PATTERN OF ORDERING AND USAGE OF HOMOLOGOUS BLOOD TRANSFUSION FOR MAJOR ELECTIVE MAXILLOFACIAL SURGERY AT THE LAGOS UNIVERSITY TEACHING HOSPITAL

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ABSTRACT
Justification for the requests for homologous blood that accompany major elective maxillofacial surgical procedures is difficult to establish in most cases. This attitude of ordering for cross-matched blood is understandable in today's legal climate, but has led to serious problems in terms of laboratory inefficiency which can no longer be ignored. To evaluate the pattern of ordering and use of homologous blood, and transfusion ratios for major elective maxillofacial surgeries at the Lagos University Teaching Hospital (LUTH), Idi-Araba Lagos. Sixty-three consecutive subjects who required major elective maxillofacial surgery under general anaesthesia, and who met the inclusion criteria were included in the study. Data collected included age, sex, weight, and height of subjects, type of surgery done, preoperative and intraoperative haemoglobin concentration, blood units cross-matched and units transfused intraoperatively. Each subject was made to donate through a representative donor, at least one unit of homologous blood prior to surgery. There was a male predominance (57.1%) among subjects, with male to female ratio of 1.3 : 1. Mean age of subjects was 33.9 ± 13.5 years. O+ was the most predominant blood group (62%). Tumours (58.8%), were the most common indication for surgery. Majority of subjects (95.2%), had a preoperative haemoglobin concentration of ≥ 10 g/dl. Haemoglobin concentration at the point of transfusion was < 10 g/dl for 58.8% of transfused subjects. The overall cross-match to transfusion ratio was 3.35, overall probability of transfusion was 26.9%, while the overall transfusion index was 0.6. Only oncological surgical procedures showed an efficient blood usage in all the 3 indices. This study also demonstrated that only onclogical surgical procedures have an indication for cross-matching of blood for surgery, however there is a need to determine the maximum surgical blood ordering schedule for these procedures. There is therefore the need to change the blood ordering pattern, and minimize over-ordering of blood for major elective maxillofacial surgery.

Keywords: Homologous blood transfusion, Elective oral & maxillofacial surgery, Transfusion indices

INTRODUCTION
Major elective maxillofacial surgical procedures involve operations for tumours, trauma, or congenital malformations in the head and neck region (Adeyemo *et al*., 2010; Fenner *et al*., 2009; Parkin *et al*., 2008). One of the major complications of these operations is the potential for excessive blood loss, especially in large tumours at advanced stages that often require extensive excision (Fenner *et al*., 2009; Moenning *et al.,* 1995; Samman *et al.,* 1996). In such cases, transfusion of blood units may become necessary despite improvements in techniques (Christopoulou *et al*., 2001; Fordyce *et al*., 1998).

All parties involved in maxillofacial surgery, the maxillofacial surgeon, anaesthesiologist, and the patient are interested in the expected operating time and anticipated need for blood transfusion (Yu *et al.,* 2000).

The indications and trigger for blood transfusion have been redefined in the last decade to ensure that blood and blood products are considered and treated as medications in their own merit (Rouault and Gruenhagen,1978). Although a haemoglobin concentration of 10 g/dl is considered a safe one at which to allow operation under general anaesthesia for a normal cardio-respiratory system with intact

compensatory mechanisms (Dodsworth and Dudley, 1985), nowadays, operations can be performed successfully at haemoglobin concentration of 8 g/dl (Bo¨ttger *et al*., 2009; Kowalyshyn *et al*., 1976).

Previous reports have indicated that it is possible to achieve considerable cost savings by changing the blood ordering practices of physicians without compromising the quality of patient care (Kretschmer *et al*., 2010). The over-ordering of cross-matched blood to cover operation can result in blood shortages, is costly and cannot be free of risk (Fenner *et al*., 2009). By realigning cross-matching orders with actual expected needs, substantial savings can be realized in terms of personnel time, reagents, and outdating of units of blood (Kretschmer *et al*., 2010). One of the standard methods used as a quantification of this problem and so determine the efficiency of blood ordering, is to determine the ratio of units cross-matched to units transfused, the cross-match/transfusion ratio (C:T ratio) (Kretschmer *et al*., 2010; Marcucci *et al*., 2004). For a hospital with a full range of clinical services the C:T ratio should be about 2.5:1 (Kretschmer *et al*., 2010). A considerably higher ratio indicates that there have been areas where excessive ordering has taken place.

It has been observed that homologous blood is often requested for every patient undergoing major elective surgeries whether depending on the claim of the surgeon or the anaesthesiologist for needing it (Yu *et al*., 2000). Since a large number of units of blood is ordered for and a significant number is administered to patients undergoing major elective maxillofacial surgical procedure, there is a need to study the current pattern of ordering and use of homologous blood in order to assess how much cross-matched blood is wasted (Yu *et al*., 2000).
The present study therefore seeks to determine the efficiency of blood ordering practice, and to evaluate the pattern of use of homologous blood in patients undergoing major elective maxillofacial surgical procedures at the Department of Oral/Maxillofacial Surgery, Lagos University Teaching Hospital, Idi-Araba Lagos.

PATIENTS AND METHOD

Consecutive subjects who required major elective maxillofacial surgery under general anaesthesia, and who met the inclusion criteria for this study (patients who consent to participate in the study after having been fully informed about the study, patients between 18 – 65 years old, and healthy individuals classified as status one American Society of Anaesthesiologist status, (ASA I), or individual with mild but well-controlled systemic disease classified as status ASA II, who are scheduled for and are certified fit by the anaesthetist for major elective oral and maxillofacial surgery) were included in the study. The weight and height of subjects were obtained. Five milliliters of venous blood was obtained from subjects 24 hours before surgery, and analysed for haemoglobin concentration at the laboratory. Baseline haemodynamic variables were obtained for each subject, by the anaesthetist, upon arrival at the theatre red line. All surgeries were performed under strict aseptic technique, under general anaesthesia, and based on the type of surgery planned for the subject. Haemodynamic variables (Systolic BP (mmHg), Diastolic BP (mmHg), Mean arterial pressure (mmHg), and Capillary refill time (s) which are part of the anaesthesiologist's transfusion trigger) were measured, and five milliliters of venous blood, obtained at the point of transfusion from all subjects that were to be transfused. The blood sample was then sent to the laboratory immediately for analysis of haemoglobin concentration, while transfusion was ongoing. Intraoperative blood loss was estimated at the end of the procedure by measuring the surgical blood soaked gauze, and the blood in the suction bottle, with subtractions made for dilution fluid, before adding them together.

RESULTS

There was a male predominance (57.1%) among subjects, with male to female ratio of 1.3 : 1. Mean age of subjects was 33.9 ± 13.5 years. Blood group O Rh +ve was the most predominant blood group (62%). Tumours (58.8%), were the most common indication for surgery, followed by maxillofacial trauma (19.0%). (Table 1) One hundred and twenty four units of homologous blood (range = 1 – 4 units) were

cross-matched for surgery as ordered by the anaesthesiologists in conjunction with the surgeons. Preoperative haemoglobin concentration values for all subjects ranged between of 9.2 - 16.6 mg/dl, (mean = 12.3 ± 1.6 mg/dl). Most of them (95.2%) had values of ≥10 mg/dl. There was no statistically significant association between the means of preoperative haemoglobin concentration and the cross matched blood ordered for subjects (P = 0.645), (Table 3). Majority of transfused subjects (58.8%), had haemoglobin concentration of < 10g/dl at the point of transfusion. There was a statistically significant inverse relationship (P = 0.007, Pearson Correlation = - 0.63) between haemoglobin concentration at the point of transfusion and the number of units of blood transfused, (Table 4).

Overall mean estimated blood loss was 867.3 ± 736.4 ml. Oncological surgical procedures had the highest number of units of cross-matched and transfused blood. This was followed by salivary gland tumour excision with 24 units of blood cross-matched, and only 3 units transfused, (Table 5). Oncological surgical procedures and orthognathic surgical procedures showed significant blood utilization by all the 3 transfusion indices. The overall crossmatch-to-transfusion ratio (C:T ratio), transfusion probability (PoT), and transfusion index(TI) were 3.35, 26.9, and 0.6 respectively. The overall percentage blood utilization was 28.9%, (Table 6). No mortality or transfusion reaction of subjects was recorded during the study.

Table 1: Indications for surgery in 63 subjects undergoing major elective maxillofacial surgery in LUTH

Diagnosis	N	%
Odontogenic Tumours	17	27
Salivary Gland Tumours	13	20.6
Connective Tissue Tumours	5	7.9
Epithelial Tissue Tumours	2	3.2
Fibrosseous Lesion	2	3.2
Maxillofacial Trauma	12	19.0
Cleft Lip and Palate	7	11.1
TMJ Disorders	3	4.8
Others	2	3.2
Total	63	100.0

Others = Other surgeries that do not fall into any of the categories above

Table 2: Grouping of surgical procedures in 63 subjects undergoing major elective maxillofacial surgery in LUTH

Surgical procedures	N	%
Oncological Surgical Procedures	24	38.1
Salivary Gland Tumour Excision	13	20.6
Maxillofacial Trauma Procedures	12	19.0
Cleft surgery	7	11.1
Orthognathic Surgical Procedures	2	3.2
Microvascular Reconstruction	2	3.2
Others	3	4.8
Total	63	100.0

Table 3: Distribution of preoperative haemoglobin concentration and the cross- matched blood ordered for 63 subjects undergoing major elective maxillofacial surgery in LUTH

Preoperative Haemoglobin Concentration (g/dl)					Blood Ordered	
	N	%	Mean ± SD	Range	n	%
Hb <10	3	4.8	9.5 ± 0.3	9.2 - 9.7	4	3.2
Hb ≥10	60	95.2	12.4 ± 1.5	10.0 - 16.6	120	96.8
Total	63	100.0	12.3 ± 1.6	9.2 - 16.6	124	100.0

P = 0.645

N = Number of subjects

n = Number of units of blood ordered

Table 4: Distribution of the means of haemoglobin concentration at the point of blood transfusion (intraoperative) and number of units of blood transfused in 17 subjects that were transfused during major elective maxillofacial surgery in LUTH

Intraoperative Haemoglobin Concentration (g/dl)					Blood Transfused	
	N	%	Mean ± SD	Range	n	%
Hb <10	10	58.8	7.9 ±1.01	6.3 - 9.5	26	70.3
Hb ≥10	7	41.2	11.2 ± 0.7	10.2 - 12.3	11	29.7
Total	17	100.0	9.22 ± 1.89	6.3 - 12.3	37	100.0

P = 0.007

Pearson Correlation = - 0.629

N = Number of subjects

n = Number of units of blood transfused

Table 5: Distribution of blood cross-matched and transfused in 63 subjects undergoing major elective maxillofacial surgery in LUTH

	Crossmatched		Transfuse	
Type of surgery	Subjects	Units	Subjects	Units
Oncological Surgical Procedures	24	64	14	31
Salivary Gland Tumour Excision	13	24	1	3
Orthognathic Surgical Procedures	2	5	2	3
Maxillofacial Trauma Procedures	12	15	0	0
Cleft surgery	7	8	0	0
Microvascular Reconstruction	2	5	0	0
Others	3	3	0	0
Total	63	124	17	37

Table 6: Blood transfusion indices

	CT	PoT	TI	Utilization
Type of surgery		%		%
Oncological Surgical Procedures	2.06	58.3	1.3	48.4
Salivary Gland Tumour Excision	8	7.7	0.23	12.5
Orthognathic Surgical Procedures	1.67	100.0	1.5	60.0
Maxillofacial Trauma Procedures	∞	∞	∞	∞
Cleft surgery	∞	∞	∞	∞
Microvascular Reconstruction	∞	∞	∞	∞
Others	∞	∞	∞	∞
Total	3.35	26.9	0.6	29.8

C:T = Cross-match to transfusion ratio (A ratio of 2.5 or less is considered as significant for blood usage)

PoT = Transfusion probability (A value of 30% or more is considered indicative of significant blood usage)

TI = Transfusion index (A value of 0.5 or more is considered indicative of a need for blood grouping, screening for atypical antibodies and saving the serum for future cross-matching if required).
∞ = Value cannot be mathematically defined

DISCUSSION

Preoperative over-ordering of blood for elective surgery has been documented since the findings of Friedman *et al.,* (1976), was published. Several other studies (Bo¨ttger *et al*., 2009; Burdett and Stephens, 2006; Friedman *et al*., 1976; Kretschmer *et al*., 2010; Marcucci *et al*., 2004; Messmer, 1987; Mintz and Sullivan, 1985; Scottish Intercollegiate Guidelines Network, 2001; Shaikh *et al*., 2011), have also reported over-ordering of blood by the surgeons despite the difficulty in mobilizing an equal number of blood donors in most countries (Mintz and Sullivan, 1985). To prevent over-ordering, protocol for elective surgical procedures in some institutions mandates that the surgeon do not make any blood order, or instead may order preoperative type and screen testing, or request only a preparation of 1 unit of packed red cells before the operation (Burdett and Stephens, 2006; Friedman *et al*., 1976; Marcucci *et al*., 2004; Messmer, 1987; Scottish Intercollegiate Guidelines Network, 2001; Shaikh *et al*., 2011).

A widely accepted transfusion protocol which has been reported to significantly reduce blood ordering and hence transfusion rate, requires that blood be cross-matched only for patients with a preoperative Hb level < 11g/dl (Kretschmer *et al*., 2010). Despite this, 95.2% (60) of subjects who had Hb ≥ 10g/dl in this study had 120 units of blood ordered for them (an average of 2 units per subject). This may probably be due to the expected extent of surgery and blood loss. The fact that every patient undergoing a major elective maxillofacial surgery was made to donate at least one unit of blood, irrespective of their preoperative haemoglobin concentrations (95.2% of which had ≥ 10g/dl, mean 12.3 ± 1.6g/dl.) suggests that preoperative haemoglobin concentration was not a strong determinant of the number of units of blood ordered for subjects in this study.

Transfusion guidelines issued by some organizations (Bo¨ttger *et al*., 2009; Kretschmer *et al*., 2010; Kowalyshyn *et al*., 1976) suggested haemoglobin level of 7-8 g/dl as the threshold for transfusion in patients who are not critically ill (Shaikh *et al*., 2011). Though the correct strategy for transfusion of patients with haemoglobin concentrations between 7 and 10 g/dl is less clear (Messmer, 1987), the need for homologous transfusion in between this range is further defined by clinical indicators (Friedman *et al*., 1976). However guidelines and consensus statements over the last decade have consistently expressed the transfusion threshold as a range, usually between 7 and 10 g/dl haemoglobin (Scottish Intercollegiate Guidelines Network, 2001; Shaikh *et al*., 2011).

The cross-match to transfusion ratio (C:T ratio), is the number of units of blood ordered and cross-matched for each patient, divided by the number of units transfused or used (Messmer, 1987). It reflects the efficiency of blood ordering and usage, and indicates the frequency of use of blood preparations in relation to the amount of blood that has been cross-matched or transfused (Samman *et al*., 1996). According to some studies (Christopoulou et al 2001; Kretschmer *et al*., 2010; Parkin *et al*., 2008; Yu *et al*., 2000) this ratio should be 1.0 but a ratio of ≤ 2.5 was suggested to be indicative of efficient blood usage. It has been recommended that for procedures with a high likelihood of blood transfusion, the number of units cross-matched should be twice the median requirement for that surgical procedure (cross-match-to-transfusion [C:T] ratio of 2:1) (Mintz and Sullivan, 1985). A C:T ratio of more than 2.5 is said to indicate over-ordering of cross-matched blood, in that 2.5 times more blood is ordered than used, or that < 40% of cross-matched units are transfused (Bo¨ttger *et al*., 2009). The overall cross-match-to-transfusion ratio (C:T ratio) in this study was 3.35. This indicates an overall over-ordering of cross-matched blood in that 3.35 times more blood was ordered than used, or that < 30% of cross-matched units are transfused. In this study at least one unit of blood was ordered for each procedure, despite the fact that 95.2% of subjects had a preoperative haemoglobin concentration of $\geq$ 10 g/dl, even for known low-volume blood loss procedures like cleft surgery. Also the anaesthesiologist, depending on how comfortable he is with the judgement of the surgeon on the expected blood loss for a particular procedure, often requested for multiple units of blood for some cases. Several studies (Burdett and Stephens, 2006; Lin *et al.,* 2006; Yu *et al*., 2000) have reported over-ordering as indicated by a C:T ratio that range from 17.6–64.1:1.

The transfusion index (TI), the number of units transfused divided by the number of patients cross-matched, is an index of the average number of units used per patient cross-matched (Lin *et al.,* 2006; Parkin *et al*., 2008; Yu *et al.,* 2000). A value of 0.5 or more is indicative of the need for a policy of blood grouping, screening for atypical antibodies and saving the serum for future cross-matching if required (Kretschmer *et al*., 2010; Marcucci *et al* .,2004). The overall transfusion index (TI) was 0.6. The number of units of blood transfused in this study is about one half the number of subjects cross-matched. Though the C:T ratio from this study indicates an over-ordering of blood, and that routine cross-matching of blood for all major elective maxillofacial surgical procedures may not be justified, both the PoT and the TI suggest that some major elective maxillofacial surgical procedures may require transfusion for which blood grouping, screening for atypical antibodies and saving the serum for future cross-matching will suffice. The need to find out which major elective maxillofacial surgical procedures will benefit from this policy could be the object of further study.

Oncological surgical procedures and orthognathic surgical procedures showed significant blood utilization by all the 3 transfusion indices. Oncological surgical procedures based on its significant utilization, seems to be more likely to need to be given transfusion. This may be due to the fact that it had the highest mean blood loss (1320 ± 718.3 ml) which is an important predictor of transfusion. Salivary gland tumour excision showed insignificant blood utilization by all the 3 transfusion indices. The procedures done under this group of surgery ranged from those that were associated with minimal blood loss such as excision of ranula, to ones that may involve significant blood loss such as parotidectomy, all of which had blood cross-matched for them. In surgeries with insignificant blood usage such as this, only grouping of patients can be done with cross-matching avoided, but with an assurance of availability of blood in the event of an emergency situation (Parkin *et al*., 2008). The other types of surgery in this study,

maxillofacial trauma procedures, cleft surgery, microvascular reconstruction, and other single case procedures that do not fall into the major surgical groupings, did not have any transfusion.

It is therefore necessary to streamline blood ordering and transfusion practices in our environment to minimize over ordering such that, blood will be made available in the operating theatre only in surgeries in which all three indices show significant blood usage. For surgical procedures where the 3 indices showed insignificant blood utilization, only blood grouping should suffice with the serum saved for emergency cross-matching should the need arise.

REFERENCES

Adeyemo, W.L; Ogunlewe, M.O; Desalu, I; Ladeinde, A.L; Adeyemo, T.A; Mofikoya, B.O; *et al*., (2010), Frequency of homologous blood transfusion in patients undergoing cleft lip and palate surgery. Indian J Plast Surg, 43:54-9.

Bo¨ttger, S; Streckbein, P; Hartmann, B; *et al*., (2009), Retrospective analysis of autologous blood use in bimaxillary repositioning osteotomy surgery: a quality improvement study. Transfusion, 49:1747-1753.

Burdett, E; Stephens, R; (2006), Blood transfusion: a practical guide Practical Procedures British Journal of Hospital Medicine, 67:67-69.

Christopoulou, M; Derartinian, H; Hatzidimitriou, G; Iatrou, I; (2001), Autologous blood transfusion in oral and maxillofacial surgery patients with the use of erythropoietin. J Cranio-Maxillofac Surg, 29: 118-125.

Dodsworth, H; Dudley, H.A.F; (1985), Increased efficiency of transfusion practice in routine surgery using pre-operative antibody screening and selective ordering with an abbreviated crossmatch. Br J Surg, 72: 102-104.

Fenner, M; Kessler, P; Holst, S; Nkenke, E; Neukam, F.W; Holst, A.I; **(**2009), Blood transfusion in bimaxillary orthognathic operations: Need for testing of type and screen. Br J Oral Maxillofac Surg, 47: 612–615.

Fordyce, A.M; Telfer, M.R; Stassen, F.A; (1998), Cross-matched blood for major head and neck surgery: an analysis of requirements. Br J Oral Maxillofac Surg, 36: 103-106.

Friedman, B.A; Oberman, H.A; Chadwick, A.R; Kingon, K.I; (1976), The maximum surgical blood order schedule and surgical blood use in the United States. Transfusion, 380-387.

Kowalyshyn, M.J; Prager, D; (1976), Young J. A review of the present status of preoperative haemoglobin requirements. Anaesth Intens Care, 4:176-185.

Kretschmer, W.B; Baciut, G; Bacuit, M; Zoder, W; Wangerin, K; (2010), Intraoperative blood loss in bimaxillary orthognathic surgery with multisegmental Le Fort I osteotomies and additional procedures. Br J Oral Maxillofac Surg, 48: 276–280.

Lin, J.S; Chen, Y.J; Tzeng, C.H; Lyou, J.Y; Lee, C.H; (2006), Revisiting of Preoperative Blood Ordering Policy—A Single Institute's Experience in Taiwan. J Chin Med Assoc, 69:507–511.

Moenning, J.E; Bussard, D.A; Lapp, T.H; Garrison, B.T; (1995), Average blood loss and the risk of requiring perioperative blood transfusion in 506 orthognathic surgical procedures. J Oral Maxillofac Surg, 53: 880-3.

Marcucci, C; Madjdpour, C; Spahn, D.R; (2004), Allogeneic blood transfusions: benefit, risks and clinical indications in countries with a low or high human development index. British Medical Bulletin, 70 :15–28.

Messmer, K.F; (1987), Acceptable haematocrit levels in surgical patients. World J Surg, 11: 41-6.

Mintz, P.D; Sullivan, M.F; (1985), Preoperative crossmatch ordering and blood use in elective hysterectomy. Obstet Gynecol, 65: 389-392.

Parkin, I.R; Chiu, G.A; Schwarz, P.A; Hodder, S.C; (2008), Acute perioperative normovolaemic haemodilution in major maxillofacial surgery. Br J Oral Maxillofac Surg, 46: 387–390.

Scottish Intercollegiate Guidelines Network. *(*2001), A national clinical guideline, Perioperative blood transfusion for elective surgery. Publication No. 54, October.

Rouault, C; Gruenhagen, J; (1978), Reorganization of Blood Ordering Practices. Transfusion, 18: 4.
Samman, N; Cheung, L.K; Tong, A.C; Tideman, H; (1996), Blood loss and transfusion reqiurements in orthognathic surgery. J Oral Maxillofac Surg, 54: 21-24.
Shaikh, I.A; Umer, M.F; Mehdi, H; Abdulla-el-Mutt aqi; Shaikh, A.H; Arsalaan, M; Ahmed, S.F; **(**2011), Routine Cross-match ordering practices, an unnecessary step in routine cholecystectomy. Pak J Surg, 27: 271-273.
Yu, C.N.F; Chow, T.K; Kwan, A.S.K; Wong, S.L; Fung, S.C; (2000), Intraoperative blood loss and operating time in orthognathic surgery using induced hypotensive general anaesthesia: prospective study. Hong Kong Med J, 6: 307-11.