Original Articles

Blood ordering and utilization in patients undergoing elective general surgery procedures in a tertiary care hospital: A prospective audit

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ABSTRACT

Background. Blood ordering is commonly done for patients undergoing major elective surgery. Excessive order of the blood for elective surgery leads to wastage of resources, time and workforce. Auditing preoperative blood ordering decreases the cost of medical care by avoiding unnecessary cross-match without compromising patient safety.

Methods. For this hospital-based audit, we collected data prospectively from July 2017 to June 2018 regarding the transfusion and transfusion indices, namely cross-match-to-transfusion ratio (C/T ratio), transfusion probability (T%), transfusion index (TI) and maximum surgical blood ordering schedule (MSBOS) for elective surgeries done in the Department of Surgery.

Results. A total of 1151 patients were included in the study. A total of 160 units of blood were issued of which only 138 were transfused to 116 patients. Seventy-one procedures were included in the study. The C/T ratio was less than 2.5 for 16 procedures, T% was >50% for 9 procedures and MSBOS was more than 0.5 for 16 procedures.

Conclusion. Cross-matching is overused for elective surgical procedures. Only 16 of the 71 procedures had an ideal C/T ratio. Group and screen policy can be adopted for most of the commonly performed procedures, and cross-matching of blood may not be needed.

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INTRODUCTION

It is a practice among medical professionals to order more blood than the actual need.[1] These cross-matched/reserved units deprive other patients of blood in emergencies. Excessive ordering of blood for elective surgery where little is used leads to wastage of resources, time and workforce.[2–4] Monitoring preoperative blood ordering decreases the cost of healthcare by avoiding unnecessary cross-match without compromising patient's safety. It will indirectly improve the safety of patients by reducing the turnaround time, especially when there is need of blood, by speeding up the process of issuing blood. Many studies in the past have stressed on reducing unnecessary transfusions by following evidence-based guidelines.[5,6] An audit needs to be conducted by every hospital to have an optimal blood ordering strategy.

Transfusion indices are used to determine the efficiency of blood ordering and utilization in surgical services. Cross-match-to-transfusion ratio (C/T ratio) is the ratio of the number of units cross-matched and the actual numbers of units transfused. Ideally, this ratio should be 1.0, but a ratio of 2.5 and below is considered an acceptable indicator of appropriate blood ordering and usage.[1] Transfusion probability (T%) is the proportion of patients who were actually transfused among all the patients who were cross-matched for a given surgical procedure. T% above 30% suggests efficient usage of blood.[7] Transfusion index (TI) is the average number of units consumed for each surgical procedure. A value of 0.5 or more is indicative of efficient blood usage.[1,7] Maximum surgical blood ordering schedule (MSBOS) defines the maximum number of units of blood to be cross-matched preoperatively for elective surgical procedures. MSBOS is roughly one and half times the TI and can be computed as MSBOS=1.5×TI.[8]

We analysed the blood ordering and utilization practices in patients undergoing an elective general surgical procedure by studying the transfusion indices such as C/T ratio, T%, TI and MSBOS for various surgical procedures. Based on the MSBOS and C/T ratio, we can adopt 'Group and Screen' (G and S) for many surgical procedures. The G and S policy is used by blood banks to avoid unnecessary reservation of the blood. In this policy, blood will not be cross-matched unless there is a need for transfusion; rather the patient's blood is grouped and screened for the presence of antibodies.

When a surgical patient is admitted and there is a probability of a procedure being done on him, however trivial, the patient is phenotyped for his ABO and Rh blood group and his serum screened for any antibodies. Many of the patient's antibody screen would be negative at least for clinically important antibodies. Such patients can receive group-matched blood with immediate spin cross-match without requirement of extensive pre-transfusion testing/compatibility at the time of blood requirement. Hence, calculation of the blood indices helps to reduce the burden on the blood bank without compromising on blood availability or delay in issue of blood for the patient who needs transfusion.

METHODS

This hospital-based, single-centre, cross-sectional, descriptive study was done at a tertiary care centre from July 2017 to June 2018. All patients who were planned for elective surgery in the department of surgery and for whom blood was requested were included in the study. All patients who received a blood transfusion in the postoperative period, for which a new cross-match request was sent, were excluded from the study. Ethical clearance was obtained by the institutional ethics board (JIP/IEC/2016/1012 dated 22/11/2016).

Assuming that at least 50% of all patients undergoing surgeries and for whom cross-match will be sent will need blood transfusions, with an absolute precision of 5% and type I error of 5%, the sample size was calculated for estimation of single proportion as a minimum of 384. However, we included all patients undergoing surgery over a period of 1 year and for whom cross-match was sent. Hence, we included 1151 samples, which was nearly thrice the minimum calculated.

Data for all 1151 patients were entered in MS Excel. Blood indices were analysed and calculated using SPSS version 20.

Samples of patients' blood were tested for ABO grouping, Rh (D) grouping and antibody screening. ABO testing was done with the help of anti-A, anti-B and anti-AB sera (Tulip Diagnostics, Goa, India). Rh (D) testing was done with tube test using anti-D (Tulip Diagnostics, Goa, India). The antibody screening was done with ID-DiaCell I-II-III (Bio-Rad Laboratories, India). Grouping and antibody screening was done for all blood recipients and blood donors.

All cross-matches sent from the Department of Surgery were analysed. The data included were hospital number of the patient, diagnosis, type of request, date of request, date of transfusion, blood transfused or not, type of product transfused, the number of blood products transfused, blood products returned or not and the number of blood products returned.

Data about the number of units requested, type of request (cross-match/group and save), the number of units transfused and the number of units returned were studied for each elective surgical procedure. The C/T ratio, T%, TI and MSBOS were calculated for each procedure.

RESULTS

A total of 1151 patients were included in the study. In our study, 71 different procedures were evaluated and all blood indices were calculated for each surgical procedure. Of the 1151 samples received for cross-match, blood was issued against only 13.9% (160). Of the 160 units, 138 (86.25%) units were transfused to 116 patients and 22 unused units (13.75%) were returned to the blood bank.

We divided the procedures (n=71) into seven broad groups—patients undergoing upper gastrointestinal (GI) surgery, lower GI surgery, hepatobiliary surgery, breast surgery, head and neck surgery, genitourinary surgery and others.

In the breast surgery group, modified radical mastectomy was done in 323 of 337 patients who were cross-matched but only 5 patients were transfused a unit each giving a C/T ratio of 43, a TP of 1.54, a TI of 0.02 and a MSBOS of 0.034.

We found the C/T ratio was ≤2.5 in splenectomy with lienorenal shunt, total gastrectomy, thoracoscopic-assisted oesophagectomy (Table I), sigmoidectomy, total proctocolectomy with ileostomy (Table II), Whipple procedure, Frey procedure, radical antegrade modular pancreatosplenectomy (RAMPS), left hepatectomy (Table III), total thyroidectomy with modified radical neck dissection (MRND) (Table IV) and adrenalectomy (Table V).

TP was more than 30% in thoracoscopic-assisted oeso-

TABLE I. Transfusion indices for upper gastrointestinal surgery

Procedure	Number of patients cross-matched	Number of units cross-matched	Number of units transfused	C/T ratio	Number of patients transfused	TP (T%)	TI	MSBOS
Truncal vagotomy and gastrojejunostomy	19	10	1	10	1	5.26	0.1	0.15
Modified Heller's cardiomyotomy	7	4	0	NA	0	NA	NA	NA
Duodenojejunostomy	2	2	0	NA	0	NA	NA	NA
Transhiatal oesophagectomy (THE)	22	28	19	1.47	10	45.45	0.67	1.00
Gastrojejunostomy	10	4	0	NA	0	NA	NA	NA
Laparoscopic/open fundoplication	7	3	0	NA	0	NA	NA	NA
Splenectomy and lienorenal shunt	11	10	5	2	5	45.45	0.5	0.75
Subtotal gastrectomy	95	38	15	2.53	17	17.8	0.39	0.58
Total gastrectomy	6	6	3	2	1	16.6	0.5	0.75
Laparoscopic/open splenectomy	7	8	6	1.33	3	42.85	0.75	1.12
Thoracoscopic-assisted oesophagectomy	2	4	2	2	1	50	0.5	0.75
Robotic-assisted truncal vagotomy and gatsrojejunostomy	1	1	0	NA	0	NA	NA	NA
Feeding gastrostomy	1	0	0	NA	0	NA	NA	NA
Laparoscopic/open deroofing of splenic cyst	2	0	0	NA	0	NA	NA	NA

NA transfusion indices not calculated for procedures where blood transfusion was not done C/T ratio cross-match transfusion ratio TP transfusion probability TI transfusion index MSBOS maximum surgical blood ordering schedule

TABLE II. Transfusion indices for lower gastrointestinal surgery

Procedure	Number of patients cross-matched	Number of units cross-matched	Number of units transfused	C/T ratio	Number of patients transfused	TP (T%)	TI	MSBOS
Abdominoperineal resection	41	30	11	2.72	11	26.82	0.36	0.54
Stoma closure	33	5	0	NA	0	NA	NA	NA
Laparoscopic/open appendicectomy	43	4	0	NA	0	NA	NA	NA
Sigmoidectomy	17	10	5	2	5	50	0.5	0.75
Coloplasty	2	3	0	NA	0	NA	NA	NA
Right hemicolectomy	22	15	1	15	1	4.5	0.06	0.09
Laparoscopic/open rectopexy	15	5	0	NA	0	NA	NA	NA
Anterior resection	20	10	4	2.5	5	25	0.4	0.6
Left hemicolectomy	8	4	0	NA	0	NA	NA	NA
Total proctocolectomy with ileostomy	5	5	3	1.66	3	60	0.6	0.9
Robotic-assisted appendicectomy	2	0	0	NA	0	NA	NA	NA
Robotic-assisted abdominoperineal resection	1	1	0	NA	0	NA	NA	NA
Robotic-assisted anterior resection	1	1	0	NA	0	NA	NA	NA
Robotic-assisted hemicolectomy	1	1	0	NA	0	NA	NA	NA
Resection and anastomosis	6	2	0	NA	0	NA	NA	NA
Diversion stoma	1	0	0	NA	0	NA	NA	NA

NA transfusion indices not calculated for procedures where blood transfusion was not done C/T ratio cross-match transfusion ratio TP transfusion probability TI transfusion index MSBOS maximum surgical blood ordering schedule

TABLE III. Transfusion indices for hepatobiliary and pancreatic surgery

Procedure	Number of patients cross-matched	Number of units cross-matched	Number of units transfused	C/T ratio	Number of patients transfused	TP (T%)	TI	MSBOS
Whipple procedure	35	30	19	1.57	19	54.28	0.63	0.945
Open cholecystectomy and exploration of the common bile duct	17	10	0	NA	0	NA	NA	NA
Cholecystectomy	151	100	6	16.6	4	2.64	0.06	0.09
Triple bypass	8	2	0	NA	0	NA	NA	NA
Frey procedure	10	8	5	1.6	5	50	0.62	0.93
RAMPS (radical antegrade modular pancreatosplenectomy)	1	5	2	2.5	1	100	0.4	0.6
External cystectomy for hydatid cyst	1	0	0	NA	0	NA	NA	NA
Left hepatectomy	4	10	7	1.42	2	50	0.7	1.05
Right hepatectomy	2	4	0	NA	0	NA	NA	NA
Distal pancreatectomy	2	4	1	4	1	50	0.25	0.37
Robotic-assisted cholecystectomy	5	1	0	NA	0	NA	NA	NA
Open splenectomy and cholecystectomy	1	0	0	NA	0	NA	NA	NA
Open right hepatic artery ligation	1	0	0	NA	0	NA	NA	NA

NA transfusion indices not calculated for procedures where blood transfusion was not done C/T ratio cross-match transfusion ratio TP transfusion probability TI transfusion index MSBOS maximum surgical blood ordering schedule

TABLE IV. Transfusion indices for head and neck surgery

Procedure	Number of patients cross-matched	Number of units cross-matched	Number of units transfused	C/T ratio	Number of patients transfused	TP (T%)	TI	MSBOS
Total thyroidectomy	32	26	1	26	1	3.12	0.03	0.04
Hemithyroidectomy	19	10	0	NA	0	NA	NA	NA
Superficial parotidectomy	2	0	0	NA	0	NA	NA	NA
Total thyroidectomy and bilateral MRND	10	9	6	1.5	6	60	0.66	1
Total thyroidectomy and central lymph node dissection	1	1	0	NA	0	NA	NA	NA
Subtotal thyroidectomy	12	0	0	NA	0	NA	NA	NA
Submandibular gland excision	1	0	0	NA	0	NA	NA	NA
Parathyroidectomy	1	0	0	NA	0	NA	NA	NA

NA transfusion indices not calculated for procedures where blood transfusion was not done C/T ratio cross-match transfusion ratio TP transfusion probability TI transfusion index MSBOS maximum surgical blood ordering schedule MRND modified radical neck dissection

TABLE V. Transfusion indices for genitourinary surgery

Procedure	Number of patients cross-matched	Number of units cross-matched	Number of units transfused	C/T ratio	Number of patients transfused	T P (T%)	T I	MSBOS
High inguinal orchidectomy	2	NA	0	NA	0	NA	NA	NA
Adrenalectomy	9	8	4	2	4	44.44	0.5	0.75
Total penectomy	2	0	0	NA	0	NA	NA	NA
Bilateral eversion of sac	1	0	0	NA	0	NA	NA	NA
Bilateral ilioinguinal block dissection	6	3	1	3	1	16.66	0.33	0.5
Totally extra-peritoneal (TEP)	2	1	0	NA	0	NA	NA	NA
Transabdominal pre-peritoneal (TAPP)	1	0	0	NA	0	NA	NA	NA

NA transfusion indices not calculated for procedures where blood transfusion was not done   C/T ratio cross-match transfusion ratio   TP transfusion probability
TI transfusion index   MSBOS maximum surgical blood ordering schedule

TABLE VI. Transfusion indices for other surgeries

Procedure	Number of patients cross-matched	Number of units cross-matched	Number of units transfused	C/T ratio	Number of patients transfused	T P (T%)	T I	MSBOS
Diagnostic laparoscopy and proceed	8	3	2	1.5	2	25	0.66	0.99
Wide local excision	17	5	2	2.5	2	11.76	0.4	0.6
Excision	10	0	0	NA	0	NA	NA	NA
Below knee amputation	1	1	0	NA	0	NA	NA	NA
Anatomical repair	1	0	0	NA	0	NA	NA	NA

NA transfusion indices not calculated for procedures where blood transfusion was not done   C/T ratio cross-match transfusion ratio   TP transfusion probability
TI transfusion index   MSBOS maximum surgical blood ordering schedule

phagectomy (Table I), total proctocolectomy with ileostomy (Table II), Whipple procedure, Frey procedure, RAMPS, left hepatectomy, distal pancreatectomy (Table III) and total thyroidectomy with MRND (Table IV).

TI was $\geq$0.5 in transhiatal oesophagectomy (THE), laparoscopic/open splenectomy (Table I), Whipple procedure, Frey procedure, left hepatectomy (Table III), total thyroidectomy with MRND (Table IV), adrenalectomy (Table V) and diagnostic laparoscopy and proceed (Table VI). MSBOS was found to be $\geq$1 in THE, laparoscopic/open splenectomy (Table I), left hepatectomy (Table III), total thyroidectomy with MRND (Table IV).

The procedures for which blood units were returned included Whipple procedure (8 patients), abdominoperineal resection (APR) (1), THE (6), subtotal gastrectomy (3), total gastrectomy (1), RAMPS (1) and left hepatectomy (2).

DISCUSSION

Ordering of blood is a common practice in all elective surgical procedures. The preoperative request of blood is usually based on the worst-case assumptions demanding a large quantity of blood or overestimating the anticipated blood loss, of which ultimately a small amount is used. Increasing demand for blood and blood products together with rising cost led to several studies reviewing the blood ordering and transfusion practices.[1,3]

Since the introduction of blood transfusion into clinical practice, its correct use is a matter of debate. Only a small percentage of cross-matched blood, sent for elective surgical procedures, is actually used. Many studies have shown over-ordering of blood by surgeons and utilization of blood ranges from 5% to 40%. The utilization rate in India is 28%, Kuwait 13.6% and Nigeria 69.7%.[3,7,9] Hence, regular auditing is required to improve the blood utilization practices.[1]

In our study, 1151 cross-match samples were received from the department of surgery. A total of 1151 cross-matches were done and 160 units of blood were issued. Of these 138 units were transfused to 116 patients and 22 unused units were returned to the blood bank. Overall, we found that only 13.9% of cross-matched blood was utilized.

Several indices have been used to assess blood ordering and utilization. C/T ratio was first introduced by Boral Henry in 1975.[10] Ideally, the ratio should be 1 but a ratio of 2.5 or below is indicative of efficient blood use. Consequently, this ratio has been used by many authors for assessing blood ordering and utilization.[1]

We found the C/T ratio to be <2.5 for oesophagectomy, Whipple procedure, anterior resection and Frey procedure. C/T ratio was >2.5 for subtotal gastrectomy, APR, laparoscopic/open appendicectomy, laparoscopic/open cholecystectomy, modified radical mastectomy and thyroidectomy. Ayantunde *et al.*, from the UK in 2008, found that the C/T ratio for oesophagectomy was 4:1, which was high compared to our study.[11] However, we surmise that this difference may be because anaemia is more prevalent in our study population. Bhutia *et al.*, from India in 1997, found the C/T ratio for oesophagogastrectomy, small bowel and colonic resection, cholecystectomy, modified radical mastectomy, ilioinguinal block dissection and thyroidectomy was suggestive of significant blood use in contrast to our study.[2] This may be because the previous study was done two decades ago, and the advances in surgical technique and anaesthesia since then would have led to a decrease in transfusion rates now. In the study, the C/T ratio for Whipple procedure was suggestive of significant use of blood, a finding similar to our study. However, there was a drastic reduction in the use of blood in our study. Juma *et al.*, from Kuwait in 1990, had found that the C/T ratio for gastrectomy was 1.1 in contrast to our study; however, the number of surgeries performed were few.[12] Ghirardo *et al*. included 726 patients undergoing laparoscopic appendicectomy and found that the C/T ratio was negligible and recommended that even G and S is not required.[13] Hall *et al*. in 2013 had results similar to our study for APR and hence they recommended adopting a G and S policy.[14] Faridi *et al*. in 2017 found the C/T ratio for thyroidectomy to be 11.88, a finding similar to our study,[15] and suggested the 'G and S' policy for thyroidectomy. Zaidi *et al*., from Pakistan in 2017, concluded that the blood utilization for a modified radical mastectomy was insignificant.[16] Al-Benna *et al*. also found that blood utilization for breast surgery was insignificant.[17] Both studies had findings similar to the present study.

Transfusion probability is the proportion of patients who were actually transfused among all the patients who were cross-matched for a given surgical procedure. T% >30% suggests efficient usage of blood. In our study, T% was significant for oesophagectomy, splenectomy, total proctocolectomy, Whipple procedure, hepatectomy, adrenalectomy and thyroidectomy with MRND. Bhutia *et al*. found that T% was significant for small bowel and colonic resection and ilio-inguinal block dissection, in contrast to our study.[2] Lin *et al*., in 2006, found that T% was 4.8 for hemicolectomy suggesting insignificant use of blood, a finding similar to our study.[18]

The MSBOS defines the maximum number of units of blood to be cross-matched preoperatively for elective surgical procedures. It is calculated by Mead criteria.[19] We found that the MSBOS was significant in oesophagectomy, splenectomy, sigmoidectomy, Whipple procedure and Frey procedure. Juma *et al*., from Kuwait in 1990, found that the MSBOS for gastrectomy was significant in contrast to our study.[12] Bhutia *et al*. found that the MSBOS was significant for Whipple procedure, a finding similar to our study.[2] However, in our study, MSBOS was 0.9 compared to the previous study, which was 4.2, indicating that the usage of blood has decreased markedly. It was also found that the MSBOS for small bowel or colonic resection was 1.8 and modified radical mastectomy was 1.8, in contrast to our study, which was 0.06 and 0.034, respectively, indicating that blood utilization has reduced drastically compared to the previous study. Similarly, Faridi *et al*., in 2017, found that the use of blood for thyroidectomy is insignificant and they opined for designing MSBOS for all institutes for all elective surgeries so that unnecessary cross-match can be avoided, which supports the finding of our study.[15]

In our study, few procedures such as hepatectomy, RAMPS, proctocolectomy, etc. in which there was more blood usage indicated by the C/T ratio and MSBOS. However, these surgeries are done in small number of patients and to use MSBOS as guidelines for blood transfusion practices needs further evaluation. A study by Shaker *et al*., from the UK in 2010, found the C/T ratio was high for proctocolectomy, although the number of surgeries performed was less, a similar finding to our study.[20]

We found that for all the patients there was excessive ordering of blood for surgical procedures. In the absence of MSBOS, ordering of blood products is frequently based on subjective anticipation of blood loss rather than evidence-based requirement of blood for the particular surgical procedures.

Our study has some limitations. First, we have not taken into consideration the individual differences of patients such as the stage of the disease, comorbid conditions, preoperative and postoperative haemoglobin, amount of intraoperative blood loss and duration of surgery, all of which can influence transfusion requirements. A new index, surgical blood ordering schedule, has been designed, which includes patient age- and surgery-specific variables.[5] Another drawback of our study was that there are few surgeries that are performed less in numbers, calculation of transfusion indices for such procedures may not reflect the actual transfusion needs. Hence for such procedures, longer duration studies are needed so that adequate numbers can be included to calculate the blood ordering indices.

Conclusion

We suggest that for many surgical procedures a 'G and S' policy can be adopted, and cross-matching of blood may not be needed. These include subtotal gastrectomy, APR, sigmoidectomy, hemicolectomy and anterior resection, cholecystectomy, modified radical mastectomy, breast conservation surgery and total thyroidectomy. However, for other procedures such as total proctocolectomy, Whipple procedure, transhiatal oesophagectomy and total thyroidectomy with MRND cross-matching of blood and its reservation will be needed. We conclude that based on our results MSBOS for commonly done procedures can be implemented, which will avoid unnecessary cross-match, wastage of resources, time and workforce.

Conflicts of interest. None declared

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