43	7	29	145	44
False	53	35	17	32		2	7	28	8	30	3	25	13	46	10	42	113	35
Not know	35	23	12	23		1	4	16	4	15	4	33	3	11	7	30	70	21

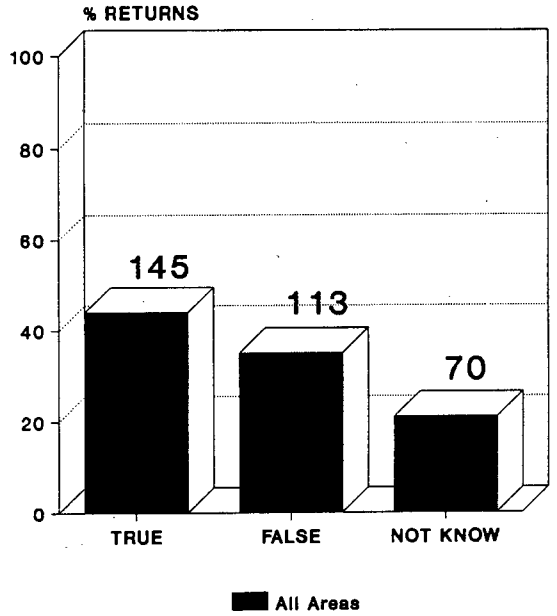
Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
True	71	88	65	57	8	28
False	66	36	36	32	11	38
Not know	48	26	13	11	10	35

RENAL SURVIVAL



Note that the most experienced anaesthetists (>20 years) proportionately had the poorest knowledge.

RENAL SURVIVAL



Note that 44% (145) respondents stated that long term renal transplantation improved with blood transfusion.

Survey Question

Please answer the following questions **True** or **False** or **Don't know**:

	True	False	Don't know
Blood transfusions increase the post-operative sepsis rate	☐	☐	☐

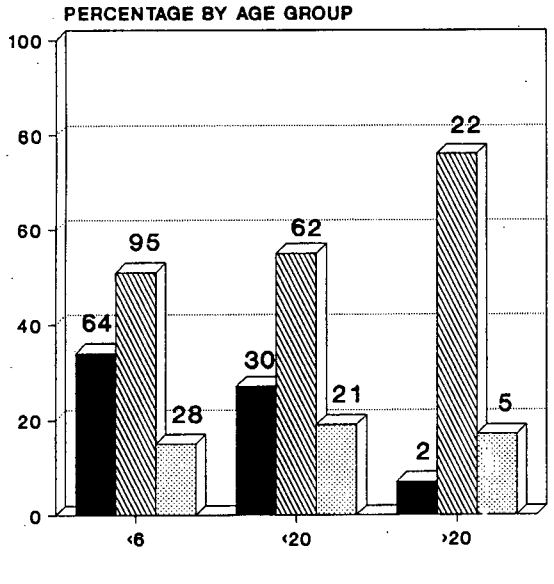
RESULTS

Sepsis

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																4		
True	40	36	14	26		2	10	42	7	26	6	46	9	32	8	33	96	29
False	85	55	30	57	1	1	11	46	17	63	7	54	17	61	11	46	180	55
Not know	29	19	9	17		2	3	13	3	11			2	7	5	21	53	16

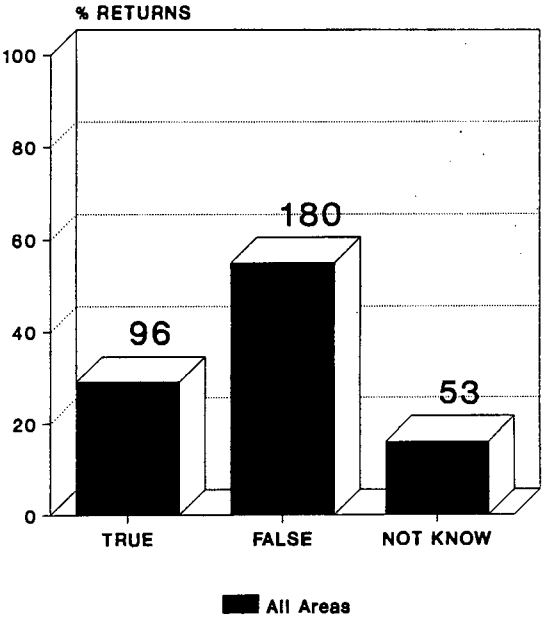
Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
True	64	34	30	27	2	7
False	95	51	62	55	22	76
Not know	28	15	21	19	5	17

SEPSIS



Note that the most experienced anaesthetists (>20 years) proportionately appeared to have the poorest knowledge.

SEPSIS



Note that 29% (96) replied that the sepsis rate was increased with blood transfusion.

DISCUSSION

Immunological Effects of Blood Transfusions

Repeated transfusion of blood or blood products lower both the helper/suppressor (T4/T8) lymphocyte ratio and Natural Killer activity, decreases circulating fibronectin and impairs macrophage function **(Woodruff & van Rood, 1983)**. These effects on the immune system have been postulated as having an effect on cancer patient survival, renal transplant survival and post-operative sepsis rate.

Effects of Blood Transfusion on cancer

Colorectal Cancer

Peri-operative blood transfusions have deliterious effects on the prognosis for a cure and the five year survival rate after surgical resection in patients with colorectal cancer (**Blumberg et al 1988, Foster et al 1985, Burrow 1982**). This finding, however, was not supported by **Cheslyn-Curtis et al (1990)** in a multicentre study on 961 patients with large bowel cancer. They could find no overall differences between the patients who had received blood and those who had not. In particular there was no survival disadvantage for those patients who had received peri-operative blood transfusion. However, the study did strongly indicate that heterologous blood given in peri-operative period changes the site of metastasis formation. Liver metastases developed more frequently in the patients who were not transfused. They strongly recommend that heterologous blood transfusion be avoided where possible by improved surgical techniques and autologous blood collection.

Lung Cancer

Blood transfusion has been found to be significantly associated with diminished survival in patients who had resections for Stage I and Stage 2 lung tumours (**Tartter et al 1984**). Survival rates at 5 years were 44% in those who had had no transfusions compared with 27% in those who had been transfused. There was no effect of transfusion found in patients who had had Stage 3 tumours resected. These authors retrospectively studied disease free survival rates in 165 patients with Stage I non-oat cell tumours. Those who had been transfused had a significantly worse disease free survival rate at 5 years when compared with those who had not been transfused. When those patients who had had extensive resections were eliminated the better survival rate for patients who had not been transfused was still evident but no longer statistically significant.

Breast Cancer

The one year disease free survival rate following mastectomy for Stage I, 2 and 3 tumours was 95% in those with no transfusions and 77% in those who had had blood transfusions (**Tartter 1985**).

Soft Tissue Sarcomas

The overall survival and disease free rate at 5 years was significantly lower in patients who had had amputation plus transfusion. The worsening of the prognosis was related to the number of units of blood received (**Rosenberg et al, 1985**).

Natural Killer cells play an important role in anti-tumour host defences particularly against circulating tumour cells. The number of circulating Natural Killer cells is reduced acutely post-operatively and this effect is increased if the patient received transfusions (**Lennard et al, 1985**). This combination of transfusion and operation induced depression of Natural Killer activity might enhance the survival of tumour microemboli released during operation. This could account for the poorer prognosis reported in patients who were transfused peri-operatively.

Effects on Renal Transplantation

Previous blood transfusions, if no cytotoxic antibodies against the donor are formed,appear to have a beneficial effect on the survival of kidney grafts (**Bucin et al, 1981**). Giving peri-operative transfusions to a patient who had not been previously transfused improved gross renal survival compared to patients who had never been transfused (**Williams et al, 1980**) but not with patients who had had pre-operative transfusions (**Corry et al, 1980**).

The precise mechanism of action remains obscure. The main theories are:

1. The selection theory. Broad spectrum antibodies occur in 30-50% of renal patients receiving blood in the pre-transplant period. This makes finding a suitable donor harder. However if an adequately HLA cross-matched donor is found, the results of the transplant is likely to be better because of the greater tissue compatability of donor to recipient.
2. T-cell blocking theory (**van Rood, 1983**). The effect of a blood transfusion has two stages. Initially antibodies are formed to Class I HLA antigens and cytotoxic lymphocyte activation is suppressed non-specifically. This is followed by the production of specific anti-idiotypic antibodies that prevent T-cell activation by Class I and 2 antigens present in donor blood. These antibodies may subsequently block host T-cell activation in response to the Class I antigens on the graft, thus decreasing the chance of transplant rejection.

Bacteria and Sepsis

Prospective studies have shown that patients having elective colorectal operations had significantly more infections if they received blood transfusions (**Tartter et al, 1986**).

It is suggested that prostaglandin E2 formed after blood transfusions during the phagocytosis of efete red blood cells inhibits the lymphocyte response through activation of T-suppressor lymphocytes (**Lenhard, 1985**). This together with the lowering of the circulating fibronectin may impair the host capacity for bacterial clearance (**Snyder et al, 1981**).

CONCLUSION

That blood transfusions temporarily decrease the body's immune responses appeared to be unkown to a significant number of the survey's respondents. Thus 71% did not know of the increase in sepsis, 56% did not know the improvement of renal transplant survival and 43% didn't know transfusion worsened the prognosis in certain cancers treated by surgery.

BLOOD COMPONENT KNOWLEDGE : THE COSTS

Survey Question

What is the cost to the hospital of the various blood components?

	Less than 50R	R50-75	R75-100	R100-300+	R300
Fresh Frozen Plasma	☐	☐	☐	☐	☐

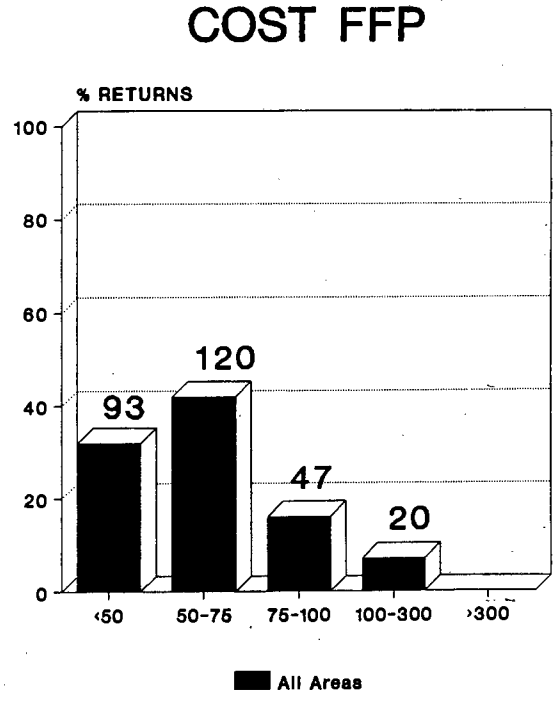
RESULTS

Cost FFP

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	45	
<50	34	24	8	20		1	14	70	11	44	4	36	13	62	8	36	93	32
50-75	68	47	15	38	1	3	4	20	11	44	5	46	6	29	7	32	120	42
75-100	27	19	12	30			1	5			2	18			5	23	47	16
100-300	12	8	1	3		1	1	5	2	8			2	10	1	5	20	7
>300	1	1															1	
Spoilt																	7	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
<50	59	35	29	32	5	23
50-75	71	41	38	41	9	41
75-100	23	13	20	22	4	18
100-300	17	10	3	3		
>300			1	1		
Spoilt						

Note that 42% (120) of respondents replied that FFP cost between 50 and 75 Rand. The actual cost varied between R58 for the SABTS and R69 for the WPBTS.



Survey Question

What is the cost to the hospital of the various blood components?

	Less than 50R	R50-75	R75-100	R100-300	R300+
Dried Plasma	☐	☐	☐	☐	☐

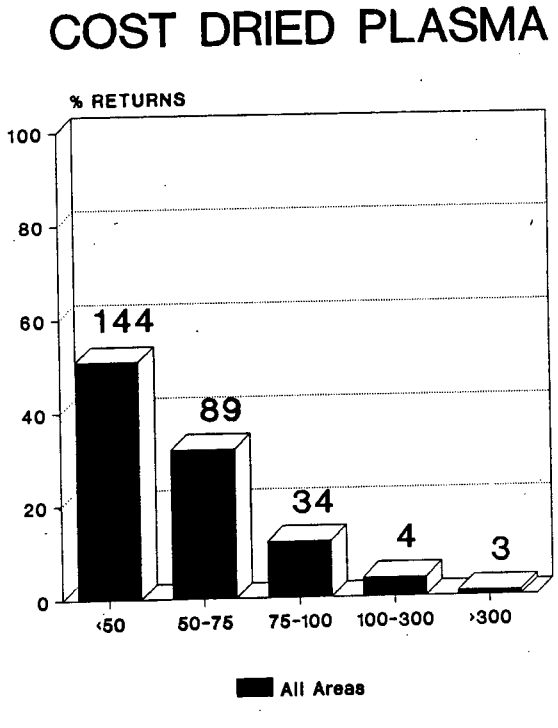
RESULTS

Cost Dried Plasma

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	53	
<50	65	47	11	28		1	18	90	14	56	7	70	16	76	12	57	144	51
50-75	44	32	17	43	1	4	1	5	9	36	2	20	4	19	7	33	89	32
75-100	19	14	9	23			1	5	2	8	1	10	1	5	1	5	34	12
100-300	3	2													1	5	4	4
>300	3	2															3	1
Spoilt																	6	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
<50	90	53	44	49	11	50
50-75	46	27	37	41	6	27
75-100	26	15	5	6	3	14
100-300	3	2	1	1		
>300	1	1	2	2		
Spoilt						

Note that 12% (34) of respondents stated that dried plasma cost between 75 and 100 Rand. The actual cost ranged from R70 (SABTS) to R85 (NBTS).



Survey Question

What is the cost to the hospital of the various blood components?

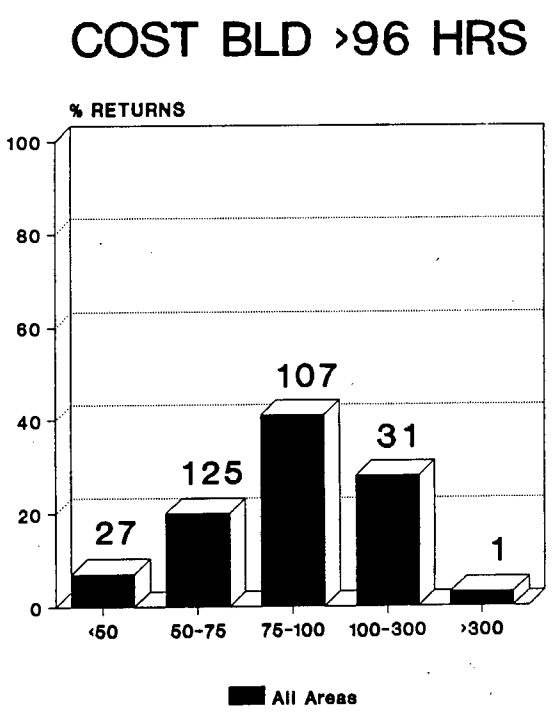
	Less than 50R	R50-75	R75-100	R100-300	R300+
Whole Blood (>96 hours)	☐	☐	☐	☐	☐

RESULTS

Cost Whole Blood >96 hrs

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	37	
<50	5	3	1	2			3	14	8	32	2	20	5	23	3	13	27	9
50-75	52	36	11	26	1	2	15	71	13	52	4	40	11	50	16	70	125	42
75-100	64	44	21	49		3	3	14	4	16	2	20	6	27	4	17	107	36
100-300	23	16	7	16							1	10					31	10
>300											1	10					1	1
Spoilt																	1	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
<50	19	11	7	7	2	8
50-75	73	42	41	42	11	46
75-100	62	35	36	37	9	38
100-300	19	11	12	12		
>300						
Spoilt						



Note that 36% (107) of respondents stated blood cost between 75 and 100 Rand and 42% (125) between 50 and 75 Rand. The actual cost of blood >96 hours old ranged from R58 (SABTS) to R90-R500 (NBTS).

Survey Question

What is the cost to the hospital of the various blood components?

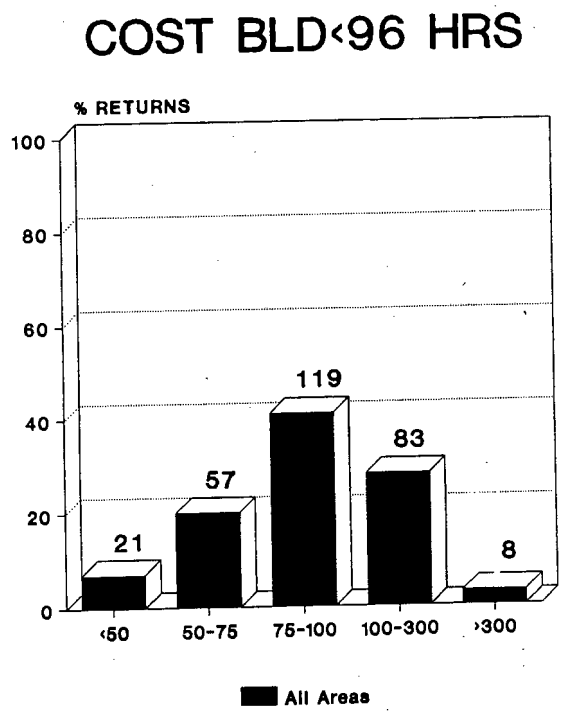
	Less than 50R	R50-75	R75-100	R100-300	R300+
Whole Blood (<96 hours)	☐	☐	☐	☐	☐

RESULTS

Cost Whole Blood <96 hrs

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	42	
<50	3	2				1	5	26	5	20	2	20	2	9	3	14	21	7
50-75	16	11	3	7		1	9	47	9	36	3	30	9	39	7	33	57	20
75-100	65	45	18	42	1	1	5	26	9	36	1	10	10	44	9	43	119	41
100-300	55	38	17	40		2			2	8	3	30	2	9	2	10	83	28
>300	5	3	2	5							1	10					8	3
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
<50	11	6	7	7	4	17
50-75	37	21	13	14	7	30
75-100	72	41	41	44	6	25
100-300	47	27	30	32	5	21
>300	6	3	2	2		
Spoilt						



Note that 41% (119) of respondents replied that the cost of fresh blood was 75-100 Rand. The actual cost was R78 (SABTS); R105 (NBTS) and R109-50 (WPBTS).

Survey Question

What is the cost to the hospital of the various blood components?

	Less than 50R	R50-75	R75-100	R100-300	R300+
Cross-match cancelled	☐	☐	☐	☐	☐

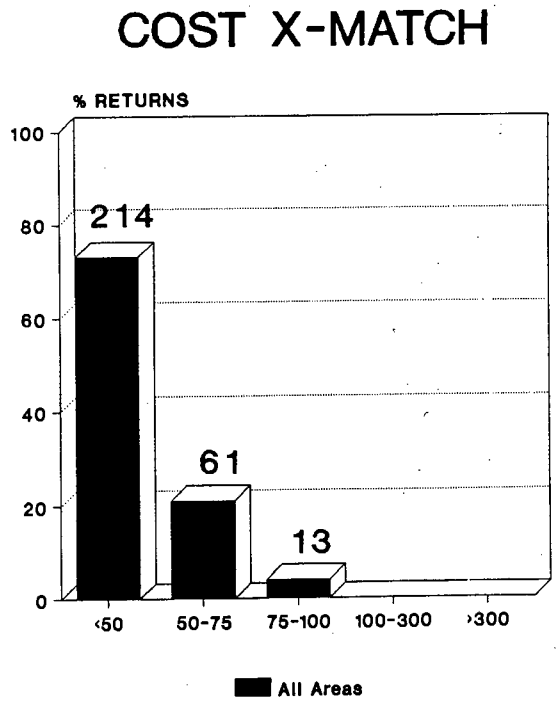
RESULTS

Cost Cross Match Cancelled

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																		38
<50	105	72	30	70	1	4	60	76	17	68	5	50	19	86	17	77	214	73
50-75	28	19	11	26		1	4	19	7	28	4	40	3	14	3	14	61	21
75-100	9	6	1	2			1	5							2	9	13	4
100-300	1								1								2	
>300											1	10					1	
Spoilt																	1	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
<50	130	74	67	69	19	79
50-75	34	19	24	25	2	8
75-100	7	4	5	5	1	4
100-300	2	1				
>300	1					
Spoilt						

Note that 73% (214) of respondents replied that the cost of a cross-match was less than 50 Rand. The actual cost ranged from R32 (SABTS) to R57 (NBTS).



Survey Question

What is the cost to the hospital of the various blood components?

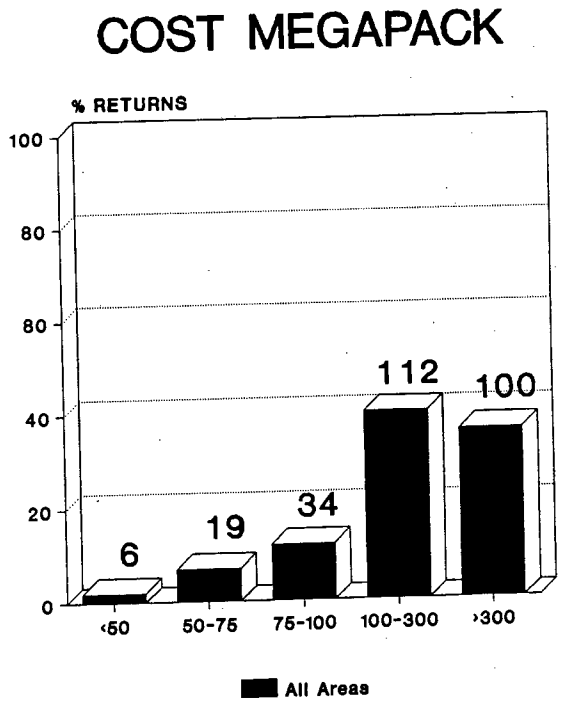
	Less than 50R	R50-75	R75-100	R100-300	R300+
Megapack platelets	☐	☐	☐	☐	☐

RESULTS

Cost Megapack Platelets

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	56	
<50							3	18	1	4			1	6	1	5	6	2
50-75	2	1	2	5	1		3	18	8	32			1	6	2	9	19	7
75-100	7	5	5	13		2	5	30	5	20	3	30	2	13	5	23	34	12
100-300	57	40	21	53		1	4	24	10	40	3	30	7	44	9	41	112	40
>300	74	52	9	23		2	2	12	1	4	3	30	4	25	5	23	100	36
Spoilt																	6	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
<50	4	2	2	2		
50-75	10	6	7	8	2	10
75-100	25	15	6	7	3	15
100-300	72	43	34	38	7	35
>300	54	32	40	45	5	25
Spoilt						



Note that only 36% (100) of respondents replied that a Megapack of platelets cost more than R300. Taking a megapack as six random units the actual cost ranged from R312 (SABTS) to R353 (NBTS) - By comparison a Megapack from a single donor costs R511 (WPBTS).

DISCUSSION

All South African blood banks publish lists of the cost of their products which are sent to all the hospitals they service (Table 4:1) (personal communication Dr. P. Cochlan, Medical Director, W.P.B.T.S.). Thus each Department should have the latest costings readily available. As blood and blood components are often used in the peri-operative period when anaesthetists are an important part of the Health-Care Team the costs should be known to him or her.

TABLE 4 : 1

1989 COSTS (IN RANDS)

	WPBTS	BBTS	EPBTS	NBTS	SABTS
Fresh Frozen Plasma	69	77.80	70.00	65.00	58.00
Dried Plasma	67	81.90	92.00	85.00	70.00
Whole Blood >96 hrs	87.50	81.90	92.00	90.50	58.00
Whole Blood <96 hrs	109.50	106.50	114.00	105.00	78.00
Cross Match cancelled	52.00	57.35	46.00	57.00	32.00
Random Platelets 1 unit	66.00	73.70	65.00	70.50	52.00
Megapack Platelets (single donor)	511.00	573.00	450.00		
Total Blood Products Sold 1988) (± numbers)	287,000	50,000	45,000	160,000	405,000

WPBTS = Western Province Blood Transfusion Service
BBTS = Border Blood Transfusion Service
EPBTS = Eastern Province Blood Transfusion Service
NBTS = Natal Blood Transfusion Service
SABTS = South African Blood Transfusion Service

Note that the percentage of correct answers by area, tended to be poor especially in those areas which charged the most.

CONCLUSION

The fact that the majority of respondents tended to underestimate the cost of blood products must be another factor in the upward spiral of health care costs. This ignorance may also discourage the use of safer and cheaper alternatives such as the synthetic colloids (approximately one quarter the price) where a colloid substitute is required. Knowledge of the costs of blood and blood components should be included in the Anaesthetic Department's teaching curriculum.

CHAPTER FIVE

BLOOD TRANSFUSION ADJUVANTS

* Intra-operative Blood Scavenging

* Micro Aggregate Blood Filter Usage

AUTOLOGOUS TRANSFUSION : SCAVENGING

Survey Question

Do you use autologous blood scavenging replacement techniques?

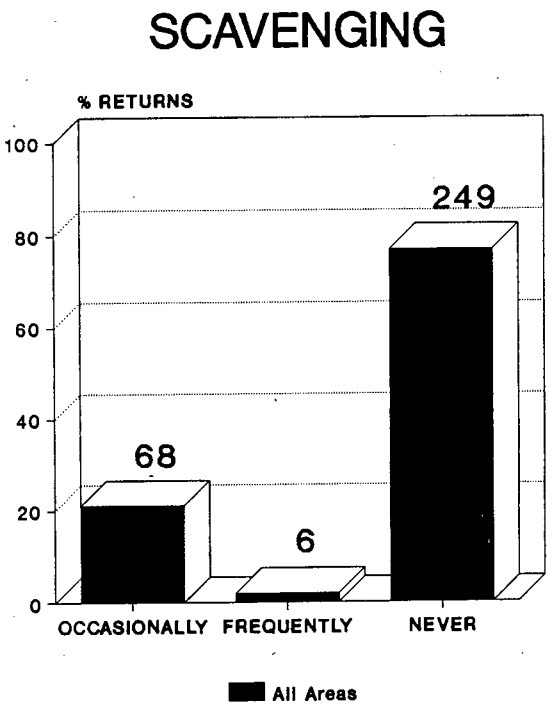
Occasionally ☐ Frequently ☐ Never ☐

RESULTS

Scavenging

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
Occas.	52		4			1	7		2		1				1		68	21
Freq.	2								2				2				6	2
Never	96		48		1	4	18		22		12		25		23		249	77
N/A																	8	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
Occas.	37	20	27	24	3	11
Freq.	2	1	3	3	1	4
Never	144	78	83	74	23	85
N/A						



Note that 77% (249) of respondents never use blood scavenging techniques intra-operatively.

DISCUSSION

SCAVENGING TECHNIQUES

Blundell in 1818 was the first to report on autotransfusion salvage experiments and postulate as to its uses in shocked states, particularly post partum haemorrhage. In three of these experiments blood was allowed to flow from an artery to a cup and was directly returned into the vein, using "great caution in removing all air". Using this method he reported "twelve pints of blood were passed through the syringe without serious inconvenience, although the loss of one-half a pint of blood would have destroyed a dog of the same size". He also concluded from his experiments that blood from one animal species could not be transfused with impunity into another species. **Duncan** in **1886** described the first successful use of scavenging blood, "in all about three ounces", in a surgical amputation performed in 1885.

The advantages for intraoperative salvage and transfusion have been described as:
- Provides immediately available blood
- Requires minimal initial investment of time and money
- Obviates cross-matching
- Reduces the chances of errors
- Assures immunological compatibility
- Reduces blood bank workload
- Conserves blood resources
- Is suitable for elective or emergency surgery
- Is acceptable by some Jehovah's Witnesses
- Does not transmit hepatitis or other infectious diseases into a new host
- May preserve essential opsonins
- Relative safety with fewer haemolytic, febrile or allergic reactions
- Autotransfused blood is already warm
- Hyperkalaemia, hypocalcaemia and acidosis is avoided.

Equipment:
The properties of the ideal transfusion device should be:
- Rapid assembly
- Low cost
- Ease of operation
- Inline filtration system
- Minimised air/blood interface
- Simplified anticoagulation
- Safety from air embolism and coagulopathy.

The commonest type at present in South Africa appears to be the Sorenson Autotransfusion System. This autotransfusion system uses a special suction tip that mixes aspirated blood with citrate-phosphate-dextrose (CPD) anticoagulant in a minimum ratio of 7:1. All components are disposable, except the receptal cannister and the regulator which controls the pressure from the vacuum source. The collection bag has a 1,900ml capacity and a 170-μ screen filter. When full, the bag is disconnected from the suction and the rigid cannister and a new bag is inserted. A standard blood administration set is inserted into the filled collection bag and the bag is inverted for conventional transfusion. A pressure cuff, although somewhat awkward, may be used to accelerate the infusion rate. The risk of air embolism is minimal as the system transfuses blood either by gravity or pressure cuff and not by pressure transfusion through the system (contrast the Bentley Autotransfusion System ATS-100 now off the market).

Other types include:
Haemonetics Cell Saver 1. This utilises wall suction and consists of four components: (1) The heart of the system is a continuous-flow, disposable washing bowl which is driven by a compact, simple, centrifuge. The bowl may be used to process multiple units for a transfusion in an individual patient. The blood processing unit includes prepackaged "Y" tubings which are programmed to cycle the blood. (2) The aspirating device is a special tubing connected to a plastic suction tip which allows mixture of heparin solution. (3) The reservoir may be either a standard cardiotomy reservoir or a Haemonetics autotransfusion reservoir with a 3L capacity. The Haemonetics reservoir consists of a reusable vacuum shell and a disposable set-up. When washing is completed, red cells are pumped into a transfer pack for transfusion to the patient. The Cell Saver I requires a trained operator to be present at all times.

Haemonetics Cell Saver III. This system automatically washes and concentrates red blood cells with one-button operation and is programmable. It has a digital readout for wash volumes selected, pump speed, volume processed and volume returned. It uses the same disposable software as the Cell Saver I. The Haemonetics Cell Saver III requires minimal operator attention and comparatively less operator training.

PROBLEMS OF SCAVENGING

Potential Adverse effects of scavenging and retransfusion include:

1. Haemolysis:

This may result from vacuum-induced trauma, contact of blood with air and tissues, the kinking of roller pumps, foaming in tubing and reservoirs, and turbulent blood flows (**Fleming & Garcia, 1980**).

Free haemoglobin levels in salvaged blood have been reported as high as 1,600mg/dl (normal, less than 20mg/dl [**Brener et al, 1973**]). Studies by **de Jong et al (1980)** demonstrated that perfusion with cardiotomy suction produces six times more haemolysis than perfusion without suction. These investigators concluded that suction introduces a definite adverse effect during extracorporeal circulation. A general observation made during the early years of clinical cardiopulmonary bypass was that a large volume return from the cardiotomy suction correlated with increased abnormalities in coagulation. On the other hand, a very large return, sufficient to maintain continuous blood flow in the suction tube, appeared to cause less damage than when frequent breaks occurred in the blood column. This suggested that damage occurred at the blood-air interface.

2. Red Cell Survival:

Mati et al (1973) studied the survival of autotransfused red cells by radioactive chromium techniques. They reported on five patients with ruptured ectopic pregnancies who had salvaged peritoneal blood labelled and autotransfused, the percentage of red blood cells surviving on day 5 was significantly less than that for labelled and autotransfused venous blood in control patients. By extrapolation, the half-life of peritoneal red blood cells was approximately eight days, whereas the half-life of venous red blood cells was approximately 60 days. The peritoneal blood obtained for these studies was less than six hours old.

3. Coagulation Disorders:

Duncan and associates suggested caution in using autotransfusions, inasmuch as three of eight deaths were thought to be related to the use of the autotransfusion unit. All the patients had abnormal coagulation studies prior to death. The patients reported by **Duncan** had 7,000-12,000ml of homologous blood transfused. It has been demonstrated in baboons that DIC can largely be prevented by washing the autologous blood using a continuous flow centrifuge to remove thromboplastic substances and prevent activation of the coagulation mechanism (**Kingsley et al, 1978**). Washing devices function by repeatedly suspending the collected material in saline and centrifuging away the supernant, leaving a washed red cell product.

4. DPG:

Orr (1978) demonstrated that levels of 2,3 DPG were significantly greater in autologous red blood cells when compared with stored homologous cells averaging 4.2 days old. Higher levels of 2,3 DPG were also found in autologous blood collected by the Sorenson System (**Noon, 1978**).

5. Microemboli:

The significance of microembolization reported after intraoperative salvage and autologous transfusion is not clear. **Dowling (1973)** reported three patients with pulmonary insufficiency after autonomous transfusion; however, two of these patients had large volumes of homologous blood transfused in addition to autologous transfusions. The third patient had a flail chest and pulmonary contusion. Post-traumatic pulmonary insufficiency did not occur in patients who were autotransfused only (i.e. received no homologous whole blood).

6. Air Embolism:

Several cases of fatal air embolism have been reported in association with use of the Bentley system. These problems were usually related to operator error or to failure of the alarm to function or to clots obscuring the photoelectric cell (**Thurer & Hauer, 1982**). Other autologous transfusion systems do not appear to have a risk of air embolism in excess of that of routine transfusion.

7. Sepsis & Malignancy:

Several studies support the feasibility of autotransfusing contaminated blood. **Klebanoff et al, 1970** prepared a test mixture consisting of approximately 10ml or solid fecal material, approximately 30g of splenic tissue, 30g of liver, 10-15ml of bile and 10g of body fat suspended in whole blood to a volume of 100-150ml. After wounds were contaminated with this mixture, blood cultures of 10 dogs yielded positive results during the immediate post-transfusion period, but were negative at the end of 24 hours. There were no sequelae. However, it is recommended that gastrointestinal tract disruption is an absolute contraindication to scavenging (**Morris, 1985**). Other relative contraindications include evidence of injury to the liver, pancreas and urinary tract. Patients with malignancies are not candidates for intraoperative salvage and autologous transfusion. **Yaw et al, 1971** demonstrated malignant cells in blood salvaged with the Bentley system. These malignant cells were readily identified in centrifuged blood removed from the pleural cavity after the sample had passed through the filter device.

Morris (1985) recommended that certain precautions should be taken during autotransfusion practices. To reduce septic complications, autotransfusion blood should be reinfused within 4 hours and use inline microemboli filters should be used to trap gross contaminants. The use of systemic broad spectrum antibiotics in cases of suspected contamination is mandatory. To reduce the amount of haemolysis, it is advocated that one minimises suction pressure to 15-30 centimeters of water for closed thoracotomy chest tube drainage and 40-60 centimetres of water for open field aspiration. Aspiration of the autotransfusion from the bottom of the blood pool decreases the air fluid interface. To minimise the possibility of subsequent coagulapathies, it is advisable to limit autotransfusion to less than 4 litres of blood.

CONCLUSION

There appears to be well documented advantages for the patient in receiving his own scavenged blood. Yet only 23% of South African anaesthetists surveyed use scavenging techniques at all, only 2% using them frequently. The reasons may include complicated or lack of equipment, lack of training in the technique, the cost of the disposables involved may not make it cost effective, or there may be too few suitable patients seen. These questions should be addressed by each Anaesthetic Department and scavenging techniques should be encouraged where possible.

MICRO FILTERS : USAGE

Survey Question

When would you use micro-aggregate (effectively removing particles in the 10-30 micron range) blood filters?

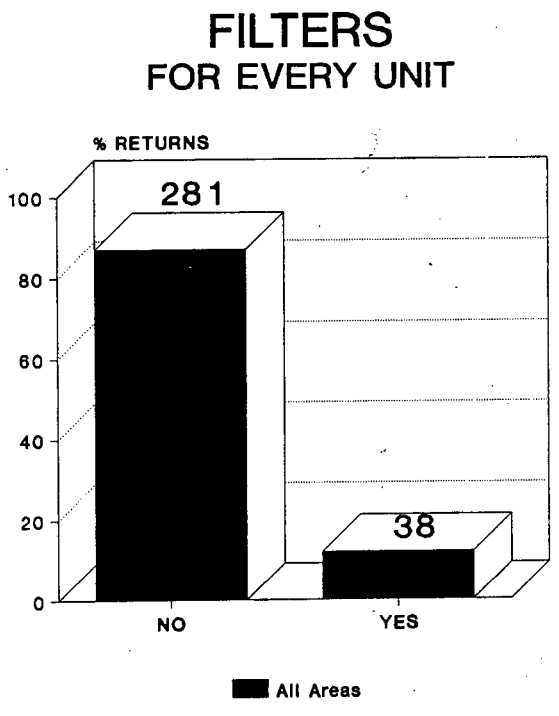
With every unit blood transfused — Yes

RESULTS

Filters every unit

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	9	
No	143	94	41	79	1	5	21	84	24	92	9	82	16	60	21	88	281	87
Yes	8	5	9	17			3	12	2	8	2	18	11	40	3	13	38	12
Spoilt																	3	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	148	81	107	95	26	93
Yes	30	16	6	5	2	7
Spoilt						



Note that 87% (281) respondents would not use a microfilter for every unit transfused.

Survey Question

When would you use micro-aggregate (effectively removing particles in the 10-30 micron range) blood filters?

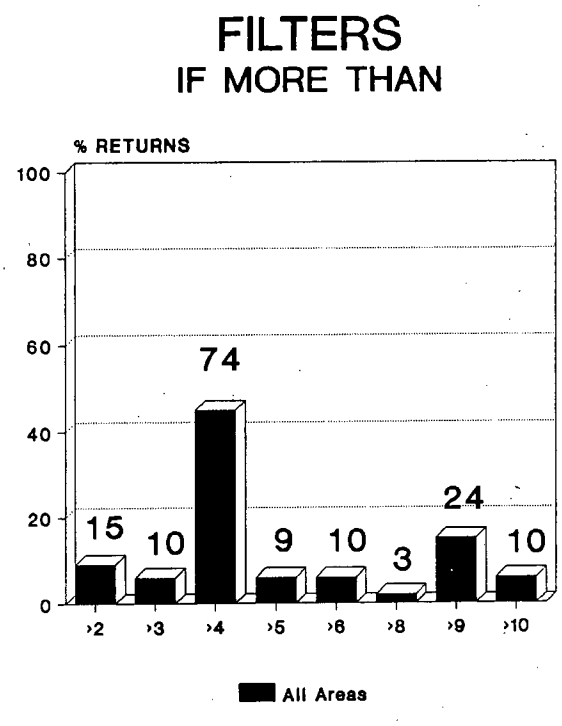
If transfusing more than ..... units

RESULTS

Filters if more than

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	180	
2	10	11					1	14	1	9	1	14	1	17	1	8	15	9
3	5	6	1	3					1	9	2	29			1	8	10	6
4	50	56	2	7	1		4	57	2	18	3	43	3	50	9	75	74	45
5	5	6					1	14	3	27							9	6
6	7	8									1	14	2	33			10	6
8	3	3															3	2
9	4	5	19	61			1	14									24	15
10	4	5	1	3					4	36					1	8	10	6

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
2	5	6	9	16	1	7
3	5	6	4	7		
4	41	45	24	42	9	60
5	7	8	2	4		
6	7	8	3	5		
8	1	1	2	4		
9	12	13	10	18	2	13
10	6	7	1	2	3	20



Note that 60% (99) of respondents would use microaggregate filters when transfusing four or fewer units of blood.

Survey Question

When would you use micro-aggregate (effectively removing particles in the 10-30 micron range) blood filters?

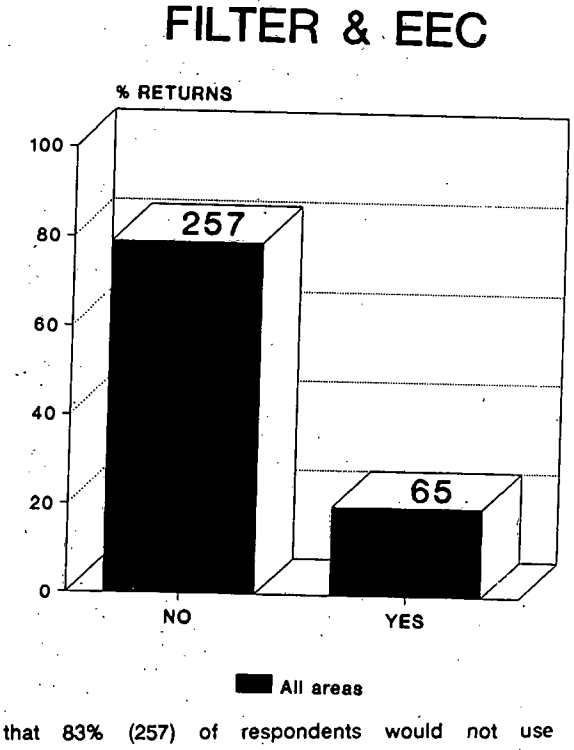
Only with extra-corporeal circulation Yes

RESULTS

Filters only with ECC

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	9	
No	124	81	39	75	1	5	16	64	19	73	11	100	22	82	20	83	257	79
Yes	28	18	12	23			9	36	7	27			5	18	4	17	65	20
Spoilt																	2	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	151	83	84	74	23	82
Yes	30	16	29	26	5	18
Spoilt						



Note that 83% (257) of respondents would not use microaggregate filters with extra corporeal circulation.

DISCUSSION

Early blood bankers were aware that large blood clots formed during storage and filters were needed to remove this, potentially harmful, debris (**Fantus 1938**). Later, microaggregates (MA) composed of platelets, non-viable granulocytes and fibrin strands ranging in size from 20-200 microns were recognised. As MAs were thought to be clinically unimportant, early blood filters were designed with pore sizes between 140 and 300 microns, primarily to allow maximum flow rates whilst removing the larger debris (**Walter & Batton 1966, Cooksey 1940**). In 1961 **Swank** reported that MAs may have caused adverse effects following transfusion during bypass surgery. This was followed by **Mosley & Doty (1970)** reporting on deaths due to pulmonary emboli possibly caused by MAs. Since that time there has been much controversy as to the specific role of microaggregates and microaggregate blood filters (MABFs).

Debris from transfused blood is removed primarily by the pulmonary capillary bed. Early MAs are composed mainly of degenerating platelets, whilst older MAs contain granulocyte and fibrin strands (**Mosley & Doty 1970, Marshall et al 1976**). The number of aggregates increases with the length of time the blood is stored. Their size varying from <7 micron in diameter whilst their numbers may be in the order of 140 000 per ml (**Ashmore et al 1972**). However, even in the absence of transfusions the number of microaggregates normally increases after trauma, possibly due in part to release of serotonin and ADP from platelets at the site of injury (**Swank et al 1963**). Thus the clinical role played by exogenous microaggregates in transfused blood is not clear in trauma situations.

MABFs in common use are classified as either screen or depth filters. Screen filters are made of woven polyester with a pore size of 40 microns and depth filters are composed of a variety of substances including dacron, wool, polyester wool or polyurethane in foam and effectively remove particles from 10-30 micron size (**Snyder & Bookbinder 1983**). The capacity of most filters is between 3 and 6 units with older blood occluding the filter sooner. The flow rates can be of the same order as the standard large pore filters because of their large surface areas. However the use of bulky filters may cause blood flow to channel so negating their effectiveness.

The results of animal experiments and MABFs are confusing. **Snyder & Bookbinder (1983)** in their review suggest that animal experiments are, for a variety of reasons, not readily applicable to humans. Logically it would appear that blood should be filtered down to 40 microns as the average diameter of the pulmonary arteriole in adults is slightly greater than 40 microns. Each arteriole services approximately a dozen capillaries, and therefore, the same number of alveolae. Whilst the loss of individual pulmonary capillaries is of no significance, the loss of a number of pulmonary arterioles could be of major significance. However clinical data has failed to show that microemboli exclude pulmonaryarterioles in man.

Cardiopulmonary Bypass

In the early years of cardiopulmonary bypass,complications such as visual disturbances, renal dysfunction, amnesia, psychosis and delirium were attributed, in part, to MAs infused into the systemic arterial system (**Swank & Porter 1963, Hill et al 1969**). **Osborn et al (1970)** using an in-line MABF reported a decrease in the incidence of post-operative problems. **Hill et al (1970)** and others (**Skagseth 1974**) reported a marked reduction in mortality and evidence of non-fat emboli when MABFs were used in the extra-corporeal circuit. Although some microembolic complications cannot be prevented by the use of MABFs (**Slogoff et al 1982**) it is recommended that the use of MABFs with cardiopulmonary bypass is both medically prudent and cost effective (**Snyder & Bookbinder 1983**).

Sub-massive transfusion

Virglio et al (1977) studied 40 patients undergoing elective aneurysmectomy, being given between 6 and 7 units of blood. Post-operatively there were no differences in pulmonary function between the MABF group (40 microns Pall screen filter) and a control group (170 micron filter). Other studies using 3 units of blood in abdominal surgery (**Takaori et al, 1977**), 4-5 units in hip surgery (**Snyder et al, 1979**), 5 units blood in aortic aneurysmectomy (**Grindlinger et al, 1980**), 1 unit blood (**Browning et al, 1980**), all found either no, or only minor changes in sensitive pulmonary function tests while comparing control to MABF groups. These changes in the pulmonary function tests were not clinically significant (PaO_2, $PaCO_2$, morbidity, mortality or post-operative respiratory distress). Thus, in terms of patients' survival and morbidity there is little data to suggest the routine use of MABFs is justified in sub-massive transfusions.

Massive transfusion (more than 10-12 units within 24 hours)

Collins et al (1978) reviewed the data on the relationship between the infusion of MA debris using standard 170 micron filters and the development of pulmonary dysfunction in wounded soldiers. They showed that, despite the infusion of over two blood volumes to some casualties, no detectable decrease in PaO_2 was found up to three days post-transfusion.

Rosario et al (1978) reviewed autopsy slides of patients dying shortly after massive transfusion. Readily detectable microemboli were only seen after infusions of over 10 units of blood given through the standard screen filters and the degree of microembolisation was proportional to the units of blood transfused. However, they found no correlation between the number of units received and the frequency of respiratory insufficiency and they felt that sepsis and shock were more important than transfused MA debris in the etiology of post-traumatic pulmonary insufficiency.

Pepe et al (1982) in a study of patients with adult respiratory distress syndrome showed that, when multiple transfusions were the sole risk factor, the clinical syndrome only occurred in patients receiving more than 22 units of blood within 12 hours. Patients with sepsis, however, were at high risk of acute adult respiratory distress syndrome.

It must be remembered that shock, soft tissue injury, and sepsis may all, on their own, cause a significant amount of endogenous MAs (**Carrico, 1979**) which MABFs will be unable to prevent. In fact MABFs may play an adverse role if transfusion of blood through the filters delays the speed of resuscitation and hypovolaemic correction (**Collins, 1974**).

MABF's and Thrombocytopaenia:

Lim et al (1989) reported that in patients with initial low platelet counts due to leukaemia or myelodysplasia the use of 40μm MABF's significantly reduced the fall in platelet count. This was in contrast to the use of 170μm filters in the same patients when ± 20 day old blood was transfused and a clinically significant fall in platelets occurred. **Bareford et al (1987)** suggest the major cause for the platelet fall is the infusion of microaggregate debris which cause splenic sequestration of the patient's circulating platelets. The fall in platelet count on transfusion of blood via 170μm filters (average 15×10^9 platelets) would probably not be clinically significant in patients with a normal platelet count. In thrombocytopaenic patients, however, the drop could precipitate haemorrhagic complications.

CONCLUSION

Snyder and Bookbinder (1983) conclude their review into MABFs by stating their routine use, even for massive transfusion, cannot be justified by present data. MABFs have only been shown to be useful for transfusion during cardiopulmonary bypass surgery to prevent arterial emboli. There may, however, be a role for MABFs in the prevention of febrile transfusion reactions, in the patients with pre-existing pulmonary disease where the normal filtration and degredation mechanisms are compromised, or in patients with pre-existing low platelet counts.

The present survey shows that most S.A. anaesthetists who responded to the question do not use microfilters under most circumstances. However 60% (99) stated they would use MABF's when transfusing four or fewer units of blood which is a gross overusage of expensive disposables. This question however was not answered by 180 respondents.

83% (257) of the respondents also replied they wouldn't use microfilters for their main indicated function, that of extra corporeal circulation. This agreed with the question where 79% (229) of respondents stated they never used microfilters. This may be due to inexperience with cardiopulmonary bypass although all teaching hospitals visited performed operations requiring bypass and proportionally those who stated they wouldn't use MABF's present in equal numbers were in all three age experience groups.

Thus the survey appears to indicate the correct non-use of microfilters may be based as much on ignorance as definitive knowledge.

CHAPTER SIX

PLATELET USAGE

* Platelet Elevation by Transfusion

* Pre-operative Acceptable Levels

* Platelet Inhibiting Drugs

* Platelet Replacement during Operation

PLATELET KNOWLEDGE

Survey Question

On average in patients with thrombocytopoenia how much would you expect six units of random collected platelets to raise the platelet count by?

a) 24,000 ☐

b) 60,000 ☐

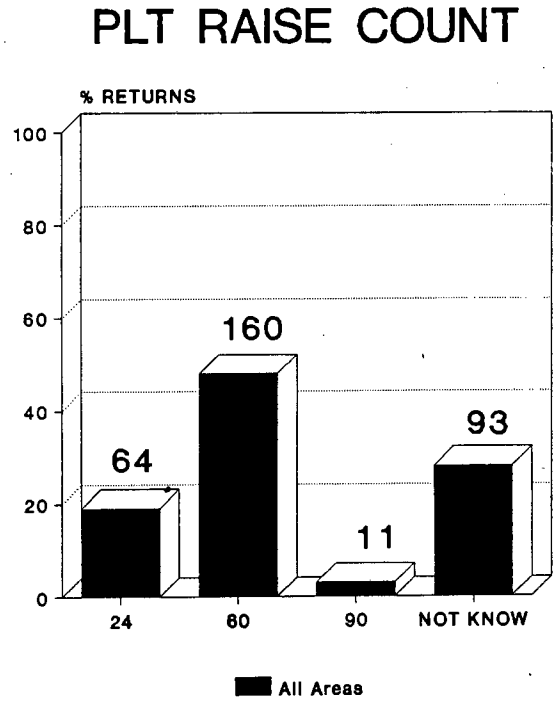
c) 90,000 ☐

d) Don't know ☐

Platelet Raise Count

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
24	28		11			1	10		6		2		4		2		64	19
60	78		22		1	3	11		11		6		15		13		160	48
90	4		4				1		1						1		11	3
Not know	42	28	17	32		1	4	15	8	30	5	39	8	29	8	33	93	28
Spoilt																	3	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
24	34	18	29	26	2	7
60	91	48	58	51	11	38
90	6	3	3	3	2	7
Not know	55	29	23	20	14	48
Spoilt						



Note that 48% (160) of respondents answered that the platelet count would be raised 60,000. 28% (93) of respondents did not know the answer.

DISCUSSION - PLATELET KNOWLEDGE

Platelet Donation

Platelets rapidly lose their viability in stored blood. **Baldini et al (1960)** estimated the platelet viability index to be 60% of normal after 3 hours of storage. After 24 and 48 hours the indices were only 12% and 2% of normal respectively.

Platelets may be harvested from a single donor by plateletpharesis either at random or selected on a HLA compatibility basis. They may also be separated from whole blood with pooling of cells from multiple donors to achieve a therapeutic dose (random single units).

The number of platelets from a single donor plateletpharesis is equal to 5 or 8 random single donations. It has potential advantages for the recipient over the multiple donor product because of less exposure to infectious agents and a decreased likelihood of allo-immunisation. It is, however, more expensive (Western Province Blood Transfusion Service charges 1989, R511 for single donor compared with R396 for 6 random units). Plateletpharesis also requires highly trained personnel, sophisticated equipment, and a greater donor commitment. The storage time for single donor platelets depends on the methods used for harvesting but, in some cases, the product must be used within 24 hours. HLA matched single donor products are the most effective therapy for patients who have become refractory to unselected single donor or multiple donor platelets. An HLA matched sibling should not be used as a donor if that sibling may later serve as a donor for some marrow transplantation. Multiple donor concentrates have the advantages of being cheaper, more readily available as they are derived from conventional whole blood donations and they can be stored for up to 5 days at 20-24°C.

Platelet Transfusions:
It is difficult to predict the ability of a platelet transfusion to increase the patient's platelet count because of many variables. Given the ideal situation of a healthy, unmedicated donor and recipient who has not received previous platelet transfusions, an increase of 5 000 to 10 000 platelets per mm^3 for each unit of platelet concentrate infusion is to be expected (**Barrer & Ellison 1977**). The common practice is to transfuse one unit per 10kg body weight of multiple donor platelets or the concentrate from one platelet-pharesis donor. Where platelets are transfused for a bleeding episode, larger doses are recommended (**Tomasulo, 1981**). **Coté et al (1985)** suggest that 0,3 units of platelets per Kg in paediatrics should be the initial dosage.

The donor platelets will circulate for ± 8 days in contrast to a normal platelet lifespan of 9 to 11 days. Efficacy is better in those platelets which have been stored less than 24 hours (**Rapaport, 1987**). Moreover as they are stored at room temperature the risk of contamination increases as the storage interval increases. A standard 170 micrometer filter is recommended for transfusion, filters of smaller pore size are not indicated (**Consensus Conference 1987**).

If platelet transfusion is considered necessary the operative procedure should be carried out within twelve hours (**Grindon et al, 1985**).

CONCLUSION

Only 48% of respondents knew the correct answer for how much six random units would raise the platelet count. The fact that 28% did not know the answer shows a lack of knowledge about a product which is possibly over used in the peri-operative period. These 93 who did not know included 14 (48%) of those in practice more than 20 years; 23 (20%) between 6 and 20 years and 55 (29%) in practice less than 6 years implying the lack of knowledge was widespread.

PLATELETS : PRE-OPERATIVE ACCEPTABLE LEVELS

Survey Question:

For a non-emergency case what is the minimum level of platelets you would consider to be adequate for elective surgery?

a) No minimal requirement ☐

b) More than 50,000 ☐

c) More than 75,000 ☐

d) More than 100,000 ☐

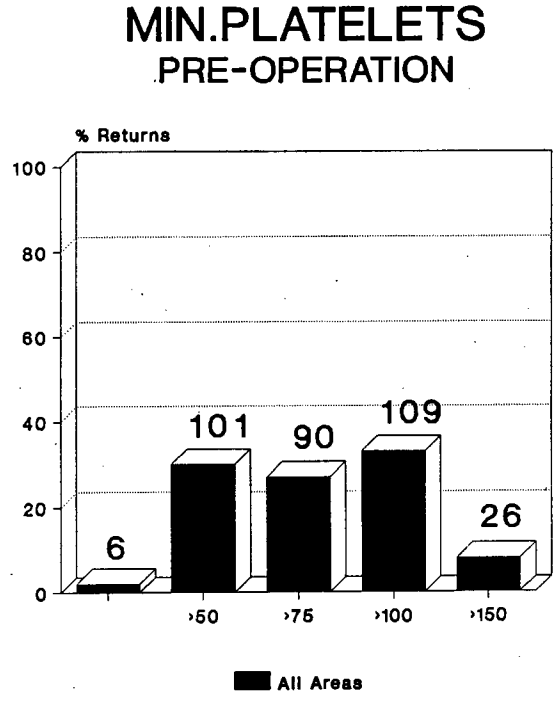
e) More than 150,000 ☐

RESULTS

Platelet Minimum Pre-op

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	2	
Nil	2	4															6	2
>50	41		19			3	8		8		3		9		10		101	30
>75	54		11			1	8		5		1		6		4		90	27
>100	46		19		1	1	8		13		4		9		8		109	33
>150	11						2		1		5		4		3		26	8
Spoilt																	1	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
Nil	3	2	2	2	1	3
>50	62	33	37	33	4	14
>75	44	23	35	31	10	35
>100	68	36	29	25	12	41
>150	13	7	10	9	2	7
Spoilt						



Note that 57% (95) of respondents would consider levels of 75,000 or more to be an adequate pre-operative platelet number. 33% (109) would require more than 100,000 and 8% (26) would require more than 150,000.

Survey Question

For which of the following circumstances would you require that platelets are available pre-operatively?

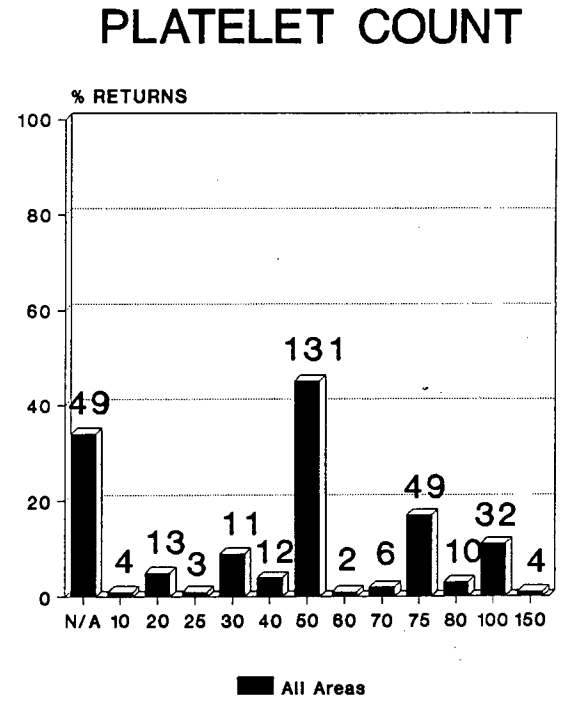
Platelet count less than .....

RESULTS

Platelet Count

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	49	34
10	1						2								1		4	1
20	5		4						2				1		1		13	5
25						1									2		3	1
30	5					1	1		1				1		2		11	9
40	4		2			1	1		1				1		2		12	4
50	60		23		1	1	7		15		3		12		9		131	45
60	2																2	1
70	5						1										6	2
75	32		3				4		2		2		3		3		49	17
80	5		1								2		2				10	3
100	13		3				4		4		2		4		2		32	11
150	2						1						1				4	1
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A		9		6		
10	3	2	1	1		
20	9	6	4	4		
25	3	2				
30	5	3	4	4	2	9
40	6	4	5	5	1	4
50	71	44	46	43	14	61
60	2	1				
70	4	3	2	2		
75	27	17	17	16	5	22
80	4	3	6	6		
100	20	12	12	11		
150	1	1	3	3		
Spoilt						



Note that 61% (204) of respondents accept a level of 50,000 platelets or less. A further 20% (57) accept a level between 50 and 75,000; 34% (49) of respondents did not answer this question.

Platelets - Physiology

Platelets are formed in the bone marrow and are present in the blood in numbers of 240 000 ± 100 000/mm^3 in healthy subjects. They have a discoid form and contain cytoplasmic granules the contents of which include Adenosine Di-Phosphate (ADP), Platelet Factor 4 (PF4), serotonin, catechols and substances which modify vascular permeability and integrity (**Marcus 1969**).

Platelets are activated by exposure to a suitable stimulus, usually contact with sub-endothelial basement membrane following vessel damage (**Barrer & Ellison 1977**). The platelet changes shape to become a spiney sphere which sticks to the damaged basement membrane and initiates aggregation with other platelets. This primary aggregation is a reversible process which is probably started by low levels of ADP release during the initial injury to the vessel. Calcium and fibrinogen must also be present for aggregation to occur.

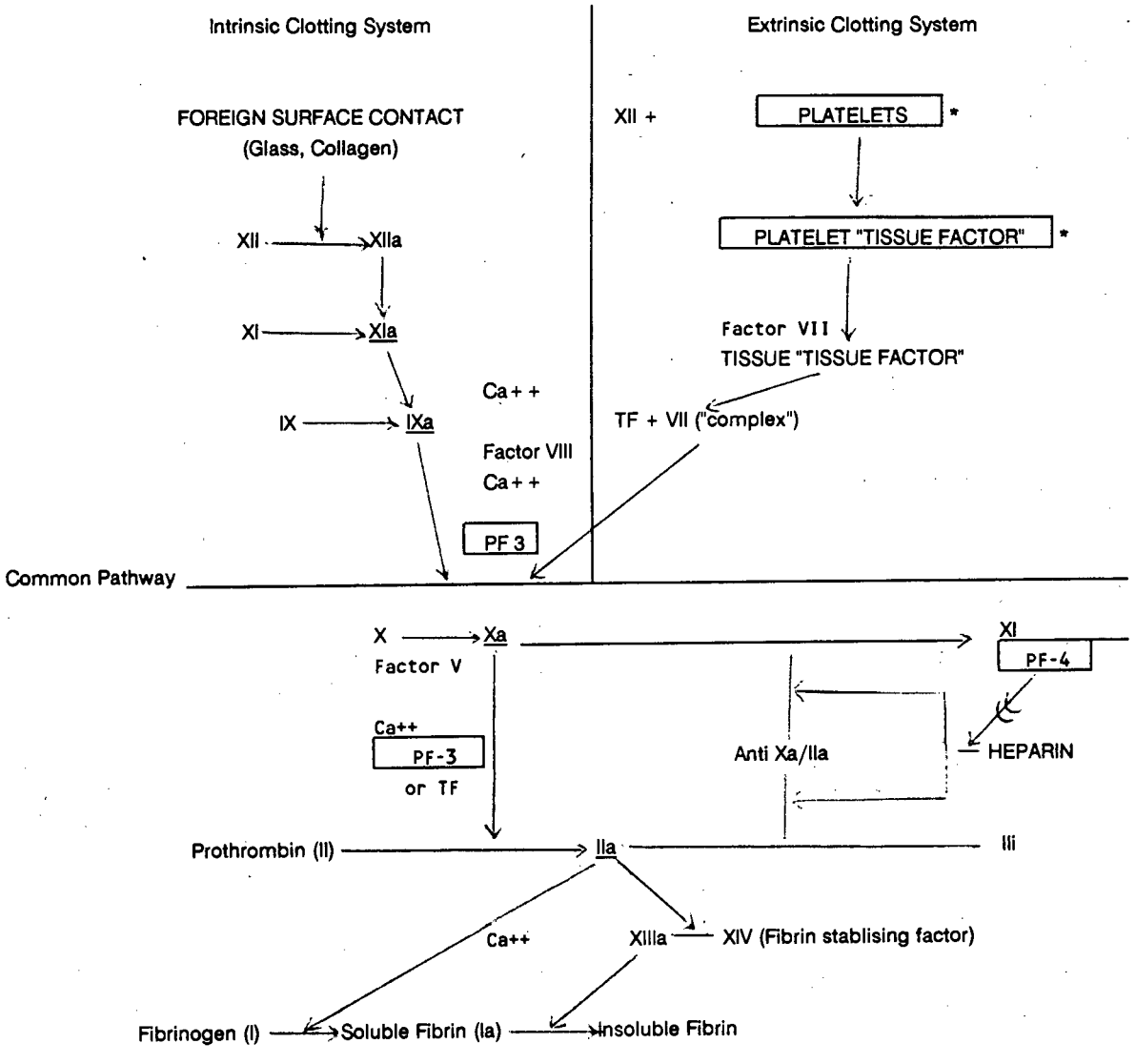
This primary phase of platelet activation culminates with the "release reaction" wherein the contents of their cytoplasmic granules are released extracellularly. If the stimulus is strong enough to cause a release reaction in many platelets large quantities of ADP are released causing a self-sustaining aggregation. This is termed secondary aggregation. If the stimulus is weak and only a few platelets release ADP, the remaining platelets resume their normal shape and return to the circulation.

Platelets not only form a plug initiating haemostasis they also participate in several steps in the coagulation cascade (Fig. 6:1). Platelet Factor 3 (PF3) is essential for activation of Factor X by the complex Factor IXA, VIII and calcium ion and for the conversion of prothrombin to thrombin by the complex of Factor XA, V and calcium ions. PF3 is a property of the lipoprotein in the membrane of the platelets. PF4 is released from the platelet granular sites.

The final step of clot retraction is due to a contraction of actin and myosin myofilaments found in the platelets.

FIGURE 6.1

PLATELET FUNCTION



sites of Heparin activity

▭	platelet
TF	tissue factor
*	speculated role of
PR-3	platelet factor 3
PR-4	platelet factor 4
a	activated substance
i	inactivated substance
→	activation pathway
⊣	inhibition pathway

Barrer & Ellison, Anesthesiol. 1977: 46; 205

Pre-Operative Platelet Transfusions:

In assessing the need for platelet transfusion various factors need to be taken into account.

1) Cause of the thrombocytopaenia:
Patients with increased platelet destruction due to splenomegaly who are about to undergo splenectomy are not usually given platelet transfusions prior to the spleen's removal because of the extremely short platelet lifespan. With the removal of the spleen the platelet count usually rapidly spontaneously reverts towards normal levels. Patients with idiopathic thrombocytopenic purpura, disseminated intravascular coagulation, thrombotic thrombocytopenic purpura or haemolytic uraemic syndromes in general also do not respond to platelets. In addition, platelets may be harmful because of the risk of platelet antibody formation or transmission of disease **(Grindon et al 1985)**.

2) The platelet count pre-operatively:
If thrombocytopaenia is the sole abnormality a platelet count of 50 000mm^3 or higher is unlikely to benefit from platelet transfusion **(Consensus Conference 1987)**. Levels as low as 20 000 or even less have been accepted before the need for prophylactic platelet transfusion is undertaken. Whilst it is impossible to fix an absolute minimal platelet count below which the risk of haemorrhage contraindicates surgical procedures, a range of 55 000 to 75 000 is generally accepted **(Miller et al 1971; Wilson et al, 1971)**. Thus the 41% (135) respondents who require pre-operative platelet counts of 100,000 or above would, if they adhered to this policy, be giving their patients platelets needlessly. Of those respondents who answered the question as to what figure they would use for the lower acceptable platelet level 81% (261) answered 75,000 or less with 61% (204) accepting 50,000 or less. Inexperience may be a factor in the knowledge of normal safe peri-operative platelet levels, as 34 of the 49 respondents who didn't answer the question had less than six years anaesthetic experience. 20 of the 32 who would require levels of more than 100,000 were also of less than six years experience.

3) Concomitant Disease:
Patients with advanced hepatic or renal insufficiency often have associated disorders of coagulation and platelet function. Platelet transfusion may be required pre-operatively to correct the bleeding time, although there appear to be no pertinent studies.

4) Type of Operation:
Controlled prospective studies have demonstrated no correlation between platelet counts and bleeding following cardiac pulmonary bypass **(Ulmas 1975, Haring et al 1975)** and no detectable benefit from prophylactic administration of platelets to such patients. Therefore, it seems there is no justification for prophylactic platelet administration in patients undergoing open heart surgery **(Consensus Conference 1987)**. However, paediatric patients with cyanotic heart disease and polycythaemia often require platelets post bypass because of poorly functioning platelets, although the actual platelet count may be within normal limits.

In neurosurgical procedures, where any haemorrhage into the CNS may be critical, prophylactic platelet transfusion to elevate a low platelet count may be justified **(Consensus Conference 1987)**.

CONCLUSION

It appears that between 20 to 40% of respondents take as their minimal pre-operative level unacceptably high platelet counts. Although the majority of these were the least experienced anaesthetists (1-5 years experience) incorrect replies were also common amongst the other, more experienced, personnel.

Survey Question

For which of the following circumstances do you require that platelets are available pre-operatively (not extra-corporeal operation)?

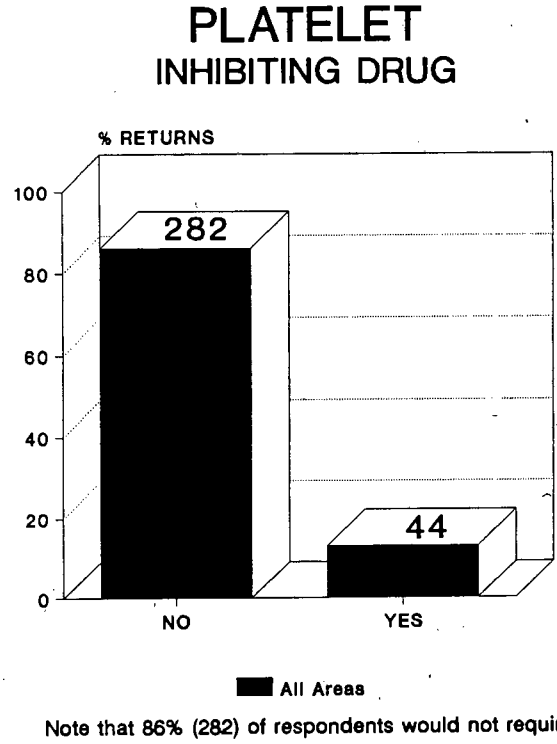
Platelet inhibiting drug ☐

RESULTS

Platelet Inhibiting Drug

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	3	
No	138		42			1	4	17	24		10		24		22		282	86
Yes	13		9				1	9	3		2		4		3		44	13
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	164	87	98	87	20	69
Yes	24	13	12	11	8	28
Spoilt						



Note that 86% (282) of respondents would not require platelets to be available pre-operatively.

Drugs and platelet function:

The anaesthetist should be aware that various drugs affect platelet function by a variety of mechanisms such as inhibiting the release reaction (aspirin) (Table 6.2). These effects may be irreversible and persist as long as the effective platelet cohort survives i.e. about one week. It must be remembered that many "over the counter (OTC) preparations contain aspirin and may be used on a regular basis by patients who do not consider they constitute a medication. Thus OTC's must always be asked about when eliciting a medication history from a patient. Analgesics which are presumably safe include paracetamol, codeine and other opiates, synthetic narcotics, propoxyphene and acetaminophen. To assess *in vivo* the platelet function a modification of Ivy's Bleeding Time should be used (**Ivy et al, 1941; Harker & Slichter, 1972**). This method consists of applying a sphygmomanometer to the arm and keeping it inflated to 40mm of mercury. Duplicate, template, standardised incisions are made 1mm depth and 9mm long in previously cleaned volar skin of the forearm. The time required for cessation of bleeding is then measured by careful blotting with filter paper every 30 seconds without disturbing the clot. The normal bleeding time in patients with a mean platelet count of 250,000 ± 40,000 platelets per microlitre was 4,5 ± 1,5 minutes (**Harker & Slichter, 1972**). This same method could be used during surgery, if microvascular bleeding appears to be a problem, to assess the need for platelet transfusion. As most patients undergoing surgery are hypothermic and as cooling decreases platelet aggregation, a normal bleeding time in a patient under anaesthesia would indicate there is no reason for a platelet transfusion.

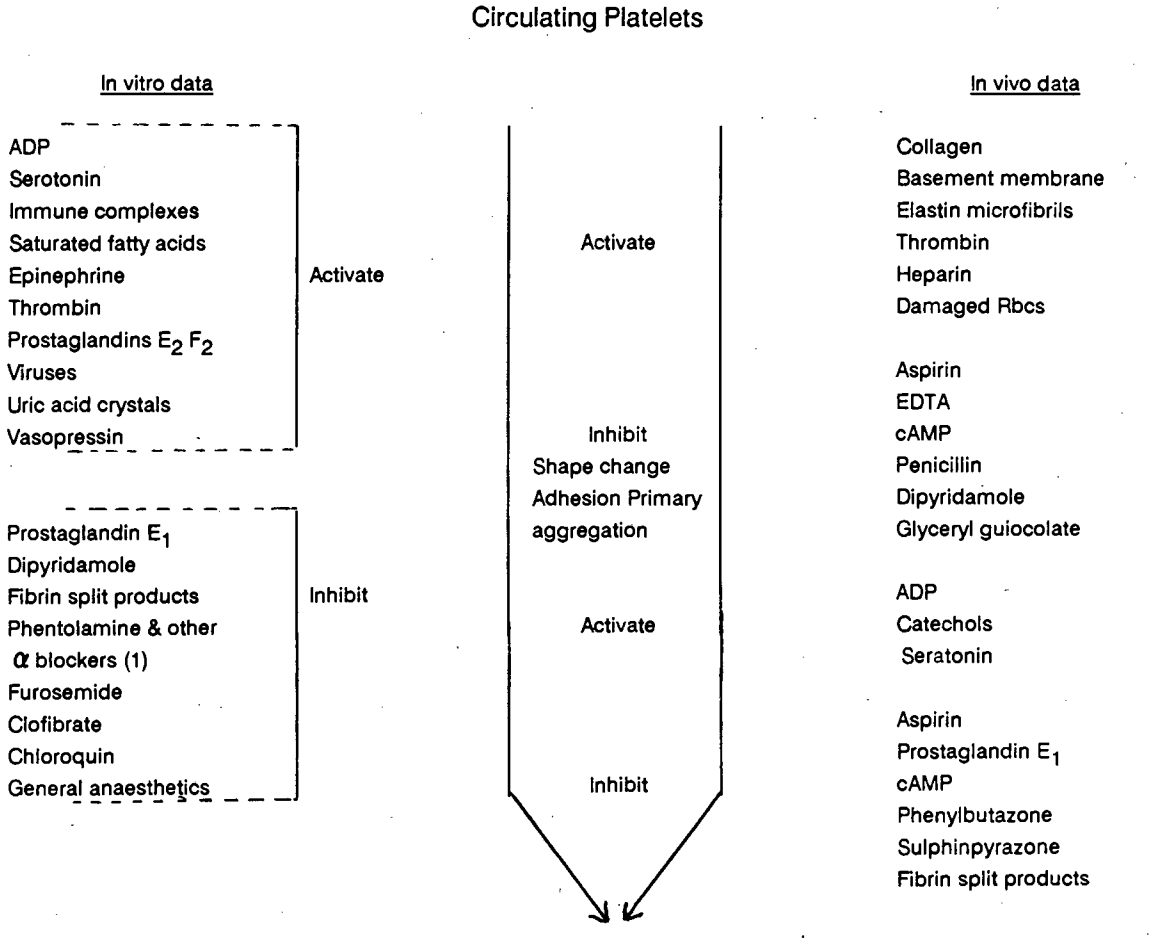
With the recent popularity of regular low dose aspirin in many adult males to try and diminish the risk of a myocardial infarction, many patients are presenting themselves for operations whilst on a platelet inhibiting drug. Unfortunately they may not have been informed to stop their medication a week prior to the operation.

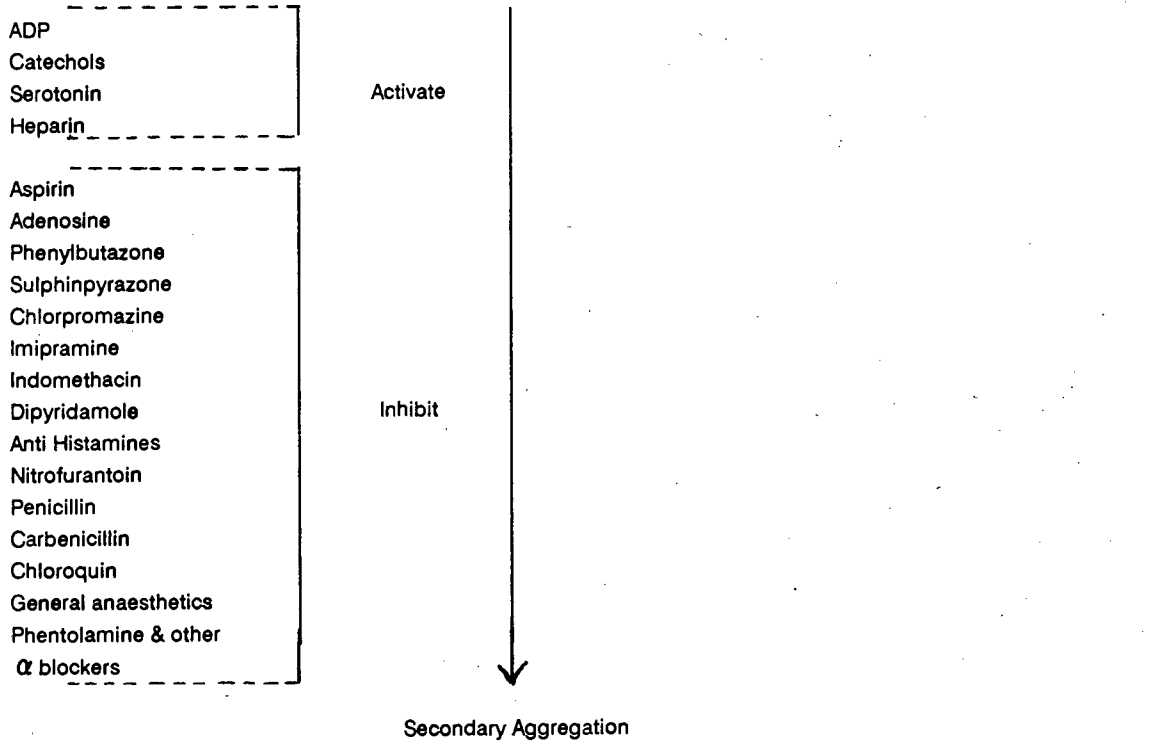
CONCLUSION

The majority (86%) of respondents stated they would not require platelets to be available for patients who are on a platelet inhibiting drug. This corresponds with common clinical practice as many patients may be on such drugs when presenting for surgery. The anaesthetist, however, must have a high index of suspicion for drugs causing abnormal bleeding in the peri-operative period.

TABLE 6.2

PLATELET FUNCTION





Barrer & Ellison, Anesthesiol. 46, 203

PLATELET REPLACEMENT ; DURING OPERATION

Survey Question

For which of the following circumstances do you require that platelets are available pre-operatively (not extra-corporeal operation)?

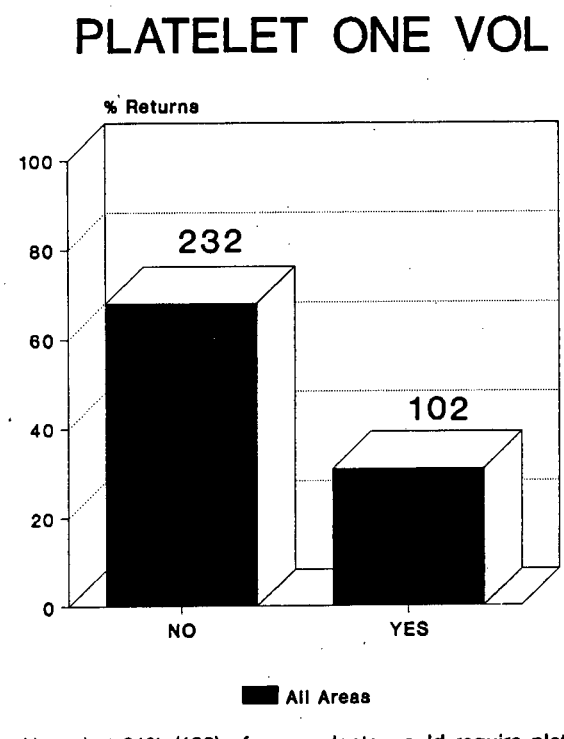
One estimated blood volume replacement ☐

RESULTS

Platelet One Volume

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	4	
No	94	61	39	74		2	24	92	19	70	8	73	18	64	19	76	232	68
Yes	57		12		1	3	2		8	5	3		10		6		102	31
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	125	67	73	65	25	86
Yes	62	33	37	33	3	10
Spoilt						



Note that 31% (102) of respondents would require platelets to be available where one blood volume loss is predicted.

Survey Question:

For which of the following circumstances do you require that platelets are available pre-operatively (not extra-corporeal operation)?

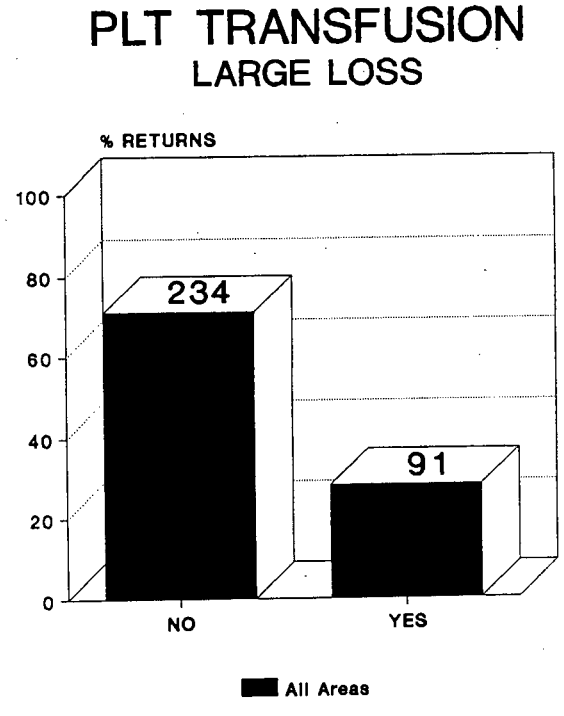
Procedure usually associated with large blood loss ☐

RESULTS

Platelet Large Loss

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	4	
No	114	75	32	60	1	5	16	2		23		9	82	15	19	76	234	71
Yes	37	24	19	36			10	39	4	15	2	18	13	46	6	24	91	28
Spoilt																	4	

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	145	78	71	63	19	66
Yes	42	23	39	35	9	31
Spoilt						



Note that 71% (234) of respondents would not have platelets available if the procedure was expected to be associated with a large blood loss.

Intra and post-operative platelet transfusion:

Following one blood volume replacement 35-40% of platelets usually remain and the majority of patients who have received rapid replacement of 1-2 blood volumes do not develop microvascular bleeding as a result of thrombocytopaenia. Thus a plan regarding platelet use must be formulated prior to an elective surgical procedure which may involve massive blood loss based on actual platelet numbers and functions. **Coté et al (1985)** reported that most paediatric patients who started with a high platelet count may not require exogenous platelet transfusion until two or more blood volumes have been lost. However, the patient who started with a low platelet count (less than 150,000/mm^3) may require platelets after only one blood volume transfusion. Thus a pre-operative platelet count is extremely important. They also suggested that prophylactic platelet transfusions should only be considered when the platelet count had decreased to less than 100,000 and considerably more bleeding is anticipated. The present survey showed 31% (102) of respondents appeared to be unaware that adequate number of platelets still remained after one blood volume exchange transfusion. 62 had less than six years anaesthetic experience but 37 had more than six years and 3 had more than 20 years experiences. Similarly 41% (91) would have platelets available for a large blood loss. This latter question must be criticised as being poorly worded as there are differing definitions of a large blood loss. Thus a two whole blood volume loss where platelets may well be required could fall into the definition of a large blood loss. This specific question will, therefore, not be analysed further.

A standard 170μ filter is adequate for platelet transfusion. Microfilters should be used during blood transfusion only if the initial platelet count is low. **Lim et al (1989)** demonstrated a significant fall in platelet levels in leukaemia patients given blood transfusions via the standard 170μ filter compared to a 40μ filter. This was postulated to be due to microemboli in the transfused blood causing aggregation of the recipient's platelets. They strongly recommended that microfilters be used routinely in thrombocytopaenic patients receiving blood transfusions.

If abnormal bleeding occurs with a platelet count of more than 50,000/mm^3, other causes of bleeding such as mechanical causes, disseminated intravascular coagulopathy or dilution of clotting factors should be sought (**Coté et al, 1985**). This is in agreement with the **Consensus Opinion on Platelet Therapy (1987)** which stated that platelet transfusion should not be administered in the absence of both documented thrombocytopaenia and clinically abnormal bleeding.

Adjuvant Therapy

In uraemia bleeding due to poor platelet function responds, in the majority of cases, to treatment with cryoprecipitate or 1-desamino-8-d-arginine vasopressin (DDAVP) and platelet transfusions may be avoided (**Consensus Conference 1987**). DDAVP has also been found to shorten the bleeding time in cirrhotic patients (**Richardson & Robinson, 1985**).

PLATELETS CONCLUSION

The correct usage of platelets was indicated by approximately 60-70% of respondents with the majority of those who didn't know or answered incorrectly having less than six years anaesthetic experience. However, there was a generalised tendency, independent of experience, amongst 30% of respondents to transfuse for one blood volume replacement. This is an overusage of an expensive component which carries a high risk of infection transmission.

CHAPTER SEVEN

FRESH FROZEN PLASMA

* Usage as a Colloid

* Usage with Blood Replacement

* FFP and Clotting Studies

F.F.P. : USAGE AS A COLLOID

Survey Question

Under what circumstances do you administer FFP?

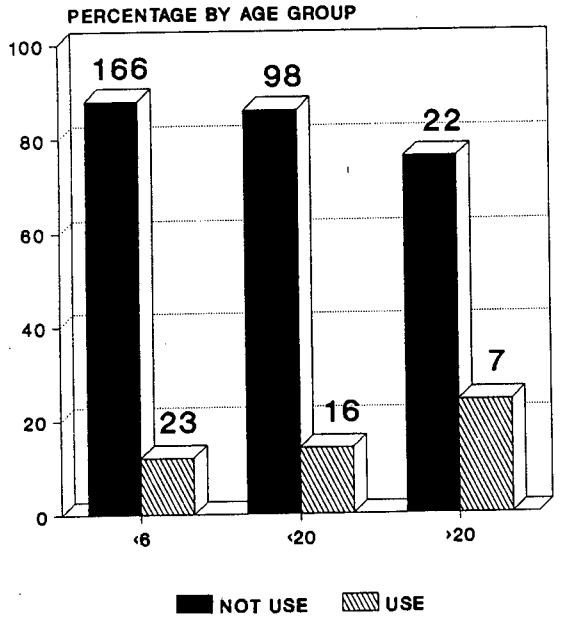
As a colloid volume substitute when red blood cells are not required ☐

RESULTS

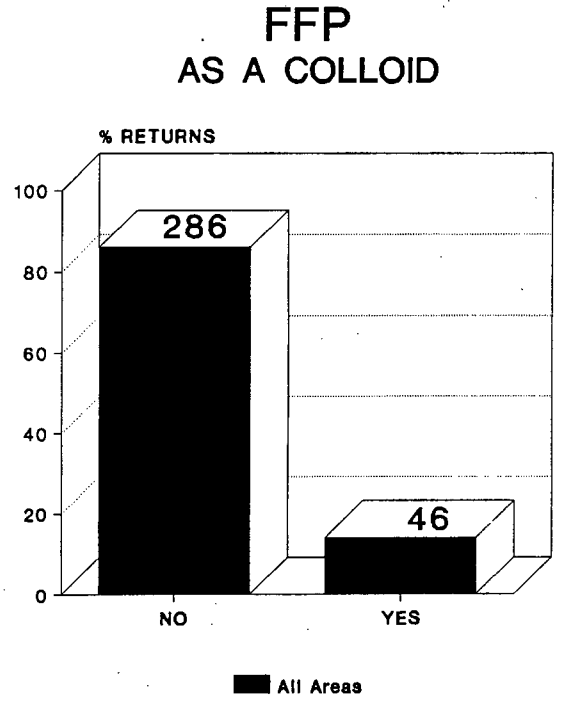
FFP as a Colloid

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	1	
No	142	92	42	78	1	4	18	69	22	82	12	92	22	79	23	96	286	86
Yes	12	8	12	22		1	8	31	5	18	1	8	6	21	1	4	46	14

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	169	89	95	83	22	76
Yes	20	11	19	17	43	40



Note that there was no difference, proportionately, between the different age groups experience-wise and their use of FFP as a colloid.



Note that 14% (46) of respondents would use FFP as a colloid.

Survey Question

What colloid volume substitute do you use if blood is not required?

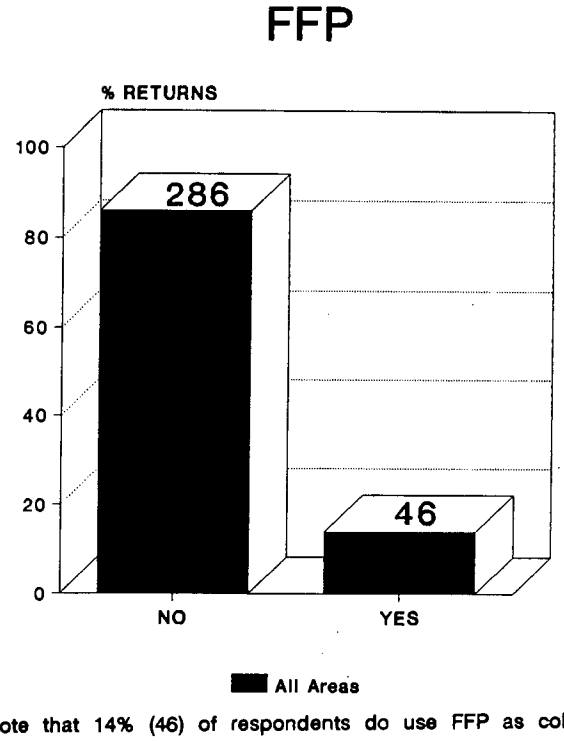
Fresh Frozen Plasma?

RESULTS

FFP

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
Spoilt																	1	
No	135		48		1	4	22		23		10		21		22		286	86
Yes	19		6			1	4		4		3		7		2		46	14

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
Spoilt						
No	166	88	98	86	22	76
Yes	23	12	116	14	7	24



Note that 14% (46) of respondents do use FFP as colloid volume substitute for blood replacement.

DISCUSSION

One unit of Fresh Frozen Plasma carries the same risk of disease transmission, and anaphylaxis as one unit of whole blood. Thus as safe and cheaper synthetic colloidal solutions are available the **Consensus Conference on Fresh Frozen Plasma (1985)** concluded there is no justification for the use of FFP as a volume expander.

CONCLUSION

The replies to both questions were consistent with 86% of anaesthetists surveyed stating they would not use FFP as a colloidal blood substitute. However, a disturbing 14% (46) would. These few were evenly distributed throughout the areas in all the two younger age groups. However there was a higher proportion of those in anaesthetic practice more than 20 years who would use FFP incorrectly.

FFP AND BLOOD REPLACEMENT

Survey Question

Under what circumstances do you administer Fresh Frozen Plasma (FFP)?

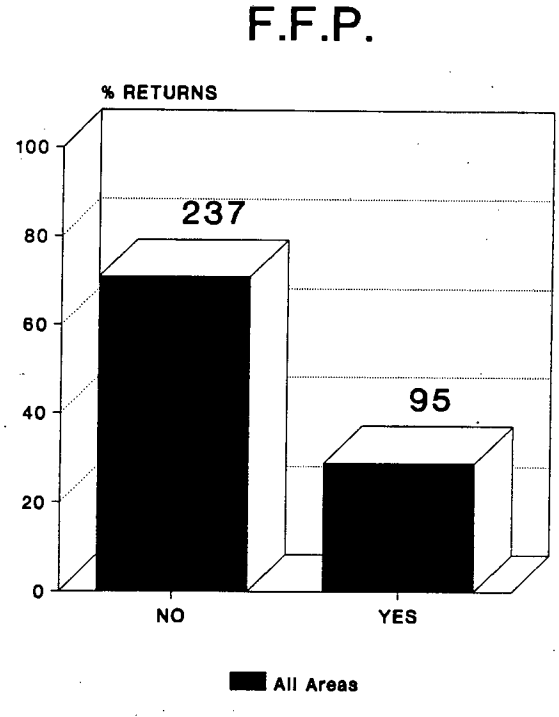
Blood replacement is between 25-50% estimated blood volume

RESULTS

FFP 25-50%

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	1	
No	97	63	44	82	1	5	20	77	21	78	9	69	22	79	18	75	237	71
Yes	57	37	10	18			6	23	6	22	4	31	6	21	6	25	95	29

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	129	68	88	77	19	66
Yes	60	32	26	23	10	34



Note that 29% (95) of respondents would transfuse FFP when blood loss is between 25-50% of one blood volume.

Survey Question

Under what circumstances do you administer FFP

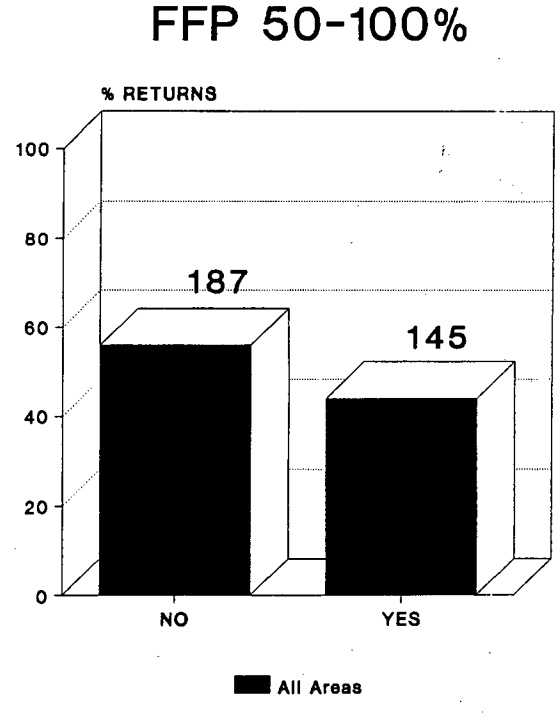
Blood replacement is between 50-100% estimated blood volume

RESULTS

FFP 50-100%

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	1	
No	79	51	42	78	1		17	65	19	70	7	54	12	43	10	42	187	56
Yes	75	49	12	22		5	9	35	8	30	6	46	16	57	14	58	145	44

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	105	56	67	59	17	59
Ye	84	44	47	41	12	41



Note that 44% (145) of respondents would transfuse FFP with a 50-100% blood volume loss.

FRESH FROZEN PLASMA AND DRIED PLASMA

Fresh frozen plasma is separated from whole blood within six hours of donation. It is frozen at 18-30°C and remains a viable product for up to one year. Dry plasma is separated from whole blood usually when the blood is time expired (**Opperman 1981**). All stable clotting Factors (I, II, VII, IX, X, XII and XIII) are represented equally in dried plasma and FFP. However the levels of labile Factors XI, V and XIII are far less in dried plasma. Twenty-four hours after thawing units of FFP, levels of Factor V and VIII may still average 76% and 67% or higher respectively (**Milam et al 1980**). Recommended levels of the various Factors required for haemostasis have been considered to be between 10% and 50% (**Hondow et al 1982, Smith & Bibwell 1979**).

It must be remembered that FFP is a hyperosmolar, hypernatraemic, hyperglycaemic, hyperphosphataemic and normokalaemic solution (Fig. 7.1). These abnormal characteristics may be important if large volumes of FFP are transfused.

Figure 7.1 **(Cochlan, 1985)**

Constituents	Mean Values	Normal (Physiological) Range)
pH	7,067	7,38-7,42
Sodium (mmol/l)	167,5	135-145
Potassium (mmol/l)	4,0	3,5-5,0
Chloride	76,0	95-105
Glucose (mmol/l)	17,1	3,9-6,0
Osmolality (mOsm/Kg)	320,4	280-300
Inorganic phosphate (mmol/l)	3,08	98-1,4

APPROPRIATE USES OF FFP

Uses recommended by the Consensus Report on FFP (1985) include:

a) Replacement of isolated Factor deficiencies
b) Reversal of Warfarin effect
c) Treatment of anti-thrombin-3 deficiency
d) Treatment of specific immunodeficiencies
e) Treatment of thrombotic thrombocytopaenic purpura.

Use of FFP with blood transfusions

There are various unreferenced statements advocating pre-established regimes for FFP transfusion (**Wilson et al 1971, Howland 1981, Gill et al 1975**). Commonly suggested FFP infusion rates include 1 unit FFP for every 2 units of RBC/albumin mixture to 1 unit FFP for every 6 units RBC.

In a prospective study of 25 patients with haemorrhagic shock **Hehne et al (1979)**, showed a temporary improvement in Factors I, II, V and VII was achieved with at least 800ml of FFP per hour per 70 kg. body weight. (Range 800-2 000mls in 90-120 minutes). FFP was transfused only after the initial conventional therapy for shock had failed to control the bleeding. Although the effect was temporary the authors believed it to have been sufficient to restore haemostasis. Slower rates of FFP infusion or less FFP were found to be ineffective. This is one of the few reports to show efficacy for FFP in massive blood transfusions.

Mannuci et al (1982) compared sixty-six massively transfused patients who received 1 unit FFP to every 3 units whole blood or RBC to sixty-four massively transfused patients who received only whole blood or RBC transfusions. There were no significant differences between the two groups in coagulation profiles (except PTT, and plasma fibrinogen levels were more often abnormal in the FFP group!). There was also no difference in whole blood or RBC requirements between the two groups. Another groups of 42 patients who received 3 units of platelet concentrations and 2 FFPs for every 10 units whole blood or RBC had no significant difference in coagulation profile or transfusion requirements when compared with those only receiving whole blood or RBC. The authors concluded that "indiscriminate administration of components based on pre-established routine schedules was unjustified".

Harke & Rahman (1980) concluded that "even after substitution of more than 24 units with a mean age of 9 days, relevant haemostatic changes were not observed when transfusion was performed immediately" **Miller et al (1971)** infused 500-1,000ml volumes of fresh frozen plasma but no platelets into combat casualties who were bleeding after receiving more than 20 units of blood. They demonstrated return to normal of the activated partial thromboplastin and prothrombin times without correction of the bleeding disorders. Subsequent administration of fresh blood which contained viable platelets resulted in correction of these bleeding disorders. **Baunstein & Oberman (1984)** in a well referenced review concluded that there is insufficient agreement to permit specific criteria of FFP transfusions even in patients with coagulopathies secondary to massive transfusions. The transfusion of FFP to patients recovering up to 15 units of whole blood or RBC or frozen deglycerolized RBC is probably unnecessary. The poor correlation between the quantity of stored blood transfused and associated coagulopathy may be due, in part, to the presence of stable and labile factors in stored whole blood. Factors I, II, VII, IX, X, XII and XIII are stable during storage. There are conflicting statements regarding Factor XI. **Urbaniak & Cash (1977)** and **Counts et al (1979)** consider Factor XI to be stable. **Heustis et al (1981)** consider Factor XI to have a half-life of 3 to 4 days in stored blood. A factor level of approximately 30% is necessary for haemostasis (**Urbaniak & Cash, 1977; Smith & Bidwell, 1979**).

Factor V has a reported storage half-life ranging from 3-5 days (**Urbaniak & cash, 1977**) to 10 to 16 days (**Counts et al, 1979; Heustis et al, 1981**). The level of Factor V in 21 day old blood may be 30% or more. The level required for haemostasis is between 10-15% (**Urbaniak & Cash, 1977**) and 50% (**Hondow et al, 1982; Smith & Bidwell, 1979**).

Thus stored blood contributes significantly to the coagulation factor pool especially if they are less than 10 days old (**Hondow et al, 1982**). *De novo* synthesis and internal reserves of coagulation factors also help maintain haemostasis in traumatised patients (**Harker et al, 1980**) and diminishes the need for Fresh Frozen Plasma.

FFP and Open Heart Surgery:

Milam et al (1981) studied 75 patients who underwent open heart surgery but were not transfused. They found that levels of coagulation factors V, VII and fibrinogen fell 30, 40 and 37 percent respectively. However, none of the patients had abnormal bleeding or required replacement therapy. **Ulmras and Sakhuja (1975)** transfused only frozen deglycerolised RBCs and no plasma during and after cardiopulmonary bypass. They found no clinical difference in laboratory results and intra-operative or post-operative bleeding when compared with a control group who used whole blood. Several studies suggest that platelet deficiencies rather than coagulation abnormalities may be responsible for abnormal post-operative bleeding after cardiopulmonary bypass (**Harker et al, 1980; Moriau et al, 1977**). **Snyder et al (1986)** suggest mild to moderate abnormalities of coagulation factors following bypass surgery can be tolerated and FFP transfusions "can be withheld".

Coagulation Coagulopathy

This complication may occur in 5-30% of traumatised patients (**Counts et al 1979, Mannuci 1982, Sherman 1982, String et al 1971**) with a mortality as high as 80%. Its development relates closely to the location, extent of trauma, duration of oligaemic shock and underlying liver disease. Whilst FFP would appear to be a logical therapy for the replacement of coagulation factors, the efficacy of FFP in such patients is questionable and its specific indications remain unclear (**Baunstein & Oberman 1984**).

De novo synthesis and internal reserves of coagulation factors contribute to the variability in coagulation factor levels associated with massive transfusions and thus the difficulties in recommending a set regime for FFP usuage.

CONCLUSION

The indiscriminate use of FFP in so-called dilutional coagulopathy without documented significant coagulation factor deficiencies is not recommended by the majority of authors for transfusions of up to 15 units of whole blood. Beyond this replacement volume the data is contradictory (**Mannuci et al 1980, Harke & Rahman 1980, Counts et al 1979 and Baunstein & Oberman 1984**). The **Consensus Conference on FFFP (1985)** was of the opinion that pathological haemorrhage in patients receiving massive transfusions (more than 1 blood volume replacement within several hours) was caused more frequently by thrombocytopaenia than by depletion of coagulation factors.

The majority of South African anaesthetists in the survey responded correctly that FFP should not be used even where 50-100% of blood volume has been lost. However, 29% (85) and 44% (145) replied that they do give FFP where blood loss is between 25-50% and 50-100% respectively. This indicates an incorrect usage of FFP to the possible detriment of the patient.

FFP AND CLOTTING STUDIES

Survey Question

Under what circumstances do you administer FFP?

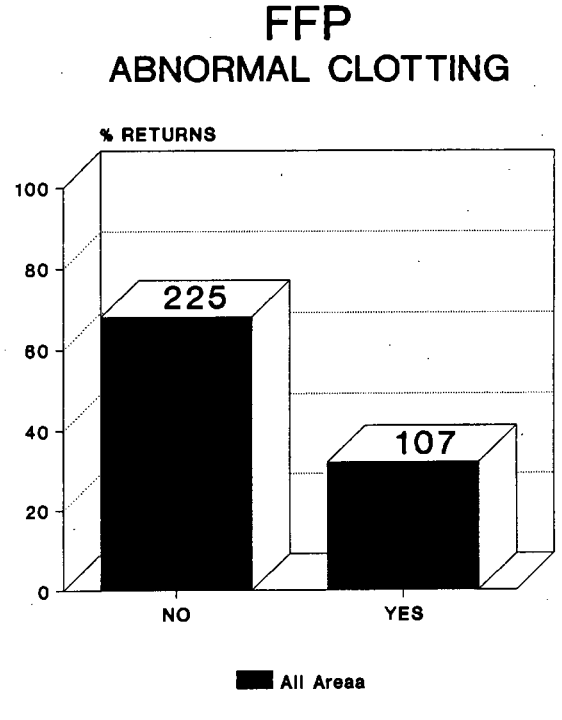
Only on the basis of abnormal clotting studies. ☐

RESULTS

Abnormal Clotting

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
N/A																	1	
No	117	76	27	50		4	15	58	16	59	10	77	19	68	17	71	225	68
Yes	37	24	27	50	1	1	11	42	11	41	3	23	9	32	7	29	107	32

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
N/A						
No	140	74	64	56	21	72
Yes	49	26	50	44	8	28



Note that 68% (225) of respondents would not use abnormal clotting as an indication for FFP.

DISCUSSION

Although abnormal clotting studies are frequent after operations such as open-heart surgery these may not be significant and correlate poorly with required replacement therapy (**Milan et al, 1981; Ramsey et al, 1983**). **Counts et al (1979)** and **Wilson et al (1971)** reported on two prospective studies of massively transfused patients. They found that the PT (prothrombin time) and PTT (Partial thromboplastin time) had poor sensitivites (40-63%) and poor positive predictive values (47-67%) as 800ml of FFP per hour per 70Kg body weight in 25 patients with haemorrhagic shock, who continued to bleed despite conventional therapy, caused a temporary and transient improvement in clotting factors which was clinically significant.

Thus, abnormal clotting profiles may not be as important in determining the need for FFP during operation and in the immediate post-operative period as it is in the pre-operative period.

CONCLUSION

Although PT and PTT are not a sensitive predictor for the need for FFP they are in practice often the only automated ones rapidly available. So they should be used in the face of continued bleeding where FFP may be considered necessary. 32% of respondents indicate this is what they do. However it is important to know how much FFP to transfuse and also whether or not cryoprecipitate has been removed by the blood bank. The policy of removing cryoprecipitate, high in Factor VIIIC, VIII:VWF, and fibrinogen, is standard practice by the W.P.B.T.S. for all units of FFP. This means the dose of FFP plus cryoprecipitate needs to be individualised, not only for the patient but also for the blood bank supplying the FFP.

CHAPTER EIGHT

COLLOID USAGE

* SHS
* Dried Plasma
* Albumin
* Dextran 70 and 40
* Haemaccel

COLLOIDS : GENERAL DISCUSSION

The two main reasons for giving a colloid suspension are to increase the colloidal osmotic pressure and to decrease the viscosity and, therefore, improve that rheology of the circulation.

There are three body compartments: the intravascular space, the interstitial space and the intracellular space. One of the main theoretical advantages for colloid infusion is that the majority of the colloid is retained in the intravenous space. The relative volumes of the three compartments in an adult male are shown below:

EXTRACELLULAR SPACE 19l		
Intravascular Space	**Interstitial Space**	**Intracellular Space**
5l	14l	23l

INTRAVASCULAR SPACE

Measurement

Most measurements and methods of assessing fluid status relate to the intravascular space, namely pulse, blood pressure, CVP, cardiac output, left and right atrial pressures, urine output and peripheral and central temperature differences.

INTERSTITIAL SPACE AND INTRACELLULAR SPACE

Measurement

These are usually measured using isotope dilution techniques which are labourious, time consuming and need steady state conditions. Practical measurement in a clinical setting is difficult. Tissue turgor plus a chest x-ray may give some objective indication if the interstitial space is over-hydrated.

The intravascular compartment and interstitial space together comprise the extracellular space. They are in equilibrium but with different compositions and functions.

Effect of Intravenous Infusions

Water from dextrose solutions is rapidly distributed to each of the three compartments and because the intracellular space is the largest, dextrose solutions will predominantly be distributed there. Isotonic saline solutions such as as plasmalyte B and Ringer's lactate also rapidly distribute in the extracellular space in a ratio of about 1 to 3 with the larger portion going into the interstitial space. This proportion is even greater in hypotensive patients (**Shizgal et al 1977, Virtue et al 1966**). One hour after infusion, only 8% of the Ringer's lactate given remained in the circulation, whilst 73% was found in the extravascular compartment. After 4 hours Ringer's lactate gave no plasma volume expansion but 67% was still in the extravascular space (**Dawidzon et al 1980B**). Colloids, however, remain in the intravascular space because of their oncotic pressure. After 1 hour **Dawidzon** reported 40-63% (**Dawidzon et al 1980B**) of colloid remained in the circulation with 12-44% in the extravascular space. After 4 hours most colloids still gave considerable plasma volume expansion. If the colloid used has a higher osmotic pressure than plasma (e.g. 20% albumin or high molecular weight dextrans) interstitial fluid will move into the intravascular space expanding the plasma volume by more than the original volume of colloid transfused. This type of fluid is called a plasma expander (**Twigley & Hillman 1985**).

Survey Question

What colloid volume substitute do you usually use if red blood cells are not required?

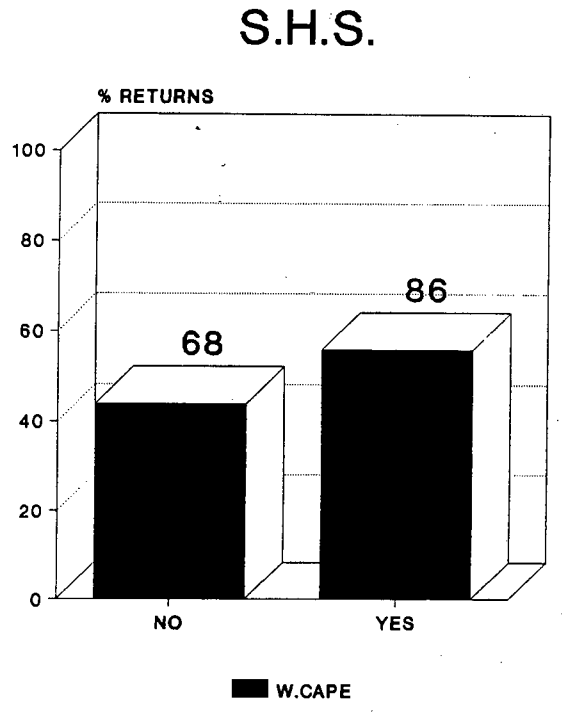
Stablised Human Serum Yes

RESULTS

Colloid SHS

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
Spoilt																	1	
No	68		53			5	26		27		13		28		24		245	74
Yes	86		1														87	26

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
Spoilt						
No	147	78	76	67	22	76
Yes	42	22	38	33	7	24



Note that results are only shown for the Western Cape as SHS is only available in this area. 56% (86) of respondents do use SHS as a colloid for blood replacement.

Stabilised human serum. SHS is presented in 250ml solutions containing 50g of total protein. It contains immuno globulins, IGG (7,5g per litre), IGA (1,65g per litre), IGM (1,25g per litre), sodium 120-140mmol/l, potassium 3-4mmol/l, calcium 1-1,15mmol/l, also alpha antitrypsin, haptoglobins, and alpha 2 macroglobins. This solution is expensive but free from the risk of hepatitis transmission. However there was a small risk of HIV transmission until recent changes in sterilisation of the solution make it 100% free of transmissable disease (personal communication Dr. A. Bird, Medical Director, Western Province Blood Transfusion Service). At normal capillary endothelium permeability infusion results in intravascular retention of only 80% of the amount initially infused (**Messmer, 1987**).

Protein solutions such as SHS are not completely inert and might trigger mild adverse reactions as well as life threatening reactions (**Ring et al 1982, Isibister & Fisher, 1980**).

Messmer (1987) recommends that natural protein solutions, because they are in short supply and very expensive, should not be used for volume replacement. They should be reserved for patients with hypovolaemia in association with significant hypoproteinaemia (plasma protein content <5g/100ml). SHS also has a role in certain immunodeficiency diseases and for rapid reversal of warfarin or suxamethonium where clinically indicated.

CONCLUSION

A disturbingly high 56% of respondents in the Western Cape, where SHS is available, use SHS as a colloid for replacement of blood loss, when cheaper synthetic colloids are readily available.

DISCUSSION

Once reconstituted (with saline) a bottle of dried plasma carries the same risk of disease transmission as one unit of whole blood. Because of its expense, and danger of infection transmission and anaphylaxis, and as other safer synthetic colloids are available, the use of dried plasma should be restricted to specific indications for replacement of coagulation factors.

A disturbingly high number of respondents (54) replied they would use dried plasma as a colloid. Twenty-five of the 54 were in one specific area (Southern Transvaal). This implies the indication for dried plasma transfusions in this area requires to be re-examined. The 54 respondents were evenly divided between those anaesthetists with less than 6 years experience and those with between 6 and 20 years. There was, however, proportionately larger numbers of those with more than 20 years experience who would use dried plasma as a colloid substitute.

Survey Question

What colloid volume substitute do you usually use if red blood cells are not required?

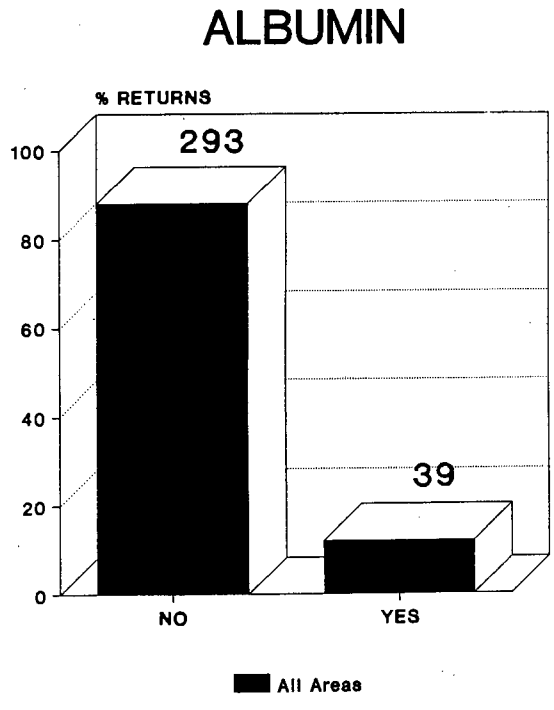
Albumin

RESULTS

Colloid Albumin

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
Spoilt																	1	
No	149		53			5	3		21		13		27		22		293	88
Yes	5		1		1		23		6				1		1		39	12

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
Spoilt						
No	170	90	99	87	24	83
Yes	19	10	15	13	5	17



Note that 12% (39) of respondents do use albumin as a colloid for blood replacement.

DISCUSSION

Albumin. Albumin is expensive to produce but has a long shelf life a lower sodium than fresh frozen plasma and is free of transmissable diseases. The usual concentration is 5% although 20% concentrations are available. It is readily metabolised by the liver - particularly in the metabolically depleted patient and rarely stays in the circulation for more than 24-48 hours (**Schultz & Heremans, 1966**) although its theoretical half-life is 5-10 days. 5% albumin's osmotic pressure is the same as whole blood, but the 20% solution is hyperosmolar and so will cause some reduction of the extravascular (mainly intracellular) compartments by mobilising fluid into the intravascular space. Albumin solutions contain bradykinins and carry a small risk of an allergic reaction.

The recommended usage for albumin is primarily for hypoalbuminaemic shocked states and protein-losing enteropathy. Thus it is not indicated for the substitution of red blood cells as the majority, 88% of respondents, correctly indicated. The fact that 23 out of 26 at one institution (OFS) replied that they would use albumin indicated that that specific Department should look critically at its colloid transfusion guidelines.

CONCLUSION

88% of South African anaesthetists surveyed indicated they do not abuse albumin by utilising it as a red blood cell substitute.

Survey Question

What colloid volume substitute do you usually use if red blood cells are not required?

Dextran 40 Yes

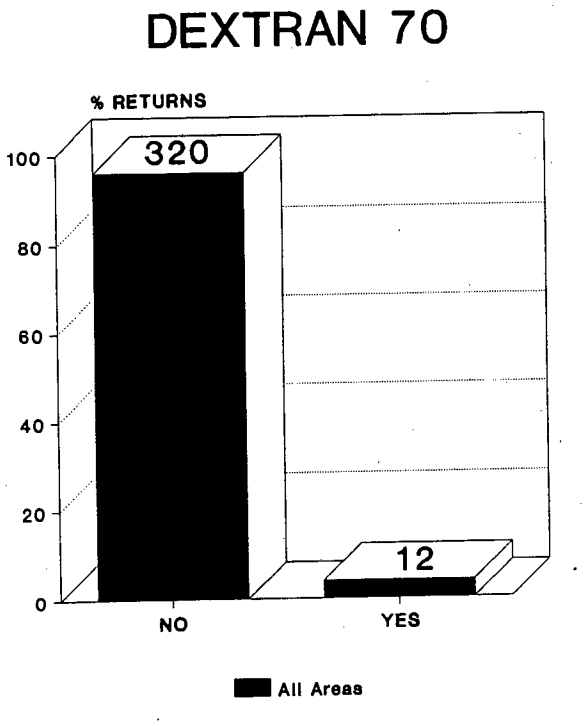
Dextran 70

RESULTS

Dextran 70

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
Spoilt																	1	
No	152		45		1		26		27		13		27		24		320	96
Yes	2		9						1								12	4

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
Spoilt						
No	184	97	108	95	27	93
Yes	5	3	6	5	2	7

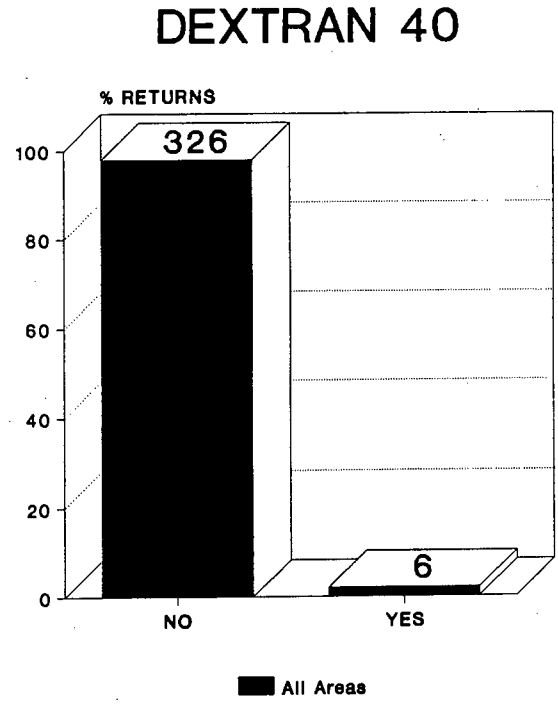


Note that 96% (320) of respondents do not use Dextran 70 as a colloid for blood replacement.

Dextran 40

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
Spoilt																	1	
No	153		51		1	5	26		27		13		28		22		326	98
Yes	1		3												2		6	2

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
Spoilt						
No	187	99	111	97	28	97
Yes	2	1	3	3	1	3



Note that 98% (326) of respondents do not use Dextran 40 as a colloid for blood replacement.

DISCUSSION

Dextrans are produced by the action of the bacterium leuconostoc mesenteroides on sucrose. The dextran molecule is a polysaccaride composed of glucose of varying chain lengths and the solution is classified according to molecular weight. High molecular weight dextran 150 and 110 are no longer available because they were found to cause an unacceptable increase in plasma viscosity and aggregation of red blood cells.

The two commonly used dextrans are Dextran 70 and Dextran 40. Dextran 70 has an average molecular weight of 70 000, but does contain some molecules smaller and others larger than this mean weight. It is prepared as a 6% solution in isotonic saline and has a colloidal osmotic pressure greater than that of normal plasma. Consequently a 500ml infusion can be expected to increase the plasma volume by some 750ml.

Dextran 40 has an average molecular weight of 40 000, the majority being excreted by the kidneys within six hours. Because of its smaller molecular size and the fact that it is made up of a 10% solution, Dextran 40 will have a greater osmotic effect than Dextran 70. A 500ml infusion will increase the plasma volume by ± 1,500ml. An infusion of Dextran 40 will decrease the aggregation of red blood cells by both its haemodiluting effect and by increasing the negative red cell charge. Intact intima is also negatively charged whilst damaged intima or exposed media is positively charged. It is thought that dextrans may form a monomolecular film over the site of damage and restore the continuity of the negative charge. Dextrans may also increase the negative platelet charge and so decrease platelet stickiness. Thus both Dextran 40 and 70 have antithrombotic effects.

The kidneys can excrete up to 5g of dextran per day, so the dextrans may stay in the circulation for a number of days depending on their molecular size. Fifty percent of Dextran 40 will be excreted within 3 hours compared with 30% of Dextran 70 in 6 hours. This results in an effective half-life of approximately 2 hours for Dextran 40 and 6-8 hours for Dextran 70.

Adverse effects of Dextrans

1. Haemostasis problems. The decrease in platelet stickiness which occurs with Dextrans is one mechanism interfering with haemostasis. Dextrans also interfere with the normal action of Factors VIII, V, fibrinogen and prothrombin. Thus, excessive dextran infusions can create an artificial Von Willebrand's Disease (**Marshall & Bird 1983**).

   It is recommended that dextrans should be limited to a maximum dose of 1,5g per Kg per day or less than 1500ml in the average adult (**Isbister & Fisher 1980**).

2. Interfering with cross-matching.

   This sometimes occurred with the high molecular weight dextrans and inexperienced haematotology technicians. It is recommended that blood for cross-matching be taken prior to dextran infusions.

3. Allergic reactions.

   Reactions typically occur after patients have received only a very small amount of solution. In first time responders the antibodies have probably been produced in response to ingested dextrans or in response to genetically similar bacterial polysaccarides. Many normal patients have circulating anti-dextran antibodies but only very few react adversely to dextran infusions. Severe anaphylactic reactions occur in only about 0,008% of patients but there is a higher incidence of minor reactions compared to the other colloids (0,07%-1,1%) (**Ring & Messmer 1977**). As a consequence the use of monovalent hapten has been advocated to block the antigen combining

sites of preformed circulating dextran reactive antibodies (**Messmer et al, 1980; Ljunstrom et al, 1988**). Hapten has been used in Sweden since 1982 and has led to a reduction in the reports of severe reactions to dextran from 22 per 100,000 units used between 1975 and 1979 to 1,2 per 100,000 units between 1983 and 1985. The number of fatal reactions decreased from 23 to one. More than 600,000 units of dextran were used during each period (**Ljunstrom et al, 1988**). Hapten, at the time of the survey (September, 1989), was unavailable in South Africa.

4. Renal Damage

When renal perfusion is reduced, Dextran 40 may form a plug blocking the renal tubules. In addition to this mechanical damage, osmotic damage due to back diffusion of dextran from the tubules may occur. Renal failure may be the end result (**Feest 1976**).

CONCLUSION

Dextran 40 and 70 are little used as a colloidal substitute for blood loss by the South African anaesthetists surveyed. This may be due to lack of availability or the fear of a dextran-induced anaphylactoid/anaphylactic reaction the incidence of which ranges from 0,07% to 1,1% in patients without shock or trauma (**Hedin et al, 1981; Ring and Messmer, 1977; Messmer et al, 1980**). The Dextran-induced antibodies arise in response to immunisation with bacterial polysaccharides and are widely distributed in the normal human population (**Hedin et al, 1979**). Thus, prior to Dextran infusion, the pre-injection of a high dose of monovalent hapten-dextran (dextran 1, M_w 1,000) to block the binding sites of the circulating antibodies has been recommended (**Messmer et al, 1980; Ljungstrom et al, 1988**). Unfortunately at the time of the survey (1989) Hapten was not available in South Africa.

Survey Question

What colloid volume substitute do you usually use if red blood cells are not required?

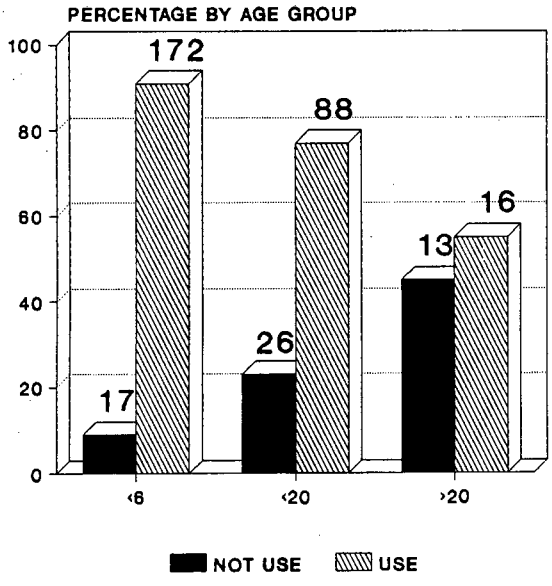
Haemaccel ☐

RESULTS

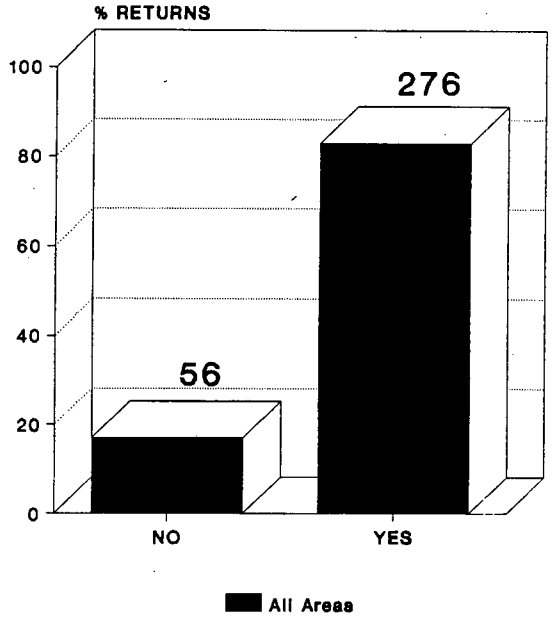
Colloid Haemaccel

Answer	W.Cape		Natal		NTvl	STvl	OFS		Pretoria		Medunsa		JHB		Baragwanath		Total	%
	No	%	No	%	No	No	No	%	No	%	No	%	No	%	No	%		
Spoilt																	1	
No	34		5				8		1		2		5		1		56	17
Yes	120		49		1	5	18		26		11		23		23		276	83

Answer	1-5		6-20		>20	
	No	%	No	%	No	%
Spoilt						
No	17	9	26	23	13	45
Yes	172	91	88	77	16	55



Note that Haemaccel was used proportionately more by those anaesthetists who had more than 20 years anaesthetic experience.



Note that 83% (276) of respondents do use haemaccel as a colloid for blood replacement.

DISCUSSION

Haemaccel. This is a synthetic polymer of urea and polypeptides derived from degraded gelatin produced by heat desaturation or chemical hydrolysis of starches. The modified fluid gelatin is then suspended in isotonic saline. The average molecular size is 35 000 but there is a wide range (5,000-50,000). The smaller molecules are distributed to the extra cellular space more readily and are excreted more rapidly by the kidney. The higher molecular weight fractions are retained in the intravascular compartment.

The gelatins are eliminated mainly by the kidneys (85%) with some excretion in the faeces and a small amount metabolised in the body. However, they do not appear to accumulate in patients with renal failure (**Kohler et al 1978**). The half-life is shorter than other colloids, being 3-4 hours, necessitating more frequent infusions in hypovolaemia (**Isbister & Fisher 1980**).

As approximately 70% of the molecules are below the renal threshhold, this provokes a mild osmotic diuresis. However, unlike Dextran 40, no cases have been reported of osmotic tubular damage. Haemaccel also does not affect the coagulation and fibrinolytic systems or blood cross-matching procedures.

Rapid infusion of Haemaccel may be associated with histamine release. Many people have circulating anti-gelatin antibodies which have probably been formed in response to food stuffs or in response to the breakdown of their own connective tissue. Patients who have damaged connective tissue, such as those with rheumatoid arthritis or degenerative arthropathies, are reported to have anti-gelatin antibodies more often and at higher levels than the rest of the population. These patients have also been reported to be more likely than others to show adverse reactions to gelatin infusions (**Schoning & Koch 1975**). **Ring & Messmer (1977)** calculated the incidence of severe reactions to gelatin solutions was 0,038%, which was higher than any other plasma substitute. However in 1979 a change in the manufacture of Haemaccel decreased the excess hexamethylene di-isocyanate, the agent used to cross link the peptides. This appears to have markedly reduced the histamine release seen with this agent. **Weis (1983)** reported on a prospective multicentre trial showing an adverse reaction rate of 0.78% in 1,147 patients. In eight of these nine patients, the reaction was cutaneous only; in the ninth a slight fall in lung compliance was noted. It would thus appear that in this respect the present Haemaccel is superior to that used prior to 1979. Prevention of anaphylactoid reactions by H_1 and H_2 receptor anatagonists has been shown to have a prophylactic effect (**Schoning et al, 1982**).

CONCLUSION

From the literature it would thus appear that haemaccel is a safer colloid to use from the point of view of the risk of anaphylaxis compared to the Dextrans it also does not interfere with clotting parameters. The fact that it is the principle colloid used by the South African anaesthetists surveyed may indicate ready availability, awareness of the greater anaphylactic risk, or knowledge of the risks and expense of blood derived colloids.

CONCLUSIONS

CONCLUSIONS

BLOOD TRANSFUSIONS

The Survey revealed that there appears to be a tendency for over transfusion in the peri-operative period, this was shown by:

1. Pre-operative Minimal Acceptable Haemoglobin Level

The minimum pre-operative haemoglobin level (Question 3) is taken as 10g/dl by 60% of respondents. This implies that some asymptomatic patients, with a chronic anaemia, about to undergo elective minor surgery, may be transfused up to 10g/dl to avoid postponement or cancellation of their operation by the anaesthetist. This was partly confirmed by Question 4c where 45% of respondents stated they would transfuse pre-operatively a 30 year old female with memorrhagia and a haemoglobin of 8,5g/dl, booked for a D & C. A haemoglobin of 8g/dl in an asymptomatic patient undergoing elective minor surgery does not increase the anaesthetic risk, although the effect of altitude has not been well researched.

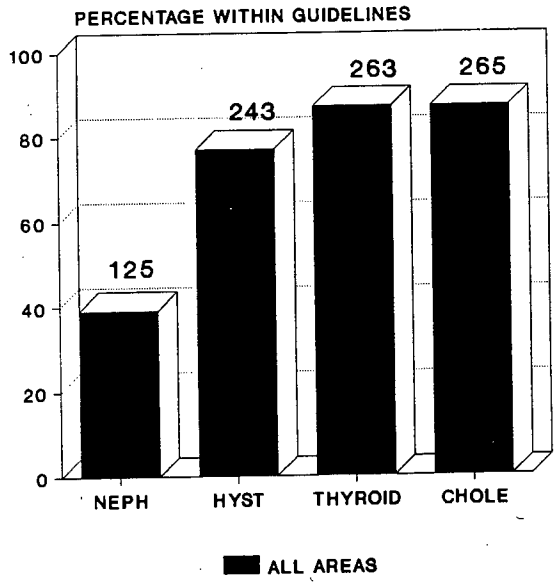
A more critical approach to anaemia needs to be taken by the anaesthetist. A minimal acceptable haemoglobin needs to be calculated for each patient pre-operatively to avoid excessive transfusion in this period.

2. Pre-operative Cross Matching of Blood

There is a lack of Maximum Blood Ordering Schedules (Question 12) or a lack of awareness that such a schedule existed. This could increase the amount of blood cross matched and not transfused. This would lead to an excessive waste of Blood Bank's personnel time, unnecessary expense for the patient and hospital services and a waste of a valuable product. Excessive cross matching pre-operatively may also influence some medical personnel to give the blood "because its there".

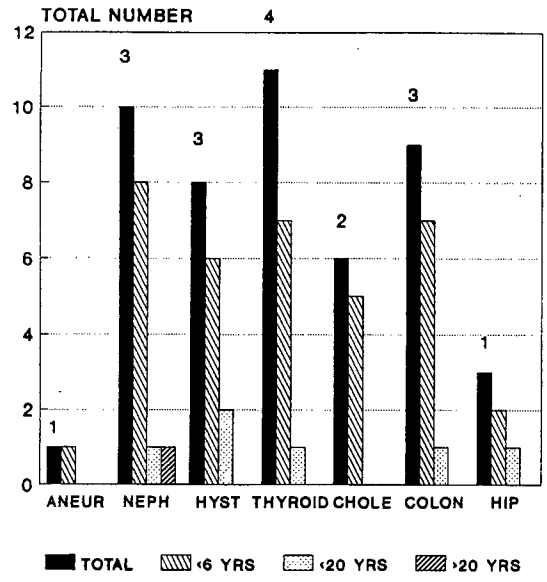
It is impossible to give absolute blood requirements for each operation as it will vary between patients and especially with the skill of the surgeon. However, the GSH recommended MSBOS (Appendix 2) is very similar to those reported in the literature. Using this as a guideline it was shown that the respondents cross matching for the more common operations such as Thyroidectomy, Cholecystectomy and Hysterectomy had a high level of agreement with the GSH recommendations.

CROSS MATCHING



Note that the percentage of respondents who were within GSH recommended cross matching guidelines were 39%, 77%, 87% and 87% for nephrectomy, hysterectomy, thyroidectomy and cholecystectomy respectively.

Lack of MSBOS guidelines may encourage the ordering of one unit of blood pre-operatively. However, although one unit ordering does occur amongst the respondents of the survey, it accounted for less than 3% of the anaesthetists.



Note that pre-operative cross matching of one unit of blood was only performed by a small number of anaesthetists and they tended to be the least experienced (<6 years).

Maximum Surgical Blood Ordering Schedules should be drawn up for each operation with variations being noted for individual surgeons. These should be available for all members of the Anaesthetic and Surgical Departments.

3. Pre-operative Blood Replacement

Most respondents (60%) used an estimated blood loss of 10-20% blood volume during an operation as their end point, after which they would transfuse. Volume loss estimation is often inaccurate and may lead to excessive transfusion. Similarly a blood volume loss of 20% in a patient with a haemoglobin of 15g/dl will drop his/her haemoglobin to 13g/dl. If isovolaemia is maintained with clear fluids there is no additional anaesthetic risk for the patient and thus a transfusion is both illogical and creates additional hazards for the patient.

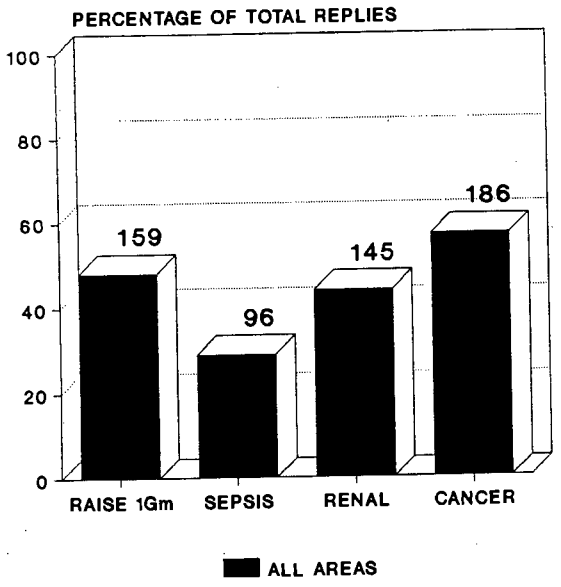
Most patients can be allowed to bleed isovolaemically down to a haematocrit of 30% before transfusing. The haematocrit is a simple and reliable test to perform during an operation and serial haematocrit readings should be used as an objective measurement of blood loss when deciding when to transfuse. Unfortunately only 24% of respondents used a haematocrit of 30% as their guideline for blood volume replacement. This indicates poor anaesthetic practices which reflects badly on the academic Departments.

The use of serial haematocrit estimations should be taught and encouraged. The estimation of blood volume loss as the only manner of calculating when to commence blood replacement should be discouraged.

KNOWLEDGE OF BLOOD PRODUCTS

There is a poor knowledge about blood as gauged by certain of the survey questions. Thus only 48% of respondents knew that one unit of blood raised the haemoglobin level by 1g/dl. Suppression of the immune system by a blood transfusion was also incorrectly answered by the majority of respondents. Similarly on average only 30-40% of respondents knew the cost of the main blood components and 40-50% did not know how disease transmission compared between whole blood and other products.

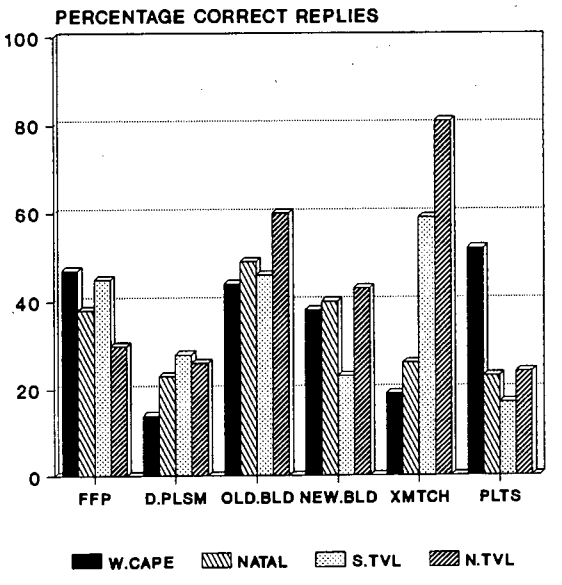
CORRECT REPLIES



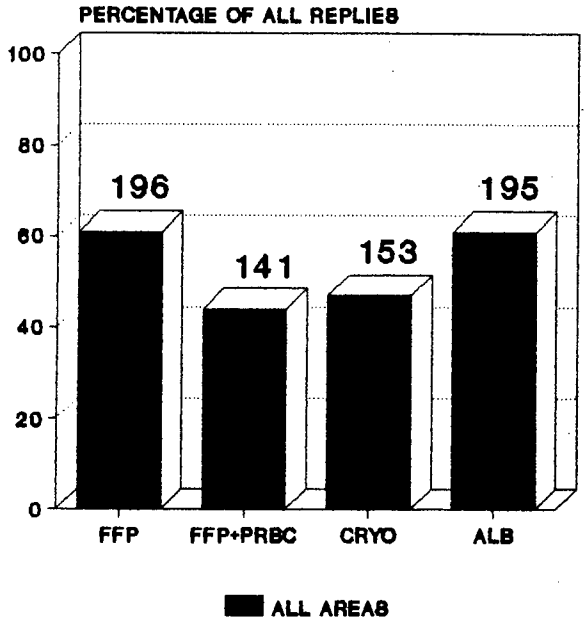
Note that the majority of respondents answered incorrectly the questions regarding the level of haemoglobin rise with one unit of blood and the effects of immune suppression with a blood transfusion.

Note that the majority of respondents in all areas did not know the costs of blood or blood components.

COST KNOWLEDGE
CORRECT REPLIES BY AREA



INFECTION
CORRECT ANSWERS



Note that the majority of respondents did not know about the increased risk of transmission of infection with FFP + PRBC and cryoprecipitate. 40% did not know albumin carries no risk for disease transmission.

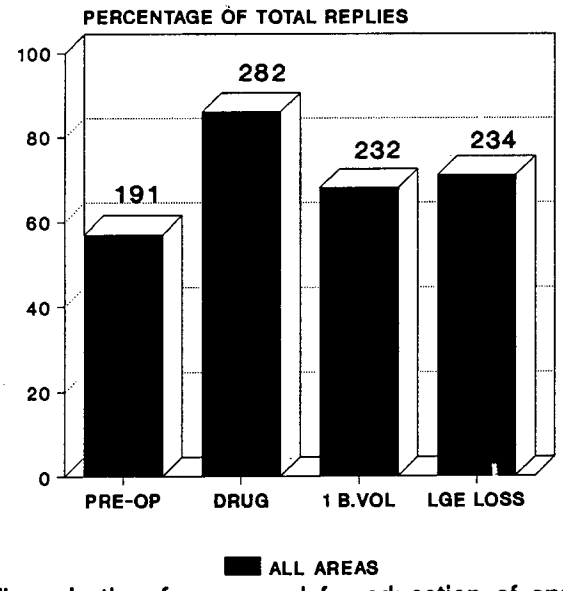
The above results clearly indicate a need for education of the anaesthetists about blood transfusion. This should occur at Departmental level and should include the costs and the dangers of transfusion.

PLATELETS

The replies regarding the usage of platelets were, on the whole, satisfactory. However, 109 respondents (68 with less than 6 years experience) would require pre-operative platelet levels of more than 100,000/μl and 26 (13 with less than 6 years experience) would require levels of more than 150,000/μl. This would mean unnecessary pre-operative platelet transfusions in patients who had normal bleeding times if these pre-operative "out-off" levels were adhered to.

The knowledge of how much six random units of platelets would raise the platelet count by (60,000/μl) and how much these cost was poor. Only 48% and 36% of respondents respectively indicated the correct answer

PLATELET USE
CORRECT REPLIES



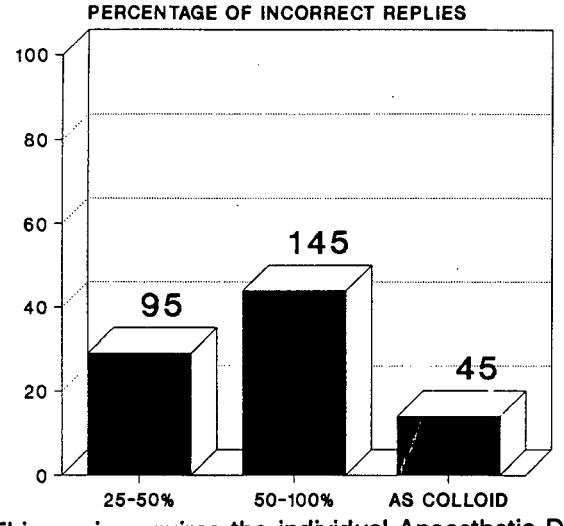
Note that the majority of respondents were within recognised guidelines for the use of platelets regarding: the acceptable pre-operative platelet number; and whether or not to have platelets available for the presence of a platelet inhibiting drug; one blood volume replacement, or a large blood loss.

There is therefore a need for education of anaesthetists about indications for and costs of platelet transfusion.

FRESH FROZEN PLASMA

As also reported in the literature (see Chapter Seven) FFP appears to be overused during replacement for blood loss. The fact that dilutional coagulopathy does not normally occur before 1,5 to 2 blood volumes have been transfused was not appreciated by the majority of respondents. Also 14% of respondents use FFP incorrectly as a colloid solution.

FFP USAGE
INAPPROPRIATE REPLIES

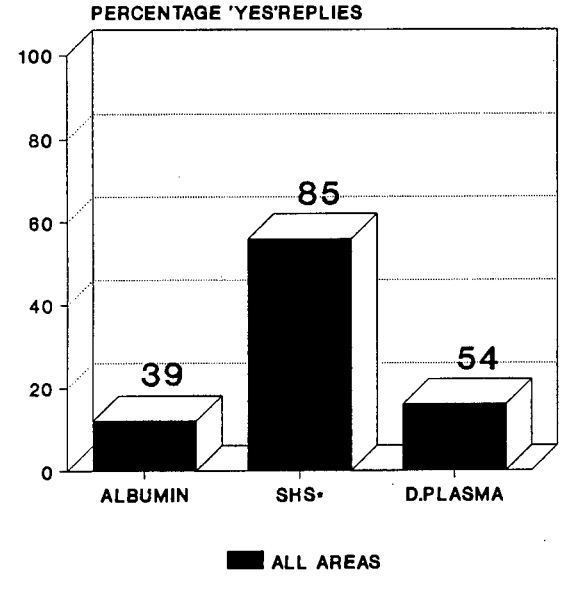


Note that a significant number of respondents transfuse FFP with relatively small blood transfusions. 14% use FFP as a colloid.

This again requires the individual Anaesthetic Departments to reassess their policy for FFP usage and rationalise it, where necessary.

COLLOID USE

Blood products were used as colloids by some anaesthetists in the survey.



Note that 12% of respondents used albumin. 16% used dried plasma and 56% in the Western Cape used SHS as a colloid when safer and cheaper synthetic substitutes are available.

*-W.CAPE ONLY

The use of blood products as colloids needs to be addressed by the various Anaesthetic Departments with recommendations being made for their members. The use of cheaper and safer synthetic colloids should be encouraged where a colloid and not red blood cells is indicated. In the survey 83% of respondents used the colloid Haemaccel which was widely available in the teaching hospitals visited.

RECOMMENDATIONS

RECOMMENDATIONS BASED ON THE SURVEY

1. Education

South African anaesthetists need to be reminded of the correct usage of blood and blood components. To help achieve this I have developed a booklet on blood component therapy in the peri-operative period (Appendix 3). I hope this booklet, if made available, will partly address this problem.

2. Blood User Committees

These need to become more active in the auditing of the use of blood and components in the peri-operative period. It does however require an enthusiastic team to work out protocols and follow up individual cases where blood or blood components may have been misused.

Suggestions

Blood Transfusions

Any patient receiving a transfusion with RBC's should have a haemoglobin or haematocrit within 24 hours of the end of the transfusion. The post-operative value should not be greater than the pre-operative value. It has been suggested that the haematocrit should not exceed 36% in the intra-operative or 33% in the post-operative period (**Giovanetti et al, 1988**).

Cross Matching

The cross match to transfusion ratio should be examined continually. Where excessive blood is ordered pre-operatively an explanation should be sought by the Blood Bank from the doctor in charge of the case. Where consistently less blood is used than ordered for a specific operation the MSBOS for that operation should be revised. The GS.H. recommended MSBOS guidelines (Appendix 2) have also been added to the educational booklet (Appendix 3).

Platelets

Patients should have low platelet counts and evidence of abnormal bleeding prior to platelet transfusion. The charts of patients receiving platelet transfusions should contain a platelet count within 18 hours following transfusion.

Fresh Frozen Plasma

Patients receiving FFP or dried plasma should have had a PT and a PTT or specific coagulation factor assay immediately before and within four hours of FFP transfusion.

The Committee should be able to access the files of patients who have had blood or blood component transfusions to evaluate the indications and appropriate usage.

3. Autologous Transfusion

The Blood User Committee should set standards and undertake education regarding autologous donations either by intra-operative haemodilution, or scavenging, or pre-donation of blood by the patient in the weeks leading up to elective surgery.

4. Research

Further research, of relevance in South Africa, which needs to be undertaken includes:

1) Assessing the safe minimum acceptable haemoglobin level of patients for elective procedures especially at altitude.

2) Finding the correct dosage of FFP which will have clinical significance during massive transfusion. This is of particular importance in areas such as the Western Cape where the FFP is cryoprecipitate poor.

It is hoped that the information accumulated in this survey, plus the knowledge I have tried to impart during my lectures around South Africa, will help to focus on what are becoming increasingly scarce but nonetheless life-giving products.

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REFERENCES

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APPENDICES

1. Survey Questionnaire

2. Groote Schuur Hospital Recommended Maximum Blood Ordering Schedule

3. Educational Booklet for Anaesthetists and Surgeons

   "Blood Component Therapy in the Peri-operative Period"

UNIVERSITY OF CAPE TOWN

Department of Anaesthetics

Medical School, Observatory
Cape, South Africa 7925
Telephones: Medical School: 47-1250 Ext. 143
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Head & Professor of Department: **M.F.M. James**, MBChB(Birm), FFARCS(Eng)

SURVEY OF SOUTH AFRICAN ANAESTHETISTS

USE OF BLOOD COMPONENTS

M.MED. THESIS

Dr. Gordon Irving, MB.BS, MSc(Med.) FFA(SA)
Registrar in Anaesthesia
Groote Schuur Hospital, Cape Town

As anaesthetists administer at least 50% of red blood cell products used in some countries, I thought it would be of value and relevance to investigate the transfusion practices and knowledge of blood component therapy amongst South African Anaesthetists.

The survey is not intended to be an inquisition into an individual anaesthetists' practices, but to ascertain if there are wide differences between recommended schedules and what is commonly practiced. If there are large differences, it should surely be beholden to us anaesthetists to rationalise the use of what can be a life saving, but certainly not innocuous, form of therapy.

I would, therefore, be grateful if you would take the time to fill in the appropriate box(es) opposite the answer you consider to be correct and post it to me in the enclosed pre-paid addressed envelope. Please do not refer to textbooks or colleagues with regards to the answers. I would prefer to know what you would do, or your level of knowledge, AT PRESENT. Full results of the survey and recommendations will be published in due course.

ALL QUESTIONS RELATE TO ADULTS UNLESS OTHERWISE STATED.

Many thanks,

Signed

GORDON IRVING

QUESTIONNAIRE

Date:

NAME

AREA W. Cape; E. Cape; Natal Coast; Natal Inland; N. Tvl; S. Tvl; OFS; SWA.

Please mark with a tick in the appropriate box(es).

1. Time in anaesthetic practise

- Less than 5 years ☐
- 6-20 years ☐
- More than 20 years ☐

2. Employer

Are you employed by the State ☐ Yes ☐ No

If **yes** are you: part-time ☐ full-time ☐

Are you in a teaching hospital ☐ Yes ☐ No

Section 1 - Pre-operative

3. For a non-emergency, asymptomatic patient on average, what is your minimum pre-operative haemoglobin level which you consider to be adequate for elective minor surgery?

a) No requirement if blood volume considered normal ☐

b) 8g/100ml ☐

c) 10g/100ml ☐

d) 12g/100ml ☐

4. What course of action would you take in the following cases:

	Transfuse Pre-op	Administer General Anaesthetic	Require Blood Cross Matched
a) A healthy three-month-old patient for hernia repair haemoglobin 9,2g/100m	☐	☐	☐
b) 15 year-old male with sickle cell anaemia for arthroscopy of the knee, haemoglobin 7,5g/100ml	☐	☐	☐
c) 30 year-old female with menorrhagia for a D & C, haemoglobin 8,5g/100ml	☐	☐	☐
d) 45 year-old male with end stage renal disease for creation of an arterio-venous fistula in the arm, haemoglobin 6g/100ml.	☐	☐	☐

5. For a non-emergency case, on average, what is the maximum pre-operative haemoglobin level above which you would suggest postponing the operation?

a) No maximum requirement ☐

b) 17-18g/100ml ☐

c) 18-19g/100ml ☐

d) 19-20g/100ml ☐

6. For a non-emergency case what is the minimum level of platelets you would consider to be adequate for elective surgery?

a) No minimal requirement ☐

b) More than 50,000 ☐

c) More than 75,000 ☐

d) More than 100,000 ☐

e) More than 150,000 ☐

7. For which of the following circumstances do you require that platelets are available pre-operatively (not extra-corporeal operation)?

a) Platelet inhibiting drug ☐

b) One estimated blood volume replacement ☐

c) Platelet count less than .....

d) Procedure usually associated with large blood loss ☐

8. On average in patients with thrombocytopoenia how much would you expect six units of random collected platelets raise the platelet count by?

a) 24,000 ☐

b) 60,000 ☐

c) 90,000 ☐

d) Don't know ☐

9. On average in patients with anaemia how much would you expect one unit of blood to raise the haemoglobin?

a) 0,5g/100ml ☐

b) 1g/100ml ☐

c) 1,5g/100ml ☐

d) Don't know ☐

10. A haemophiliac (Type A) presents for an elective dental clearance under general anaesthetic. What is the minimal level of Factor VIII you would consider necessary prior to operation?

a) More than 25% ☐

b) More than 50% ☐

c) More than 75% ☐

d) 100% ☐

11. An average of how many units of blood would you cross-match for the following procedures? Assume it is an elective procedure in a patient with a normal haemoglobin pre-operatively.

	*Group & Hold	1 Unit	2 Units	4 Units	More than 4 Units
a) Abdominal aneurysm resection	☐	☐	☐	☐	☐
b) Total hip replacement	☐	☐	☐	☐	☐
c) Nephrectomy	☐	☐	☐	☐	☐
d) Hysterectomy (Vaginal, Abdominal)	☐	☐	☐	☐	☐
e) Thryoidectomy	☐	☐	☐	☐	☐
f) Cholecystectomy	☐	☐	☐	☐	☐
g) Colon resection	☐	☐	☐	☐	☐

*** Group & Hold or Type & Screen**

12. Does your hospital have a Maximum Surgical Blood Order Schedule? (i.e. recommendations for maximum blood ordering for elective operations)

Yes ☐ **No** ☐ **Don't know** ☐

Section II - During Operation

13. Which methods of blood loss assessment do you usually employ during major abdominal surgery? (Tick as many as you use)

a) Visual estimation ☐

b) Measuring suction bottles ☐

c) Weighing swabs ☐

d) Serial haemoglobin estimation ☐

e) Serial haematocrit (PCV) estimation ☐

14. During an operation NOT normally requiring blood replacement which of the following best describes your approach? (Tick only one)

a) Replace when blood loss is, or will be, by the end of the procedure 10% of estimated blood volume: ☐

b) Replace when blood loss is, or will be, by the end of the procedure, 20% of estimated blood volume ☐

c) Allow the patient to bleed to a haematocrit of 30% before transfusing: ☐

d) In adults administer blood only if more than one unit is required ☐

e) Administer blood only if vital signs change e.g. blood pressure drops or pulse rate increases significantly ☐

15. Under what circumstances do you administer Fresh Frozen Plasma (FFP)?

a) Blood replacement is between 25-50% estimated blood volume ☐

b) Blood replacement is between 50-100% estimated blood volume ☐

c) Only on the basis of abnormal clotting studies ☐

d) As a colloid volume substitute when red blood cells are not required ☐

16. What colloid volume substitute do you usually use if red blood cells are not required?

a) Albumin ☐

b) Stablised Human Serum ☐

c) Haemaccel ☐

d) Dextran 40 ☐

e) Dextran 70 ☐

f) Dried Plasma ☐

g) Fresh Frozen Plasma ☐

h) Other (Specify) _____

17. Do you use autologous blood scavenging replacement techniques?

Occasionally ☐ Frequently ☐ Never ☐

18. When would you use micro-aggregate (effectively removing particles in the 10-30μm range) blood filters?

a) With every unit blood transfused ☐

b) If transfusing more than ..... units

c) Only with extra-corporeal circulation ☐

d) Never ☐

General Questions

19. What risk do the following blood products have of carrying transmissable disease when compared to one unit of whole blood?

	More Risk	Less Risk	Same Risk	Don't Know
a) Unit of fresh frozen plasma (FFP)	☐	☐	☐	☐
b) 1 Unit FFP plus 1 Unit pre-packed red blood cells	☐	☐	☐	☐
c) 1 Unit Cryoprecipitate (AHF 500 units)	☐	☐	☐	☐
d) 100ml Albumin	☐	☐	☐	☐

20. What is the cost to the hospital of the various blood components?

	Less than 50R	R50-75	R75-100	R100-300	R300+
a) Fresh Frozen Plasma	☐	☐	☐	☐	☐
b) Dried Plasma	☐	☐	☐	☐	☐
c) Whole Blood (>96 hours)	☐	☐	☐	☐	☐
d) Whole Blood (<96 hours)	☐	☐	☐	☐	☐
e) Cross-match cancelled	☐	☐	☐	☐	☐
f) Megapack platelets	☐	☐	☐	☐	☐

21. Please answer the following questions **True** or **False** or **Don't know**:

	True	False	Don't know
a) Blood transfusions increase the post-operative sepsis rate	☐	☐	☐
b) Blood transfusions improve long-term renal transplant survival rate	☐	☐	☐
c) Blood transfusions worsen the prognosis in certain cancers being operated upon (Colon, Breast, Lung, Sarcomas)	☐	☐	☐

22. Within the last five years have you ever received incorrectly labelled blood (wrong patient or wrong folder number)?

Yes ☐ No ☐

If **Yes** - how many times over the last 5 years?

Once ☐ ~~more~~ < than 3 ☐ 3-9 times ☐ more than 9 times ☐

15.6.89
/sg

BLOOD COMPONENT THERAPY

IN THE PERI-OPERATIVE PERIOD

FOR ANAESTHETISTS AND SURGEONS

By: Gordon Irving, MB BS, MSc(Med), FFA(SA)
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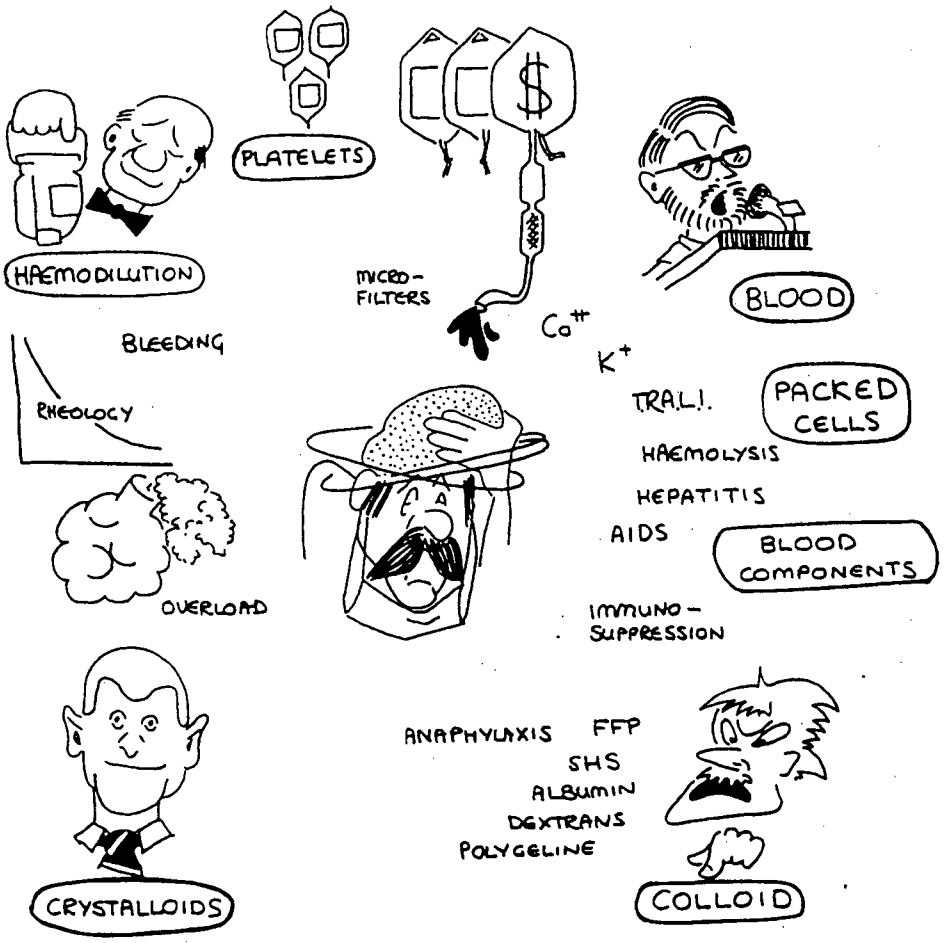
Cartoons by: Ben van der Veen, MBChB, DA(SA), FFA(SA)

It's not ignorance

But the illusion of knowledge

That many anaesthetists resort to

When using blood components



BLOOD TRANSFUSION : GENERAL INFORMATION

Whole blood

One unit of whole blood contains approximately 450ml of blood and 63ml of preservative. The haematocrit ranges from 36-40%. If mixed with Citrate Phosphate-Dextrose (CPD) preservative it has a shelf life at 1-6°C of 21 days and 35 days if mixed with CPD-A (Adenine). There should be more than 70% red blood cell survival at the end of the storage period with surviving cells having a normal life span. Whole blood stored over 24 hours has few viable platelets or granulocytes. 25% of Factor VIII remains after 24 hours and 50% of Factor V after 14 days. All the remaining factors remain relatively constant during storage.

Packed red blood cells

These are prepared by removing 200-250ml of plasma. If stored with ADSOL (Adenine, saline, glucose and mannitol) the shelf life is 42 days with a haematocrit of 60% which gives an adequate flow for rapid infusion. If stored with residual CPD or CPD-A this results in a haematocrit of 70-80% which may have to be diluted with normal (0,9%) saline or, in special circumstances, albumin or compatable human plasma, to improve flow characteristics. Hypotonic solutions (e.g. 5% Dextrose in water) will cause haemolysis and other solutions containing calcium (e.g. Ringer's lactate) may initiate *in vitro* coagulation of the citrated blood. Thus these solutions must NOT be mixed with citrated red blood cells.

Time limits for transfusion

Any unit of blood, if not used, must not be allowed to warm up above 10°C or it cannot be reissued by the blood bank because of the risk of bacterial contamination. The rate of infusion depends on the clinical condition of the patient but should not be longer than four hours.

Filters

Changing the 170μm blood filter every four hours is recommended. The use of a microfilter (20-40μm pore size) is only recommended for use during cardiopulmonary bypass as microaggregate debris has not otherwise been shown to cause clinically significant problems.

Blood warming

Ideally all blood should be warmed when given during an operation to try and limit the fall in body temperature associated with general anaesthesia. However there is no evidence that patients receiving 1-3 units of blood over several hours receive any additional benefit from blood warming. Where possible blood should be warmed with a commerically available blood warmer which limits the temperature to 40°C. A higher temperature may cause haemolysis. Blood should definitely be warmed where*:

1) Adult patients receive rapid and multiple transfusions (rate over 50ml/Kg/hr)
2) Exchange transfusions in infants
3) Children receiving blood in volumes in excess of 15ml/Kg/hr
4) Patients with cold agglutinins active *in vitro* at 37°C
5) Rapid infusion through central venous lines

*American Association of Blood Banks recommendation

Medication into blood units

Medication should never be added to blood units as:

1) It may cause haemolysis if the drug has a high pH
2) A drug reaction would be impossible to differentiate from a blood transfusion reaction
3) Any blood reaction necessitating stopping the transfusion would mean the full dose of drug not being administered.

WHOLE BLOOD & PACKED RED BLOOD CELLS TRANSFUSION

PRE-OPERATIVE TRANSFUSION

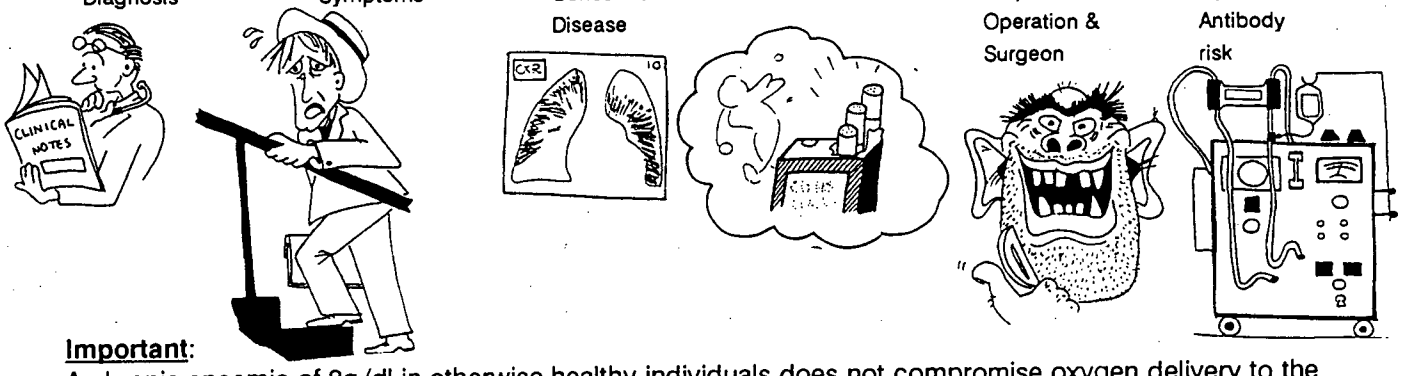
Pre-operative anaemia clinically significant?

|

Decision based on

|

Diagnosis | Symptoms | Concomitant Disease | Smoker | Proposed Operation & Surgeon | Cytotoxic Antibody risk



Important:
A chronic anaemia of 8g/dl in otherwise healthy individuals does not compromise oxygen delivery to the tissues during operation.

Transfusion required to raise haemoglobin level 1g/dl:
4 ml/Kg body weight Packed red blood cells
6 ml/Kg body weight Whole blood

Optimal Blood Ordering:
Group and screen where blood may be required. Cross-match, which is approximately twice the cost of Group and screen, where blood will be required. Use a Maximum Surgical Blood Ordering Schedule as a guideline.

Optimal Peri-operative haematocrit/haemoglobin: 27-33% (9-11g/dl)

PERI-OPERATIVE TRANSFUSION:

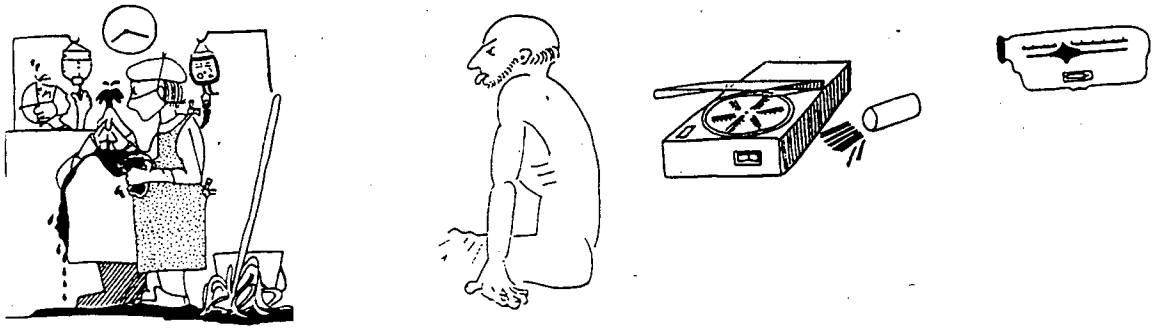
Blood Loss Significant

|

Decision based on

|

Present blood loss | Expected blood loss | Patient's acceptable haemogolobin | Haematocrit | Haemoglobin



PRE-OPERATIVE ANAEMIA - IS IT CLINICALLY SIGNIFICANT?

Pre-operative assessment of Anaemia:
A healthy person can tolerate anaesthesia safely with a chronic anaemia of 8g/dl or even less. However, for each patient, an ACCEPTABLE HAEMOGLOBIN limit should be set. This is the haemoglobin level which one will allow the patient to bleed down to isovolaemically during the operative period, without transfusing blood. This limit is based on:

1. Cause of the anaemia?
   This diagnosis may have a direct bearing on the anaesthetic risk. Sub-acute bacterial endocarditis causes anaemia and is, itself, an absolute contra-indication to all but the most urgent surgery. Iron deficiency and malnutrition compromise the immune system and may prolong recovery. Liver thyroid and renal disease may all produce anaemia and may have a profound effect on the anaesthesia if not recognised pre-operatively.

2. Chronicity
   Chronic anaemia implies a normal blood volume with the red blood cells having a right shift on the haemoglobin disociation curve due to increased 2, 3 DPG (Diphospho-glycerate). The haematocrit will be lower and there is a decreased viscosity which, together with a concomitant vasodilation may improve oxygen tissue oxygenation to the various organs.

   Acute anaemia implies sudden blood loss due to trauma or rupture of a blood vessel e.g. ruptured ectopic pregnancy. The initial haemoglobin in these cases may be a poor indicator of the degree of blood loss but, taken in conjunction with the clinical signs of pulse, blood pressure, urine output and specific gravity, peripheral skin temperature and mucous membrane colour it allows an estimate of the total blood deficit to be made. Any acute blood loss if clinically significant should be treated by intravenous transfusion. Clear fluid replacement is adequate unless haemoglobin levels are 9 or less, when blood should be given because of the risk of dilutional hypoxia[1].

3. Symptoms of Anaemia
   These include dyspnoea on effort, excessive tiredness, weakness and tachycardia at rest. They occur at different haemoglobin levels depending on concomitant medical disease. In the otherwise healthy individual mild, chronic anaemia (9-11g%) may cause only pallor and tachycardia on exertion. A level of 7-8g% causes dyspnoea on exertion, 6g% weakness, 3g% dyspnoea at rest and 2-2,5g% may cause congestive cardiac failure. Age affects the level of haemoglobin necessary to cause symptoms. Children appear to be remarkably resistant to the effects of anaemia, whereas the elderly may not tolerate even minor reductions in haemoglobin level.

   Any symptoms which are associated with anaemia should be noted and where appropriate the anaemia should be corrected prior to surgery.

4. Concomitant Disease
   A history of myocardial ischaemia, peripheral vascular disease, cerebrovascular disease, or severe obstructive airways disease, will affect the tolerance of the individual to anaemia. Thus a higher minimal level of haemoglobin must be maintained in these patients than in the healthy individual. Severely wasted or elderly patients may be chronically dehydrated, giving a falsely high haemoglobin estimation. If the blood volume is not expanded prior to induction of a general anaesthetic, a marked fall in blood pressure may occur with significant ischaemic sequelae.

5. Smokers
Heavy cigarette smokers who continue to smoke up until the operation and will continue in the early post-operative period will have a significant leftward shift of the haemoglobin dissociation curve due to carbon monoxide "poisoning". They are also mildly haemoconstricted giving a falsely high haemoglobin reading and a tendency to hypotension with the vasodilation effect of an anaesthetic. This group of patients is also at a higher risk of ischaemic heart disease, obstructive airways disease, and cerebrovascular disease. Thus anaemia will be more poorly tolerated. Where feasible cigarettes should be stopped for 24-48 hours prior to operation.

6. Type of Operation
The extent of the operation, the expected blood loss and the surgical skill of the operator must be taken into account when considering the minimal acceptable haemoglobin levels.

7. Danger of Antibodies
In certain diseases such as end stage renal failure, the risk of creating cytotoxic antibodies with future difficulty in finding a compatable donor, as well as the danger of overload are present. A much lower haemoglobin (5-8g/dl) is therefore usually accepted in this group of patients going for elective surgery.

TREATMENT OF ANAEMIA

Based on the above clinical observations is the pre-operative anaemia clinically significant: If the answer is 'yes', the question to ask is whether the operation is: not urgent, semi urgent, or urgent.

1. Not Urgent Surgery
Patients with a haemoglobin of 8g/dl or less without symptoms of hypovolaemia or hypoxia should be investigated for a nutritional reason for their anaemia, such as iron deficiency, pernicious anaemia, intestinal malabsorption, or hereditary haemolytic anaemia. Nutritional therapy with postponement of their operation and not transfusion is the more appropriate treatment.
Iron deficiency, the most common type of nutritional anaemia, should be treated with 4-5mg/Kg/day of elemental iron, three times a day. Because of gastrointestinal intolerance the dose should be built up gradually. As the marrow of a severely iron deficient patient needs time to 'wind-up' to produce red blood cells, a delay of up to 7-10 days may occur before a rise in haemoglobin is noted. This rise should be of the order of 1-2g/week.

2. Semi Urgent Surgery
Pre-operative transfusion should be by packed red blood cells given slowly (4 hours per unit), 1-2 days prior to the operation to allow time for normalisation of fluid shifts. A diuretic may be ordered if there is a risk of cardiopulmonary embarrassment.

3. Urgent Surgery
If the anaemia is chronic i.e. normal blood volume, the transfusion should be commenced with packed red blood cells. If the anaemia is acute, as a result of haemorrhage, rapid replacement with whole blood should be commenced if the patient shows signs of shock, i.e. pulse >100 b.p.m., BP <100mm Hg systolic, skin periphery cold, mucous membranes pale, oliguric or a haemoglobin of 9g/dl or less. Isovolaemia should be maintained and central venous pressure lines or even Swan Ganz catheters may be required for monitoring.

How much blood to transfuse?

To raise the haemoglobin 1g/dl requires: 4 ml/Kg body weight of packed red blood cells; 6 ml/Kg body weight of whole blood.

Optimum blood ordering for the operation

Every hospital should have a Maximum Blood Ordering Schedule (MBOS) (see Appendix 1) which consists of a list of the recommended maximum number of units of blood which should be cross-matched pre-operatively for most commonly performed surgical procedures. Although this guideline may vary between institutions they are usually remarkably similar. Using a MBOS should reduce excessive ordering of blood and wastage of valuable Blood Bank personnel's time.

Blood should be ordered as Group and Screen (Type and Screen) when doubt occurs if blood will be required. This consists of ABO and Rhesus typing plus a screen for unexpected, significant antibodies in the recipient's blood. The test takes about 1 hour. Blood administration following a negative antibody screen is 99,99% safe as regards having an incompatable transfusion[2]. However, most Blood Banks prefer to complete a full cross-match (± 1 hr), if time allows, prior to releasing the blood for transfusion.

Blood Transfusion during operation

The maintenance of isovolaemia by replacement of 1 ml of colloid or 2-3 ml of crystalloid for every 1 ml of blood loss should be routine throughout any operation. The extent of the blood loss is estimated by various means: visual assessment of blood on drapes and swabs; blood in the suction bottles; weighing swabs and by serial haemoglobin and haematocrit estimation. These latter two techniques are probably the most accurate although all the methods have drawbacks.

Optimal haematocrit/haemoglobin values

The haematocrit value at which peak oxygen transport occurs has been reported to be about 30% (Hb 10 g/dl). A study of critically ill post-operative patients found a maximal survival rate in those patients who had a haematocrit between 27 and 33% (haemoglobin 9-11 g/dl)[3].

Mild anaemia (Hb 9-11 g/dl) is not associated with peri-operative morbidity or poorer surgical healing. The frequency and severity of post-operative infections and the incidence of increased bleeding is also not increased with anaemia.

Whole blood versus Packed cells

Packed red blood cells can be used as equivalent to whole blood for up to 3-4 units of blood loss replacement. After this volume whole blood should be used because of the need for the coagulation factors present in the stored plasma.

Fresh and old blood

The term *fresh blood* varies with the Blood Banks but often means less than 96 hours old. *'Super fresh* means less than 24 hours old. However *superfresh* blood is rarely available because of the time required to do ABO and rhesus typing, screening for atypical antibodies and completing hepatitis and HIV testing. Blood older than 24 hours has very few functioning platelets and labile factors V and VIII are diminishing rapidly. There is little advantage for *fresh* blood against *old* blood except in massive, rapid transfusions when blood less than 10 days old should be used to limit the amount of potassium load transfused.

BLOOD PRODUCTS : DANGER - HANDLE WITH CARE

Possible adverse effects of any transfusion:

1. INFECTION
   - Viruses - hepatitis B; Non-A, Non-B*; Cytomegalovirus*; HTLV 1 & 2*; Epstein Barr*; HIV**.
   - Protozoa - Toxoplasmosis*, Malaria*
   - Bacteria - Syphilis

   *Not routinely tested for by the Blood Bank

   **patient with HIV may never seroconvert. HIV testing is negative but the blood product is infective.

   The following products have the same risk of infection transmission as 1 unit of whole blood: 1 unit packed RBC; 1 unit FFP and 1 unit platelets. The following carry a much higher risk because they are produced from pooled donors; cryoprecipitate, factor concentrates and megapack platelets (six random units).

2. IMMUNOLOGICAL DEPRESSION : When blood is transfused the immune system is suppressed causing: decreased five year survival and increased metastatic spread for cancer operations of colon, rectum, lung, breast and soft tissue sarcomas; an increased survival for renal transplants and an increased sepsis rate. Possible reasons are: activation of T suppressor lymphocytes, lowering circulating fibronectin and depression of Natural Killer cell activity.

3. ALLOIMMUNISATION : To red cell and leucocyte antigens. The commonest source of serious or fatal haemolytic reaction is human error between taking blood and giving it to the patient. Reactions vary from mild fever chills and urticaria (1:100) to fatal (1:100,000 in USA).

4. TRANSFUSION RELATED ACUTE LUNG INJURY (T.R.A.L.I.) : Acute pulmonary oedema due to leukoagglutinins in the recipients or the donor's blood. Within 2-4 hours of transfusion the patient develops respiratory distress, hypoxia, hypotension, fever and a chest x-ray picture of pulmonary oedema but with no signs of circulatory overload. 75% of patients will need mechanical ventilation and the chest is usually clear within 48 hours (incidence 1:5000).

5. ANAPHYLAXIS : Probably caused by antibodies against plasma proteins WBC's and platelets.

6. OTHERS : These include impaired red blood cell deformability, infusion of plasticizers, infusion of denatured proteins and vasoactive substances, graft vs host reactions, toxicity of new products, elevated ammonia and phosphate. In practice their effects are usually clinically insignificant but may be important in explaining some adverse reactions.

Treatment of acute transfusion reactions
(A.A.B.B. recommendations)[4]

1. **Immediate Steps For All Reactions:**
   a) Stop transfusion
   b) Keep I.V. open with 0.9% NaCl
   c) Notify attending physician and blood bank

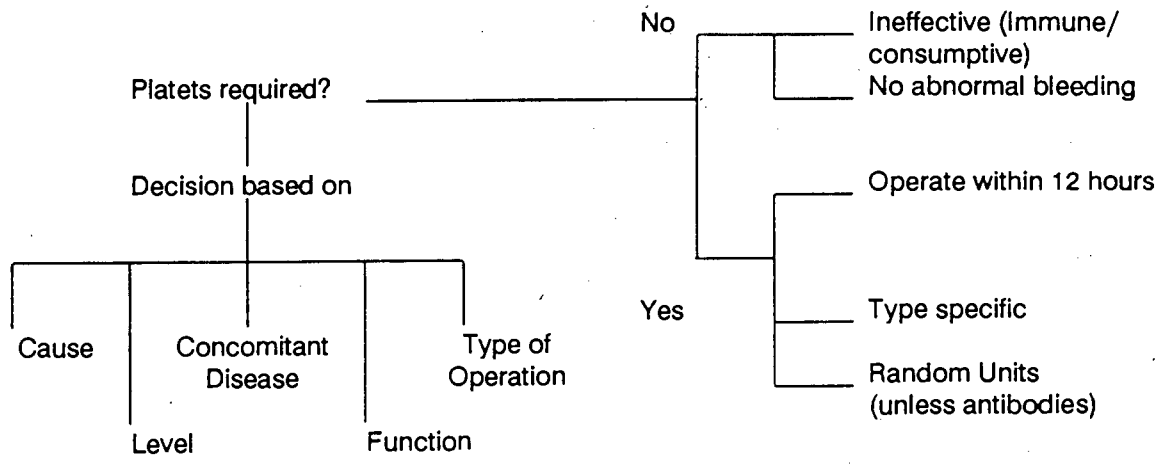
   if transfusion is terminated:
   d) Send freshly collected blood and any necessary urine samples to blood bank
   e) Send blood unit and administration set to blood bank.

Reaction Type	Signs and Symptoms	Aetiology	Clinical Action
Allergic	pruritus, urticaria (hives)	antibodies to plasma proteins	Steps (a)-(c) (above); administer antihistamines (PO, IM or IV); resume transfusion. If no improvement in 30 mins treat as below
Allergic or Febrile	anxiety, pruritus, fever, chills, agitation, flushing, hives, tachycardia, mild dyspnoea, hypotension, anaphylaxis	antibodies to WBC, platelets, plasma proteins - including antibodies to 1gA	Steps (a)-(e) (above; administer antihistamines, antipyrectics, vasopressors and corticosteroids as needed; avoid reactions with washed cells or other specifically prepared components
Acute Haemolytic	anxiety, chest pain, flank pain, headache, dyspnea chills fever, red urine, agitation, shock, hypotension, unexplained bleeding, haemoglobinaemia	gram negative sepsis from blood transfusion; intravascular haemovascular haemolytic transfusion reaction	Steps (a)-(e) (above); treat shock with vasopressors, IV with corticosteroids as needed; maintain adequate airway, increase renal blood flow (IV fluids; furosemide, mannitol); maintain brisk diuresis; if DIC is present consider heparinization; renal status for acute renal failure requiring dialysis, administer blood components (platelets, plasma etc.) as needed

Possible adverse effects of massive transfusions:

1. Hyperkalaemia - The older the stored blood, the higher the potassium content. This increase is about 1mmol/l/day of storage (21 day old CPD. - A stored blood has a K^+ content of 21,7 mmol/l). This may be significant if the infusion rate is >1,5.2ml/Kg/min, monitor T waves and K^+ levels - Treatment IV calcium. After redistribution and warming K^+ rapidly re-enters red cells and potassium levels may become sub-normal.
2. Hypocalcaemia. Due to citrate lowering the ionised calcium levels. This effect is transient and lasts ± 10 minutes. May be significant if the infusion rate is > 1,5-2ml/Kg/min, monitor Q and T waves, treatment IV calcium.
3. Acid Base Derangements - metabolic acidosis initially, alkalosis later
4. Hypothermia
5. Haemoglobin Oxygen Dissociation - A low 2, 3 D.P.G. shifts the oxygen dissociation curve to the left and decreases oxygen availability to the tissue
6. Microembolisation - Shock in itself causes endogenous microemboli to form. Microfilters are not proven to be clinically effective except for use in coronorary bypass arterial lines
7. Dilutional thrombocytopaenia - Unusual below 2 blood volume replacements if normal platelet count and function initially - one whole blood volume replacement (10 units) with old blood lowers platelet levels only 30-40%
8. Dilutional coagulopathy - This is unusual if whole blood is transfused. Even with 1,5 blood volume replacements (15 units), enough labile factors V and VIII are still present to initiate clotting. Other clotting factors are stable and present inadequate amounts in stored blood.

PRE-OPERATIVE THROMBOCYTOPAENIA



Pre-operation - more than 55,000μl/l if no immune or consumptive cause

Test for function

Tenplate Bleeding Time - more than 10 minutes - (normal 2-9,5 minutes) means platelet dysfunction or lack

Dose: Single donor (donation by platelet-pheresis)
Raises platelet count 60-70,000/μl
Random donor - single unit raises platelet count 5-10,000/μl
Dose = 1 Random unit/10Kg body weight

PLATELETS - GENERAL INFORMATION

Random Donor:

Prepared from individual units of whole blood, each bag contains not less than 5,5 x 10^{10} platelets. Stored at 20-24°C with continuous agitation for up to 5 days depending on type of plastic blood bag. Each unit contains up to 50ml of plasma.

Repeated transfusions may cause alloimmunisation to HLA antigens which only responds to HLA matched platelets.

Single Donor:

These are collected from an individual donor during a 2-3 hour apheresis procedure. The platelets, collected in 200ml-500ml of plasma raise the recipients platelet count 30,000-60,000/μl (70Kg adult) which is the equivalent of 6-8 units of random donor platelet concentrates. Single donor platelets are usually reserved for patients with platelet antibodies or where the risk of HLA antibody formation is to be avoided.

The expected rise in platelets will be less if the patient has sepsis, DIC, splenomegaly, platelet auto or alloantibodies or is receiving chemotherapy.

Reactions:

Chills, fever and allergic reactions may occur. Avoid using non-steroidal antiinflammatories or aspirin containing compounds to treat any reactions because of the adverse effect on platelet function, acetaminophen, paracetemol and codeine may be used safely.

Rapid infusion may cause circulatory overload. Rhesis negative females of childbearing age should only receive Rh-negative platelet concentrates because of the small amounts of red blood cells in the concentrates.

Transmission of hepatitis and HIV viruses etc., risk is increased with pooled random donor units.

Filters:

Platelets can be administered through a standard 170μm blood filter at a rate of 1-2ml/min or as tolerated by the patient.

DILUTIONAL THROMBOCYTOPAENIA FOLLOWING MASSIVE TRANSFUSION

Although thrombocytopaenia is more commonly a cause of abnormal bleeding than clotting factor depletion following massive transfusion. In patients with a normal platelet count and function pre-operatively, after one blood volume replacement 35-40% of platelets usually remain. Thus the majority of patients who have rapid replacement of 1-2 blood volumes do not develop microvascular bleeding as a result of dilutional thrombocytopaenia. Therefore platelets should probably not be transfused for abnormal bleeding without evidence of a low platelet count or an increased bleeding time.

1. **PLATELETS:**
Whether to transfuse platelets peri-operatively depends on several factors:

a. Cause of the thrombocytopaenia
Patients with idiopathic thrombocytopaenic purpura, DIC, thrombotic thrombocytopaenic purpura, or haemolytic uraemic syndrome in general do not respond to platelet transfusions. In addition, platelets may be harmful because of the risk of transmission of infection.

Patients with increased platelet destruction and splenomegaly who are booked for splenectomy are not routinely transfused with platelets prior to the operation because of the platelets extremely short lifespan. After splenectomy platelet levels rapidly return to normal.

b. Level of thrombocytopaenia
The minimal recommended platelet level prior to surgery in most patients with haematological disorders is generally accepted as 50-75,000.

c. Concomitant Disease
Patients with advanced hepatic or renal insufficiency often have associated disorders of coagulation and platelet function. Platelet transfusion may be required pre-operatively to correct the bleeding time although there are few, if any, pertinent studies.

d. Platelet Function
Although there are hereditary causes of disorders of platelet function (thrombasthenia, Storage Pool Disease, Bernard Soulier Syndrome etc.,) clinically the commonest cause is drug induced. The drug often inhibits both primary platelet aggregation and the release mechanism. These effects are irreversible and the platelets are functionally deficient as long as the effective cohort survives (e.g. $\pm$ one week).

The doctor should be aware that the following drugs have been shown to cause platelet changes.[5] Many "over the counter" medications may contain substances such as aspirin which should be specifically asked about during the pre-operative work-up. Where possible the operation should be postponed for seven days until the effect of the drug has been eliminated.

Analgesics which are presumably 'safe' include codeine, paracetemol, opiates, propoxyphene and acetaminophen.

MEDICATIONS WHICH INHIBIT PLATELET FUNCTION[5]

1. Anti-inflammatory agents: aspirin, ibuprofen, indomethacin, phenylbutazone, naproxen, sulphin-pyrazone and congenors, sulindac, suprofen.

2. Anti microbials: amantadine, ampicillin, carbenicillin, cephalothin, methicillin, nitrofurantoin, penicillin gentamycin, streptomycin, ticarcillin.

3. CNS: amitriptyline and congenors, chlorpromazine, cyproheptadene, desmethylimiprame, imipramine, promethazine, reserpine, phenytoin, phenothiazines, phenobarbitone.

4. Adrenergic Blocking Agents: phentolamine, propanolol.

5. Miscellaneous: chloroquin, clofibrate, dextran, diphenhydramine, dipyridamole (Persantin), digoxin, gliclazide, heparin, papaverine, tolbutamide, corticosteroids, lithium, furosemide, colchicine, ethanol, caffeine, theophylline, antihistamines.

   Where one is unsure as to the effects of a drug on platelet functioning a Tenplate Bleeding Test should be performed. This consists of inflating a blood pressure cuff and maintaining it at 40mmMg. A template is used to produce one or two standardised cuts 1 x 9mm distal to the cuff. Blood is then blotted by filter paper every 30 seconds, taking care not to disturb any developing clot, until bleeding ceases. The normal bleeding time is 2-9,5 minutes, a bleeding time of 10 minutes or longer indicates platelet lack or dysfunction.

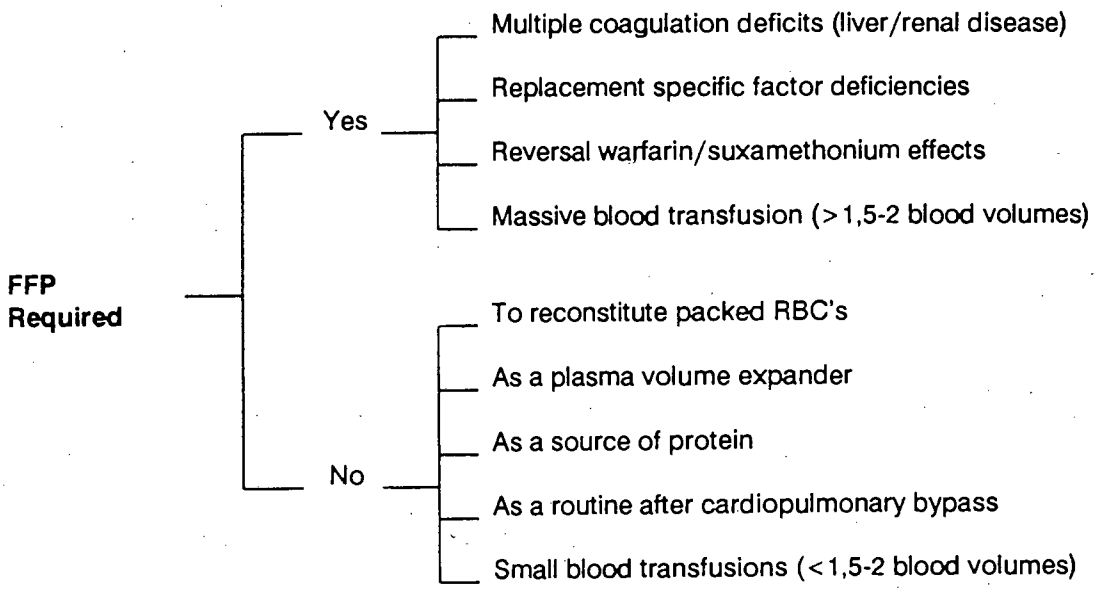
6. Type of Operation
   a) Neurosurgical: Even small bleeds into the central nervous system may have devastating effects. It is probably logical to raise platelet levels to correct any prolongation of the bleeding time prior to operation.
   b) Cardiopulmonary Bypass: Controlled prospective studies have demonstrated no correlation between platelet counts and bleeding following cardiopulmonary bypass, and no detectable benefit from prophylactic administration to such patients. Therefore there is no justification for prophylactic platelet transfusion in these patients except in certain patients with abnormal platelet function e.g. cyanotic heart disease.

Conclusion

Haemorrhage due to thrombocytopaenia is never rapid and there is usually time to check the platelet function or level and then order platelets if these are abnormal. Platelet transfusion is only urgent if the site of bleeding is critical e.g. brain or retina.

Platelets should not be administered pre-operatively in the absence of documented poor platelet functioning or thrombocytopaenia plus clinically abnormal bleeding[6].

FRESH FROZEN PLASMA (FFP)



Dose: As clinically required - monitor prothrombin and partial thromboplastin times
For massive transfusion related coagulation problems 800-1,000ml ± cryoprecipitate need to be given over 90-120 minutes (70Kg adult)

Cross matching: : ABO compatability with recipient important

FRESH FROZEN PLASMA - GENERAL INFORMATION

Fresh frozen plasma (FFP) is prepared from whole blood by separating and freezing the plasma within six hours of phlebotomy. It may be stored for up to one year at -180°C or lower. Under these conditions the loss of Factors V and VIII, the labile factors, is minimal. The usual volume is 200-250ml.

FFP should be thawed between 30-37°C with constant agitation and must be used within 24 hours of thawing to obtain maximum levels of coagulation factors. ABO compatible plasma should be used.

CRYOPRECIPITATE POOR FFP

Cryoprecipitate is prepared by thawing one unit of fresh frozen plasma at 40°C. After thawing, a white precipitate is formed (cryoprecipitate) which contains Factor VIIIC, Factor VIII:VWF (Von Willebrand's factor), fibrinogen, Factor XIII and fibronectin. The supernatant fluid is removed and refrozen at -180°C. The routine removal of cryoprecipitate from all units of FFP depends on the blood bank. Users of plasma should familiarise themselves with the local policy.

When cryoprecipitate poor FFP is required for multiple coagulation deficits or for pathological bleeding after massive transfusion (more than 1,5-2 blood volumes) cryoprecipitate should be transfused concurrently.

DRIED PLASMA

Plasma is separated from whole blood, usually when the blood is time expired and dried. It can be reconstituted with crystalloid solutions and has the advantage of a long shelf life without freezing. All stable clotting Factors are present (I, II, VII, IX, X, XII and XIII) but Factors V, VII and XI are deficient.

FILTER

A standard 170μm blood filter should be used.

MASSIVE TRANSFUSIONS

The main cause of pathological haemorrhage in patients receiving massive blood transfusion (more than 1.5 blood volumes rapidly) is thrombocytopaenia rather than depletion of coagulation factors. Thus FFP is not required in this situation.

Indications[8]:

- Multiple coagulation defects (e.g. chronic liver and renal disease)
- Protein losing enteropathy
- Reversal of warfarin effect
- Reversal of scoline (suxamethonium) apnoea
- Replacement of isolated factor deficiencies
- Certain immuno deficiencies
- Massive blood transfusion (>1.5 blood volumes or 15 units of blood in an adult)

Situations where FFP is **NOT** indicated[6 & 8]:

As a plasma volume expander
To reconstitute packed red blood cells
As a source of protein for nutritionally deficient patients
In the initial stages of treatment of Disseminated Intravascular Coagulation (DIC) where the primary therapy should be directed at the initiating disease process such as: sepsis, malignancy, hypotension or obstetrical complications
For small blood transfusions (<1.5 blood volumes or 15 units in an adult)
As a routine after cardiopulmonary bypass operations

Dose for Massive Transfusions:

800ml-2,000 (4 to 8 packs of FFP) for a 70Kg adult over 90-120 minutes. This causes a temporary but possibly significant improvement in clotting factors. Slower rates of infusion or smaller volumes of FFP have been found to be ineffective[9].

Problems with FFP:

Infection: one unit of FFP carries the same risk of disease transmission as one unit of blood
Hypervolaemia
Allergic reactions
Others - Each unit of FFP is hyperglycaemic (17,1mmol/l), hypernatraemic (168mmol/l) and hyperphosphataemic (3,1mmol/l) each may cause problems if large volumes are transfused.

COLLOIDS

	Type	½ Life	Problems	Recommended Uses
BLOOD DERIVATES	Albumin	5-10 days	25% solution very hyperosmolar Very expensive May not be readily available	Hypoalbuminaemic shocked states Protein losing enteropathy
	Stabilised Human Serum SHS (PPF)	5-10 days	Expensive Mild adverse reactions May not be readily available	As above plus certain immuno-deficiencies
	FFP or Dried Plasma		Infection transmission anaphylaxis	Not recommended for use as a colloid
SYNTHETIC COLLOIDS	Dextran 70	6-12 hrs	Platelet dysfunction Tissue dehydration anaphylaxis (Immunoglobulin mediated. Block by pre-load with HAPTEN 1) Maximum dose 1,5g/Kg/day (± 1500ml in average adult)	High risk deep vein thrombosis Shocked states where blood not indicated* Isovolaemic haemodilution* *Pre-load with HAPTEN 1 if available
	Dextran 40	2-3 hrs	Tissue dehydration Renal failure if dehydrated	High risk of deep vein thrombosis
	Haemaccel	3-5 hrs	Anaphylactoid (histamine release) block with anti H_1/H_2 drugs	Shocked states where blood not indicated Isovolaemic haemodilution

*Transfuse 1ml colloid for each 1ml blood loss

BLOOD DERIVATIVES

Albumin

Derived from donor plasma from outdated blood or plasmapharesis. It is heated to 60°C for 10 hours to inactivate viruses. It is free of transmissable diseases and has a long shelf life.

Albumin is available in 5% (Iso-osmotic with plasma) or occasionally 20% (hyperosmotic) solutions.

Indications:

Patients should be hypovolaemic AND hypoproteinaemic - it is readily metabolised in the liver and rarely stays in the circulation more than 24-48 hours in these patients.

Problems:

Hyperosmolar 25% albumin will cause a reduction of the extravascular (mainly intracellular) body compartment and is contraindicated in dehydration.
Expense
Hypervolaemia
Allergic reactions

Filter: No filter or crossmatching required.

Plasma Protein Fraction (PPF), Stabilised Human Serum (SHS)

Prepared in a similar way to albumin but with fewer fractionation steps. It contains about 83% albumin and 17% globulins. There is no risk of disease transmission with SHS. Shelf life is 5 years at 2-25°C if protected from the light.

Indications: Protein losing enteropathies, certain immunodeficiency diseases, reversal warfarin and suxamethonium, hypoalbuminaemic shocked states.

Problems:

Expense (about 4-5 times as expensive as synthetic colloids)
Hypervolaemia
Infusions of more than 10ml may produce hypotension due to both sodium acetate and Hageman factor fragments.

Filter: No filter or crossmatching required.

Dried Plasma and Fresh Frozen Plasma

Because of the risk of disease transmission and anaphylaxis neither FFP nor dried plasma should be used as a colloid replacement.

SYNTHETIC DERIVATIVES

Dextrans

These are produced by the action of the baterium leuconostoc mesenteroides on sucrose. The dextran molecule is composed of varying chain lengths of glucose polymers. They are classified according to molecular weight.

Dextran 70 - average molecular weight 70,000 prepared as a 6% solution in isotonic saline. It is hyperosmolar, a 500ml infusion will increase the intravascular volume by about 750ml.

Dextran 40 - average molecular weight 40,000 prepared as a 10% solution in isotonic saline. A 500ml infusion will increase the intravascular volume by about 1,500ml.

Both dextrans have a shelf life of 5 years at steady room temperature.

Half Life
Dextran 40 - 2 hours because of rapid renal excretion
Dextran 70 - 6-12 hours.

Dose
Limited to 1,5g/Kg body weight/day (<1,500ml in 70Kg adult)

Problems

Haemostasis
Causes a decrease of platelet stickiness and in high doses (>1,500ml) interferes with the action of Factors VIII, V, fibrinogen and prothrombin

Crossmatching interference
Only occurred with very high molecular weight dextrans (no longer available) and inexperienced haematology technicians.

Allergic Reactions
Usually occur with infusion of only a small volume of dextrans due to circulating anti-dextrans with a fatality rate of 3,4 per 100,000 units infused antibodies. Severe anaphylaxis occurs in about 0,008% of patients. The use of monovalent Hapten to block antigen combining sites of preformed circulating reactive antibodies is recommended prior to dextran infusion.[10 & 11]

Renal Damage
If renal perfusion is decreased, Dextran 40 may form a plug blocking the renal tubules which together with osmotic damage may precipitate renal failure.
Hypervolaemia
Dehydration - because of the intravascular shifts at the expense of the extravascular space, Dextran 40 and 70 should be avoided in dehydration states.

Advantages
Free from disease transmission
Decreases post-operative deep vein thrombosis

Haemaccel

A synthetic polymer derived from degraded gelatin produced by heat desaturation and cross-linked with hexamethylene di-isocyanate to form molecules with urea bridges (average molecular weight 35,000, range 5,000-50,000). Iso-osmotic with plasma, a 500ml infusion will raise the intravascular volume by the same amount.

Shelf life is 5 years and is not affected by temperature regulation or freezing.

Half Life[1] 3-6 hours

Dose As clinically necessary

PROBLEMS

Allergic Since a change in manufacture in 1981 which decreased excessive cross-linkages, the number of adverse reactions due to histamine release has decreased. No fatalities have been reported since the change in formulation and those reported are mainly cutaneous.[12] Prevention of cutaneous anaphylactoid reactions is possible by H_1 and H_2 antagonists.

Hypervolaemia

ADVANTAGES Free from disease transmission
No interference with haemostasis
Renal function maintained or improved
Unaffected by storage temperature.

PRE-OPERATIVE ASSESSMENT OF THE PATIENT WITH A BLEEDING PROBLEM

Screening

A simple clinical history and examination may be all that is required. In the absence of positive findings further expensive investigations are probably unnecessary. Specific questions to ask include:

Do you bleed a lot from small cuts?
Do you bruise very easily?
Are you, or is anyone in your family a "bleeder"?
Have you ever had teeth extracted, if so, how long did you bleed afterwards and did you bleed again the next day?
Do you suffer from nose bleeds?
What do you use for pain or headaches, how much and how often?
What medicines, including over the counter preparations, are you taking

Specific examination:
Look for bruising, petechiae and signs of liver failure.

Haematological Tests:
Negative history and examination : Platelet count and possibly platelet function test are all that is required.

Positive history or examination. The following need to be done:

1. Haematologists opinion if: There is a history of a genetic bleeding disorder; or there is severe systemic disease with manifestations of, or predisposition to liver failure, DIC or fibrinolysis.
2. Routine automated full blood count and platelet count.
3. Routine automated clotting tests -
   "Extrinsic" function - prothrombin time or INR not >60% of control
   "Intrinsic" function - partial thromboplastin time not >40 seconds
   "Common" pathway - thrombin time should be 9-20 seconds
4. If impaired platelet function is suspected, do a bleeding time, should be <10 minutes

Interpretation of routine tests:

Abnormal PTT, PT and TT	Factor deficiencies, severe liver disease, DIC, severe inhibitor, hyprofibrinogenaemia
Abnormal PTT and PTT, normal TT	Vitamin K defect, liver disease, inhibitor present, factor defects
Abnormal PTT, normal PT	Deficiency in factors VIII, IX, XI, XII, Fletcher, Fitzgerald
Abnormal PT, normal PTT	Deficiency factor VII.

SPECIFIC HAEMATOLOGICAL DISORDERS

Von Willebrand's Disease (Factor VIII: C and VIII: VWF lack)

Caused by congenitally deficient levels of Von Willebrand Factor (VWF), a high molecular weight protein which is closely bound to Factor VIII and which is required for optimal platelet adhesion. It is associated with low levels of Factor VIII:C (procoagulant activity) and an increased bleeding time. Treat peri-operatively with cryoprecepitate not Factor VIII concentrates, as the latter does not contain Factor VIII:VWF Normalise procoagulant activities and bleeding time before operation.

Haemophilia : Type A (Factor VIII:C procoagulant activity lack)

When the deficient factor VIII is infused pre-operatively the volume required depends on: patient size, desired elevation in factor VIII level and preparation potency. About 10% of haemophiliacs have an inhibitor to factor VIII where replacement fails to achieve the expected level. These patients need to be managed in association with an experienced haematologist.

For dental extraction a single infusion to raise the factor VIII level above 50% is required followed by the fibrinolytic inhibitor epsilon aminocaproic acid at a dose of 100mg/Kg/day for 10 days. This should obviate the need for further factor VIII replacement. For major surgery it is common to infuse sufficient factor VIII to raise the level to 80-100% and then give boosters every 12 hours to maintain levels above 50% for 10-14 days.

Haemophilia : Type B (Factor IX lack)

Replacement involves similar formulas as those for calculating Factor VIII requirement. Factors IX has a half-life of 18-24 hours *in vivo* but is maintained at a stable level throughout the dating period of a unit of blood, or fresh frozen plasma.

Vitamin K Lack

Due to inadequate intake, malabsorption (steatorrheoa) or inadequate utilisation (liver disease). Necessary for Factors II, VII, IX and X but requires adequate hepatic function to provide the gamma carboxy glutamic acid modification.

Chronic Liver Disease

Patients with liver disease have multiple haemostatic defects as most coagulant factors, except Factor VIII are produced in the liver. They also may have: impaired Vit K utilisation; increased fibrinolysis activity because of decreased metabolism of plasmin and decreased synthesis of plasminogen activators; and thrombocytopaenia due to hypersplenism which may be refractory to platelet transfusion.

Peri-operatively Vit K and FFP can be given to try to normalise coagulation. Monitor with prothrombin and partial thromboplastin times.

Chronic Renal Failure

Normochromic, normocytic anaemia in the range of 5-8g/dl refractory to therapy except with recombinant erythropoietin, occurs in almost all patients with chronic renal failure who have plasma creatinine concentrations above 3,5mg/dl. The degree of anaemia often parallels the degree of renal dysfunction but remains relatively constant after end stage renal failure has occured. As the anaemia is of slow onset it is well tolerated, and due to the risk of cytotoxic HLA antibodies being produced blood transfusions are usually not given.

Disseminated Intravascular Coagulation (DIC)

Sepsis, malignancy, hypotension or obstetrical complications may be associated with activation of the coagulation system and damage to various organs by clot deposition. Excessive consumption of fibrinogen, Factors V, VIII and platelets may also occur, with associated bleeding. Treatment is by treating the primary pathology,but fresh frozen plasma, cryoprecipitate or platelet concentrates may all be required if the patient has to be prepared for surgery. To normalise PTT or ACT (activated clotting time) replace Factors V, VIII with FFP or cryoprecipitate. To normalise fibrinogen give FFP or cryoprecipitate until fibrinogen >200mg%. Give platelets until count >100,000/μl. If intravascular phospholipids are involved heparin may be required.

Polycythaemia Rubra Vera

Any patient pre-operatively with a haemoglobin above 17g/dl in a male 16g/dl in a female (add an extra 1g/dl if patient lives considerably above sea level) requires an explanation for the high level. If the patient has hypoxaemia due to cyanotic heart disease or other right to left shunt heart conditions, pulmonary disease, hypoventilation syndrome or sleep apnoea and if only the red cell number is increased no further explanation is required. It is, however, important in most instances to verify an absolute increase in red cell mass as the cause, as there are situations where a decrease in plasma volume may cause a similar haematological picture (relative polycythaemia, dehydration, cigarette smoker etc.,). If, however, other cell lines such as white cells and platelets show proliferation, Polycythaemia Rubra Vera (PRV) needs to be excluded as a diagnosis. The complication rate of operations on uncontrolled PRV patients has been reported to be as high as 79% with a 36% mortality due to both excessive thrombosis and haemorrhage. Controlled (more than 4 months) PRV patients had a complication rate of 5% with no deaths[13].

AUTOLOGOUS TRANSFUSION

The indications include (1) patients wishing to avoid potential complications such as transmission of infection or exposure to allergens by receiving homologous blood transfusion; (2) patients who have red cell antibodies incompatable with most donor blood.

Pre-donation Autologous Transfusion:

A healthy patient with a haematocrit above 34% can donate a unit of his own blood weekly for up to 3-5 weeks. The last donation being made 3 days prior to operation. If necessary the blood can be frozen for use at a later date. This ensures:

a) He has his own blood available during the operation.
b) His haematocrit is rheologically more suitable for tissue perfusion whilst not compromising his oxygen carrying ability.
c) His bone marrow is producing large amounts of new blood cells.
d) His oxygen dissociation curve is pushed to the right by the increase in 2,3 DPG.

The problems include: inconvenience to the doctor and extra expense to the patient and blood bank. It may be difficult or impossible if there is poor venous access, pre-existing anaemia or infection, semi-urgent surgery or where there is a severe vasovagal response to phlebotomy.

The use of recombinant erythropoietin may allow more blood to be donated safely and may be indicated in patients with a low initial haematocrit.

Blood Scavenging:

Transfusion of the patient's own shed blood by intra-operative salvage can be used in certain circumstances e.g. bleeding into the pleural cavity or peritoneal cavity where no bowel soiling has occurred. Intra-operative scavenging is contraindicated where there is a risk of the blood being contaminated by tumour cells or bacteria. There are various types of machine available but all salvaged blood must be filtered before reinfusion.

Intra-operative Haemodilution:

Haemodilution should be carried out in an isovolaemic fashion, immediately prior to operation. Equal volumes of a colloid such as Haemacell or Dextran 70 (1ml/ml of blood removed) or crystalloids (2-3ml/ml of blood removed) being infused as blood is removed by phlebotomy. The end point should be a haematocrit of 27-33% (Hb of 9-11g/dl). This autologous blood (1-3 units) is stored beside the patient and can be re-infused at any time. Any blood loss during surgery is replaced first by the last unit of blood removed (which contains the least red blood cells). The autologous blood, which still contains viable platelets, can be re-infused after the operation when surgical bleeding has diminished to ensure maximal conservation of the red cells.

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GROOTE SCHUUR HOSPITAL

GUIDELINES FOR MAXIMUM BLOOD ORDERING FOR ELECTIVE OPERATIONS

GENERAL SURGERY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
Aortic aneurysm	Oesophaegectomy	Total colectomy	Dr. Intraperitoneal abscess	Vagotomy Gastrectomy
Aorto-femoral bypass	Pancreaticoduodenectomy	AP resection	Liver abscess	Sympathectomy Cholecystectomy
Hindquarter amputation			Mastectomy & axillary clearance Radical gastrectomy	Incisional/large para-umbilical hernia Non-toxic thyroidectomy
Major liver resection			Adrenalectomy	Laparotomy B/K & A/K amputation
Porta-systemic shunts			Distal pancreatectomy C.S.D. exploration	NO GROUP & SCREEN
				Groin hernia Varicose vein Salivery gland surgery Laparoscopy Benign breast biopsy Node biopsy Haemorrhoidectomy Minor ano-rectals

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GUIDELINES FOR MAXIMUM BLOOD ORDERING FOR ELECTIVE OPERATIONS

OBSTETRICS & GYNAECOLOGY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
CARDIAC SURGERY	Closed heart operations 2 Units Whole Blood & 2 Units Red Blood Cells		Caesarean Section for placenta praevia Radical vulvectomy Wertheim's Hysterectomy	Cone Biopsy* Hysterectomy abdominal or vaginal Elective Caesarean section Termination of pregnancy over 12 weeks Simple vulvectomy

* only if problems anticipated

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GUIDELINES FOR MAXIMUM BLOOD ORDERING FOR ELECTIVE OPERATIONS

ORTHOPAEDICS

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
		Forequarter amputation	Forequarter amputation	Amputation A/K & B/K
			En block excision tumour	Bone grafting (major) Retrograde Küntscher nailing
			Open reduction fracture	Moore's Prosthesis Open reduction of upper limb fractures Zimmer Screwplate
			Dislocation hip-central dislocation	En bloc excision tumour
			Arthrodesis of hip	Lumbar spinal fusion
			Hip disarticulation	Open reduction fracture dislocation hip - posterior Retrograde Küntscher nailing Arthrodesis of hip Open reduction of lower limb fractures (femur or tibia)

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GUIDELINES FOR MAXIMUM BLOOD ORDERING FOR ELECTIVE OPERATIONS

PLASTIC SURGERY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
			Breast reconstruction Maxillo-facial surgery	Breast reconstruction Musculocutaneous flap

UROLOGY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
	Cystectomy Radical abdominal lymphadenectomy		Open Prostatectomy Nephrectomy Nephrolithotomy Urinary diversion Ureterectomy Open bladder operation Ruptured urethra Radical penectomy	Transurethral resections of prostrate, bladder tumours Urethroplasty

THORACIC SURGERY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
Pulmonary resection, major, inflammatory	Pulmonary decortication	Mediastinal tumour	Pulmonary resection non-inflammatory	Pleurectomy

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GUIDELINES FOR MAXIMUM BLOOD ORDERING FOR ELECTIVE OPERATIONS

E.N.T.

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
	Angiofibroma excision		Mastoidectomy (urgent)	Hemiglossectomy
	Commando		Laryngectomy	Partial Pharyngectomy
	Paraganglioma excision		Mandibulectomy	Frontal sinus obliteration
	Laryngopharyngectomy		Maxillectomy	Parotidectomy
			Temporal bone excision	Partial laryngectomy
			Deltopectoral flap	
			Myocutaneous flap	
			Neck dissection	

NEUROSURGERY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
	Large cerebral arterio-		Cerebral aneurysm	
			Transsophenoidal hypophysectomy	
			Vascular Cerebral Tumours	

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GENERAL SURGERY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
Aortic aneurysm	Oesophagectomy	Total colectomy	Dr. Intraperitoneal abscess	Vagotomy Gastrectomy
Aorto-femoral bypass	Pancreaticoduodenectomy	AP resection	Liver abscess	Sympathectomy Cholecystectomy
			Mastectomy & axillary clearance Radical gastrectomy	Incisional/large para-umbilical hernia Non-toxic thyroidectomy
Hindquarter amputation			Adrenalectomy	Laparotomy B/K & A/K amputation
Major liver resection			Distal pancreatectomy C.S.D. exploration	NO GROUP & SCREEN
Porta-systemic shunts				Groin hernia Varicose vein Salivery gland surgery Laparoscopy Benign breast biopsy Node biopsy Haemorrhoidectomy Minor ano-rectals

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GUIDELINES FOR MAXIMUM BLOOD ORDERING FOR ELECTIVE OPERATIONS

OBSTETRICS & GYNAECOLOGY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
			Caesarean Section for placenta praevia	Cone Biopsy*
				Hysterectomy abdominal or vaginal
			Radical vulvectomy	Elective Caesarean section
			Wertheim's Hysterectomy	Termination of pregnancy over 12 weeks
				Simple vulvectomy
CARDIAC SURGERY	Closed heart operations 2 Units Whole Blood & 2 Units Red Blood Cells			

* only if problems anticipated

Burns and skin grafting in children:

Add together the percentage area of donor site and recipient site. If this area is equal to 32%, one blood volume needs to be cross matched and will probably be required during the procedure.

Therefore Cross Match (in ml) = $\frac{\text{Total Area (Donor site + recipient site)}}{32} \times 80$ (blood volume in ml/Kg)

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			En block excision tumour	Bone grafting (major) Retrograde Küntscher nailing
			Open reduction fracture	Moore's Prosthesis Open reduction of upper limb fractures Zimmer Screwplate
			Dislocation hip-central dislocation	En bloc excision tumour
			Arthrodesis of hip	Lumbar spinal fusion
			Hip disarticulation	Open reduction fracture dislocation hip - posterior Retrograde Küntscher nailing Arthrodesis of hip Open reduction of lower limb fractures (femur or tibia)

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UROLOGY

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	Cystectomy Radical abdominal lymphadenectomy		Open Prostatectomy Nephrectomy Nephrolithotomy Urinary diversion Ureterectomy Open bladder operation Ruptured urethra Radical penectomy	Transurethral resections of prostrate, bladder tumours Urethroplasty

THORACIC SURGERY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
Pulmonary resection, major, inflammatory	Pulmonary decortication	Mediastinal tumour	Pulmonary resection non-inflammatory	Pleurectomy

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	Commando		Laryngectomy	Partial Pharyngectomy
	Paraganglioma excision		Mandibulectomy	Frontal sinus obliteration
	Laryngopharyngectomy		Maxillectomy	Parotidectomy
			Temporal bone excision	Partial laryngectomy
			Deltopectoral flap	
			Myocutaneous flap	
			Neck dissection	

NEUROSURGERY

5 UNITS	4 UNITS	3 UNITS	2 UNITS	GROUP & SCREEN
	Large cerebral arterio-		Cerebral aneurysm	
			Transsophenoidal hypophysectomy	
			Vascular Cerebral Tumours	

MEMORY JOGGER

BLOOD REPLACEMENT :

To raise haemoglobin level 1g/dl
4ml/Kg body weight Packed Red Blood Cells
6ml/Kg body weight Whole blood

OPTIMAL :

Peri-operative haematocrit/haemoglobin* (Dependent on patient)
Hct 27-33% (Hb 9-11g/dl)

PLATELETS :

Level Pre-operative replacement level if no immune or consumptive cause - 50-75,000/μl
Functional Test - Tenplate Bleeding Time (normal 2-9,5 minutes)
Dose Single random unit raises count 5-10,000/μl
Usual dose 1 unit/10Kg body weight

FFP :

Main Indications
Multiple coagulation defects
Reversal warfarin/suxamethonium effects
Massive blood transfusions (>1,5 blood volumes)
Dose 800ml-2,000ml (4-8 packs of FFP) for 70Kg adult over 90-120 minutes

COLLOIDS :

Blood derivatives
Albumin, SHS (PPF) - Expensive, use in hyproproteinaemic shocked states
Synthetic Derivatives
Dextran 70 - Danger immunoglobin mediated anaphylaxis
Limit to 1,5Kg/day (± 1,500ml)
Haemaccel H istamine release may be a problem

BLOOD REPLACEMENT

1ml blood loss replace with 2-3ml crystalloid or 1ml colloid