

**STUDY OF ELECTIVE SURGICAL BLOOD USAGE  
AT GROOTE SCHUUR HOSPITAL**

**Study for the M.Med.**

**Period of study: 1st July 1990 to 31st October 1990.**

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## INTRODUCTION

Blood utilising practices amongst South African anaesthetists has been surveyed recently<sup>1</sup>. The results showed that several areas of practice could be improved. In particular, the response to the question, "does your hospital have a Maximum Surgical Blood Ordering Schedule (i.e. recommendations for maximum blood ordering for elective operations)?", revealed considerable ignorance: at the Tygerberg and Groote Schuur (GSH) Hospitals only 14% of respondents answered with a 'yes' (versus 35% for all hospitals in the country, at hospitals that had a such a schedule). Fifty-seven percent answered in the negative and 27% did not know. Furthermore, answers to other questions revealed that inappropriate transfusions are likely to occur not infrequently: only 48% of respondents knew that one unit of blood on average raised the haemoglobin by 1 g/dl; 64% did not do serial haemoglobin (Hb) measurements intraoperatively to assess blood loss and 32% did not use serial haematocrits; 63% of respondents would not have accepted a preoperative Hb less than 10 g/dl for an asymptomatic patient for an elective minor operation.

The Maximum Surgical Blood Ordering Schedule (MSBOS) is designed to rationalise blood usage in elective surgery, thereby reducing costs (of unused crossmatched blood) and decreasing the strain on blood bank resources at times of heavy demand (by minimising/reducing the amount of blood 'on reserve' for elective patients). As such ignorance about the MSBOS exists, as knowledge of Hb requirements as outlined above is lacking and because anaesthetists are responsible for 50% of blood usage in a large teaching hospital<sup>1</sup>, blood ordering and utilisation in elective surgery at GSH were investigated.

## METHOD

With the exceptions of ophthalmology and obstetrics, all elective surgical lists were collected from the two main operating suites at GSH at the end of each day (thereby ascertaining cancellations and additions) for the period 1st August to 31st October 1990. All blood requests were obtained with the assistance of the staff of GSH's blood-bank. The chief technician enlisted the help of the staff who routinely filled in the request statistics. As each specimen is accepted at the blood-bank, a record of the date, time, patient, ward and nature of the request is noted in a receipt book. Each day's record was photocopied and when the statistics were done 2 days later, the following details were completed for all the requests: the nature of the crossmatch (i.e. Group and Screen (G&S) or full crossmatch and number of units ordered (the original request is sometimes changed telephonically from what is written on the request form) and the number of units subsequently transfused, if any. It was decided to abandon the collection of data for fresh frozen plasma (FFP) and platelets as this was found to be too time consuming (FFP was often routinely used in elective cardiac surgery, but blood can be requested as much as a week in advance and FFP, occasionally platelets, are only requested on the day of surgery).

The elective surgical lists were then cross-referenced with blood-bank records to determine which of them were for elective surgical patients. All pre-, intra- and post-operative (up to two days) crossmatches were noted by referencing the date and time of the request to the date of surgery. In those cases where this was not clear, the original blood request form was checked by myself (each year's entire requests are kept on file in the blood bank) and if there were any uncertainties regarding the time, date and nature of the operation, this was checked in the theatre log-book. Where necessary, the blood bank records were checked for up to 7 days prior to the date of surgery if a preoperative transfusion was suspected from computer results of full blood counts (FBC) i.e. when an immediate preoperative coulter Hb result was markedly higher than an earlier coulter Hb. When available, all pre- and post-operative patient Hb and haematocrit (Hct) results were obtained from the hospital computer records.

The MSBOS recommendation for each operation was noted for each request. This involved using the MSBOS that was available in the blood bank for their staff to refer to (blood-bank MSBOS which was less detailed than that included in Irving's thesis<sup>1</sup>) as well as the updated 1990 version in the "Guidelines for transfusion practice, University of Cape Town Teaching Hospital's group, February 1990" (appendix II). This document has the following boxed statement on its front page, "These guidelines replace all previous documents, which should be destroyed. ... with the final form having been developed by the Blood Users' Committee through representatives from all divisions".

All data was collected on a computerised spreadsheet (VPPlanner) and analysed using dBASE IV (Ashton-Tate).

In the original protocol, I had planned to visit each patient post surgery to ensure a post-operative FBC was taken, as well as to record each patient's clinical details and the estimated blood loss during surgery (from the anaesthetic record). Unfortunately, no research time was allocated for this project and I had instead the task of conducting it whilst having been posted to another hospital (Somerset); hence none of the above was carried out. I attempted instead to visit as many housemen as I could find in the surgical wards to ask for post-operative FBC's to be done on all elective patients for whom blood had been crossmatched. At this time I questioned them on their knowledge of the MSBOS as worded in Irving's questionnaire. The housemen however rotated some time before the completion of the study.

## RESULTS

### 1) Crossmatch Transfusion Ratios (CTR)

This relates the number of units crossmatched for all patients to the number actually transfused and is regarded as a reasonable assessment of the efficacy of a hospital's transfusion program. It is obtained by dividing the total number of units crossmatched by the total transfused. Overall CTR and those for the various disciplines studied are depicted in fig.1.

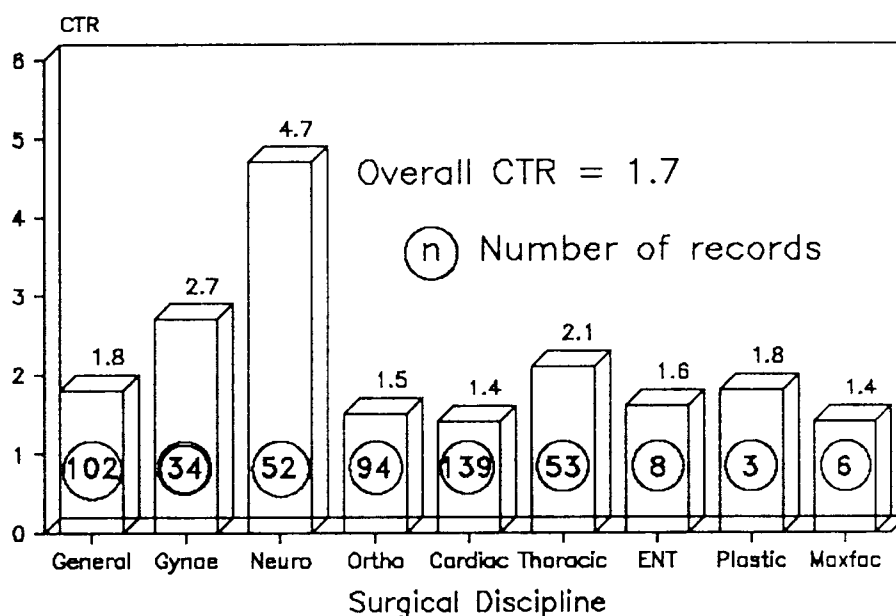


Figure 1. Crossmatch transfusion ratios for individual surgical disciplines; the circles indicate no. of crossmatch records for each calculated CTR.

The CTR for transfusion requests that complied with the MSBOS was 1.8; it was also 1.8 for those operations that had no MSBOS listing. When crossmatching was less than the MSBOS guidelines, the CTR was 1.3; it was 1.4 for those requests that were greater than the MSBOS. The CTR was 3.4 for records where a crossmatch had been done instead of the MSBOS's recommended G&S (Fig.2).

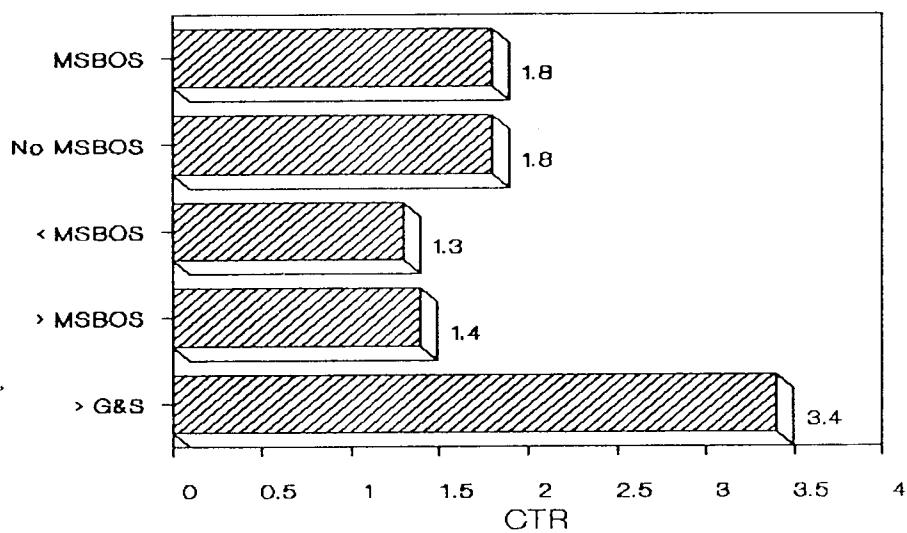


Figure 2. Crossmatch-transfusion ratios for blood bank requests and their adherence to the MSBOS

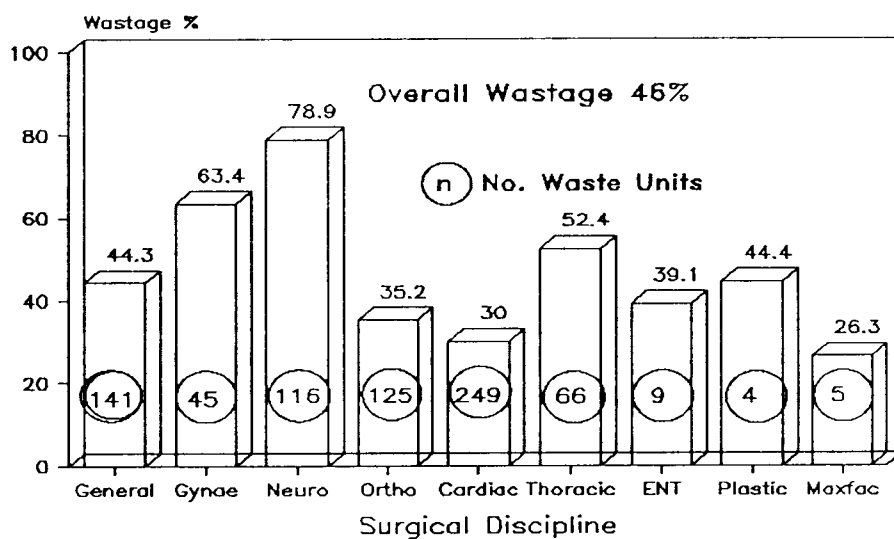


Figure 3. Blood wastage for each surgical discipline; actual numbers of packed cell units not used are shown within the circles.

To calculate "wastage", the number of units transfused was subtracted from the number crossmatched, since this number would represent the amount of blood temporarily unavailable to other patients. Since a cancellation fee is charged, this also represents a cost to the hospital. The wasted units are depicted graphically in Figure 3. Not surprisingly, the greatest wastage occurs in those theatres with the highest CTR's.

2) Adherence to the MSBOS

a) **Overall** (fig.4)

A total of 1457 patient records were studied. Fifty-six percent (813) complied with MSBOS guidelines; 27% (399) exceeded the recommendations, while 11% (161) had no MSBOS listing. Three percent (41) had preoperative transfusions and 3% (43) had intra or postoperative crossmatches (i.e. MSBOS not applicable).

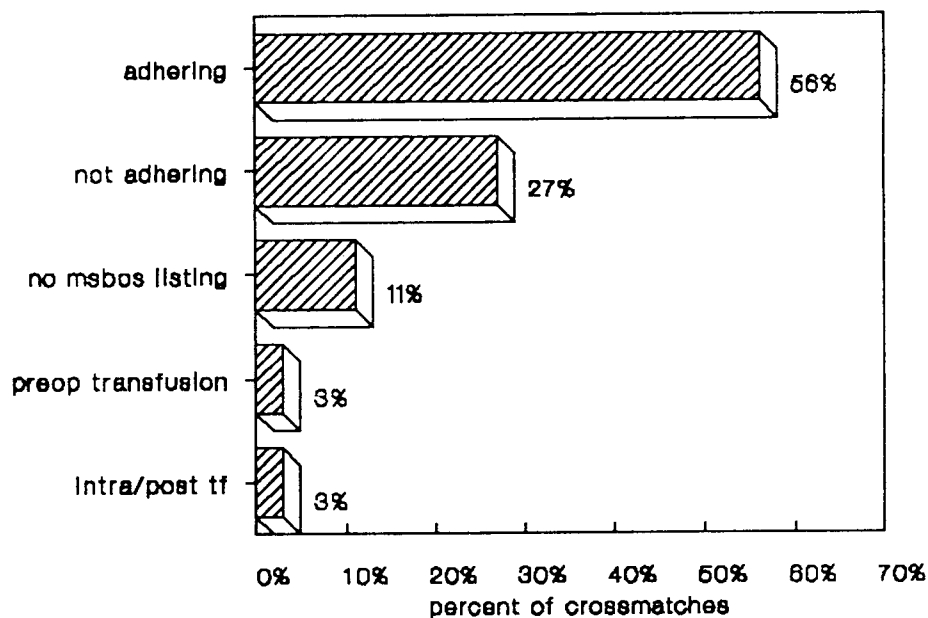
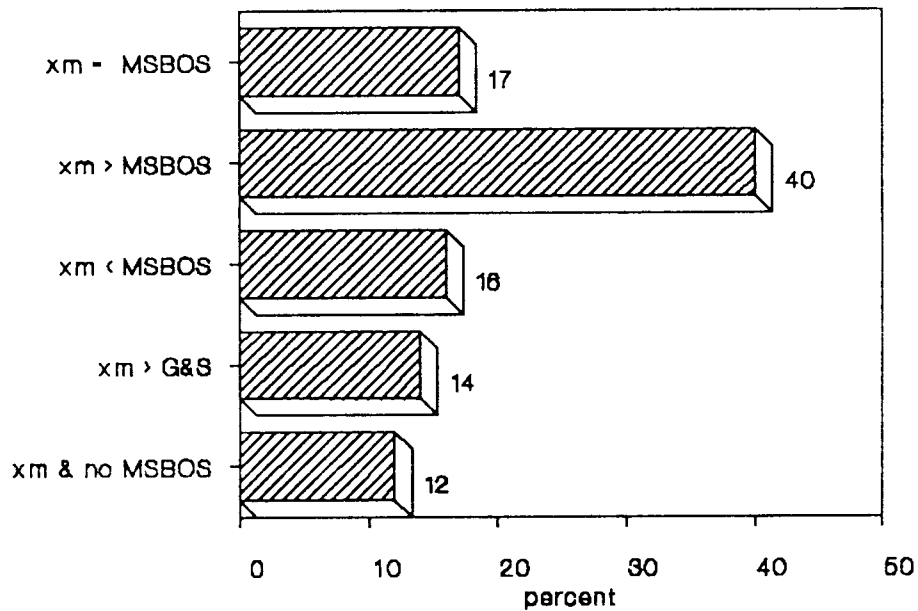


Figure 4. Adherence of all blood bank requests (n = 1457) to the MSBOS

b) **Full Crossmatches** (fig.5)

Five hundred and eighteen records were full crossmatch requests. Of these, only 17% (88) matched the recommended maximum number of units in the MSBOS while 16% (85) had fewer units ordered than the MSBOS. Hence 33% of crossmatch requests fell within the MSBOS limits. Forty percent (208) exceeded MSBOS guidelines, a further 14% (73) had a crossmatch when only a G&S was recommended and 12% (64) had no MSBOS listing due to an inadequate MSBOS.



**Figure 5** Blood bank requests for full crossmatch (n=516) and their adherence to MSBOS. (xm=crossmatch - crossmatch adhering to MSBOS; xm > - greater than MSBOS; xm < - less than MSBOS.)

c) **Group & Screens (fig.6)**

Group and screen requests numbered 534 of which 322 (60%) matched the MSBOS recommendation. Twenty percent (107) could have had a full crossmatch according to the MSBOS and 9% (48) had no MSBOS listing. Eleven percent (57) had a G&S when no form of crossmatch should have been sent and none of these were subsequently converted to a full crossmatch. Of all the G&S requests, 11% (60) were subsequently converted to full crossmatch (only 42 of these were transfused (of whom 7 had postoperative Hb > 11.0 g/dl)); half of these could have had a full crossmatch initially if the MSBOS had been followed. A further 248 G&S requests could have been ordered according to the MSBOS but the records reflected no crossmatch request.

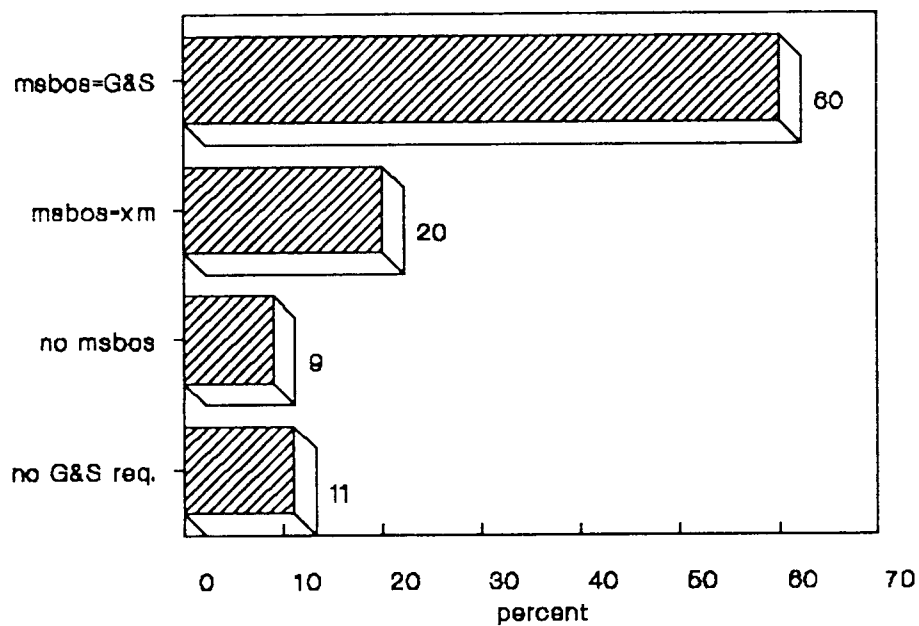


Figure 6. Blood bank requests for group and screen (G&S - n=534) and their adherence to the MSBOS.

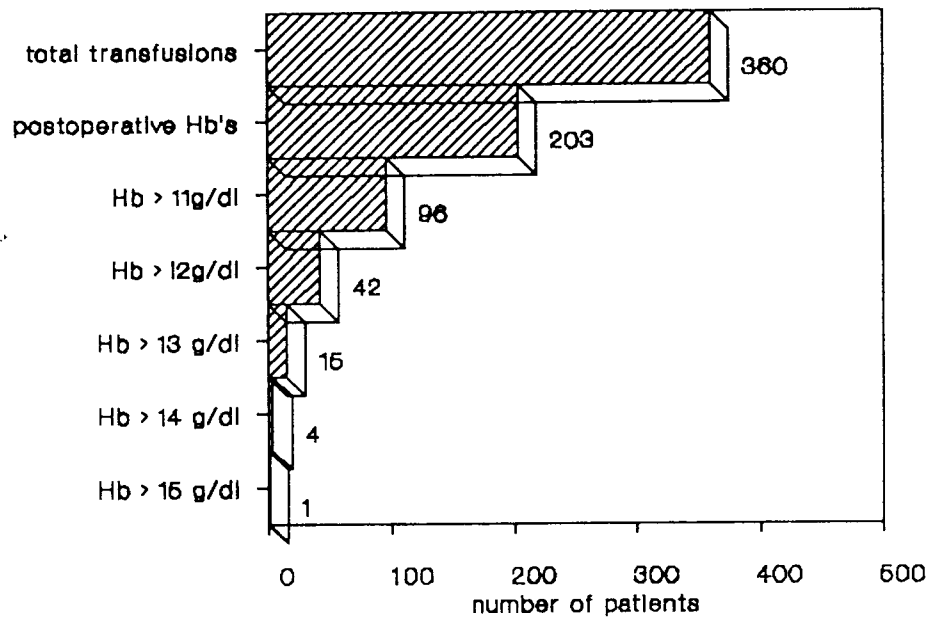
If group and screens are regarded in conjunction with preoperative Hb: there were 144 records where the G&S was according to the MSBOS in patients whose preoperative Hb was greater than 12.0 g/dl; only 2 of these were converted: 2 units for an anterior spinal decompression and 2 for an axillo-femoral-popliteal graft, with all 4 units being transfused.

3) Transfusion Appropriateness (fig.7)

There were a total of 360 crossmatch records in which blood was transfused. Of these, 44% (157) had no postoperative Hb available on the hospital computer network (mostly because they were not done, but several had been removed from access). Twenty-seven percent (96) had a post operative Hb greater than 11.0 g/dl; just over half of these (51) were in cardiac surgical patients. Twelve percent (42) had a Hb greater than 12.0 g/dl; of these, 13 were cardiac, 7 general surgical and 4 neurosurgical patients.

There were 31 patients with a preoperative Hb of less than 10.0 g/dl who had an unconverted G&S following surgery. The lowest postoperative Hb was in a renal transplant case with a Hb of 5.4 g/dl; the Hb was 4.2 g/dl on the 2nd postoperative day but had increased to 5.7 g/dl two days thereafter (assumed transfusion). Other examples of documented "low" (i.e. less than 9 g/dl) postoperative haemoglobins were: a total abdominal hysterectomy with a preoperative Hb of 7.8 g/dl and a postoperative Hb of 8.3 g/dl on the afternoon following surgery (Hct preop was 26% and 25% postoperatively); a cholecystectomy with preop Hb of 7.9 g/dl (no postoperative Hb nor G&S conversion) and a cholecysto-jejunostomy with preop Hb of 9.6 and postoperative Hb eight days later of 7.3 g/dl. This patient subsequently had a G&S (reason not determined), but two days later had a separate crossmatch and was transfused two units (the non use of a G&S and additional crossmatch request one or two days later, or even the same day, thereby incurring costs of both, was not an infrequent occurrence). The highest postoperative Hb following transfusion was 15.9 g/dl (preop Hb was 16.1 g/dl) in a cardiac surgery case (Fontan procedure). The next highest was 14.4 g/dl (also cardiac: redo aortic valve replacement) in a Jehovah's Witness patient for whom blood was only requested when the Hb had dropped to 4.7

g/dl on the first postoperative day). Third was a hepatic resection (preop Hb was 14.4 g/dl and 4 units crossmatched and transfused) with a postoperative Hb of 14.1 g/dl.



*Figure 7. Transfusion appropriateness; a post-transfusion haemoglobin (Hb) greater than (>) 11,0 gm/dl was regarded as representing excessive transfusion. Only 203 of the 360 transfused patients had a post-operative laboratory Hb.*

## BLOOD USAGE IN THE DIFFERENT SURGICAL DISCIPLINES

(see Appendix II for abbreviated version)

In the following, "units" refers virtually only to packed cells; only in cardiac cases were the first 2 units crossmatched as whole blood. When "no blood bank requisition" applies to an operation, it means that no specimen was sent to the blood bank for crossmatching nor group & screening for up to a week prior to the operation and for 2 days following it for that particular patient. CTR and Transfusion Index (TI - see below) have not been given for those examples where the number of operations make their calculation meaningless. At the time of the study a G&S specimen was only kept for 24-36 hrs (see Discussion, section 2) and the blood bank required another specimen to be sent in for repeat compatibility testing if blood were required for that patient after this period.

### GENERAL SURGERY

#### 1. MAJOR VASCULAR

##### a) **Abdominal Aortic Aneurysm** (MSBOS: 4 units )

9 operations, 3 postponements, 1 cancellation.

13 full crossmatches: 75 units: 51 transfused; 1 Group and Screen (cancelled). 12 units cancelled from 3 surgical cancellations

**CTR = 1.5 (75/51) TI = 5.6 (51/9)**

The transfusion index (TI) is the number of units of blood transfused in total for a given number of the same operation, divided by that number of operations.

The average postoperative Hb was 11.4 (9.4 - 14.2) g/dl.

The highest received no blood (preop Hb = 15.5 g/dl).

The patient with the largest transfusion (12 units) had a postoperative Hb = 10.4 g/dl (preop = 13.5).

b) **Aorto-bifemoral Graft (MSBOS: 4 units )**

6 operations, 2 postponements and 1 cancellation.

9 full crossmatches: 28 units: 14 transfused; 10 units were cancelled in all due to surgical cancellation.

1 group and screen: converted to 4 units: 2 transfused.

**CTR = 2.3 (32/14) TI = 2.3 (14/6)**

The average post-operative Hb was 10.9 (9.6 - 13.0) g/dl The patient with the highest received no blood (preop Hb = 14.8 g/dl).

2 . MINOR VASCULAR (MSBOS for "direct vascular procedures": Group and Screen)

a) **Femoral-popliteal Bypass Graft**

14 operations, 2 postponements, 2 cancellations (data followed by an "\*\*", denote the same patient for all the data)

5 full crossmatches (1 postoperative): 19 units: 9 transfused (8 units requested for one case with preoperative Hb of 7.3 g/dl, 4 transfused and the case cancelled). 5 units transfused in operative cases (3 units 2 days postoperatively\*).

10 Group and Screens (2 for cancellations); one record postponed twice, had a G&S on 1st booking (4th Oct.), but on both subsequent bookings (9th and 23rd Oct.) had no covering crossmatch of any nature despite the official operating slate, as prepared by the surgeons, claiming that a G&S had been sent.

One G&S converted (preop Hb = 9.6 g/dl): 2 units: 0 transfused.

6 operations had no covering crossmatch of which only one required a postoperative crossmatch and transfusion of 3 units\*.

**CTR = 3.0 (24/8) TI = 0.6 (8/14)**

Only 2 of the records had post-operative Hb's sent: 12.8 g/dl (pre-op Hb = 15.6, unconverted G&S); 11.8 g/dl (up from immediately postop 7.7 g/dl following 3 unit transfusion)\*.

**b) Femoral-femoral Bypass Graft**

3 operations; 2 Group and Screens; 1 no blood bank requisition

No FBC's done.

**c) Lower Limb Arterial Surgery**

13 operations:

**2 Bifemoral Explorations, 1 Femoral Aneurysm, 1 Femoral Venous Patching, 1 Popliteal Aneurysm, 2 Popliteal Explorations, 1 Popliteal Angioplasty, 2 Ilio-femoral-popliteal Grafts, 1 Ilio-femoral Graft, 1 Axillo-femoral-popliteal Graft, 1 External Iliac Graft.**

3 full crossmatches: 10 units: 4 (2,2) transfused.

7 Group and & Screens (2 for the same patient), two converted to 2 unit crossmatch and transfusions (one of which was a postoperative G&S). 1 converted to 2 unit crossmatch had no blood subsequently transfused.

5 had no preoperative blood bank requisition (only one of these subsequently had a crossmatch: 2 units transfused after a converted postoperative G&S).

**CTR = 2.0 (16/8) TI = 0.6 (8/13)**

Only 1 transfused case had a post-operative Hb (10.2 g/dl).

Only 3 others had postoperative Hb's (g/dl):

The femoral venous patch angioplasty had postop Hb = 12.1 (preop = 17.7).

An axillary-fem-pop. had postop Hb = 9.7; (preop = 12.8).

An ilio-fem. graft had postop Hb = 7.9 (preop = 15.0).

d) **Upper Limb Arterial Surgery**

4 operations: **1 axillary arterial repair, 2 brachial artery repairs, 1 brachial arterio-venous fistula repair.**

2 Group and Screens, neither converted.

2 cases no blood bank requisition

Only 1 case had a postoperative Hb: brachial repair = 10.9 g/dl (preop = 15.2 g/dl)

e) **Common Carotid Repair**

1 operation

1 full crossmatch: 4 units: 0 transfused; preop Hb = 11.5 g/dl.

3) **ABDOMINAL SURGERY**

a) **Laparotomy (MSBOS = Group & Screen)**

22 operations

2 full crossmatches: 4 units: 2 transfused (1 patient and this was from an intra-operative crossmatch (none preop.)

7 had G&S, none converted.

13 had no blood bank requisition.

**CTR = 2.0 (4/2) TI = 0.09 (2/22)**

Average (9 cases) preop Hb = 12.1 g/dl; Average (5 cases) postop Hb = 10.4 g/dl.

b) **Vagotomy and Antrectomy (MSBOS = Group & Screen)**

19 operations, 2 cancellations

13 had a G&S (1 outdated, 2 for the same patient on the same day and both cancellations). 1 G&S converted to 2 units: 0 transfused and the case cancelled.

4 full crossmatches: 10 units (2,2,2,4): 2 transfused.

8 no blood bank requisition.

**CTR = 6.0 (12/2) TI = 0.1 (2/19)**

No cases had a post-operative Hb sent.

- c) **Gastrectomy** (MSBOS = 2 units for "total gastrectomy"; Group and Screen for "radical / revision gastrectomy".)

21 operations: 2 listed as 'revision'  
4 'total'  
1 leiomyoma excision  
14 listed as 'gastrectomy'.

2 full crossmatches: 4 units: 0 transfused

10 group and screens; 2 conversions to full crossmatch: 4 units (2,2): 2 (2,0) transfused

9 operations had no blood bank requisitions (3 were 'totals')

**CTR = 4 (8/2) TI = 0.1 (2/21)**

Only 1 record had a postoperative Hb: 9.7 g/dl (preop 11.2, unconverted G&S)

- d) **Cholecystectomy** (MSBOS = Group & Screen)

47 operations and 1 cancellation

22 had a G&S (including the cancellation), 1 outdated; none converted

1 full crossmatch: 2 units: 0 transfused (preop Hb = 14.6 g/dl)

25 operations had no blood bank requisition

Only four patients had postoperative Hb's sent

1 **laparoscopic cholecystectomy** was done without covering crossmatch.

1 **common bile duct exploration** similarly done.

- e) **Splenectomy** (MSBOS = Group & Screen)

4 operations; 3 had a G&S, none converted to full crossmatch.

1 had no blood bank requisition

3 postop Hb's were sent, 2 of which were higher than the preop Hb whilst the 3rd dropped from preop of 13.6 g/dl to 12.8 g/dl.

f) **Nissen Fundoplication (MSBOS = Group & Screen)**

2 operations. No blood bank requisitions for both. No Hb's available.

g) **Whipple's Procedure (MSBOS for "complex lap" = 2 units)**

4 operations and 1 cancellation (it is not known whether or not the intended procedure was carried out in the cases)

2 full crossmatches: 8 (4,4)units: 0 transfused.

3 had a G&S (including the cancellation), none converted.

Only 1 case had a postop Hb sent (9.1 g/dl; preop of 12.4 g/dl)

h) **Other Small Bowel "Plumbing" Operations:**

**resection(1), gastrojejunostomy(2), gastroenterostomy(1), pancreatic jejunostomy & choledochojejunostomy(1), roux-en-y(2), hepatojejunostomy(1)**

(MSBOS for "laparotomy" = Group & Screen; "complex laparotomy" = 2 units)

7 operations, 1 cancellation (hepatojejunostomy)

4 full crossmatches: 11 units(1,2,4,4): 5 transfused (4 into the single cancellation).

3 had no blood bank requisitions (the 2 gastrojejunostomies and the gastroenterostomy).

**CTR = 2.2 (11/5) TI = 0.7 (5/7)**

Only 1 case (pancreatic jej.& choledochojej.) had a posttransfusion Hb: 12.8 g/dl after a 4 unit transfusion and a preop Hb of 12.4 g/dl.

i) **Colon Resection/Anastomosis:**

**total colectomy (4), sigmoid colectomy (4) (2 cancelled), ileoanal pouch(2), transverse colectomy (1), abdomino-perineal resection (1), anterior resection (2), major anorectal procedure (2), closure Hartman's colostomy (2)**

(MSBOS = 2 units for "total colectomy" and "abdomino-perineal resection", Group & Screen for "subtotal colectomy" and "laparotomy" (closure Hartman's))

16 operations and 2 cancellations

10 operations had full crossmatches (including both Hartman's closures): 24 units (8 of 2,4,4): 4 (1 patient) transfused.

7 had a G&S, 5 converted to full crossmatch: 15 units (4,2,4,2,3): 11 (4,2,2,3) transfused.

1 (abdomino-perineal) had no crossmatch record.

**CTR = 2.6 (39/15) TI = 1.0 (15/16)**

Three patients had a postop Hb sent:

a total colectomy = 9.4 g/dl (no transfusion and preop Hb = 13.3 g/dl).

an anterior resection = 13.8 g/dl (3 units transfused from a converted G&S and preop Hb = 11.6 g/dl).

a major anorectal = 10.4 g/dl (after 4 unit transfusion, no preop Hb).

j) **Adrenalectomy (MSBOS = 2 units)**

6 operations

1 full crossmatch: 2 units: 2 transfused (postop Hb = 12.5 g/dl, preop = 12.9).

4 group and screens; 2 converted: 4 units (2,2): 2 (2,0) transfused

1 had no crossmatch record.

**CTR = 1.5 (6/4) TI = 0.67 (4/6)**

There were no other postop Hb's sent.

k) **Hepatic Resection** (MSBOS = 4 units)

2 operations: 1 unspecified and 1 with resection of hydatids from the kidney as well.

The former had 4 units crossmatched and transfused: postop Hb = 14.1 g/dl, preop Hb = 14.4 g/dl. The latter had a G&S for the first booking, was cancelled, rebooked without any crossmatch being repeated, had an intraoperative crossmatch of 2 units: 0 transfused (no Hb's).

l) **Thyroidectomy** (MSBOS = Group & Screen)

20 operations; 1 had an unconverted G&S (preop Hb = 14.2 g/dl).

19 had no crossmatch records.

5) **Mastectomy** (MSBOS = 2 units for "mastectomy and axillary clearance")

33 mastectomies were performed, 9 with axillary clearance (3 booked as 'mastec. + frozen section').

28 had no crossmatch records, including 8 of the axillary clearances.

3 had a G&S, 2 of which were converted to full crossmatch: both had 2 units crossmatched and transfused (preop Hb = 9.5 g/dl and blood request stated "anaemia" for the one; the other had a preop Hb = 7.3 g/dl)

2 patients had full crossmatch ab initio: 1 with an intra-operative crossmatch (2 units: 0 transfused); 1 with 6 units crossmatched and transfused (4 initially, 2 transfused preoperatively, 2 further matched and transfused intra-operatively; preop Hb = 9.0).

"CTR = 1.2 (12/10) TI = 0.3 (10/33)"

None of the cases had a postop Hb sent.

6) **Above Knee Amputation** (MSBOS = Group & Screen)

17 operations; 12 had no crossmatch records

4 had a G&S; 1 converted: 2 units: 1 transfused (preop Hb = 9.5 g/dl).

2 patients had full crossmatches ab initio. One of these had a G&S as well (preop Hb = 7.1 g/dl; 3 units crossmatched and transfused; postop Hb = 13.5 g/dl).

1 patient had a postoperative crossmatch record only (postop Hb = 7.3 g/dl; 2 units crossmatched and transfused)

There was only one postoperative Hb as noted above.

7) **Below Knee Amputation** (MSBOS = Group & Screen)

25 operations (2 as revision bka's) and 2 postponements

9 cases had a G&S (2 for a single patient; and both postponements on their initial bookings only); 1 converted: 2 units: 0 transfused (diabetic with chronic renal failure.)

2 patients had full crossmatches ab initio: 2 units crossmatched and transfused in each.

13 operations had no covering crossmatch record.

2 had preoperative transfusions.

"CTR = 1.1 (10/9) TI = 0.2 (4/21)"

Average postop Hb of the 4 (two of whom received 2 units each) that were sent was 9.8 g/dl.

8) **Split Skin Graft** (MSBOS has no specifications for these procedures)

7 bookings, the same patient in 4 of them: 3 were cancelled

1 had a G&S, converted to 2 units, both transfused (preop Hb = 8.6 g/dl).

There were 6 full crossmatches: 11 units, 2 of which were transfused.

CTR = 5.5 (11/2) TI = 0.5 (2/4)

9) **Hip Disarticulation** (MSBOS = 4 units)

2 bookings for 1 patient (patient postponed once). A G&S was done on the first booking (preop Hb = 12.2 g/dl) but no valid crossmatch was done prior to surgery and there was no immediate postoperative one either. No postoperative Hb was sent.

## GYNAECOLOGICAL SURGERY

- 1) **Hysterectomy** (MSBOS = Group & Screen "for difficult hysterectomy"; 2 units for Wertheim's hysterectomy)

a) **All Hysterectomies**

126 operations & 4 cancellations

99 had a G&S (including the 4 cancellations): 3 converted: 7 (2,3,2) units: 6 (2,2,2) transfused.

13 operations had full crossmatch ab initio: 27 (12 of 2,3) units: 8 (4 of 2) transfused (2 had G&S as well); 3 crossmatch and transfusions (2 units matched and transfused in each) were preoperative

1 was postoperative: 2 units: 2 transfused.

19 had no form of pre (nor post)-operative blood request.

Total crossmatched excluding preoperative transfusions = 36 units (27+7+2). Total transfused 16 (8+6+2).

**CTR = 2.25 (36/16) TI = 0.12 (16/126)**

Average (23 records) postoperative Hb = 11.1 g/dl

Average preop Hb in these = 12.2 g/dl

One preoperatively transfused patient's Hb rose from 9.9 g/dl to 14.7 g/dl after 2 units.

Two of the transfused patients had postoperative Hb's sent:

11.3 g/dl (preop Hb = 11.8 g/dl; 2 units transfused)

10.2 g/dl (preop Hb = 11.8 g/dl; 2 units transfused).

b) **Wertheim's Hysterectomy**

3 cases booked as this and 3 as 'Pelvic Clearance'

5 had full crossmatch: 6 units for Wertheim's (2,2,2): 0 transfused.

4 units for the pelvic clearances (2,2): 2(2) transfused.

2 had a G&S, both unconverted (one was in addition to a full crossmatch)

**CTR = 5.0 (10/2) TI = 0.33 (2/6).**

Only one Wertheim's had a postoperative Hb sent: 10.7 g/dl ( no transfusion; preop Hb = 11.3 g/dl)

Two of the clearance patients' postoperative Hb's were taken:

8.0 g/dl (preop 13.7), no blood transfused

11.0 g/dl (preop 13.5), no transfusion.

c) **Vaginal Hysterectomy**

15 operations

12 had G&S; none converted to full crossmatch.

3 had no pre- nor postoperative blood requests.

2 postoperative Hb's were taken: 10.5 g/dl (preop 12.7); 11.6 g/dl (no preop)

2) **Myomectomy (MSBOS = 2 units)**

5 operations

1 full crossmatch: 3 units: 0 transfused. 3 had G&S: none converted.

1 had no pre- nor postoperative blood request.

There were no postoperative Hb's. Average preop Hb (in 4 patients) was 13.6 g/dl.

3) **Abdominal Pregnancy, Laparotomy For (no MSBOS listing)**

1 operation: 2 units crossmatched, 0 transfused

Preoperative Hb = 12.2 g/dl; no postoperative Hb.

4) i) **Suction Termination Of Pregnancy (MSBOS = Group and Screen)**

26 operations and 1 cancellation.

19 had a G&S (including the cancellation); none were converted to full crossmatch.

2 had full crossmatches: 2 units each; 0 transfused.

7 had no blood bank requisition.

One of the full crossmatched patient's Hb was 11.5 g/dl.

Only 2 patients had post-operative Hb's sent: 12.8 g/dl & 11.2 g/dl.

ii) **Hysterotomy Termination Of Pregnancy (no MSBOS)**

1 patient

1 Group and Screen, not converted.

No Hb's available.

5) **Ovarian Cystectomy (no MSBOS)**

4 operations

2 had a G&S, both unconverted.

2 had no blood bank requisition.

No Hb's available.

6) **Minor Procedures (no specific listing on MSBOS, but no group and screen implied by exclusion)**

All had a G&S, none of which were converted and consisted of the following operations (Hb's listed where and when available):

**laparoscopy (& dye)...** 10 (2 cancelled); 5 preop Hb's available: 15.1 - 9.9, mean of 13.2 g/dl. An additional 1 case had full crossmatch of 2 units, 0 transfused (no preop Hb).

**laparoscopic tubal ligation...** 2.

**uterine polypectomy...** 4; preop Hb's: 13.6, 10.8 & 13.5 g/dl; no postop Hb's.

**vaginal polypectomy...** 1; preop Hb = 14.2 g/dl; no postop Hb.

**fallopian tubal (micro) surgery...** 4; one had preop Hb (12.4 g/dl)

**anterior colpotomy...** 1

**"gonadectomy"...** 1; preop Hb = 13.0 g/dl.

**micro-hysteroscopy &/or dd&c...** 8 (2 cancelled); range of preop Hb's in 6: 11.4 - 15.3,  
mean = 13.1 g/dl.

**cone biopsy & dd&c & repair of 3rd degree tear...** 1; preop Hb = 13.3 and postop =  
13.6 g/dl.

**"raz" procedures, anterior repair, posterior repair, bladder neck suspension...** 6;

3 had preop Hb's: 14.6, 12.2, 10.5 g/dl.

**excision of vaginal septum...** 1 (cancelled).

**eua & fine needle aspiration biopsy...** 1.

## ORTHOPAEDIC SURGERY

- 1) **Open Reduction And Internal Fixation (Orif) Of Acetabular Fracture** (no MSBOS listing except for Orif pelvis, where MSBOS = 3 units)  
5 operations  
6 patients (1 cancellation and 2 postponements)  
11 full crossmatch records (including 3 intra-operative requests): 58 units crossmatched (12,6,6,16,12): 36 (5,4,6,9,12) transfused; 17 untransfused units were from cancelled procedures.  
**CTR = 1.6 (58/36) TI = 7.2 (36/5)**  
2 of the intra-operative requests were as a result of the initial request of 4 units not being sufficient; however in one case, no blood had been rebooked from the time of the previous cancellation.  
There was only 1 postoperative Hb: 8.7 g/dl after transfusion of 12 units.
  
- 2) **Orif Sacro-iliac Joint** (MSBOS as above)  
2 records for 1 patient: Group and Screen for the first booking  
4 units crossmatched: 0 transfused for actual operation.  
No Hb's sent.
  
- 3) **Cervical Spine Operations** (MSBOS = Group and Screen for anterior or posterior cervical fusion)  
1 **anterior decompression**: G&S, converted to 2 units, both transfused.  
Preop Hb = 12.3 g/dl.  
3 **posterior fusions**: 1 full crossmatch of 3 units; 0 transfused (no Hb's).  
2 patients had no blood bank requisitions.

4) **Lumbar Spine Operations** (MSBOS = Group and Screen for lumbar discectomy; 1 unit for fusion)

2 **lumbar spine fusions**: 1 full crossmatch of 3 units: 3 transfused (no Hb's).

1 no blood bank requisition.

4 **discectomies**: 2 full crossmatches: 2 units each: 0 transfused.

1 G&S, unconverted (postop Hb = 14.3 g/dl).

1 no blood bank requisition.

**CTR for above spinal operations = 2.4 (12/5) TI = 0.5 (5/10)**

5) **Thoracic/thoraco-lumbar Spinal Decompressions (tuberculosis)** (no MSBOS)

4 operations

15 full crossmatches (4 cancelled) for 4 patients: 103 units: 64 transfused (32 units not transfused as a result of cancellations)

**CTR = 1.6 (103/64) TI = 16 (64/4)**

Three of the patients had postop Hb's: 12.3, 12.5, 12.3 g/dl.

6) **Zimmer Pin And Plate** (MSBOS = 1 unit)

29 operations

9 patients had full crossmatch: 22 units: 12 transfused. Two of these requests were postoperative and 1 was intraoperative; one crossmatch had a G&S as well.

16 had a G&S; 3 converted to full crossmatch: 6 (2,2,2) units: 2 (2) transfused.

4 patients had no form of blood bank request either before or after surgery and 1 had no covering crossmatch for the day of surgery.

**CTR = 2.0 (28/14) TI = 0.48 (14/29)**

4 patients had postop Hb's (only 1 preop Hb):

8.3 g/dl which increased to 11.8 g/dl after a 2 unit postoperative crossmatch and transfusion (and unconverted G&S).

8.5 g/dl: 3 units crossmatched and 2 transfused postoperatively after this result

9.7 g/dl after a 4 unit intraoperative crossmatch and transfusion (no preoperative crossmatch)

11.1 g/dl (preop Hb = 15.9, no transfusion).

7) **Moore's Prosthesis (MSBOS = 1 unit)**

10 operations

4 had full crossmatches: 10 units: 2 transfused

5 had a G&S, one converted to 2 units: 0 transfused.

**CTR = 6.0 (12/2) TI = 0.2 (2/10)**

Only 1 patient had a postop Hb sent: 9.8 g/dl (G&S).

8) **Nailing Of Femoral Fractures (MSBOS = Group and Screen for "closed prograde intramedullary fixation of fractures")**

i) **AO nailing of femur**

17 operations

8 patients had a G&S (2 with additional full crossmatch requests, one on the same day, the other on the previous day); none converted.

6 had full crossmatches: 15 units: 8 transfused (1 patient had ORIF humerus as well).

8 operations not covered by blood bank request.

**CTR = 1.9 (15/8) TI = 0.5 (8/17)**

There were only 2 postoperative Hb's (none preop):

10.1 g/dl (3 units crossmatched, 0 transfused)

10.9 g/dl (G&S).

ii) **Russel Taylor Nailing Of The Femur**

2 operations

2 G&S, both converted: 2 units crossmatched: 2 transfused

5 crossmatched: 3 transfused.

There were no pre nor postoperative Hb's.

iii) **Enders Nailing Of Femur**

21 operations and 1 cancellation.

1 full crossmatch of 2 units; 0 transfused; preop Hb = 12.5 g/dl.

3 G&S (including the cancellation), none converted. One had a tibial plateau fracture as well; another had a postop Hb = 6.8 g/dl.

**Overall CTR = 1.8 (24/13) TI = 0.3 (13/40)**

9) **Total Hip Replacement (no MSBOS)**

2 operations (and 1 revision total hip).

2 full crossmatches: 6(2,4) units: 4(2,2) transfused (preop Hb = 12.3) in one. The revision had no preoperative request, but required intraoperative crossmatching: 4 units: 4 transfused; postop Hb = 9.1 g/dl.

10) **Internal Fixation Of Upper Limb Fractures (MSBOS = Group and Screen for open reduction of upper limb fractures")**

25 operations: 9 **Orif humerus**, 1 **shoulder**, 2 **elbows**, 11 **forearms** and 2 **Enders nailing of humerus**.

There were no full crossmatches; only 4 had a G&S (none converted) One preop Hb available: 9.4 g/dl (G&S).

- 11) **Sloughectomy (MSBOS = Group and Screen for "major desloughing procedures")**  
8 blood bank requests for 7 operations: 5 full crossmatches: 14 units: 11 transfused.  
3 had a G&S.  
**CTR = 1.3 (14/11) TI = 0.6 (7/11)**  
Only 1 postop Hb available (9.5 g/dl).
- 12) **Other Operations Not Specified In The MSBOS**  
1 **tibial osteotomy**: G&S, preop Hb = 14.7 g/dl.  
1 **knee ligament repair**: G&S.  
1 **femoral osteotomy**: G&S.  
1 **pantalar arthrodesis**: 2 units crossmatched: 0 transfused.  
1 **thoracic outlet release**: G&S.  
1 **brachial plexus exploration**: G&S.  
(No G&S converted).

## NEUROSURGERY

- 1) **Cerebral Aneurysm Clipping** (MSBOS = 2 units)
  - 8 operations and 4 cancellations (one patient cancelled twice).
  - 13 full crossmatches for 10 patients (two separate 2 unit crossmatches for one patient):
  - 34 units: 8 transfused in 4 patients (10 units cancelled from cancelled surgery)
  - One patient had no preoperative blood bank request, but had one intra operatively of 2 units matched and transfused (postop Hb = 11.6 g/dl)
  - CTR = 5.7 (34/6) TI = 0.75 (6/8)**
  - Average preop Hb = 13.8 g/dl (in 9 patients)
  - Average postop Hb= 11.4 g/dl (6 cases, only 2 of which received blood).
  
- 2) **Cirsoid Aneurysm** (no MSBOS)
  - 1 operation
  - 4 units crossmatched: 0 transfused.
  - preop Hb = 12.2 g/dl; postop = 11.7 g/dl
  
- 3) **Craniotomy: Tumour** (MSBOS = 2 units for "vascular cerebral tumour")
  - 15 operations
  - 17 blood bank requests: 11 full crossmatches: 34 units: 10 transfused (2,4,4).
  - 6 G&S (2 had full crossmatch as well): only 1 converted: 2 units: 0 transfused.
  - CTR = 3.6 (36/10) TI = 0.67 (10/15)**
  - Average preop Hb = 13.3 g/dl (13 patients)
  - Average postop Hb= 12.0 g/dl ( 9 patients). Two patients' postop Hb's who received blood were: 12.9 g/dl (after 4 units, preop Hb was 14.7); 12.7 g/dl (after 2 units, preop Hb was 14.6)

4) **Acoustic Neuroma** (MSBOS for vascular tumours as above only)

2 operations

2 full crossmatches: 6(4,2) units: 4(4,0) transfused.

Postop Hb in the patient receiving 4 units was 13.4 g/dl.

In the second patient, preop Hb = 13.9 and post 12.9 g/dl

5) **Transsphenoidal Hypophysectomy** (MSBOS = 2 units)

3 operations

2 full crossmatches, 1 no blood bank requisition.

4 units crossmatched: 0 transfused (one case) (preop Hb = 13.4 g/dl; however the case was booked as "packing of transsph.hypo.").

2 units matched; 0 transfused in the second case (postop Hb = 10.8 g/dl).

6) **Craniectomy** (no MSBOS)

2 operations

1 G&S (no conversion and postop Hb = 12.7 g/dl).

1 no blood requisition.

7) **Cranioplasty** (no MSBOS)

3 operations

1 full crossmatch: 4 units: 0 transfused (no Hb's)

1 G&S (not converted; preop Hb = 16.6 g/dl).

1 no blood bank requisition.

8) **Drainage Of Chronic Subdural Haematoma** (no MSBOS)

2 operations

No blood bank requisitions.

- 9) i) **Posterior Fossa Exploration: Tumour** (MSBOS = 2 units for vascular cerebral tumour)
- 4 operations
- 4 full crossmatches: 12 units(4,4,2,2): 2 transfused.
- CTR = 6.0 (12/2) TI = 0.5**
- Average preop Hb = 13.9 g/dl (15.5 - 11.8).
- Average postop Hb= 11.4 g/dl (13.5 - 9.3). The transfused patient had postop Hb of 13.5 g/dl after 2 units.
- ii) **Posterior Fossa Decompression** (no MSBOS)
- 1 operation (patient with fibrous dysplasia)
- 1 full crossmatch: 4 units: 2 transfused .
- Postop Hb = 9.3 and preop = 11.5 g/dl.
- 10) **Temporal Lobectomy** (no MSBOS)
- 1 operation
- No blood bank requisition.
- 11) **Excision Of Sacral Cordoma** (no MSBOS)
- 1 operation (postponed once)
- First booking had a G&S; At operation, 2 units matched: 0 transfused (no Hb's).
- 12) **Posterior Rhizotomy** (no MSBOS)
- 2 bookings, 1 cancelled
- The cancellation had 2 units crossmatched (0 transfused)
- The operated case had a G&S, unconverted.
- postop Hb = 9.0 g/dl.

13) i) **Cranial Osteitis Biopsy (no MSBOS)**

1 operation

4 units crossmatched: 0 transfused; preop Hb = 16.1 g/dl.

ii) **Removal Of Septic Bone Flap**

2 operations

1 full crossmatch: 2 units: 0 transfused (preop Hb = 16.7 g/dl)

1 G&S (not converted; preop Hb = 11.8 g/dl).

14) **Lumbar Laminectomy (MSBOS = Group and Screen under orthopaedics only)**

8 operations

1 full crossmatch: 2 units: 0 transfused (no Hb's).

1 G&S (unconverted, no Hb's).

6 with no blood bank requisitions.

15) i) **Cervical laminectomy / discectomy (MSBOS as above for lumbar)**

5 operations

3 full crossmatches: one of 4 units: 0 transfused (postop Hb = 13.7 g/dl)

two of 2 units: 0 transfused (postop Hb in one case = 10.4).

1 G&S (unconverted, no Hb's).

1 had no blood bank requisition.

ii) **Cervical Foraminotomy (no MSBOS)**

1 operation (C5 - 6 level)

Full crossmatch: 2 units: 0 transfused

Preop Hb = 14.2 g/dl; postop = 12.6 g/dl

16) **Thoracic Laminectomy; Tumour (no MSBOS)**

1 operation

Full crossmatch: 2 units: 2 transfused.

Preop Hb = 11.2, post = 10.5 g/dl.

17) **Miscellaneous**

a) 2 cases of **removal of knife blades** from i) **iliac crest** ii) **frontal bone**.

i) 2 units crossmatched: 0 transfused (preop Hb = 11.4 g/dl).

ii) no blood bank requisition.

b) **change of drain**

1 case: G&S, converted to 2 units: 2 transfused.

Preop Hb = 11.8 g/dl; post = 13.3 g/dl.

**CARDIAC SURGERY****1) Cardio-pulmonary Bypass Operations (MSBOS = 4 units)**

There were 86 crossmatch records: 8 from cancelled operations and 6 postoperative crossmatches.

74 CPB operations performed: 513 units crossmatched: 370 transfused;

48 units cancelled from cancelled surgery.

25 units crossmatched: 14 transfused postoperatively.

**CTR = 1.4 (513/370) TI = 5.0 (370/74)**

Average preoperative Hb was 12.6 g/dl (16.2 - 8.8 g/dl).

Average postop Hb was 10.9 g/dl (15.9 - 7.6 g/dl)

**2) Pericardectomy (no MSBOS)**

2 operations

1 crossmatch for 4 units: 1 transfused (preop Hb = 13.2 g/dl; postop Hb = 9.5 g/dl).

1 crossmatch for 3 units: 3 transfused (preop Hb = 13.7 g/dl; postop Hb = 13.0 g/dl).

**3) Removal Of Pacemaker Wires (no MSBOS)**

1 operation

Group and Screen procedure done; converted to 3 units: 1 transfused.

Preop Hb = 11.4 g/dl; postop = 11.5 g/dl.

**THORACIC SURGERY****1) Pleural Toilet / "Clear Out Of Chest" (no MSBOS)**

20 operations

6 had full crossmatches: 16 units: 7 transfused.

8 had a group and screen: 2 were converted to a total of 4 units: 4 transfused.

1 case had a preoperative transfusion of 2 units (preop Hb = 6.9 g/dl but had no covering crossmatch for the surgery).

5 other cases had no blood bank requisitions.

**CTR = 1.8 (20/11) TI = 0.55 (11/20)**

Average preoperative Hb (8 cases) = 8.8 g/dl (7.6 - 11.1).

Only 2 patients had postop Hb's: 9.6 g/dl after 2 units (4 crossmatched)

10.2 g/dl after 2 units (2 matched).

**2) Empyema Drainage (no MSBOS)**

4 operations

1 full crossmatch: 2 units: 0 transfused (preop Hb = 15.3 g/dl; postop Hb = 11.6 g/dl).

1 group and screen (preop Hb = 11.4 g/dl).

2 with no blood bank requisitions (no Hb's).

**3) Drainage Of Thoracic Abscess (no MSBOS)**

2 operations

1 full crossmatch: 4 units: 0 transfused (preop Hb = 8.5 g/dl).

1 group and screen: converted to 2 units: 2 transfused (preop Hb = 12.2 g/dl).

- 4) **Thoracotomy** (MSBOS = 5 units for "Pulmonary resection, major, inflammatory"; 2 units for "Pulmonary resection, non inflammatory")
- 4 operations
- i) **excision of pulmonary mets** (cancelled) ii) **excision of superior sulcus tumour**
- iii) **major haemoptysis** iv) **evacuation of aspergilloma and latissimus dorsi flap.**
- 4 full crossmatches: 9 units: 5 transfused.
- CTR = 1.8 (9/5) TI = 1.6 (5/3)**
- Preop Hb in ii) was 16.3 g/dl (2 units: 0 transfused); in iii) was 13.3 g/dl; postop was 13.0 g/dl (3 units: 3 transfused); in iv) was 12.6 g/dl; postop was 11.9 g/dl (2 units: 2 transfused).
- 5) **Open Lung Biopsy** (no MSBOS)
- 2 operations: both had group and screens, neither converted.
- Preoperative Hb's were: 9.3 and 10.5 g/dl.
- 6) **Pleurectomy** (MSBOS = 2 units)
- 2 operations
- 1 full crossmatch: 2 units: 0 transfused.
- (preop Hb = 12.4 g/dl and INR greater than 4.0 on date of crossmatch; postop Hb = 12.3
- 1 group and screen, unconverted.
- preop Hb = 19.6, postop = 16.9 g/dl.
- 7) **Bullectomy Plus Pleurectomy** (MSBOS = 2 units for pleurectomy plus decortication)
- 3 operations
- 2 full crossmatches: 6 units (4,2): 0 transfused.
- 1 group and screen: converted to 4 units: 0 transfused.
- Hb's(g/dl), preop/postop: 14.5/10.7 12.1/9.2 12.9/?

8) **Lobectomy** (MSBOS 5 and 2 units as for 4))

19 operations:

**12 right upper, 2 each for left upper, left lower and right lower. 1 left unspecified.**

Whether operation performed was the same as that planned was not determined.

There were 15 full crossmatches (one patient had two separate 2 unit requests):

35 units: 13 transfused.

5 had a G&S, none converted (all had preop Hb's greater than 13 g/dl).

1 operation was postponed (initial 2 unit crossmatch cancelled) and subsequently uncovered by any crossmatch.

**CTR = 2.7 (35/13) TI = 0.7 (13/19)**

Average (17 cases) preop Hb = 13.9 g/dl (15.6 - 11.6 g/dl).

Average (15 cases) postop Hb = 11.8 g/dl (13.2 (no transfusion)- 8.8 g/dl (post 3 units)).

Average postop Hb in patients receiving blood (5) = 11.2 g/dl (12.9 (patient had 2 units and preop Hb was 11.6) - 8.8 g/dl).

If **right upper lobectomies** (12) alone are considered:

11 full crossmatches: 23 units: 6 transfused.

3 G&S (nil converted)

**CTR = 3.8 (23/6) TI = 0.5 (6/12)**

9) **Pneumonectomy** (MSBOS as above)

7 operations

7 full crossmatches: 24 units: 20 transfused (7 in one operation).

**CTR = 1.2 (24/20) TI = 2.9 (20/7)**

Average (all 7) preop Hb = 11.5 (13.2 - 9.0) g/dl.

Average (5 cases) postop Hb = 11.4 (12.6 - 9.1) g/dl.

The highest postop Hb's were 12.6 (preop = 13.2) g/dl after 4 units and 12.3 (preop = 10.9) g/dl after 2 units.

- 10) **Pleuro-pneumonectomy (MSBOS as above)**
  - 1 operation
  - 1 crossmatch: 2 units: 2 transfused.
  - Preop Hb = 13.4 g/dl; Postop = 11.1 g/dl.
  
- 11) **Hydatid Cyst Excision (no MSBOS)**
  - 2 operations
  - 2 group and screens, neither converted.
  - Preop/postop Hb in one patient: 15.5/14.9 g/dl.
  
- 12) **Thymectomy (MSBOS = 3 units for mediastinal tumour)**
  - 2 operations
  - 2 full crossmatches: 3 (2,1) units: 0 transfused.
  - Hb's (g/dl) preop/postop: 15.8/14.0; 12.7/10.9
  
- 13) **Medianoscopy (no MSBOS)**
  - 7 operations
  - 1 preoperative transfusion (Hb increased from 8.1 to 10.9 g/dl); no request covering operation.
  - 1 group and screen (open lung biopsy as well; preop Hb = 12.0 g/dl).
  - 6 operations not covered by blood bank request.
  
- 14) **Pericardial Drain (no MSBOS)**
  - 7 operations
  - 1 full crossmatch: 2 units: 2 transfused (preop Hb = 8.0; post = 12.5 g/dl).
  - 2 group and screens (one patient with preop Hb = 10.2 and platelets of 60 000); neither converted.

15) **Tracheal Resection (no MSBOS)**

1 operation

1 full crossmatch: 6 units: 2 transfused.

Hb's (g/dl) pre/postop = 13.9/11.5

16) **Repair Of Chronic Traumatic Diaphragmatic Hernia (no MSBOS)**

1 operation

1 group and screen: converted to 4 units: 2 transfused.

Hb's (g/dl) pre/postop = 11.2/10.5

## UROLOGY

- 1) **Transurethral Resection Of The Prostrate Gland (MSBOS = Group and Screen)**

87 operations, 22 booked as "? open"

50 G&S's: 7 of which were converted: 15 units: 9 transfused. Four of these converted G&S's were from "? open" cases; 1 was used for a preoperative transfusion and 1 for a patient who had had 25 units transfused in the two weeks preceding surgery.

2 patients had full crossmatches: 4 (2,2) units: 0 transfused (one crossmatch for a postponed case, uncrossmatched on repeat booking; the second case (preop Hb = 12.3 g/dl) booked for colostomy as well and crossmatched intra-operatively.

41 operations had no covering blood bank requisition.

**CTR = 2.1 (19/9) TI = 0.1 (9/87)**

Average (47 cases) preop Hb = 13.3 g/dl.

Average (7 cases) postop Hb = 10.3 g/dl.
  
- 2) **Cystectomy (MSBOS = 4 units)**

2 operations

2 full crossmatches: 2 units: 2 transfused (preop Hb = 15.7 g/dl; no postop available)

2 units: 0 transfused (preop Hb = 11.3, postop = 9.6 g/dl).
  
- 3) **Nephrectomy (MSBOS = 2 units for partial or radical)**

19 operations (7 as graft nephrectomies)

7 full crossmatches: 17 units: 12 transfused.

9 group and screens: 4 converted to 8 units (2,2,2,2): 4 (2,2) transfused.

4 operations had no covering blood bank requisitions.

**CTR = 1.6 (25/16) TI = 0.8 (16/19)**

Average (14 cases) preop Hb = 9.9 (16.6 - 6.7) g/dl.

Average ( 5 cases) postop Hb = 6.4 (8.4 - 5.4) g/dl.

**4) Renal Transplantation (no MSBOS)**

18 operations

8 full crossmatches: 17 units: 6 transfused.

9 group and screens: 2 converted to 4 (2,2) units: 1 transfused.

1 operation uncovered by blood bank request.

**CTR = 3.0 (21/7) TI = 0.4 (7/18)**

Average (14 cases) preop Hb = 8.0 (4.9 - 15.0) g/dl.

Average (13 cases) postop Hb = 6.6 (10.1 - 4.2) g/dl.

**5) Ileal Conduit (MSBOS = Group and Screen for "urinary diversion")**

1 operation

1 G&S, unconverted; preop Hb = 11.9 g/dl.

**6) Nephrolithotomy (MSBOS = 2 units)**

4 operations

1 full crossmatch: 2 units: 0 transfused (patient had a G&S converted to 2 units: 2 transfused preoperatively; pre-transfusion Hb = 7.3 g/dl).

2 group and screens: neither converted; preop Hb in one = 13.0 g/dl.

1 no blood bank request (booked as "nephrostomy").

**7) Renal Surgery (MSBOS = Group and Screen for "renal surgery")**

Operations under this heading were:

**Ureteropyelostomy (1); Ureterolithotomy (1) and Pelviureteric junction repair (1).**

All 3 had a G&S, none converted.

Only one patient had a (preoperative) Hb: 9.0 g/dl.

8) **Open Bladder Operation (MSBOS = 2 units)**

2 operations

2 full crossmatches: 4 units: 2 transfused (single transfusion).

The transfused patient had preop Hb = 9.6 g/dl; postop Hb = 12.4 g/dl, after 2 units  
second patient had preop Hb = 12.6 g/dl (no postop Hb).

9) **Bladder Diverticulectomy (MSBOS = Group and Screen)**

1 operation

1 G&S, unconverted, no Hb's.

10) **Ureterectomy (MSBOS = 2 units)**

1 operation (booked as distal right ureterectomy)

1 G&S, unconverted; preoperative Hb = 12.0 g/dl.

11) i) **Transurethral Resection Of Bladder Tumour (MSBOS = Group and Screen)**

14 operations

1 full crossmatch: 2 units: 0 transfused (pre- and postop Hb's both 9.7 g/dl).

4 G&S; none converted (preop Hb's: 15.5, 14.7, 14.6, and 9.4 g/dl).

9 operations had no covering blood bank requisition.

ii) **Cystoscopy and Biopsy or Fulgaration of Bladder Tumour (MSBOS = G&S for  
"transurethral resection of bladder tumour")**

15 operations (5 as biopsy; 10 as fulgaration).

6 G&S: none converted.

9 had no blood bank requisition (8 of them biopsy's).

Four preop Hb's were available in the biopsy group: mean of 12.6 (11.5 - 13.7) g/dl; two only in the fulguration group: 18.5 g/dl (had a G&S) and 14.3 g/dl (also covered by G&S).

12) **Cystoscopy and "Minor Procedure"** (no blood requisition required implied by exclusion)

10 operations:

i) 3 **opticals** ii) 1 **bladder neck incision**

iii) 2 **trans-rectal needle biopsies**

iv) 3 **double J stent insertions** v) 1 **panureteric Teflon injection**

1 full crossmatch (v): 2 units: 0 transfused (preop Hb = 7.1 g/dl).

9 group and screens, none converted.

Average preop Hb = 13.7 g/dl (7.1 - 17.2).

13) **Urethroplasty** (MSBOS = Group and Screen for "standard" and 2 units for "anticipated difficult" urethroplasty)

2 operations

1 G&S, unconverted; postop Hb = 6.2 g/dl (preop = 10.2); postoperative recrossmatch required: 3 units: 2 transfused, three days later.

1 uncovered by blood bank request.

## EAR NOSE & THROAT SURGERY

1) **Laryngectomy** (MSBOS = 2 units for "laryngectomy and 2 units for "neck dissection")

10 operations: 4 with "neck dissection" as well.

4 full crossmatches (all those with neck dissection): 11 units: 5 transfused (3,2).

3 G&S, none converted.

3 with no blood bank requisition.

**CTR = 2.2 (11/5) TI = 0.5 (5/10)**

Average preop Hb = 13.9 (12.3 - 15.7) g/dl.

Only one postop Hb available (had neck diss.): 9.3 g/dl (preop = 12.6 and 3 out of 5 units transfused).

2) **Neck Dissection** (MSBOS = 2 units)

1 operation

1 group and screen, unconverted, preop Hb = 11.4 g/dl.

3) **Fronto-ethmoidectomy** (MSBOS = Group and Screen for "Frontal Sinus obliteration")

2 operations: both had no blood bank requisitions.

4) **Angiofibroma** (MSBOS = 4 units)

1 operation

1 full crossmatch: 4 units: 3 transfused.

No pre- nor postoperative Hb's.

## PLASTIC SURGERY

- 1) **Mastectomy** (no MSBOS for this under plastics)  
1 operation, booked twice  
no blood bank requisitions on both occasions.
  
- 2) **Breast Reduction** (MSBOS = both 2 units and Group and Screen for "breast reconstruction")  
15 operations (5 single and 10 bilateral reductions).  
1 had a G&S, unconverted (bilateral and preop Hb = 13.6 g/dl).  
14 had no blood bank requisition.
  
- 3) **Breast Prosthesis/reconstruction** (MSBOS as above)  
6 operations: 6 no blood requisition.
  
- 4) **Musculocutaneous Flap** (MSBOS = Group and Screen for "musculocutaneous flap" only)  
2 operations; plus 1 fasciocutaneous flap  
2 no blood requisition (musculo-).  
1 G&S (fascio-), unconverted; preop Hb = 9.2; postop = 8.4 g/dl.
  
- 5) **Vaginoplasty** (no MSBOS)  
1 operation (final stage)  
1 G&S, unconverted and outdated; preop Hb = 14.6 g/dl.
  
- 6) **Functional Neck Dissection** (no MSBOS)  
2 operations. 2 no blood requisition.

## MAXILLO-FACIAL SURGERY

(MSBOS lumps all "maxillo-facial surgery" as 2 units under Plastics)

- 1) **Fractured Mandible**
  - 1 operation
  - 1 full crossmatch: 6 units: 5 transfused (no Hb's).
  
- 2) **Leforte II Operation**
  - 2 operations, 1 postponement
  - 1 full crossmatch: 2 units: 2 transfused (this in the postponed patient, no blood requisition on first booking).
  - 1 no blood requisition
  - No Hb's
  
- 3) **Gingivectomy**
  - 1 operation
  - 1 full crossmatch: 3 units: 2 transfused.
  
- 4) **Temporo-mandibular Joint Ankylosis**
  - 1 operation (with costochondral rib graft)
  - 1 full crossmatch: 3 units: 3 transfused.
  - No Hb's

## DISCUSSION

### 1) **HISTORY OF THE MSBOS**

The first published report of attempted rationalisation of blood usage in elective surgery was by Mintz et al in 1974.<sup>3</sup> They analysed blood usage in elective surgery at the New York Upstate Medical Center in order to compile a protocol for preoperative crossmatching that would improve its efficiency. A CTR of 2.48 was found which was comparable to other unpublished reports. They recommended that a group and screen procedure be introduced for those procedures which routinely required less than 0.5 units of blood and which would thus decrease the CTR; an 'ideal' CTR was not recommended, nor was a MSBOS proposed. The first referral to a Maximum Surgical Blood Ordering Schedule (and its abbreviation MSBOS) was by Friedman et al in 1976<sup>4</sup>. They presented data illustrating savings in the number of blood units crossmatched for 16 operations since the introduction of a MSBOS in the University of Michigan Hospital. Further projected data on 50 common surgical procedures was provided, derived from a Hospital Record Study drawn from 967 non-Federal short-term general hospitals. Although all figures were thus estimates, Friedman hoped the data would provide a framework for blood bank directors to establish their own MSBOS.

The reason for wanting to establish a MSBOS was primarily to increase the shelf-life of blood i.e. decrease the percentage outdating. This derives from the fact that if blood is held reserved (i.e. crossmatched) and is not used, the less chance it has of being used overall as it will have been removed from the general blood-bank pool for the period of the crossmatch. Cost savings were however also mentioned.

Rouault and Gruenhagen<sup>8</sup> in 1978 published their results of a 3 month survey of blood crossmatching and transfusion for elective surgery at the Los Angeles County-University of Southern California Medical Center. An overall crossmatch/transfusion ratio (CTR) of 4.1 was

found and a table was provided giving their recommended MSBOS for 65 operations. This MSBOS was conservative even by present GSH standards (see appendix); e.g.:

coronary vein grafts - 2 units (28 units crossmatched, 10 transfused in 6 patients); valve surgery - 4 units (32 units crossmatched, 17 transfused in 4 patients); aortofemoral bypass - 2 units (14 units crossmatched, 0 transfused in 3 patients); abdominal aortic aneurysm - 2 units (6 units matched, 0 transfused in 1 patient !)

AK & BK amputations - group and screen (50 units matched, 7 transfused in 13 patients)

However the number of cases involved were really too small to make any recommendations for a maximum no. of units to order preoperatively, even in the hospital in which the study was conducted, and clearly not applicable to other hospitals with different surgeons and patients.

Friedman<sup>2</sup> (1979) published a detailed MSBOS in which suggested maximum orders for 63 common elective surgical procedures were provided, based on blood requirements in 535 031 patients from 300 hospitals in the USA. This time the data was obtained from the Hospital Sample File compiled by the Commission on Professional and Hospital Activity's (CPHA) Professional Activities Study (PAS) and was extracted from individual patient records. The maximum suggested orders were derived from when the cumulative percent of patients receiving that number of units for a particular operation was greater than 90%: e.g. for "operations on blood vessels except vein ligation and bypass" (2 368 patients), 73% required no blood; cumulative percent receiving 0-3 units was 86.9 and 90.5 for percent receiving 0-4 units; the suggested maximum order was 4 units. Hence they were very generous, certainly when compared to the GSH MSBOS.

Sarma<sup>5</sup>(1980) published his attempt to rationalise blood usage by suggesting a short list of operations that could have a group and screen rather than full crossmatch. He had found a CTR of 4.29 for elective surgery at the Veterans Administration Medical Center of New Orleans. The operations listed for group and screening were limited to those with an average of 0.5 or less units used per patient crossmatched (in fact a G&S was even recommended for a neurosurgical laminectomy (average units/patient crossmatched 0.54); however a total knee replacement with an average of 0.57 didn't get such a recommendation!).

Gryskiewicz and Detmer<sup>6</sup> (1983) published an extensive MSBOS, whilst stating that even at the time of writing it was under review to make it more conservative. They may have thought their MSBOS excessive, but at least several operations were listed as not requiring either group & screen nor full crossmatch: e.g. in neurosurgery: burr hole and brain biopsy, cyst or abscess drainage and subdural haematoma. The number of operations listed is impressive and is really more like what GSH requires at present.

Other studies (mainly in the early 1980's), showed that excessive preoperative crossmatching for elective surgery was a common problem.<sup>6,7,11,12</sup> It is apparent from these studies and the present investigation that each major medical center should formulate a blood schedule relevant to its own requirements; preferably based on studies of current usage. Such a study had never been done at GSH; the existing MSBOS is based on publications from other hospitals and reviews by representatives of each individual surgical discipline at regular meetings of the hospital's Blood Users Committee.

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## 2) PRETRANSFUSION TESTING

It is important to differentiate between the terms compatibility testing and crossmatch; the crossmatch is only part of full compatibility testing, which consists of the following: i) review of the patient's blood-bank history ii) ABO & Rh typing of donor and recipient iii) screening of donor's and recipients' serum for antibodies iv) the crossmatch.

Ottenberg (1908) was the first to apply Landsteiner's discovery of the blood groups to transfusion medicine by looking for lysis and agglutination of donor red blood cells (rbcs) by recipient serum.<sup>20</sup> By the 1960's, many new blood group antigens and systems had been discovered as a result of pretransfusion testing and after haemolytic transfusion reactions. Hence much emphasis was placed on the detection of any possible blood group antibodies in patients' serums. Technicians were frightened of missing an antibody that might be clinically significant and as a result, pretransfusion compatibility testing became a tedious and complicated affair. Tests were performed at room temperature and at 37°C; various potentiators were used (e.g., albumin, enzymes), all designed to increase testing sensitivity and detect more antibodies; a minor crossmatch (recipient rbc's incubated with donor serum) was also routinely performed, despite it's value having been questioned as far back as 1958 by Jennings and Hindmarsh.<sup>20</sup>

Pretransfusion testing became less vigorous in 1976, after a Karl Landsteiner award lecture by Dr E.R. Giblett in which the need to screen for antibodies at room temperature was deprecated.<sup>21</sup> Transfusionists finally realised that antibodies reacting at room temperature were not clinically significant at 37°C.

Garratty<sup>21</sup> regards both the minor crossmatch and room temperature testing (apart from the "immediate spin crossmatch") as of historic interest only.

The first publications suggesting replacement of full crossmatch by a group and screen (G&S) for surgical patients was in 1976 by Mintz et al<sup>3</sup> and separately by Friedman.<sup>4</sup> Boral and Henry in 1977<sup>19</sup> looked at 12 848 patient specimens via G&S and crossmatch; they were able to demonstrate 96.11% of 283 antibodies detected in 247 patients via screening reagent rbcs. Taking antibody frequencies into consideration, they calculated that with a negative G&S, a patient

suddenly requiring blood from unexpected massive haemorrhage, would have a 99.99% chance of not having an incompatible transfusion with type specific uncrossmatched blood.

The G&S then became fairly uncontroversial as a replacement for a full crossmatch, but only for patients in whom blood was extremely unlikely to be used (in 1991, why even then the need for a G&S in these circumstances?). However there came a voice saying that if these patients can make do with a G&S, why not all patients (i.e. if an antiglobulin test (AGT) has been done in the screen, then it needn't be repeated with the crossmatch). This question had in fact been asked back in 1964 by Grove-Rasmussen<sup>22</sup>; however in 1980, both the Food and Drug Administration (FDA) and the standards of the American Association of Blood Banks (AABB) required the crossmatch stage of compatibility testing to include an AGT.

In December 1981, a meeting sponsored by the Bureau of Biologics (BoB) was presented to the FDA Blood Products Advisory Committee in which opinions from notable transfusionists were heard regarding whether the AGT phase of the major crossmatch could be dropped from the BoB requirements for compatibility testing.<sup>22</sup> Several views were heard at this meeting, most were in favour of deleting the antiglobulin phase of the crossmatch if the antibody screen had been negative. However, some felt strongly that it should not be recommended that all hospitals drop the AGT, especially smaller ones. Hafleigh from Stanford University, went as far as saying that even the immediate spin crossmatch was unnecessary, reliance being placed upon previous duplicate ABO testing and double checking of all paperwork and labels by at least two people as blood is issued. As a result of the meeting, both the FDA and the AABB made allowance for the dropping of the AGT if the antibody screen is negative.

Several publications have been made showing the low risk of complications if the AGT is omitted (with a negative antibody screen) when blood is crossmatched.<sup>18,19,21,22,23,24,25</sup> Just what is the risk involved? It is of missing a weak antibody that might interact with donated rbc's and shorten their survival. This doesn't mean that a patient will die, or even suffer any morbidity; a recent report of 1,3 million consecutive immediate spin crossmatches found an incidence of only 5 clinically overt haemolytic reactions, none of whom suffered any serious morbidity.<sup>23</sup> Most patients

have normal bone marrows and can produce their own red cells, so if a few rbc's die before they ought to, the marrow would compensate. The above example gives the small risk outlined of 1 in 260 000. By comparison, the risk of persons dying per year from some voluntary activities such as smoking 20 cigarettes/day, playing soccer, horse racing and falling pregnant are 1 in 200, 1 in 25 000, 1 in 740 and 1 in 4 350 respectively.<sup>26</sup> The risk of death totally attributable to anaesthesia is given as 1 in 10 000 with an additional 2 per 10 000 dying totally or in major part as a result of an anaesthetic.<sup>28</sup>

The risk of only crossmatching via immediate spin in GSH would have to be determined from a study generated amongst the local population served by Groote Schuur, as each population has its own blood group characteristics which may differ to the extent that comparison with risks in other populations are meaningless. Such a study will hopefully get underway in 1992 (personal communication: Dr A.Bird, Western Province Blood Transfusion Services (WPBTS)).

The purpose of omitting the AGT phase of the crossmatch is one of cost-benefit. The savings would not be massive in terms of costs per test (i.e. less Coombs serum used and time spent): Schulman et al<sup>23</sup> calculated a saving of only \$1.00 per test at their institution back in the 1980's. However, by doing group & screens (knowing blood can quickly and safely be obtained via immediate spin crossmatch), cost savings could be considerable by avoiding unnecessary crossmatching of blood.

At Groote Schuur the compatibility testing is done as follows:

- i) the history is obtained from the crossmatch requisition form as supplied by the requesting physician
- ii) donor blood is ABO & Rh grouped as well as screened for antibodies at the WP Blood Transfusion Service centre in Pinelands. Each unit is again grouped for ABO & Rh by the blood bank at GSH as a double check (no antibody screen repeated).
- iii) a recipient specimen is ABO and Rh grouped and then screened for antibodies against two reagent group O red blood cell (rbc) suspensions (commercially prepared and contain the commonest rbc antigenic components that are of clinical significance). Following this, an indirect

Coombs test is done (antiglobulin test) in which Coombs serum is added to a mixture of reagent rbc's that have been incubated for at least 30 minutes in the recipient's serum. If unusual antibodies are present, they will combine with antigenic components on the test red cells and then be agglutinated by the Coombs serum (anti-globulin). Should this occur, the patient's specimen would be sent to the serology laboratory (Pinelands) for identification of the antibody, and blood would be looked for that lacked the antigen to the patient's antibodies.

Should only a group & screen have been requested, then no more is done and the prospective recipient's specimen is kept refrigerated for a maximum of 24 to 36 hours. After this time, the red cells degenerate and lose much of their antigenicity, serum complement is destroyed and reactions with laboratory tests become unreliable; therefore, if blood is still required for the same patient, another specimen would have to be sent in, even though the original specimens are kept for a total of 14 days (in case of untoward reactions). Repeat group and screening is done for the new crossmatch as: i) there is no quick reference to the previous G&S request ii) the test would be repeated in any event in case of a clerical error having been previously made.

iv) If blood is required, a full crossmatch is now done: donor red cells are mixed with recipient serum and agglutination is looked for at room temperature (immediate spin) and then after addition of Coombs serum after incubation at 37°C for 30 minutes. If blood is requested immediately, the antiglobulin test can be omitted and the blood issued after a negative immediate spin. In this event, the blood is clearly labelled that it is to be administered at the responsibility of the requesting physician.

\* \* \* \* \*

### 3) THE CROSSMATCH TRANSFUSION RATIO

Assessing the efficiency of crossmatching via the crossmatch- transfusion ratio is not necessarily accurate. A low CTR may represent a low crossmatch incidence or alternatively a high transfusion incidence; if the latter, only by determining pre- and postoperative Hb's can one assess appropriateness of the transfusion. The lowest average CTR seen in cardiac records becomes less impressive considering they had the greatest number of inappropriate transfusions (i.e. post-operative Hb's >11.0 g/dl). Conversely, a high CTR may represent a high crossmatch incidence or low transfusion incidence; the high CTR in neurosurgery is an example of the former and with the incidence of overtransfusion by the generously set criteria for this study of 27%, low transfusion incidence is unlikely to be the cause of high CTR's.

It is interesting to note that several articles subsequent to that of Mintz et al (1976) on the subject of crossmatch efficiency, refer to 2,5 as being an acceptable CTR for a hospital with full clinical facilities.<sup>6,7,8</sup> This however, is difficult to accept since a CTR of 2.5 means 6 out of every 10 units crossmatched would be "wasted". In fact Mintz et al themselves introduced the group and screen in an attempt to reduce this figure, which they thought represented excessive crossmatching.

The overall elective surgical CTR was 1.7, which is in close keeping for the CTR of the whole of GSH (overall CTR for July - Sept. 1990 was 1.37, 1.41, 1.45 respectively; personal communication: Dr A.Bird). The fact that the former is higher than the latter is not surprising since one would hope that for medical problems requiring transfusion, a more accurate amount of blood would be assessable pre-transfusion and hence crossmatched units should be nearer the number transfused. However, pre and post transfusion Hb's would still be required to assess the appropriateness of the transfusion. Friedman (1977)<sup>28</sup> showed that inappropriate transfusion in medical patients occurred: he found a total of 401 patients (out of 3 616) admitted to hospitals across the USA with a diagnosis of anaemia, with admission Hb's of greater than or equal to 10 g/dl whom had received a mean of 2.6 units of blood.

That neurosurgery should have such a high CTR is not surprising: the surgeons are aware that very few of their patients ever require blood, but by the very nature of the surgery (e.g. cerebral aneurysm clipping) with the catastrophic effect a sudden bleed would have, they not only insist on blood being crossmatched, but want it physically in the operating theater before the direct approach on the aneurysm. However, the neurosurgeons blood wastage was unnecessarily high: many requests for blood were for 4 units when the MSBOS was 2 (e.g. aneurysm); this usually arose because 2 units are booked "on reserve" in addition to "required". The charge is identical as the reserved blood must still be crossmatched.

The next highest CTR was in gynaecology (2.7). This is a definite reflection of inappropriate crossmatching with blood requested for hysterectomies and termination of pregnancies with no clinical grounds (at least based on preoperative Hb).

Bearing in mind the inaccuracies of the CTR, it would appear that the present MSBOS did not result in more efficient crossmatching since the CTR for records adhering to the MSBOS was 1.8, whereas the CTR for records where the operations were not listed on the MSBOS was also 1.8. If however the number of units requested was less than the maximum, crossmatching was more efficient (CTR of 1.3); interestingly, crossmatches in excess of the MSBOS had a CTR lower than those adhering to it (CTR = 1.4). This is accounted for by the large number of cardiac cases done at GSH, all of whom exceeded the MSBOS's recommended 4 units by two, but nevertheless still had the lowest average CTR (1.4). This low figure is somewhat misleading, since cardiac surgical patients had the greatest number of untransfused ("wasted") units (249). Had the MSBOS been adhered to in those cases where a crossmatch was done but the maximum was a G&S (CTR = 3.4), then considerable increased efficiency and savings would have been made.

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#### 4) **MSBOS ADHERENCE: THE EXCEPTIONS**

i) **anaemia:** many anaesthetists are happy to administer blood to an anaemic patient requiring blood-losing surgery either at the onset of surgery, or as dictated by the clinical scenario during the course of the operation. Traditionally, anaesthetists have been taught that infused blood requires at least 24 hours for normalisation of 2,3,DPG and the Hb oxygen-dissociation curve (HbODC). The leftward shift in the HbODC that occurs in vitro, the degree of which was directly related to the storage period (Acid Citrate Dextrose blood), was first described in 1954 by Valtis and Kennedy.<sup>27</sup> However, whilst studies in rats have demonstrated decreases in P<sub>50</sub> and 2,3,DPG levels and human studies have shown that an increase in oxygen affinity occurs after infusion of stored blood, arteriovenous oxygen extraction changes have not been clearly demonstrated.<sup>27</sup> Hence the disadvantages to the anaemic patient of receiving stored blood on the operating table remain theoretical.

The MSBOS cannot be applied to such patients and perioperative blood requests will be dictated by the degree of the anaemia and the nature of the surgery, which would need to be supplied on the request form. Excessive preoperative transfusion has been described as resulting in a haematocrit in excess of 0.36<sup>12</sup> (Hb approximately 12 g/dl). For operations not frequently requiring blood (perhaps even those that do), this level is too high; a Hb of 10 g/dl would probably be better (less unnecessary exposure to blood and improved blood rheology during a period of risk for venous thrombosis).

Where blood was administered one or two days preoperatively for preoperative anaemia it was frequently observed that there was a failure to repeat a crossmatch request. Obviously such a request should adhere to the MSBOS unless other overriding factors exist and medical staff looking after such patients need to be educated about the need of repeating preoperative blood requests.

ii) **coagulopathy:** patients with any form of coagulopathy, be it platelet defect or intrinsic/extrinsic coagulation pathway defect, congenital or acquired, will require blood products, usually other than red cells, as dictated by the clinical scenario. Most such cases seen at GSH are

as a result of sepsis and do not fall under elective surgery, hence the MSBOS would not be applicable.

iii) **Repeat Surgery:** "redo's" frequently bleed more than the same operation on a fresh case and hence may require more blood than indicated by the MSBOS. Cardiac surgery is the best example of this and presently 6 units of blood are usually requested instead of the maximum of 4. This should be made clear on the request form or these particular operations should have their own MSBOS.

Redo laparotomies, whilst only semi-elective, rarely required blood in the 3 month study period. With adequate haemoglobin levels and clotting parameters they probably do not even warrant a group & screen.

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## 5) TRANSFUSION APPROPRIATENESS

Previous studies<sup>12,13</sup> have regarded a haematocrit in excess of 33% in the transfused postoperative patient as representing excessive transfusion. Taking the Hb as Hct/3 (the anaesthetists widely practised rule of thumb and simple comparison between the two in the same patient will show this to be so), 11.0 g/dl was chosen to represent the level above which postoperative transfusion was judged to be inappropriate. It seems that this figure was quite arbitrarily chosen based on studies of post cardiopulmonary bypass patients who reportedly suffered no increased morbidity despite postoperative haematocrits of 25-30%.<sup>14</sup> However, as the optimal haematocrit in critically ill post-surgical patients has been shown to be 32%,<sup>15</sup> this figure seems reasonable to use to divide appropriate from inappropriate transfusion with safety as there are no clinical details available for the cases. The fact that elective surgical patients are not critically ill probably means that this figure is too generous. The National Institutes of Health Consensus Development Conference Statement states in one of its conclusions: "available evidence does not support the use of a single criterion for transfusion such as a hemoglobin concentration of <10 g/dl. No single measure can replace good clinical judgment as the basis for decision making regarding perioperative transfusion."<sup>16</sup> The statement also points out that in healthy humans the cardiac output does not increase until the Hb drops below 7 g/dl provided the intravascular volume is maintained. Cane goes as far as stating: "Routine blood transfusion practices based on arbitrary Hgb levels >7 g/dl are no longer consistent with acceptable standards of care"<sup>17</sup>. Hence an even lower level than 11 g/dl could be used to divide inappropriate from appropriate transfusion, however without evidence of cardiovascular and respiratory system normality in the study patients, 11 g/dl has been left as the dividing line.

The incidence of 27% of inappropriate transfusion by the above mentioned criteria is in close agreement with previously published studies where the percentage of overtransfusion (Hct >33%) reported in a study of post colorectal cancer surgery was 25<sup>13</sup> and a 33% incidence in a broad spectrum of surgical practice.<sup>9</sup> The two commonest reasons given for overtransfusion were the over-crossmatching of blood and the continued practice of transfusing blood in paired units,<sup>13</sup>

both of which are relevant to GSH. During the study period, only one request was noted for a single unit of blood and a few were for an odd number of units. The percentage of overtransfused patients may well have been higher had more full blood counts been available. However, in most instances where no FBC was on the computer, it was because one wasn't sent. If a patient is cardiovascularly stable and does not look clinically pale after an operation, then it is hardly surprising that a coulter FBC would not be sent, particularly as a postoperative ward Hb (Spencer) would most likely have been done. However, quite a few coulter records were removed from the hospital computer by the time they were looked for. Some of these were obtained with the help of medical informatics at GSH who were fortunately setting up a program to access old computer files.

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## 6) ANAESTHESIA, ANAEMIA AND SURGERY

This subject has been superbly reviewed by Gillies as far back as 1974<sup>29</sup> and more recently by Stehling.<sup>40</sup> According to the latter, the first reference to any figure of Hb in the anaesthetic journals was probably from Adams and Lundy at the Mayo Clinic in 1941 who stated that it would be "wise" to transfuse with a preoperative Hb of 8-10 g/dl. Gillies reviews the background to the "safe" level of Hb: being from 7.5 -13.5 g/dl in articles published 1942-66, whilst those from 1968-72 favoured "around" 10 g/dl. However, he agrees with many of these previous authors that a "rule necessitating a predetermined level of haemoglobin prior to elective surgery is both unthinking and impracticable". Why then do the surgical and anaesthetic staff still today abide by the 10 g/dl "rule"?

### Physiology

A patient is anaemic when his or her Hb is less than 2 Standard Deviations of the mean for a normal population at sea level. According to Best and Taylor<sup>30</sup> this is below 14 g/dl in men and 12 g/dl in women. Using these figures as the lower limits of normality at Groote Schuur for 97.5% of the population, then 10 g/dl is already 29% lower than the lower limit of "normal" for a male and somewhat less for a female. However the normal range amongst blood donors at the Western Province Blood Transfusion Services has just recently been revised to 12.1-16.8 g/dl for males and 10.4-14.5 g/dl for females (personal communication, Mr D.Alexander, dept. Haematology); this means 10 g/dl falls even less behind the norm.

The function of haemoglobin is primarily to transport oxygen (O<sub>2</sub>) from the lungs to the tissues. Hence, a real problem only exists when the Hb level is insufficient to meet the oxygen requirements of these tissues. Cardiac tissue has the highest oxygen requirement under normal conditions (ml per 100g) and hence O<sub>2</sub> delivery (DO<sub>2</sub>) must meet this at all times. If the coronary circulation is looked at in an average 63 Kg adult human at rest<sup>31</sup>: blood flow to the heart = 250 ml/min. Maximum of 200-300% increase in coronary blood flow via coronary vasodilatation = 750 ml/min. O<sub>2</sub> consumption of the heart = 29 ml/min.

$DO_2 = \text{blood flow (Q)} \cdot O_2 \text{ content of arterial blood (CaO}_2)$

$CaO_2 = Hb \cdot (1.36 \text{ ml } O_2/\text{g Hb}) \cdot O_2 \text{ saturation (SaO}_2) + O_2 \text{ in solution (0.003 ml/mmHg} \cdot PaO_2)$

Hence  $O_2$  supply to the heart with a Hb of 10 g/dl with a 200% increase in coronary blood flow (without an increase in cardiac output) will be 104 ml/min. This value decreases as the Hb drops and will be:

85 ml/min at Hb = 8 g/dl

74 ml/min at Hb = 7 g/dl

Normal  $O_2$  extraction for the myocardium is 60%,<sup>30</sup> hence with a Hb of 7 g/dl 44 ml/min oxygen will be available for a consumption of 29 ml/min (i.e. a 50% greater supply than demand, even before the compensatory effects of anaemia (see later) and increased myocardial  $O_2$  extraction ratio are considered.

The body compensates for anaemia in 3 ways<sup>30</sup>: there is an increase in 2,3,DPG within red cells, which shifts the Hb oxygen-dissociation curve to the right, thereby increasing the release of  $O_2$  to the tissues; there is an internal redistribution of blood flow such that it is increased to those tissues where  $O_2$  supply must be maintained; thirdly, cardiac output can increase (which provided intravascular volume is maintained, does not occur "dramatically" until the Hb drops below 7 g/dl<sup>16</sup>).

### **Effects of anaesthesia**

Whilst under general anaesthesia, basal  $O_2$  consumption drops by 15 -20% and narcotic administration can decrease it by 4-9%.<sup>32</sup> Should the temperature drop, further decrease in consumption is possible (muscle relaxants would prevent shivering).

However, it is the post-operative period which is of concern: shivering is a common problem, particularly after halothane and this alone can increase oxygen consumption by as much as 500%.<sup>33,34</sup> This is made worse by the fact that hypoxaemia is common postoperatively, initially from the respiratory depressant effects of the anaesthetic and later from varying degrees of atelectasis; recently, post operative obstructive sleep apnoea has been shown to result in

significant and prolonged hypoxic episodes, persisting several days after the anaesthetic.<sup>60</sup> Post-operative pain results in stimulation of the sympathetic system and further compounds the stress response. Patients with coronary artery disease (CAD) may not be able to increase myocardial oxygen supply sufficient to meet demand under these conditions and those with lung pathology may not be able to oxygenate their blood sufficiently to meet demand to more than just the heart. According to Stoelting,<sup>35</sup> "many" patients with no risk factors have critical coronary artery narrowing by the age of 70 years; this becomes 60 if a patient smokes but has a normal cholesterol and 50 if there is hypertension as well. Considering that the disease may be asymptomatic despite 50 -70% narrowing, the elderly, those with known CAD (as well as stenotic valve lesions and patients on beta-blockers) and respiratory cripples should not be regarded as being able to tolerate such low Hb values as mentioned above.

#### **Animal studies**

These have looked at survival and wound healing. Studies in primates have shown tolerance and long-term survival with haematocrits as low as 10-15% and in baboons with normal coronary arteries, left ventricular  $DO_2$  has been demonstrated to meet demand down to a Hct of 6%.<sup>40</sup> However, measured physiological parameters (decreased systemic vascular resistance and increased cardiac output) are not always the same between different animals (pigs vs dogs or primates); differences in cardiovascular and sympathetic responses together with variable coronary anatomy and distribution possibly account for this and hence extrapolation to man shouldn't be done.

Wound healing is one concern surgeons have in anaemic patients. Heughan and co-workers<sup>39</sup> looked at the effect anaemia had on wound healing in rabbits, made anaemic by blood withdrawal via cardiac puncture, with plasma being transfused back. Stainless steel wire mesh cylinders were implanted subcutaneously, fluid was removed from inside the cylinders after 11 days for oxygen tension and pH analysis and the cylinders removed via sacrifice after 21 days. There were no differences between the oxygen tensions in the two groups (anaemic animals = Hct

of 30%; control = 38%) and the anaemic rabbits in fact produced significantly ( $p < 0.025$ ) more connective tissue (12% more by dry weight, the authors having previously shown an excellent correlation between this and collagen content) than did the controls. According to Heughan et al, not yet published at the time, Adamsons had shown a Hb of 5-6 g/dl not to impair wound healing in animals. Whilst humans are not rabbits, the authors refer to 3 out of 4 surveys of patients with abdominal wound disruption that failed to find an association between anaemia and wound dehiscence, suggesting that these patients did not have impaired collagen synthesis either.

### **Clinical experience in humans**

This comes from patients with chronic renal failure, those who refuse transfusion on religious grounds (Jehovah Witness) and controlled normovolaemic haemodilution in surgical patients.

### **Chronic renal failure**

In this 3 month study, 18 patients had a renal transplant. Average Hb was 8.0 g/dl (range 4.9-15.0) preoperatively and 6.6 (4.2 -10.1) g/dl postoperatively; average transfusion per operation was 0.4 units. In addition, there were 19 nephrectomies (7 graft) with average preop/postop Hb's of 9.9 (16.6-6.7)/ 6.4 (8.4-5.4) g/dl respectively; average transfusion in this group was 0.8 units. Other studies<sup>40,41</sup> confirm the safety of renal transplantation in the presence of anaemia without the use of blood. However Kaufman et al<sup>41</sup> point out that whilst the success rates of renal transplantation were the same whether the patient received blood or not, should a severely anaemic (Hb < 4.5 g/dl) patient have a rejection episode, outcome was poor (none of 6 patients with Hb > 7.0 g/dl and rejection died).

### **Jehovah's Witness**

An excellent review of surgery in Jehovah's Witnesses (JW) comes from Wong and Jenkins<sup>42</sup> from their experience with 58 patients (22 with pre-existing coronary heart disease)

undergoing 78 operations at the Vancouver General Hospital. Operations included cardiac surgery, abdominal aortic aneurysm, revision hip arthroplasties, burns and other major surgery. Postoperative Hb decreased below 5.0 g/dl in 3 patients and one with 3.4 g/dl survived. Postoperative morbidity however was "not uncommon" (numbers in brackets): hypotension (8), cardiac arrhythmias (6), myocardial ischaemia (3) and infarction (1), excessive bleeding (4), nausea and/or syncope (4) and wound or urinary infection (4). The patient with infarction (abdominal aneurysm repair) dropped his Hb from 12.3 g/dl preop to only 8.6 post surgery.

A report of a successful outcome in a JW patient despite a postoperative Hb of 1.8 g/dl has been described<sup>43</sup>: the patient had undergone emergency biliary surgery following parturition and required 16 days of postoperative ventilation as well as inotropic support. Hb had risen to 7.1 g/dl at the time of transfer to the ward and 7.7 on discharge home after 34 days; only permanent disability was a right vocal cord palsy.

Lichenstein et al<sup>32</sup> report a case in which postoperative Hct dropped to 4% for more than 4 hours whilst blood was awaited (permission from Superior Court Judge required). The patient had undergone drainage of an abdominal abscess and had had a sudden unexpected haemorrhage. The following steps were instituted in an attempt to decrease the oxygen consumption of the patient: cold fluids (maintaining intravascular volume) and uncovering of patient to decrease temperature; fentanyl administered, followed by morphine (decrease metabolism) and the FiO<sub>2</sub> increased to 1.0; paralysis was maintained with pancuronium (no shivering). A total of 27 litres (19.3 l Ringer's, 2.5 l hetastarch and blood products) of fluid were administered over the first 24hr perioperative period. A pulmonary artery catheter was inserted and some interesting data obtained: analysis of oxygen delivery when the Hct was 4% and temperature 30°C showed that 51% (1.9ml) of arterial O<sub>2</sub> content was via dissolved oxygen and 49% (1.8ml) via Hb-bound O<sub>2</sub>; DO<sub>2</sub> was calculated to be 197 ml/min while VO<sub>2</sub> was 105 ml/min (90% of this provided by dissolved O<sub>2</sub>). The case demonstrates that massive blood loss can be survived by a patient until blood is available, meaning that the routine crossmatching of blood for operations that may bleed torrentially but rarely do (e.g. intracerebral aneurysm (8 operations): CTR = 5.7, TI = 0.75 and

average postoperative Hb = 11.4 g/dl in this study), could be managed reasonably safely with only a group & screen preoperatively.

### **Normovolaemic haemodilution**

Messmer demonstrated that normovolaemic haemodilution in healthy volunteers resulted in optimal tissue oxygen delivery at a haematocrit of 30%.<sup>36</sup> Other clinical studies "indicate that oxygen delivery is not impaired at Hcts of 20-22%, even in patients with multisystem disease".<sup>40</sup>

### **Surgical Studies**

The ultimate results of accepting a Hb lower than 10 g/dl will require outcome studies of patient post-operative morbidity, mortality and length of hospital stay. Lunn and Elwood<sup>37</sup> looked retrospectively at 2 441 anaesthetic records from a 6 month period. They showed an association between a Hb of less than 10 g/dl and increase in "post-operative complications" (men only), increased length of hospital stay (men only) and increased deaths (both men and women). However, the nature of the complications were not stated and their reporting was left up to the discretion of the anaesthetist; 36% of the cases had no preoperative Hb and some patients had postoperative transfusions; there was no correlation between the length of hospital stay and the nature of the surgery; 75% of men with a Hb<10 g/dl were judged to have a condition serious enough to have caused the anaemia; in men, 33% of operations were emergency in those with Hb's<10 as opposed to 18% in those with Hb's>14.9 g/dl (34 and 14% respectively for women). Finally, numbers were small: 52 male and 42 females with Hb's less than 10 g/dl).

In another study from New Zealand,<sup>38</sup> Rawstron looked retrospectively at two groups of post-surgical anaemic (Hb<10 g/dl) patients (mean Hb = 9.0 g/dl for adult males (n=21) and 9.1 for adult females (n=54)) and compared them to a control group (mean Hb = 13.9 for adult male (n=87) and 12.6 g/dl for adult female (n=136)). He found there was no significant differences between the anaemic groups and the controls for: difficulties during anaesthesia and surgery,

cardiovascular complications, wound dehiscence and respiratory complications. Once again, numbers of anaemic patients were small.

More recently, Carson et al<sup>44</sup> reported a retrospective case control study of 125 JW patients and found operative mortality to be inversely related to the preoperative Hb: 7.1% for patients with Hb's greater than 10 g/dl and 61.5% for those with a level less than 6 g/dl. Mortality was also independently related to blood loss: 8% for those losing less than 500ml and 42.9% for those losing more than 2 000 ml. No patient with a Hb of greater than 8 g/dl and operative blood loss of less than 500 ml died and only 3.4% suffered a morbid cardiovascular event. A large amount of patient data was obtained that would be used in non-JW patients to guide transfusion requirements and which would constitute a confounding variable in determining operative outcome, e.g.: presence of ischaemic or valvular heart disease, arrhythmias, respiratory disease, coagulopathy, cerebrovascular, renal, liver and thrombo-embolic diseases, hypertension, "any cardiac disease", "any disease", type of surgical procedure, Goldman cardiac risk index, Apache II severity of disease score and the use of fluosol-DA. Statistical analysis involved the use of Student-t and chi-square tests as well as step-wise logistic regression analysis. Confounding variables were controlled for by stratification and logistic regression. This confirmed that the preoperative Hb and operative blood loss independently had a significant ( $p < 0.005$ ) relation to mortality and that the former was a strong risk factor independent of all the confounding variables considered.

In response to this publication, Harrison<sup>45</sup> reported his obstetrical experience (published 1985) in Zaria, Nigeria: maternal mortality was lowest in those patients (both transfused and untransfused) with Hct's between 20 and 30%. Mortality in fact rose quite sharply in patients whose Hct was greater than 40%.

The only prospective study on this subject comes from Stehling<sup>40</sup> (1989). Three hundred and 40 patients (age range 1 month to 93 years) with a mean Hb of 8.6 g/dl (5.0-9.9) received 473 anaesthetics. Stehling comments of her own article, "while it is impossible to state definitively that

anemia did not contribute to perioperative morbidity and mortality, it is unlikely". All patients who had died or suffered any serious morbidity had a serious underlying disease

Whilst these studies show that a Hb of less than 10 g/dl can be tolerated by patients, it seems that any figure less than 8 g/dl is adding extra risk. One must then weigh up the risks of disease transmission (AIDS and hepatitis) with that of increased mortality and decreased margin of safety. It seems reasonable to be selective in deciding who to leave with a postoperative Hb of 7 g/dl: a relatively fit patient should easily withstand an increased cardiac output and exertional dyspnoea for a few weeks. The bulk of the evidence disputes the concept that Hb's less than 10 g/dl give rise to poorer wound healing. In the patient with ischaemic heart disease where oxygen delivery can be critical, then the "10/30" rule should probably still hold. Experiments with recombinant erythropoietin<sup>41</sup> hold promise for an alternative to blood transfusion in anaemic patients.

Irrespective of a suitable level of haemoglobin, what the above studies show is that patients can tolerate low levels of haemoglobin provided intravascular volume is maintained and appropriate oxygen conserving measures are instituted if necessary. In terms of a MSBOS, this allows for extreme conservatism. It need not be extreme of course but in view of the apparent safety of the immediate spin crossmatch<sup>18</sup>, a more conservative MSBOS than exists at present should be instituted.

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## 7) **ADVERSE EFFECTS OF BLOOD TRANSFUSION**

The problems of incompatibility, allergy, alloimmunisation, hypothermia, alkalosis etc. are well known and fully described in any good physiological textbook. The concerns amongst surgeons and anaesthetists are primarily those of disease transmission and immunosuppression as a result of the transfusion of autologous blood. The subject of unnecessary transfusions and their risks has recently been briefly summarised by Schein<sup>46</sup> in the SAMJ.

### **Immune Suppression**

The influence of transfusion on recipient immune function has been extensively reviewed by Blumberg and Heal.<sup>47</sup> Immune effects have been studied in two types of patients: prospective renal transplants and haematological (primarily haemophiliacs and haemoglobinopathies). In the former, interest began after the observation that kidney transplanted patients who received blood had a lower incidence of rejection, but it was only after a report by Opelz and Terasaki<sup>47</sup> in 1973 that blood transfusion became accepted as an immunosuppressive tool: transfusion increased 1-year graft survival by as much as 20%. Luckily, today cyclosporin has replaced blood as an immunosuppressant agent. Interest in haematological patients began when it became apparent that patients who were frequent recipients of blood products became infected with the HIV I virus and developed AIDS. Moreover, it became apparent that patients who received pooled plasma products (haemophiliacs) were more susceptible to developing full blown AIDS than were patients who received packed cells (sickle-cell anaemia and thalassaemia).

The mechanisms of immune suppression are not fully understood but it has been found that transfusions alter macrophage function by decreasing their chemotactic migration and release of inflammatory mediators; the latter is via the increased release of prostaglandin E<sub>2</sub> which has been shown to have powerful immunosuppressive effects<sup>48</sup>: e.g. decreased activity of antigen coated cells and decreased production and function of interleukin-2. These effects are not short-lived: exchange-transfused newborns have been found to have a decreased responsiveness on

one-way mixed lymphocyte culture some 20 years later, whilst Tartter et al have demonstrated a decrease number of T-cell lymphocytes 6-18 months post transfusion.<sup>47</sup>

That blood transfusion is related to increased cancer recurrence and mortality in patients operated on for their condition is still very much in debate. Numerous articles have been published on this subject<sup>47-52</sup>; most are retrospective and show an adverse relationship between outcome after surgery and blood transfusion. The obvious argument against the immune effects of blood as the cause is that patients with more extensive tumour disease will require more aggressive surgery, lose more blood, (thereby receiving more transfusions) and therefore not do as well as less sick patients. Proven or not, the possibility that blood may adversely affect outcome in cancer surgical patients is definite; hence blood transfusion to these patients should be avoided if at all possible. This would involve appropriate surgical techniques and the anaesthetists acceptance of Hb's lower than 10 g/dl postoperatively.

### **Disease Transmission**

There are various sporadic infections that can be caused by blood transfusion (e.g. Brucellosis, Malaria, CMV-infection), but the major risks are those of transmission of AIDS and Hepatitis. Whilst AIDS is mentioned first, it is hepatitis (with its long term sequelae of possible chronic hepatitis, cirrhosis and hepatoma) that constitutes a far greater risk; however the lack of a cure and the inevitable fatality of AIDS make it the major concern in most peoples minds.

In a recent prospective study from Italy of post transfusion hepatitis (PTH)<sup>53</sup>, the authors found an incidence of 4.3% PTH in 1989 (which had decreased yearly from 11% in 1986): this tallied with a reported incidence at other centers of 3-8%. Despite the introduction of hepatitis-C virus (HCV) screening after the submission of their paper, the same authors found in a 3 month follow-up period of 85 patients, 2 (incidence of 2.35%) cases of PTH (both non-A non-B). This is apparently much higher than the reported incidence in the Western Cape: 19 cases of Hepatitis-B (HBV) and 9 of non-A non-B hepatitis (NANBH) for the years 1984-1989 (personal communication: Dr A.Bird).

The possible reasons for continued transmission of hepatitis-B virus (HBV) infection are well summarised in the editorial by Hoofnagle<sup>54</sup>: mistakes in screening of donor blood (unlikely); HBV infection from a source other than blood (infrequent); blood donated from a person in the incubation phase of HBV infection (unlikely) and infection from a donor who is a carrier of low-level HBV: i.e. serum level of HBsAg (surface antigen) below the level of available assay sensitivity. This last reason was felt to be the most likely, as PTH cases had been found that had been transfused with blood that was HBsAg negative but anti HBc (antibody to HBV core antigen) positive. The author points out that "paradoxically", most previous studies had correlated the presence of anti-HBc with non-A, non-B PTH, with the result that testing for anti-HBc was used to screen donor blood for NANBH rather than for HBV. Fortunately, a specific test for NANBH has now been developed (recombinant hepatitis C ELISA test for antibodies to Hepatitis C), but which seems not to be 100% effective in preventing HCV induced PTH (see above). However if this test were to be introduced in areas of low Hepatitis C incidence, it would significantly increase the cost of crossmatching with a dubious cost-benefit ratio.

Despite the testing for NANBH, HBsAg, anti HBc and HCV, it is unlikely that PTH will be eliminated; the alternative will be the vaccination of patients at high risk of blood transfusion against HBV<sup>54</sup> and hopefully in the future against Hepatitis C.

In America, 5 620 patients have developed the acquired immune deficiency syndrome (AIDS) as a result of blood transfusion and it is estimated that another 12-15 000 will be HIV positive but asymptomatic.<sup>55</sup> A recent report of HIV seropositivity amongst blood donors in South Africa showed an incidence of 0.5%; of even greater impact was the estimation that this figure would double every 9 months.<sup>56</sup> Given that there may be a "window" period after infection with HIV of several months and that current HIV antibody tests may have a false negative rate of up to 2%<sup>57</sup>, there is a very real danger of infection of a patient from a contaminated unit of blood. This risk is much increased in patients receiving clotting factors, since these may have been pooled from up to 8 000 donors. Furthermore, it has become evident that the HIV virus is capable of mutation: infection with HIV 2 is now a possibility and the current HIV tests may not reliably crossreact with

HIV 2 antibody.<sup>58</sup> If HIV 2 virus has emerged, why not 3, then 4? However, it must be stated that since the introduction of routine HIV testing in 1985, there have been very few cases of transfusion-related HIV infection.

One unit of blood is all that it may take to give a patient hepatitis B, C, or AIDS. Accepting a postoperative or even a preoperative Hb of around 8 g/dl may save a patient from the disastrous consequences of infection with any of the above mentioned viruses.

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8) **COSTS**

Blood is supplied to hospitals in the Western Cape by the Western Province Blood Transfusion Service. Whilst it is a "non profit" organisation, it nevertheless has to recover running costs and staff wages. As a consequence, blood products are not cheap. This fact and the adverse effects referred to in section 7, are the main boosters for the institution of an efficient and effective MSBOS. It has been shown that doctors order fewer diagnostic tests on patients when they are informed of the cost.<sup>59</sup> It seems reasonable therefore to imagine that if doctors were informed of the costs involved in blood transfusion (and non transfusion of requested units), they might be more conservative with their blood requesting for elective surgery. The costs of just two blood products during 1990 and those of excessive blood ordering during the study period are illustrated in the following table. Another cost incurred during the 3 months were those of group and screen requests: at this time a G&S cost R43 and R19 780 was spent on unconverted G&S's.

Packed cells/whole blood (each)	R 61.50
Warm return (packed cells)	R 89.00
(whole blood)	R 103.50
Total for units from cancelled operations	R 10 701.00
Total for unused units ordered for all elective surgery	R 50 860.00

**Cancellation Charges (1990) for the 3 month study period (note this excludes all non-elective surgery)**

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## 9) CONCLUSIONS AND RECOMMENDATIONS

It is evident that the present Groote Schuur Hospital MSBOS is inadequate and poorly utilised. This may be due to inadequate knowledge of this system and suggests the present MSBOS requires revision and that staff education is required not only of its existence, but of the "state of the art" in Hb requirements, the risks associated with blood transfusion and the safety of the immediate spin crossmatch following a negative group and screen. As doctors will require constant reminding of these facts and new staff join Groote Schuur for the first time on a regular basis, a means of achieving this would be the production of a pocketable and durable copy of the MSBOS with cost of blood products, cancellation and G&S charges and the above information included. A drug company has already been approached with this concept (personal communication, Dr G.Irving) and although the MSBOS is somewhat out of date before it has been produced, it is at least a step in the right direction. In addition, education at undergraduate level needs to be addressed.

In revising the MSBOS, regular audits of blood usage such as this one need to be done. Already, at the time of writing this, the blood usage has changed, e.g.: cardiac surgical cases nearly always only crossmatch 4 units of packed cells (no whole blood) and as a routine only 2 units are sent for at the start of surgery; orthopaedic acetabular open reduction, internal fixations are being operated upon with an epidural block (in addition to a general anaesthetic) and the surgeon is convinced this results in less blood loss (my personal experience however is limited to one case, which did not require any blood). Regarding the requirement for a G&S, Mintz<sup>3</sup> chose a transfusion index of 0.5 as the figure to decide which operations should have a group & screen instead of full crossmatch; why not 1.0? In view of the acceptance of Hb's lower than 10 g/dl, the relative safety of the immediate spin crossmatch, operations that use of average only one unit of blood or less should warrant only a G&S.

Some form of policing of the MSBOS is required. This should be in the hands of appropriate senior medical staff, either a specially designated person or a member of the Hospital Blood User's Committee. This person would have the authority of passing or vetoing a crossmatch

request that exceeded the MSBOS in those instances where the appropriate motivation hasn't been supplied by the requesting physician.

Revising policy issues should be considered: e.g. patients with adequate Hb's preoperatively may not even require a G&S. Although the expense of an unused full crossmatch is saved, there is still significant cost involved (see section 8). Patients with higher Hb's preoperatively shouldn't require as much blood requested preoperatively as those with lower Hb's. The MSBOS could apply different ceilings on orders for the same operation only if such full crossmatch requests were accompanied by a standardised (e.g. coulter count) Hb measurement. This would be economically feasible since the cost of a coulter FBC was under R6 at a time when a cancellation fee was R61.50 per unit of blood. Although not frequent in number, surgical patients who require elective postoperative ICU admission are often cancelled for lack of bed space and these cases frequently had big crossmatch orders (e.g. thoraco-lumbar spinal decompressions: for 4 actual operations done in the 3 months, 32 units of blood (cost of R1 968.00) were cancelled as a result of cancelled surgery due to lack of an ICU bed). These cases should have a group and screen only prior to surgery and be crossmatched on the day of surgery by immediate-spin crossmatching if required. However, the impact that this may have on the nature of the work in the blood bank, and the stress which it would impose on the service would need to be weighed against the cost saving of reducing unnecessary crossmatching, as well as the possible risk of increased numbers of clerical errors.

The use of blood in the non-elective setting should be audited. One example is the use of group and screening for post abortion evacuations of the uterus (average of 5-10 per day in the casualty theatre at GSH): these patients rarely require blood. Those that do are usually evident before arriving at theatre and would have already been fully crossmatched. According to blood bank staff, it is possible to do Rh grouping alone, thereby cutting costs and saving considerable tedious time spent on G&S's.

To improve the efficiency of the blood bank, requests coming in need to be entered in a computer. This would enable an automatic check on whether requests are unnecessary (e.g.

sample already sent for same request, or crossmatch requested and G&S already performed within the previous 24-36 hours), or exceed the MSBOS. Speedy and efficient access would be available to any Dr querying a request.

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## REFERENCES

- 1) Irving G. Blood Component Therapy in the Peri-operative period: a Survey of S.A. Anaesthetists in Teaching Hospital Practice; MMed.Anaes. UCT 1990.
- 2) Friedman B. An Analysis of Surgical Blood Use in United States Hospitals with Application to the Maximum Surgical Blood Ordering Schedule. Transfusion 1979; **19** (3): 268-278.
- 3) Mintz P, Nordine R, Henry J. Expected Hemotherapy in Elective Surgery. NY State J. of Med. 1976; April: 532-537.
- 4) Friedman B, Oberman H, Chadwick A, Kingdon K. The Maximum Surgical Blood Ordering Schedule and Surgical Blood Use in the United States. Transfusion 1976; **16**(4): 380-387.
- 5) Sarma D. Use of Blood in Elective Surgery. JAMA 1980; **243** (15): 1536-1538.
- 6) Gryskiewicz J, Detmer D. Waste Not, Want Not: use of blood in Elective Operations - Improved Utilization of Blood by Use of Blood-Ordering Protocols and the Type and Screen. Current Surgery 1983; Sept-Oct: 371-377.
- 7) Napier J, Biffin A, Lay D. Efficiency of use of blood for surgery in south and mid Wales. Br Med J 1985; **291**: 799-801.
- 8) Rouault C, Gruenhagen J. Reorganisation of Blood Ordering Practices. Transfusion 1978; **18** (4): 448-453.
- 9) Dodsworth H, Dudley H. Increased efficiency of transfusion practice in routine surgery using pre-operative antibody screening and selective ordering with an abbreviated crossmatch. Br J Surg 1985; **72** (Feb): 102-104.
- 10) British Committee for Standards in Haematology Blood Transfusion Task Force. Guidelines for Implementation of a Maximum Surgical Blood Ordering Schedule; Clin. lab. Haemat. 1990; **12**: 321-327
- 11) Smallwood J. Use of Blood in Elective Surgery: an area of wasted resources. Br Med J 1983; **286**: 868-870.
- 12) Giovanetti A, Parravicini A, Baroni L, Riccardi D, et al. Quality Assessment of Transfusion Practice in Elective Surgery. Transfusion 1988; **28** (2): 166-169.

- 13) Tartter P, Barron D. Unnecessary blood transfusions in elective colorectal cancer surgery. *Transfusion* 1985; **25** (2): 113-115.
- 14) Bayer W, Coenen W, Jenkins D, Zucker M. The Use of Blood and Blood Components in 1,769 Patients Undergoing Open-Heart Surgery. *Annals of Thoracic Surgery* 1980; **29** (2): 117-122.
- 15) Czer L, Shoemaker W. Optimal Hematocrit Value in Critically ill Postoperative Patients. *Surg, Gynae & Obstets* 1978; **147**: 363-368.
- 16) NIH Consensus Development Conference Statement. Peri-operative Red cell Transfusion 1988; Vol 7, Number 4, June 27-29.
- 17) Cane R. Hemoglobin: How much is enough? *Critical Care Med* 1990; **18** (19): 1046.
- 18) Schulman I. The Risk of an Overt Hemolytic Transfusion Reaction Following the Use of an Immediate Spin Crossmatch. *Arch Pathol Lab Med* 1990; **114**: 412-414.
- 19) Boral L, Henry J. The Type and Screen: A Safe Alternative and Supplement in Selected Surgical Procedures. *Transfusion* 1977; **17** (2): 163-168
- 20) Mollison, Engelfriet and Marcela Contreras. Red Cell Antigens and Antibodies and Their Interactions (pg 196) in: *Blood Transfusion in Clinical Medicine* 8th Edition, Oxford; Blackwell Scientific Publications 1987.
- 21) Garratty G. Abbreviated pretransfusion testing. *Transfusion* 1986; **26** (3): 217-219.
- 22) Garratty G. The Role of Compatibility Tests. *Transfusion* 1982; **22** (2): 169-172.
- 23) Shulman I. et al. Experience With a Cost-effective Crossmatch Protocol. *JAMA* 1985; **254** (1): 93-95.
- 24) Oberman H, Barnes B, Friedman B. The Risk of Abbreviating the Major Crossmatch in Urgent or Massive Transfusion. *Transfusion* 1979 **18** (2): 137-141.
- 25) Heisto H. Pretransfusion Blood Group Serology; Limited Value of the Antiglobulin Phase of the Crossmatch when a Careful Screening Test of Unexpected Antibodies is Performed. *Transfusion* 1979; **19** (6): 761-763.
- 26) Dinman B. The Reality and Acceptance of Risk. *JAMA* 1980 **244** (11): 1226-1228.

- 27) Miller RD. Transfusion Therapy (pp 1474-76) in: Anesthesia 3rd Edition, New York, Churchill-Livingstone 1990, Miller RD.(Ed).
- 28) Friedman B.A. Patterns of Blood Utilisation by Physicians: Transfusion of non-operated Anemic Patients. Transfusion 1978 **18** (2): 193-198.
- 29) Gillies I.D. Anaemia and Anaesthesia. BJA 1974; **46**: 589-601.
- 30) Rapaport SI. The Red Blood Cell (pp 407) in: Best & Taylor's Physiologic Basis of Medical Practice, 11th Edition, Baltimore, Williams & Wilkins 1985, West J. (Ed).
- 31) Ganong W.F. Circulation Through Special Regions (pp 514-17) in: Review of Medical Physiology 13th edition, Norwalk, Appleton & Lange 1987.
- 32) Lichenstein A et al. Unplanned Intraoperative and Postoperative Hemodilution: Oxygen Transport and Consumption during Severe Anemia. Anesthesiology 1988 **69** (1): 119-122.
- 33) Atkinson RS, Rushman GB, Lee JA. Accidents, Complications and Sequelae (pp 188-89) in: A Synopsis of Anaesthesia 10th edition, Bristol, Wright PSG 1987
- 34) Spence AA. Postoperative Recovery and Oxygen Therapy (pp 500) in: Anaesthesia vol 1, Oxford, Blackwell Scientific Publications 1989, Nimmo WS & Smith G (Ed).
- 35) Stoelting R, Dierdorf S, McCammon R. Coronary Artery Disease (pp 1) in: Anesthesia and Co-Existing Disease, second edition, New York; Churchill Livingstone 1988.
- 36) Jones J. Recent changes in Transfusion Practice (pp 177-191) in: Anaesthesia Review 7, Churchill Livingstone, Edinburgh 1990; Ed: Kaufman L.
- 37) Lunn J, Elwood P. Anaemia and Surgery. BMJ 1970; **3**: 71-73
- 38) Rawstron R. Anaemia and Surgery: A Retrospective Clinical Study. Aust. N.Z. J. Surg 1970; **39** (4): 425-432
- 39) Heughan C et al. The Effect of Anemia on Wound Healing. Ann Surg 1974; **179** (2): 163-167
- 40) Stehling L. The Safe Level of Hemoglobin: Is Anemia In? ASA Annual Refresher Course Lectures 1990

- 41) Kaufman D et al. A Single-center Experience of Renal Transplantation in Thirteen Jehovah's Witnesses. *Transplantation* 1988; **45** (6): 1045-1049
- 42) Wong D, Jenkins L. Surgery in Jehovah's Witnesses. *Can J Anaesth* 1989; **36** (5): 578-585
- 43) Howell P, Bamber P. Severe acute anaemia in a Jehovah's Witness. *Anaesthesia* 1987; **42**: 44-48
- 44) Carson J et al. Severity of Anaemia and Operative Mortality and Morbidity. *The Lancet* April 2, 1988: 727-729
- 45) Harrison K. *The Lancet* 1988, June 18, letter: 1392-93.
- 46) Schein M. The bad blood. *SAMJ* 1990; **70**: 60
- 47) Blumberg N, Heal J. Transfusion and Recipient Immune Function. *Arch Pathol Lab Med* 1989, March; **113**: 246-252
- 48) Alexander J. Transfusion-induced immunomodulation and infection (editorial). *Transfusion* 1991; **31** (3): 195-196
- 49) Schriemer P, Longnecker D, Mintz P. The Possible Immunosuppressive Effects of Perioperative Blood Transfusion in Cancer Patients. *Anesthesiology* 1988; **68** (3): 422-428
- 51) George C, Morello P. Immunologic Effects of Blood Transfusion Upon Renal Transplantation, Tumor Operations, and Bacterial Infections. *The American Journal of Surgery* 1986; **152**: 329-336
- 51) Taylor R, Parrott N. The Red Alert. *Br.J.Surg* 1988; **75**: 1049-1050
- 52) Wright C. Blood is Thicker (and More Dangerous) Than Water. *The Canadian Journal of Surgery* 1988; **31** (2): 77-78
- 53) Sirchia et al. Prospective Evaluation of Post-transfusion Hepatitis. *Transfusion* 1991; **3** (4): 299-302
- 54) Hoofnagle J. Posttransfusion hepatitis B. *Transfusion* 1990; **30** (5): 384-386
- 55) Dodd R et al. Antibodies to hepatitis B core antigen and the infectivity of the blood supply. *Transfusion* 1991; **31** (5): 443-449

- 56) Schoub B et al. Considerations on the further expansion of the AIDS epidemic in South Africa. *SAMJ* 1990; **77**: 613-618
- 57) Schwartz J, Dans E, Kinosian B. HIV test evaluation, performance and use. *JAMA* 1988; **259**: 2574-2579
- 58) Kay L. Impact of AIDS on Blood Transfusion Practice (editorial). *Hospital Update* 1991; **1** (9): 4-6
- 59) Tierney W, Miller M, McDonald C. The effect on test-ordering of informing physicians of the charges for outpatient diagnostic tests. *N Engl J Med* 1990; **322**: 1499-1504
- 60) Jones JG, Sapsford DJ, Wheatley RG. Postoperative Hypoxaemia: mechanisms and time course. *Anaesthesia* 1990; **45**: 566-573

## Appendix I

### Groote Schuur Hospital 1990 MSBOS

**FULL CROSS MATCH** (WB = Units whole blood; PC = Units packed cells)

<b>1. General Surgery</b>		
Aortic surgery	-	4 WB
Major liver surgery	-	4 WB
Port-caval shunts	-	4 WB
Devascularisation procedure	-	4 WB
Oesophagectomy	-	4 WB
Total gastrectomy	-	2 PC
Pancreatic resection	-	2 PC
Total colectomy	-	2 PC
Abdominoperineal resection	-	2 PC
Complex laparotomy	-	2 PC
Mastectomy & Axillary clearance	-	2 PC
Adrenalectomy	-	2 PC
Splenectomy	-	1 PC
Toxic thyroidectomy	-	1 PC
Carotid endarterectomy	-	1 PC
<b>2. Orthopaedics</b>		
Hindquarter amputation	-	3 PC
Open reduction of fractured pelvis	-	3 PC
Central dislocation of hip and open reduction	-	3 PC
Forequarter amputation	-	2 PC
En block excision of tumour	-	2 PC
Arthrodesis of hip	-	2 PC
Hip disarticulation	-	2 PC
Above knee amputation	-	1 PC
Major bone grafting	-	1 PC
Moore's hemiarthroplasty	-	1 PC
Pin and Plate for fractured neck of femur	-	1 PC
Lumbar spinal fusion	-	1 PC
Open reduction of lower limb fractures	-	1 PC

<b>3. Urology</b>		
Cystectomy	-	4 PC
Radical nephrectomy	-	2 PC
Anticipated difficult nephrectomy	-	2 PC
Nephrolithotomy	-	2 PC
Partial nephrectomy	-	2 PC
Kidney exploration post-trauma	-	2 PC
Retroperitoneal lymph node dissection	-	2 PC
Open prostatectomy	-	2 PC
Anticipated difficult urethroplasty	-	2 PC
Open bladder operation	-	2 PC
<b>4. Neurosurgery</b>		
Large cerebral AV malformations	-	4 PC
Cerebral aneurysm	-	2 PC
Transsphenoidal hypophysectomy	-	2 PC
Vascular cerebral tumours	-	2 PC
<b>5. Cardiovascular Surgery</b>		
Bronchopulmonary resection	-	2 PC
Pleurectomy and Decortication	-	2 PC
Oesophagectomy	-	2 PC
Cardiopulmonary bypass	-	4 WB
<b>6. Ear Nose and Throat</b>		
Juvenile angiofibroma excision	-	4 WB
Commando procedure	-	2 WB
Aural paraganglioma resection	-	2 WB
Neck dissection	-	2 WB
Maxillectomy	-	2 WB
Pharyngolaryngectomy	-	2 WB

7.	<b>Plastic Surgery</b>		
	Breast reconstruction	-	2 PC
	Maxillo-facial	-	2 PC
8.	<b>Gynaecology</b>		
	Radical vulvectomy	-	2 PC
	Wertheim hysterectomy	-	2 PC
9.	<b>Obstetrics</b>		
	Caesarean section for placenta praevia	-	2 WB

#### GROUP AND SCREEN

- General Surgery**  
 Radical or revision gastrectomy  
 Bile duct exploration  
 Cholecystectomy  
 All direct vascular procedures  
 Thyroidectomy  
 Laparotomy  
 BK & AK Amputations  
 Subtotal colectomy  
 Complex incisional herniae  
 Major desloughing procedures  
  
 No Group and Screen  
 Groin hernia  
 Varicose vein  
 Salivary gland surgery  
 Laparoscopy  
 Benign breast biopsy  
 Node biopsy  
 Haemorrhoidectomy  
 Minor ano-rectals

2. **Gynaecological Surgery**

Difficult TAH

Ovarian cancer surgery

Cone biopsy (anticipated difficulties)

Simple vulvectomy

Termination of pregnancy over 12 weeks

3. **Obstetrics**

Antepartum haemorrhage

Emergency caesarean section

4. **Orthopaedics**

Amputation below knee

Open reduction of upper limb fractures

Closed prograde intramedullary fixation of fractures

Anterior or posterior cervical fusion

Lumbar dissection

5. **Urology**

Renal surgery

Urinary diversion

Augmentation cystoplasty

Partial cystectomy

Transvesical excision of bladder tumour

Bladder diverticulectomy

Transabdominal vesicovaginal fistula repair

Total penectomy

Standard urethroplasty

Urethrectomy

6. **Plastics**

Breast reconstruction

Musculocutaneous flap

**7. Ear Nose and Throat**

Hemiglossectomy

Parotidectomy

Partial pharyngectomy

Partial laryngectom

Frontal sinus obliteration

**Appendix II**

OPERATION	NUMBER	CTR	TI	Av Preop. Hb g/dl	Av Postop Hb g/dl
<b>GENERAL SURGERY</b>					
AAA	9	1.5	5.6		11.4
Aorto-bifem	6	2.3	0.6		10.9
fempop bypass	14	3.0	0.6		
fem-fem bypass	3	2 G&S			
leg vasc. surg	13	2.0	0.6		
arm vasc surg	4	2 G&S			
carotid repair	1	4/0		11.5	
laparotomy	22	2.0	0.09	12.1	10.4
Vagot & antrec	19	6.0	0.1		
gastrectomy	21	4.0	0.1		
cholecystec	47	2/0	25 no request		
splenectomy	4	3 G&S			
Nissen fund	2	no request			
Whipples	4	8/0			
Small bowel	7	2.2	0.7		
large bowel	16	2.6	1.0		
hepatic resec	2				
adrenalectomy	6	1.5	0.67		
thyroidectomy	20	1 G&S	19 no request		
mastectomy	33	1.2	0.3		
AKA	17	12 no request			
BKA	25	1.1	0.2		
Skin graft	7	5.5	0.5		
hip disartic	1				
<b>GYNAECOLOGICAL SURGERY</b>					
Hysterectomy	126	2.25	0.12	12.2	11.1
Myomectomy	5	3/0			
Abdo preg	1				
Suction TOP	26	4/0; 19 G&S			
Hysterot TOP	1	G&S			
Cystectomy	4				
lapscope & dye	10	10 G&S		13.2	
& T/L	2	2 G&S			
Ut. polyp	4	4 G&S			
Vag. polyp	1	1 G&S		14.2	
Tubal surg	4	4 G&S			
Other minors	19	19 G&S			
<b>ORTHOPAEDICS</b>					
ORIF Acet	5	1.6	7.2		
ORIF SIJ	1	4/0			
C & L-spine	10	2.4	0.5		
Spinal decomp	4	1.6	16		12.4
Zimmer	29	2.0	0.48		
Moore's	6.0	0.2			

OPERATION	NUMBER	CTR	TI	Av Preop. Hb g/dl	Av Postop Hb g/dl
AO nail fem	17	1.9	0.5		
RT nail fem	2				
Enders fem	21	1.8	0.3		
Total Hip	3				
ORIF arm	25	4 G&S			
sloughectomy	7	1.3	1.6		
minors	6	2/0 & 5 G&S			
<b>NEUROSURGERY</b>					
aneurysm	8	5.7	0.75	13.8	11.4
Cirsoid aneur	1	4/0		12.2	11.7
Craniot-tumour	15	3.6	0.67	13.3	12.0
Acoustic neur	2				
TSH	3	6/0			
Craniectomy	2	1 G&S			
Cranioplasty	3	4/0			
Chronic subd	2	no request			
Post fossa ex	4	6.0	0.5	13.9	11.4
P-fossa decomp	1	4/2		11.5	9.3
Temp lobect	1	no request			
Sacral cordoma	1	2/0			
Post rhizotomy	1	2/0			
L laminectomy	8	2/0			
C laminectomy	5	8/0			
<b>CARDIAC SURGERY</b>					
CPB	74	1.4	5.0	12.6	10.9
Pericardect	2				
<b>THORACIC SURGERY</b>					
Pleural toilet	20	1.8	0.55	8.8	
Empyema drain.	4	2/0			
Thoracic absc.	2	4/0			
Thoracotomy	4	1.8	1.6		
Open lung b.	2	2 G&S			
Pleurectomy	2	2/0			
Bullect. + pl.	3	10/0			
Lobectomy	19	2.7	0.7	13.9	11.8
Pneumonect.	7	1.2	2.9	11.5	11.4
Pleuro.pn.	1	2/2		13.4	11.1
Thymectomy	2	3/0			
Hydatid excis.	2	2 G&S			
Medianoscopy	7	1 G&S			
Pericardial drain	7	2/2			
Tracheal resect.	1	6/2		13.9	11.5
Diaphragm rep.	1	4/2		11.2	10.5
<b>UROLOGICAL SURGERY</b>					
TURP	87	2.1	0.1	13.3	10.3
Cystectomy	2	4/2			
Nephrectomy	19	1.6	0.8	9.9	6.4

OPERATION	NUMBER	CTR	TI	Av Preop. Hb g/dl	Av Postop Hb g/dl
Renal transplant	18	3.0	0.4	8.0	6.6
Ileal Conduit	1	G&S		11.9	
Nephrolithot.	4	2/0			
Renal surg.	3	3 G&S			
Open blad.op.	2	4/2			
Blad.divertic.	1	G&S			
Ureterectomy	1	G&S		12.0	
TUR blad. tum.	14	2/0			
Biopsy/fulg. bt	15	6 G&S			
Cystoscopy	10	2/0; 9 G&S		13.7	
Urethroplasty	2	3/2			
<b>EAR NOSE &amp; THROAT</b>					
Laryngectomy	10	2.2	0.5	13.9	
Neck diss.	1	G&S		11.4	
Fronto-ethmoid.	2	no request			
Angiofibroma	1	4/3			
<b>PLASTIC SURGERY</b>					
Mastectomy	1	no request			
Breast reduct.	15	1 G&S			
Breast reconst.	6	no request			
Flap swing	3	1 G&S			
Vaginoplasty	1	G&S			
Neck diss.	2	no request			
<b>MAXILLO-FACIAL SURGERY</b>					
Fracture mand.	1	6/5			
Lefort II	2	2/2			
Gingivectomy	1	3/2			
TM joint surg.	1	3/3			