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Infectious nature of packed red blood cells from the perspective of pathology, medical laboratory technology and haematology - An original research

(Naturaleza infecciosa de los concentrados de hematíes desde la perspectiva de la patología, la tecnología de laboratorio clínico y la hematología: una investigación original)

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Abstract(english)

Transfusion of packed red blood cells remains a mainstay and integral part in patient management. The blood is a limited and precious resource and the attempts to come up with alternate to blood have not yielded any satisfactory results, the judicious and appropriate use of blood and its component become very important. This was a prospective study conducted in Blood bank, Department of pathology at Mahatma Gandhi Medical College and Research Institute carried out after approval of institutional ethics committee for a period of one year (May 2020- May2021). 600 patients were included in the study. All the requests form for packed red blood cells referred to blood bank more than 18 years of age from all the clinical departments included in the study. Overall, 1487 Packed red blood cell units were requested and cross-matched, 939 PRBC units were utilized by 600 patients during the study period. The maximum number of units 52.6% were utilized by female patients 53.6% and 47.3% requests from 46.3% males. We analyzed appropriate utilization of PRBC using quality indicators. In which overall, CT ratio is 1.5, TI is 1.3, TP is 84%, thereby indicating appropriate usage of packed red blood cell unit in our study. However, considering individual specialty department showed excess ordering and cross-matching of blood. NUP was observed to be 36.8%, resulting in excessive crossmatching of red cell units and non-utilization.

Keywords(english)

Pathology, laboratory, packed red blood cells, morbidity, transfusion

Resumen(español)

La transfusión de concentrados de hematíes sigue siendo un pilar fundamental en el tratamiento de los pacientes. La sangre es un recurso limitado y valioso, y los intentos por encontrar alternativas no han dado resultados satisfactorios, por lo que su uso racional

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y adecuado, así como el de sus componentes, adquiere gran importancia. Se realizó un estudio prospectivo en el Banco de Sangre del Departamento de Patología del Instituto de Investigación y Facultad de Medicina Mahatma Gandhi, tras la aprobación del comité de ética institucional, durante un año (mayo de 2020 - mayo de 2021). Se incluyeron 600 pacientes. Se analizaron todas las solicitudes de concentrados de hematíes remitidas al Banco de Sangre por pacientes mayores de 18 años de todos los departamentos clínicos participantes. En total, se solicitaron y realizaron pruebas de compatibilidad cruzada a 1487 unidades de concentrados de hematíes; 939 unidades fueron utilizadas por 600 pacientes durante el periodo de estudio. El 52,6% de las unidades fueron utilizadas por pacientes femeninas (53,6%) y el 47,3% por pacientes masculinos (46,3%). Analizamos la utilización adecuada de concentrados de hematíes mediante indicadores de calidad. En general, el índice CT fue de 1,5, el índice TI de 1,3 y el TP del 84%, lo que indica un uso adecuado de las unidades de concentrado de hematíes en nuestro estudio. Sin embargo, al analizar cada departamento de especialidad, se observó un exceso de solicitudes y pruebas de compatibilidad sanguínea. El NUP fue del 36,8%, lo que resultó en un exceso de pruebas de compatibilidad y subutilización de unidades de hematíes.

Palabras clave(español)

Patología, laboratorio, concentrado de hematíes, morbilidad, transfusión.

Introduction

Transfusion of packed red blood cells remains a mainstay and integral part in patient management. The blood is a limited and precious resource and the attempts to come up with alternate to blood have not yielded any satisfactory results, the judicious and appropriate use of blood and its component become very important (1). Audit of blood components usage of packed red blood cells are essential to assess the blood utilization pattern in any hospital or health setup. Owing to growth in demand for blood and blood products, as well as increased transfusion-related costs and morbidity it is essential to analyze the appropriateness of blood ordering practices. Due to declining donation rate and an increase in the consumption of blood components require a novel approach to access the blood utilization. Previous studies did not use quality indicators for utilization of PRBC. The practice of over-ordering of blood for elective and emergency surgical procedures often ends with wastage. Transfusion is considered appropriate when it is used to treat conditions leading to significant morbidity and mortality and which cannot be prevented or managed effectively by other means. Physicians most commonly use hemoglobin concentration level as a benchmark to decide when to transfuse. However, most guidelines emphasize that transfusion should be given for symptoms of anemia and should not be based on hemoglobin concentration alone. Therefore, inappropriate use of transfusion adds additional cost to the treatment of disease (2). An evaluation of transfusion patterns in a hospital setting can aid in identifying key areas where policy improvements are required and developing initiatives for clinician education

This study analyzes the pattern of utilization of packed red blood cells and determine the most common clinical indication for transfusion and assessing the appropriate utilization of PRBC by crossmatch transfusion ratio, transfusion index, transfusion probability and non-usage probability. The present study is intended to provide improved opportunities and to find strategies for such improvements in PRBC transfusion.

Materials and methods

Subjects and methods. This was a prospective study conducted in Blood bank, Department of pathology at Mahatma Gandhi Medical College and Research Institute carried out after approval of institutional ethics committee for a period of one year (May 2020- May2021). 600 patients were included in the study. All the requests form for packed red blood cells referred to blood bank more than 18 years of age from all the clinical departments included in the study.

Source of data was blood bank requisition forms and blood bank registers of patients who underwent packed red blood cell transfusion in the hospital, for which blood was ordered. All data regarding demographic details of the patient, number of units requested, specialty in which the patient was admitted, blood group of the patient, type of request (Routine or emergency) and hemoglobin levels was obtained. The number of units cross-matched and the subsequent number of units utilized for transfusion were noted. Appropriate Utilization of PRBC was assessed by calculating Crossmatch: transfusion ratio, Transfusion index, Transfusion probability and non-usage probability calculation and the values are entered. For our audit, all the collected data were evaluated as a whole and then divided into two

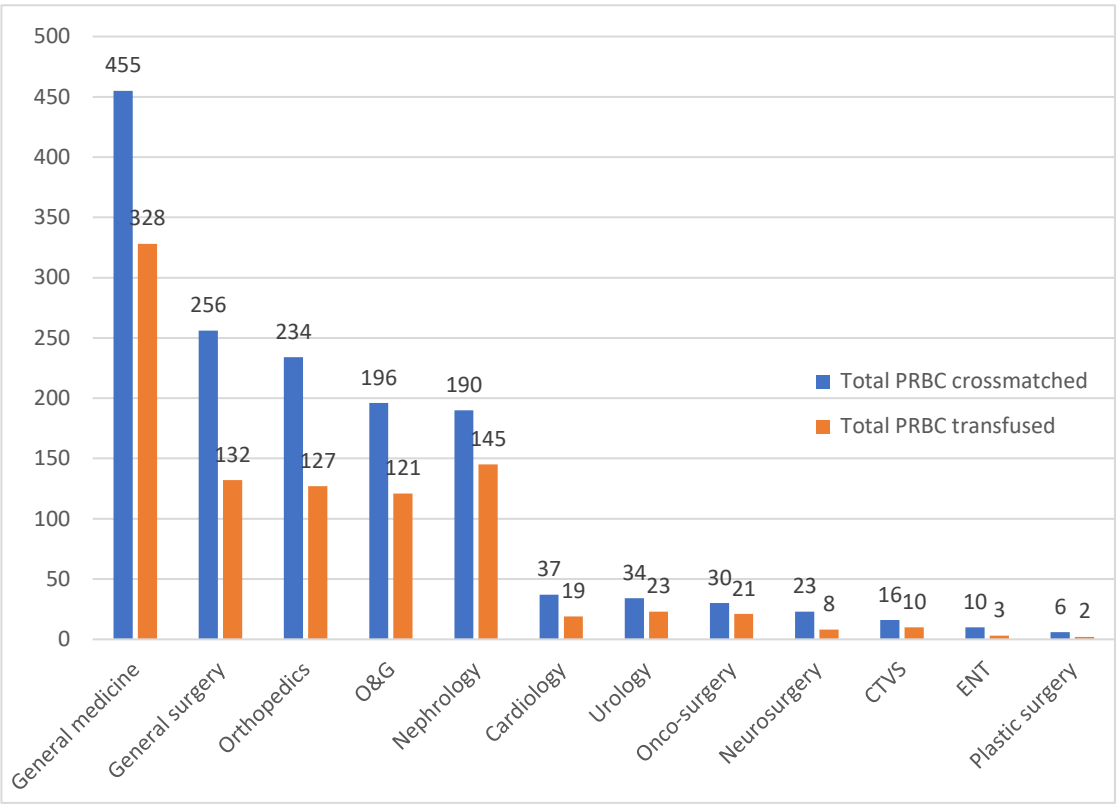


Figure. 1 Overall department wise distribution of PRBC utilization

categories as medical and surgical divisions. Medical division comprise of general medicine, cardiology, nephrology. Surgical division comprise of general surgery, orthopedics, O&G, CTVS, urology, onco-surgery, neuro-surgery, ENT, plastic surgery.

Statistical analysis. Was carried out using Microsoft Excel, the numerical variables were expressed in terms of percentage, frequency and ratios. The appropriate utilization of PRBC were assessed by using formula as follows: **1.** Crossmatch to transfusion ratio (C/T ratio) = number of units crossmatched/number of units transfused. A ratio of 2.0 and below is considered indicative of significant/efficient blood usage(3). **2.** Transfusion index (TI)= No of units transfused/ No of patient cross-matched. A value of 0.5 or more will be considered indicative of significant blood utilization(4). **3.** Transfusion probability % (TP)= No of patients transfused/ No of patients crossmatched x 100. A value of 30% and above will be considered indicative of significant blood usage (4). **4.** Non-usage probability % (NUP) = total number of units requested(cross-matched) but not used × 100/total number of units requested(cross-matched). The value >50% indicates significant wastage due to over cross-matching of blood units and not transfused (5)

Results

Overall, 1487 Packed red blood cell units were requested and cross-matched, 939 PRBC units were utilized by 600 patients during the study period. The maximum number of units 52.6% were utilized by female patients 53.6% and 47.3% requests from 46.3% males.

The Majority of the red cell units utilized, 52.4% were from the medical department and 47.6% were from the surgical department. In the medical division, the maximum utilization was from general medicine and nephrology accounted for 34.9%, 15.4% respectively. In the surgical division, the maximum utilization was from general surgery14.0% and orthopedics 13.5% as shown in figure 1.

The most common indication for transfusion were due to anemia 72% as followed by postoperative blood loss 19.1% as shown in figure 2.

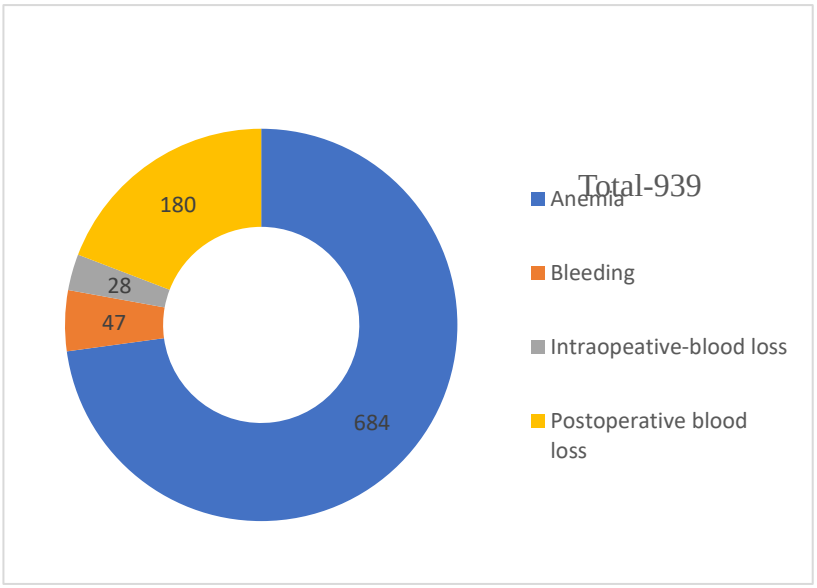


Figure. 2 Indication for transfusion

1487 red cell units cross matched 939 red cell units were transfused for 600 patient Overall CT ratio was 1.5 during the study period. The surgical division had a maximum CT ratio 1.8 and the minimum by medical division with a CT ratio of 1.3. In surgical division maximum CT ratio from ENT 3.3 followed by plastic surgery 3.0 and neuro-surgery 2.8. Blood was crossmatched for 712 patients and 600 patients utilized 939 red blood cell units. Overall TI was 1.3. The medical division has a TI 1.5 and a surgical division with a TI of 1.1. In surgical division, the least transfusion index was from ENT 0.4 and neuro-surgery 0.4. Overall transfusion probability was 84.2%. The medical division has a transfusion probability of 87.3% and the surgical division with 81.6%. In surgery division maximum highest transfusion probability was orthopedics 90.5% followed by O&G 89.6% and the least transfusion probability was plastic surgery (25%). NUP% maximum in surgical division 44% followed by medical division 27%. In surgical division the larger proportion of units cross-matched and unutilized in the department of ENT (70.1%) followed by plastic surgery (66.6%) shown in table 2.

A total of 1487 red cell units were subjected to cross-matching in our study. Out of 1487 red cell units, 939 (63.1%) red cell units were transfused. 548 (36.8%) units were unutilized. Among those, maximum number of the patients (83.0%) did not require transfusion followed by units returned with 2 hours to blood bank (8.5%) mainly due to adverse transfusion reaction as shown in table 2.

Discussion

It is important to study the pattern of utilization of packed red blood cells in the hospital. Such studies help to find out the trend of usage which helps in reducing the wastage of blood thereby decreasing the cost of treatment to the patients and aids in the improvement of transfusion practice for the future. One important tool for the improvement of blood transfusion practice is an audit of blood requisition forms and blood component utilization (6).

The maximum number of units 494 (52.6%) were utilized by female patients 322 (53.6%) and 445 (47.3%) requests from 278 (46.3%) males. 61.7% of red cell unit were given to the patients for hemoglobin level of 3-7g/dl. The rest 38.3% were to hemoglobin level more than 7g/dl. 72% of the red cell unit were utilized for anemia as an indication. Only 5% of red blood cells were utilized for bleeding in our study due to nutritional anemia and anemia of chronic disease which was low when compared to Gaur DS et al (7) showed anaemia 41.1% followed by 13% bleeding as the patient's requiring blood was due to trauma including fractures, head injuries. Intraoperative 2.9% and post-operative 19.1% which was low than that reported from

Table. 1. Overall CT, TI, TP, NUP in department wise .

S.no	Department	Crossmatch to transfusion ratio (CT)	Transfusion index (TI)	Transfusion probability (TP%)	Nonusage probability (NUP%)
1	General medicine	1.3	1.5	91.5%	27.9%
2	Cardiology	1.9	0.9	45.0%	48.6%
3	Nephrology	1.3	1.5	87.0%	23.6%
4	General surgery	1.9	1.2	88.7%	48.4%
5	Orthopedics	1.8	1.4	90.5%	45.7%
6	O&G	1.6	1.1	89.6%	38.2%
7	CTVS	1.6	0.7	78.5%	37.5%
8	Urology	1.4	1.1	65.0%	32.2%
9	Onco-surgery	1.4	0.8	86.6%	30.0%
10	Neuro-surgery	2.8	0.4	42.1%	65.2%
11	ENT	3.3	0.4	42.8%	70.0%
12	Plastic surgery	3.0	0.5	25.0%	66.6%
	Average	1.5	1.3	79%	36.8%

O&G – obstetrics and gynaecology, CTVS- cardiothoracic and vascular surgery, ENT- ear , nose, throat.

Chandrasekar, et al (8) showed intraoperative red cell utilization 19.3% and postoperative utilization 29.3% which is higher due to more elective and emergency surgeries.

The crossmatch to transfusion ratio is an important quality indicator that is used to provide the appropriate use of services offered by the transfusion laboratory service. C/T ratio of less than 2.0 is favorable, and value above 2.0 denotes over-ordering and cross-matching of blood. Overall CT ratio was 1.5 during the study period signifies appropriate utilization. Some studies showed a higher CT ratio compared to our study conducted by Obi, et al(9) with an overall CT ratio of 8.4 maximum CT ratio in ENT, Zewdie et al(10) 7.6. This is due to variable blood stores and varying transfusion regulations at different hospitals could explain the observed variations. Furthermore, blood transfusion indications differ based on the clinical status of patients and their treating doctors. But in our study showed maximum CT ratio from the surgical division was from Ent surgery 3.3 followed by plastic surgery 3, neurosurgery 2.8 signifies over-ordering of PRBC. This over ordering of blood might due to subjective over blood loss estimation of a procedure by surgeons. When deciding on a transfusion, it is necessary to review whether the patient needs a transfusion and how many units of blood should be transfused to the patient.

Transfusion index (TI) signifies the appropriateness of number of units crossmatched. A value of 0.5 or more is indicative of efficient blood usage. Overall TI was 1.3 during the study period signifies appropriate utilization similar results were reported by studies conducted by Mangwana S, et al (11) showed overall TI was 1.2, Kaur et al (12) 1.8, Banerjee, et al(13) 1. Plastic surgery TI was 0.5 which is lower due to less utilization of blood compared to study by SZ Ibrahim et al (14)showed TI 1.8 in plastic surgery. neuro-surgery TI 0.4 results were compared with study conducted by Obi, et al (9) TI 0.1 Overall, TI index in our study shows efficient blood usage even though few departments show low TI due to over requesting of blood, it should be minimized and Pattern of blood requesting should be revised with the help of maximum

Table. 2. Distribution of unutilized PRBC.

Department	Total PRBCs allotted (Cross matched)	Total PRBCs utilized (Transfused)	Units unutilized and reason for non-utilization				Total units not utilized
			Transfusion not required	Surgical procedure postponed	Patient expired	Issued but returned within 2 hours	
General medicine	455	328	111	0	6	10	127 (27.3%)
General surgery	256	132	104	7	2	11	124 (22.6%)
Orthopedics	234	127	94	4	1	8	107 (19.5%)
O&G	196	121	60	10	1	4	75 (13.6%)
Nephrology	190	145	40	0	1	4	45 (8.2%)
Cardiology	37	19	15	0	1	2	18 (3.2%)
CTVS	16	10	5	0	0	1	6 (1.0%)
Urology	34	23	9	1	0	1	11 (2.0%)
Once-surgery	30	21	3	4	1	1	9 (1.6%)
Neurosurgery	23	8	12	0	1	2	15 (2.7%)
ENT	10	3	5	1	0	1	7 (1.2%)
plastic surgery	6	2	2	0	0	2	4 (0.7%%)
Total	**1487**	**939**	**455**	**27**	**14**	**47**	**548**

surgical blood ordering schedules (MSBOS) for each procedure and clinical department.

The transfusion probability % which indicates efficient use of blood. Accordingly, a value of 30% and above has been suggested to be appropriate and signifies the appropriateness of number of units crossmatched. Overall transfusion probability was 84.2%. similar results were seen in studies conducted by Mangwana, et al (11)83.07%, Kaur et al(12) 79% indicates appropriate utilization. some studies showed low transfusion probability studies conducted by Obi, et al(9) T% 15.6, Zewdie et al(10) T% 24, AP Yazdi et al(15) 16.8% signifies inappropriate utilization that means there are over-ordering and a greater number of PRBCs is crossmatched for patients as compared to number of patient transfused without any absolute indication for transfusion.

Non-usage probability (NUP %) the value >50% indicates significant wastage due to over cross-matching of blood units and not transfused. In our study overall NUP was 36.8%, maximum in surgical department 44% followed by medical department 27%. The result correlated with study conducted by Banerjee et al(13) showed overall NUP 24%, maximum in surgery 37% signifies less wastage of red cell units. Study conducted by AU Musa et al(5)showed overall NUP 67%, maximum in obstetrics and gynecology signifies wastage of blood due to over-ordering of when compared to study. In our study most of the PRBC units unutilized as these patients 83.0% did not require transfusion, the results correlated with the study conducted by S Kumari et al(16) showed 93% did not require transfusion due to over ordering of blood by interns and junior consultant which were cancelled after reviewed by senior consultant this indirectly increased the workload on blood bank technician's as well as wastage of cross matching reagents with cost implication to both the patients as well as blood bank .

Limitation of the study:

The availability of data was restricted only to the blood bank forms. There is not much of literature specifically addressing the issue of supply, demand, and utilization. Hence comparisons are limited. Utilization of other blood component such as platelets, fresh frozen plasma, and cryoprecipitate was not included

In conclusion, we analyzed appropriate utilization of PRBC using quality indicators. In which overall, CT ratio is 1.5, TI is 1.3, TP is 84%, thereby indicating appropriate usage of packed red blood cell unit in our study. However, considering individual specialty department showed excess ordering and cross-matching of blood. NUP was observed to be 36.8%, resulting in excessive crossmatching of red cell units and non-utilization. These are recommendation to improve transfusion service by introduction of maximum surgical blood ordering schedule (MSBOS) of patients undergoing specific surgical procedures will help to improve the transfusion practice and appropriate usage of blood resources in the tertiary care hospital. Communication pathway between clinical and laboratory staff and at the clinical interface between surgeons and anesthetists will help in reducing excess ordering of blood. The hospital transfusion committee has established guidelines, continuously monitors and evaluates clinical practice is necessary for improvement of transfusion practices.

Conflict of interest

None to declare.

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References

1. Joshi AR, Ajmera RJ, Kulkarni AS, Bindu RS, Kulkarni SS. Observational study in utilization of blood and blood products at tertiary care centre. IJHSR. 2014;4: 38–47.
2. Carson JL, Grossman BJ, Kleinman S, Tinmouth AT, Marques MB, Fung MK, Holcomb JB, Illoh O, Kaplan LJ, Katz LM, Rao SV, Roback JD, Shander A, Tobian AA, Weinstein R, Swinton McLaughlin LG, Djulbegovic B; Clinical Transfusion Medicine Committee of the AABB. Red Blood Cell Transfusion: A Clinical Practice Guideline From the AABB*. Ann Intern Med. 2012; 157: 49–58. [PubMed] [Google Scholar]
3. Trisal M, Rana S, Khetrapal S, Jetley S, Mohroo RN, Jairajpuri Z. Blood Utilisation Practices and Quality Indicators at a Tertiary Care Hospital in South Delhi-A Retrospective Study. 2020. [Google Scholar]
4. Belayneh T, Messele G, Abdissa Z, Tegene B. Blood requisition and utilization practice in surgical patients at university of gondar hospital, northwest ethiopia. J Blood Transfus. 2013;2013:758910. [PubMed] [Google Scholar]
5. Musa AU, Ndakotsu MA, Hassan AA, Kilishi A, Kwaifa IK. Pattern of blood transfusion request and utilization at a Nigerian University Teaching Hospital. Sahel Med J. 2014; 17: 19. [Google Scholar]
6. Gombotz H, Rehak PH, Shander A, Hofmann A. Blood use in elective surgery: the Austrian benchmark study. Transfusion. 2007; 47: 1468-80. [PubMed] [Google Scholar]
7. Gaur DS, Negi G, Chauhan N, Kusum A, Khan S, Pathak VP. Utilization of blood and components in a tertiary care hospital. Indian J Hematol Blood Transfus. 2009; 25: 91-5. [PubMed] [Google Scholar]
8. Chandrasekar M, Balakrishnan V, Ponnaiyan A, Ramachandran T. Audit of clinical use of blood products in a tertiary care hospital. J Hematol Allied Sci. 2021; 1: 22–7. [Google Scholar]
9. Obi EI, Pughikumo OC, Korubo KI, Ejele AO. Prevalence of clinically significant antibodies in patients undergoing elective surgery in a Nigerian teaching hospital: A case for the type and screen method. Niger J Clin Pract. 2020; 23: 138-46. [PubMed] [Google Scholar]
10. Zewdie K, Genetu A, Mekonnen Y, Worku T, Sahlu A, Gulilalt D. Efficiency of blood utilization in elective surgical patients. BMC Health Serv Res. 2019; 19: 804.. [PubMed] [Google Scholar]
11. Mangwana S, Bedi N, Yadav P, Chugh R. Optimization of blood transfusion services: Analysis of blood requisition and utilization practices in cardiac surgical patients in a tertiary care hospital, India. Glob J Transfus Med. 2017; 2: 47. [Google Scholar]
12. Kaur D, Kandwal M. Blood utilization and quality indicators–Trend at a superspeciality hospital in Northern India. Hematol Transfus Int J. 2016; 2: 00037. [Google Scholar]
13. Banerjee S, Puttaiah P, Subramanian S. Revisit of efficiency of blood usage–Need for continuous audit. Glob J Transfus Med. 2019; 4: 52. [Google Scholar]
14. Ibrahim SZ, Mamdouh HM, Ramadan AM. Blood utilization for elective surgeries at main University Hospital in Alexandria, Egypt. J Am Sci. 2011; 7: 683-9. [Google Scholar]
15. Yazdi AP, Alipour M, Jahanbakhsh SS, Gharavifard M, Gilani MT. A Survey of Blood Request Versus Blood Utilization at a University Hospital in Iran. Arch Bone Jt Surg. 2016; 4: 75-9. [PubMed] [Google Scholar]
16. Kumari S. Blood transfusion practices in a tertiary care center in Northern India. J Lab Physicians. 2017; 9: 71-5. [PubMed] [Google Scholar]

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