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Original Research Article

Study on utilization of blood and blood components in surgical patients in a tertiary care hospital in Himachal Pradesh, India

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ABSTRACT

Background: This study aims to assess the utilization patterns and appropriateness of blood and blood components and evaluate transfusion practices across various surgical procedures.
Methods: A one-month record based cross sectional retrospective study involving 1392 patients fulfilling the inclusion criteria for surgical procedures has been conducted at the department of immunohematology and blood transfusion, Indira Gandhi Medical College and Hospital, Shimla, India.
Results: Out of 1392 patients enrolled, females accounted for 746 (53.6%) and males for 646 (46.4%). Surgical procedures have been broadly classified as elective and emergency. Among elective procedures most commonly performed was cholecystectomy 394 (28.3%), least common was involving surgery for Ca breast 7 (0.5%) and Ca prostate 7 (0.5%). Among emergency procedures the highest proportion was orthopaedic surgeries 143 (10.2%), lowest proportion was herniorrhaphy 12 (0.8%) and extradural haemorrhage 12 (0.8%). After further scrutinizing the data, it was found that among elective procedures, cholecystectomy, appendectomy, H. cyst, Ca Breast, Ca Prostate, Ca Colon, orthopaedics, transurethral resection of prostate (TURP), cardio-thoracic and vascular surgeries (CTVS) demonstrated a crossmatch to transfusion (C/T) ratio below 2.5, transfusion probability (TP) below 30% and transfusion index (TI) >0.5%. However, herniorrhaphy and burns demonstrated a C/T ratio>2.5, TP > 30% and TI >0.5%. Among emergency procedures, cholecystectomy, appendectomy, peritonitis, intestinal obstruction, intussusception, RSA, fracture, EDH, SDH, SAH demonstrated a C/T ratio below 2.5, TP below 30% and TI >0.5%.
Conclusions: Blood utilization practice for both emergency and elective surgical procedures appear effective with CT ratio of 1.2, TP 80.6 and TI 0.8.

Keywords: Blood components, Effectiveness, Retrospective study, Surgical procedures, Transfusion, Utilization

INTRODUCTION

Clinical studies are vital for evaluating healthcare practices, particularly in the realm of blood transfusion in surgical contexts. James Blundell, an Obstetrician in London, is renowned for successfully conducting the first human-to-human blood transfusion.[1] Subsequent discoveries by Landsteiner, including the identification of ABO blood groups, have further advanced blood transfusion practices.[2] Despite these advancements, there persists a common practice of overordering blood for both elective and emergency surgical procedures.[3] This tendency, often driven by habit rather than clinical necessity, results in the wastage of resources and compromises the efficient use of blood bank facilities and is a common practice in surgical patients.[4]

In a prospective observational study conducted in England, Wells et al reported that 5047 units (51.6% of the total during the study period) of the collected blood were administered to medical patients, while 40.7% and 6.3% were allocated to surgical and Obstetrics and Gynaecology patients, respectively. Conversely, in low- and middle-income countries, it is more frequently utilized to manage pregnancy-related complications and severe childhood anaemia.[5-7] In Tikur Abbess Specialised Hospital in Ethiopia, almost 2,00,00 surgeries are performed annually, in which ineffective blood utilisation is seen in elective procedures.[8] A comparable investigation was carried out at a Tertiary Care Hospital in West Bengal, India, where a total of 1544 units were crossmatched for 1324 patients, with 1219 units transfused to 882 patients. The overall utilization rate stood at 98.25%.[9] The prevailing practice in our setup concerning the blood product requesting system entails conducting blood typing and complete blood count for all surgical patients initially. Subsequently, crossmatched blood is prepared based on the estimated blood requirement of the patient as determined by the operating surgeon, surgical resident, or anaesthesiologist. Crossmatching is requested one day before the surgery. This allocated blood remains unavailable for other patients on the day of surgery and for 24 hours post-surgery.

Conducting studies to monitor and enhance transfusion practices is imperative to mitigate blood wastage. Therefore, it is essential to establish and adhere strictly to criteria for blood transfusion. Such research endeavours are vital for identifying areas of improvement and devising strategies for betterment in the future. This study, undertaken at Indira Gandhi Medical College and Hospital, aimed to assess the utilization patterns and appropriateness of blood and blood components, along with evaluating the transfusion practices across various surgical procedures.

In the persistent need for blood, it is essential to ensure that the resource is not squandered. One contributing factor to this issue is the excessive preoperative crossmatching coupled with ineffective utilization. A study conducted at University of Gondar, northwest Ethiopia, showed excessive crossmatching with minimal transfusion in elective surgeries.10 This necessitates a thorough review of our efficiency in utilizing the blood already collected within our system.

METHODS

Study area

This study was done at the Department of IH and BT, Indira Gandhi Medical College and Hospital (IGMC) Shimla, Himachal Pradesh, India where surgical, orthopaedics, urology, neurosurgery, cardio-thoracic and vascular surgery, gynaecology and obstetrics, ENT and medicine services are being provided. The state has 5 tertiary care hospitals, with IGMC being the oldest and the largest among all. It is the only Government tertiary care Hospital in Shimla city. IGMC has 872 beds and offers diagnostic and treatment facilities to the patients.

Study design

Record based Cross-sectional retrospective study was conducted and data was collected from blood bank requisition forms from 29. Janurary.2024 to 29. February.2024 for a period of one month. Confidentiality of the patient data as recorded in the registers and records was ensured.

Sample size

A 1-month retrospective data was collected for surgical patients for whom blood was requested between 29/01/2024 and 29/02/2024. Total number of patients who fulfilled the inclusion criteria was 1392.

Inclusion criteria

Any patient in the specified period of time for whom whole blood/ component of blood request will be made for the purpose of perioperative resuscitation.

Exclusion criteria

Surgical patients for whom blood request were done for non-surgical use like anaemia of different cause, transfusion for chronic medical condition.

Scheduled patients who were cancelled after crossmatch was done.

Data analysis

Software SPSS version 29 has been used for the integration of this data. The information then obtained has been presented through various descriptive tables, percentages and ratios. Lastly, the data obtained has been compared to the set standards to reach to an unbiased conclusion.

Blood utilization indices

We used the following operational definitions in our study.[11,12]

Crossmatch to transfusion ratio (C/T ratio)

Number of units was crossmatched/number of units was transfused. A ratio of 2.5 and below is considered indicative of significant/ efficient blood usage.

Transfusion probability

Number of patients was transfused/number of patients was crossmatched×100. A value of 30% and above will be considered indicative of significant blood usage.

Transfusion index

Number of units was transfused/number of patients cross was matched. A value of 0.5 or more will be considered indicative of significant blood utilization.

RESULTS

Profile and admissions of the patients for the month of February 2024

Our study comprised a total of 1392 patients who met the inclusion criteria, of these females constituted 746 (53.6%) while males made up 646 (46.4%) of the total cohort. We broadly classified surgical procedures into elective and emergency.

Among elective procedures

Cholecystectomy stood out as the most frequently performed operation, comprising 28.3% of all surgeries, while surgery for Ca breast and Ca prostate represented the lowest proportion at 0.5%. Among female patients undergoing surgery, the highest proportion (23%) suffered from cholelithiasis while the lowest number of surgeries were performed for appendicitis i.e. appendectomy, renal stone disease (RSD)i.e. nephrolithotomy, and peripheral vascular disease (PVD), each accounting for 0.1%. Conversely, statistics revealed a different trend among male patients, with the majority undergoing orthopaedic surgeries (5.9%) with 0.6% out of 646 undergoing Appendectomy and 0.5% undergoing surgery for Ca prostate (Table 1).

Among emergency procedures

Overall orthopaedic surgery represented the largest share of emergency procedures (10.2%), followed by surgeries for sub dural hemorrhage (SDH) at 5.5%. Both herniorrhaphy and extra dural hemmorhage (EDH) surgeries accounted for the lowest number of procedures, each at 0.8%. A mere 0.1% of Intussusception cases were treated in male children (Table 2).

Table 1: Elective surgical procedures conducted at IGMC from 29 January 2024 to 29 February 2024.

Surgery / diagnosis	Females	Percentage	Males	Percentage	Total	Percentage
Cholecystectomy	329	23	65	4.6	394	28.3
Herniorrhaphy	4	0.2	18	1.2	22	1.5
Appendectomy	2	0.1	8	0.6	10	0.7
Hydatid cyst	4	0.2	10	0.7	14	1.0
Ca prostate	-	-	7	0.5	7	0.5
Ca breast	7	0.5	-	-	7	0.5
Ca colon	29	2	31	2.2	60	4.3
Burns	15	1	12	0.8	27	1.9
Orthopaedic surgeries	63	4.5	83	5.9	146	10.4
Trans urethral resection of prostate (TURP) + nephrolithotomy	2 (excluding TURP)	0.1	13	0.9	15	1.0
CTVS - PVD	2	0.1	16	1.1	18	1.2
CTVS - TTVR	7	0.5	11	0.7	18	1.2
CTVS - ASD RHD	26	1.86	19	1.3	45	3.2

Ca (cancer), TURP (trans urethral resection of prostate), CTVS (cardio thoracic vascular surgery), TTVR (transcatheter tricuspid valve replacement), ASD (atrial septal defect), RHD (rhematic heart disease).

Table 2: Emergency surgical procedures conducted at IGMC from 29 January 2024 to 29 February 2024.

Surgery/ diagnosis	Females	Percentage	Males	Percentage	Total	Percentage
Cholecystectomy	10	0.7	4	0.2	14	1.0
Herniorrhapy	4	0.2	8	0.5	12	0.8
Appendectomy	24	1.7	32	2.2	56	4.0
Peritonitis	5	0.4	11	0.7	16	1.1
Intestinal obstruction	9	0.69	10	0.7	19	1.3
Intussusception	0	-	2	0.1	2	0.1
Road side accident	2	0.1	23	1.6	25	1.7
Orthopaedic surgery	52	3.7	91	6.5	143	10.2
EDH	6	0.4	6	0.4	12	0.8
SDH	17	1.22	60	4.3	77	5.5
SAH	18	1.2	20	1.4	38	2.7

Table 3: Blood cross matching and utilization profile for patients for whom blood was cross matched for elective surgical procedures in Indira Gandhi Medical College in 2024.

Variables	Units required			Units crossmatched			Units issued/transfused			C/T ratio	TP	TI
	Female	Male	Total	Female	Male	Total	Female	Male	Total		(%)	
Cholecystectomy	658	130	788	330	80	410	200	50	250	1.64	60	0.6
Herniorrhaphy	8	36	44	6	30	36	2	10	12	3	33.3	0.33
Appendectomy	4	16	20	2	8	10	0	6	6	1.67	60	0.6
Hydatid cyst	8	20	28	4	10	14	2	6	8	1.75	57.1	0.57
Ca prostate	-	21	21	-	18	18	-	10	10	1.8	55.5	0.55
Ca breast	26	-	26	20	-	20	10	-	10	2	50	0.5
Ca colon	87	93	180	58	62	120	40	40	80	1.5	66.6	0.66
Burns	30	26	56	15	9	24	6	4	10	2.4	41.6	0.41
Orthopaedic surgery	252	332	584	189	249	438	126	166	292	1.5	66.7	0.66
TURP	4 (excluding TURP)	39	43	2	26	28	0	13	13	2	50	0.5
CTVS-PVD	6	48	54	4	32	36	0	10	10	3.6	27.7	0.27
CTVS-TTVR	28	44	72	21	33	54	18	28	46	1.17	85.1	0.85
CTVS-ASD RHD	104	76	180	92	60	152	88	54	142	1.07	93.4	0.93

Ca (cancer), TURP (trans urethral resection of prostate), CTVS (cardio thoracic vascular surgery), TTVR (transcatheter tricuspid valve replacement), ASD (atrial septal defect), RHD (rhematic heart disease).

Table 4: Blood cross matching and utilization profile for patients for whom blood was cross matched for emergency surgical procedures in Indira Gandhi Medical College.

Variables	Units required			Units crossmatched			Units issued/ transfused			C/T ratio	TP (%)	TI
	Female	Male	Total	Female	Male	Total	Female	Male	Total			
Cholecystectomy	20	8	28	10	4	14	8	2	10	1.4	71	0.71
Herniorrhaphy	8	16	32	4	8	12	0	2	2	6	16	0.16
Appendectomy	72	96	168	48	64	112	24	32	56	2	50	0.5
Peritonitis	15	33	48	10	22	32	6	14	20	1.6	62	0.62
Intestinal obstruction	27	30	57	18	20	38	10	20	30	1.26	78	0.78
Intussusception	0	8	8	0	6	6	0	4	4	1.5	66	0.66
Road side accident	8	92	100	6	69	75	4	47	51	1.47	68	0.68
Orthopaedic surgery	204	364	568	156	273	429	144	259	403	1.06	93	0.93
Extra dural hemorrhage (EDH)	24	24	48	18	18	36	10	13	23	1.56	63	0.63
Sub dural hemorrhage (SDH)	68	240	308	51	180	231	46	159	205	1.12	88	0.88
Sub arachnoid hemorrhage (SAH)	72	80	152	54	64	118	33	53	86	1.37	72%	0.72
Cholecystectomy	20	8	28	10	4	14	8	2	10	1.4	71%	0.71
Herniorrhaphy	8	16	32	4	8	12	0	2	2	6	16%	0.16
Appendectomy	72	96	168	48	64	112	24	32	56	2	50%	0.5

Units (whole blood and PRBC).

Table 5: Blood transfusion indicators, value and utilization status.

Blood transfusion indicators	Value	Utilization status
C/T ratio	1.2	Efficient blood usage
TP	80.6%	Appropriate blood requesting
TI	0.8	Significant blood utilization

Blood utilization for surgical procedures

Among elective procedures

A C/T ratio of ≥2.5, indicating insignificant blood usage, was observed in surgeries like herniorrhaphy (3) and CTVS- PVD (3.6). A Transfusion Probability (TP) of <30% was found in CTVS PVD surgery, indicating poor/overestimation of blood request. A transfusion Index (TI) of <0.5, indicating inefficient blood utilization, was found in CTVS PVD (0.27), herniorrhaphy (0.33), and burns (0.41). all remaining surgeries, namely cholecystectomy, appendectomy, hydatid cyst, Ca prostate, Ca breast, Ca colon, orthopaedics, TURP, CTVS-TTVR, ASD-RHD, demonstrated a C/T ratio below 2.5, signifying substantial blood utilization. Additionally, they exhibited a TP above 30%, indicating appropriate blood request practices, and a TI exceeding 0.5, reflecting efficient blood utilization (Table 3).

Among emergency procedures

Herniorrhaphy was the only surgery with a C/T ratio of >= 2.5, indicating insignificant blood usage (6). Additionally, herniorrhaphy had a transfusion probability (TP) of <30% (16%), suggesting poor/overestimation of blood request. The transfusion index (TI) for herniorrhaphy was <0.5 (0.16) indicating inefficient blood utilization. Rest all the surgeries, cholecystectomy, appendectomy, peritonitis, intestinal obstruction, intersection, road side accident, orthopaedic surgeries, EDH, SDH, SAH had C/T ratio <2.5 indicating significant blood usage, TP >30% indicating appropriate blood requesting, and TI >0.5 indicating efficient blood utilization (Table 4).

Overall, blood utilization among patients undergone surgical procedures in IGMC hospital, in the month of february-2024

Overall, 3 indices used in our study indicated in Table 5.

C/T ratio was (1103% 890 = 1.2) i.e. <2.5 Indicating efficient blood usage.

TP was (890%1103×100 = 80.6%) i.e. >30% Indicating Appropriate blood requesting TI was (890%1103 = 0.8) i.e. >0.5 Indicating Significant blood utilization.

Blood transfusion status

For elective procedures

The highest demand for whole blood (WB) and packed red blood cells (PRBC) was observed in cholecystectomy requiring 394 units of each WB and PRBC and orthopaedic surgeries requiring 392 WB units and 182 PRBC units. Out of these blood demands, 322 WB Units and 114 PRBC units were crossmatched for orthopaedic Surgeries, while cholecystectomy surgery required crossmatching of 210 WB units and 200 PRBC units. Subsequently, 210 WB units were issued for Orthopaedic Surgeries, alongside 200 WB units for cholecystectomy. For PRBC, 82 units were issued for orthopaedic surgeries compared to 50 Units for cholecystectomy, making orthopaedic surgery the highest in demand. The least WB unit requirement was observed in Ca prostate (10), Ca breast (16), appendectomy (16) with (4) WB units issued for Ca prostate, (6) WB units for Ca breast and (5) WB units for appendectomy. Regarding PRBC units, the lowest requirement was for appendectomy (4) and hydatid cyst (8), resulting in minimal issuance for these surgeries (1) for appendectomy and (2) for hydatid cyst (Table 6).

For emergency procedures

The highest demand for whole blood (WB) and packed red blood cells (PRBC) was observed in orthopaedic surgeries, requiring 329 WB units and 239 PRBC units. SDH surgery followed with requests for 180 WB units and 128 PRBC units. Out of these, 288 WB units and 141 PRBC units were crossmatched for orthopaedic fractures, while SDH surgery required crossmatching of 174 WB units and 57 PRBC units. Subsequently, 283 WB units were issued for Orthopaedic fractures, alongside 143 WB units for SDH surgery. For PRBC, 120 units were issued for orthopaedic surgery compared to 62 units for SDH surgery, making orthopaedic surgery the highest in demand. The least WB unit requirement was observed in intussusception (2), cholecystectomy (14), and herniorrhaphy (20), with (5) units issued for cholecystectomy, (1) for herniorrhaphy, and none for intussusception. However, fewer WB Units were issued for EDH surgery (5) despite a requirement of (22) units, with (14) units crossmatched. Regarding PRBC units, the lowest requirement was for intussusception (6) and herniorrhaphy (12), resulting in minimal issuance for these surgeries (4 for Intussusception and none for herniorrhaphy) (Table 7).

Table 6: Blood transfusion status for elective procedures in IGMC from 29 January 2024 to 29 February 2024.

Variables	Units of Whole blood			Units of PRBC		
	Req	CM	Issued	Req	CM	Issued
Cholecystectomy	394	210	200	394	200	50
Herniorrhaphy	30	21	10	14	13	2
Appendectomy	16	8	5	4	2	1
Hydatid cyst	20	10	6	8	4	2
Ca prostate	10	9	4	11	9	6
Ca breast	16	12	6	10	8	4
Ca colon	100	78	54	80	42	26
Burns	30	16	6	26	8	4
Orthopedics	392	322	210	182	114	82
TURP	13	11	7	30	17	6
CTVS-PVD	20	10	2	34	26	8
CTVS-TTVR	50	32	29	22	20	17
CTVS-ASD RHD	112	88	80	68	64	62

req (requirement), CM (cross match), Ca (cancer), TURP (trans urethral resection of prostate), CTVS (cardio thoracic vascular surgery), TTVR (transcatheter tricuspid valve replacement), ASD (atrial septal defect), RHD (rhematic heart disease).

Table 7: Blood transfusion status for emergency procedures in IGMC from 29 January 2024 to 29 February 2024.

Variables	Units of whole blood			Units of PRBC		
	Req	CM	Issue	Req	CM	Issue
Cholecystectomy	14	7	5	14	7	5
Herniorrhaphy	20	8	1	12	4	0
Appendectomy	102	88	44	64	24	16
Peritonitis	33	20	10	15	12	10
Intestinal obstruction	42	30	20	15	8	10
Intussusception	2	2	0	6	4	4
Road side accident	80	56	44	20	19	7
Orthopaedic surgery	329	288	283	239	141	120
Extra dural hemorrhage (EDH)	22	14	5	26	22	18
Sub dural hemorrhage (SDH)	180	174	143	128	57	62
Sub arachnoid hemorrhage (SAH)	98	88	56	54	30	30

Req (requirement), CM (cross match).

DISCUSSION

Blood and its derivatives play a crucial role in patient treatment, yet their availability is restricted, and they pose risks of infections and adverse reactions. The utilization patterns and transfusion practices vary across different medical centers and countries. A study by Dr. Sulagna Das at Burdwan Medical College and Hospital in West Bengal revealed that the majority of transfusions consisted of packed red blood cells (PRBC), followed by fresh frozen plasma (FFP).[9] Since the 1970s, when Friedman et al. first reported the issue of over-ordering blood preoperatively, several studies worldwide have highlighted inefficiencies in blood utilization. Preoperative blood requests for surgical patients for perioperative resuscitation are common.[13]

However, there is a tendency to overestimate the blood requirement, leading to underutilization of crossmatched blood.

Since the 1970s, different measures have been created to evaluate the effectiveness of blood usage. Boral and Henry pioneered the use of the crossmatch to transfusion (C/T) ratio in 1975. They considered blood usage appropriate if the ratio was 2.5:1 or lower, with 1.0 being the ideal ratio (indicating that all crossmatched blood is transfused). Our study revealed an overall C/T ratio of 1.2, indicating significant blood utilization. Studies conducted globally have shown inappropriate blood usage (C/T ratio >2.5) in countries such as Malaysia, Egypt, Tanzania, and Zambia, with C/T ratios of 5.0, 3.9, 3.7, and 2.8, respectively. However, relatively better usage was observed in Ethiopia and Nepal, with C/T ratios of 2.3 and 2.5, respectively. The C/T ratio results varied among different departments and units, with the highest ratio observed in CTVS-PVD (3.6) and the lowest in CTVS-ASD RHD (1.07). These discrepancies in ratios across various surgical procedures stem from a tendency to overorder blood for specific surgeries and the absence of clear guidelines on maximal blood ordering schedules.

In the 1980s, Mead et al proposed a new metric called transfusion probability (TP) to further assess the effectiveness of blood transfusion.[14] The TP for a specific procedure was determined by dividing the number of patients who received a transfusion by the number of patients who were crossmatched, then multiplying by100. They recommended that a TP of 30% or higher indicates appropriate blood requisition and utilization. Our study found an overall TP of 80.6%, with TP ranging from 27.7% in CTVS-PVD to 93.4% in CTVS-ASD RHD.

A third measure used to evaluate the efficiency of blood utilization is the Transfusion Index (TI), which gauges the appropriateness of the number of units crossmatched. It represents the average number of units utilized per patient crossmatched. An index value of 0.5 or higher indicates effective blood utilization. Our study revealed an overall TI of 0.8, indicating substantial blood usage.

Limitation of the study

Our study being retrospective has few limiting factors. First of all, our sample size is small as data was collected in a time restricted manner. Secondly, due to scarcity of resources at our end we could only collect blood utilization data from selected departments

CONCLUSION

To conclude, the blood utilization practice for both emergency and elective procedures appear efficient, with a crossmatch to transfusion ratio (C/T ratio) of 1.2, transfusion probability (TP) at 80.6%, and transfusion index (TI) of 0.8. It is of foremost importance to form a blood transfusion committee in all Tertiary care Institutes which will in turn enforce Maximal Blood Ordering Schedule and conduct regular surveys. These surveys with detailed feedback play a pivotal role in ensuring efficient blood utilization in tertiary care institutes.

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