Original Article

Preoperative predictors of blood component transfusion in living donor liver transplantation

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Abstract

Context: Extensive bleeding associated with liver transplantation is a major challenge faced by transplant surgeons, worldwide. **Aims:** To evaluate the blood component consumption and determine preoperative factors that predict the same in living donor liver transplantation (LDLT). **Settings and Design:** This prospective study was performed for a 1 year period, from March 2010 to February 2011. **Materials and Methods:** Intra- and postoperative utilization of blood components in 152 patients undergoing LDLT was evaluated and preoperative patient parameters like age, gender, height, weight, disease etiology, hemoglobin (Hb), hematocrit (Hct), platelet count (Plt), total leukocyte count (TLC), activated partial thromboplastin time (aPTT), international normalized ratio (INR), serum bilirubin (T. bilirubin), total proteins (T. proteins), albumin to globulin ratio (A/G ratio), serum creatinine (S. creatinine), blood urea (B. urea), and serum electrolytes were assessed to determine their predictive values. Univariate and stepwise discriminant analysis identified those factors, which could predict the consumption of each blood component. **Results:** The average utilization of packed red cells (PRCs), cryoprecipitates (cryo), apheresis platelets, and fresh frozen plasma was 8.48 units, 2.19 units, 0.93 units, and 2,025 ml, respectively. Disease etiology and blood component consumption were significantly correlated. Separate prediction models which could predict consumption of each blood component in intra and postoperative phase of LDLT were derived from among the preoperative Hb, Hct, model for end-stage liver disease (MELD) score, body surface area (BSA), Plt, T. proteins, S. creatinine, B. urea, INR, and serum sodium and chloride. **Conclusions:** Preoperative variables can effectively predict the blood component requirements during liver transplantation, thereby allowing blood transfusion services in being better prepared for surgical procedure.

Keywords: Liver transplant, predictors, preoperative, transfusion

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Introduction

Ever since, the first successful liver transplant that was performed in 1967, it has evolved to become a well-established treatment modality for patients with end stage liver disease (ESLD).[1] Extensive bleeding associated with liver transplantation[2] is still a major challenge faced by transplant surgeons worldwide. Although, the dependency of liver transplant programmes on blood components has decreased appreciably over time, due to technical improvements,[3,4] better patient monitoring, better graft allocation, and use of blood sparing strategies; excessive blood loss can still occur.[5] As such, blood transfusion services remain an essential part of liver transplantation programmes, providing both quantitative and qualitative support.[1]

Even though, enforcement of stricter eligibility norms for blood donation and regulation of blood screening and processing methodologies has led to an enhanced safety, there has been a resultant decrease in the effective donor pool and hence blood supply. Therefore, several attempts have been made to find the potential predictors of blood transfusion requirements for various surgical procedures which may often be associated with extensive blood component transfusions like liver transplant surgeries. The ability to predict the same will help blood transfusion services in improving preparedness and will also help to improve postoperative outcomes, decrease wastage of limited resources, and prevent the artificial shortage of this scarce resource due to excessive cross matching.[6]

This study is an attempt to estimate our use of blood components and to determine preoperative factors that can help to predict blood component consumption in patients undergoing a living donor liver transplant (LDLT).

Materials and Methods

This prospective study on LDLT surgery cases was performed at the Department of Transfusion Medicine and Department of Surgical Gastroenterology and Liver Transplant, for a 1 year period starting from March 2010 to February 2011, after the approval of the hospital's ethical committee.

Relevant data was obtained from patient's case files including recipient's age, gender, height,

weight, history of previous abdominal surgery (PAS), preoperative diagnosis, and history of dialysis in the week prior to surgery. Height and weight of recipient were used to calculate body surface area (BSA) using Mosteller formula, that is, BSA (m^2) = [{Height (cm) × Weight (kg)}/3600]^{½}.[7] Laboratory values of the tests carried out 1 day prior to the day of transplantation, including hemoglobin (Hb), hematocrit (Hct), platelet count (Plt), total leukocyte count (TLC), activated partial thromboplastin time (aPTT), international normalized ratio (INR), total serum bilirubin (T. bilirubin), total proteins (T. proteins), albumin to globulin ratio (A/G ratio), serum creatinine (S. creatinine), blood urea (B. urea), serum sodium (Na^+), serum potassium (K^+), and serum chloride (Cl^-) were documented. The blood component usage, including packed red cells (PRCs), cryoprecipitates (cryo), fresh frozen plasma (FFP), single donor apheresis fresh frozen plasma, and single donor apheresis platelets, during the intraoperative, as well as postoperative phase of every liver transplant surgery was obtained from blood bank records. Each patient was prospectively followed-up during their stay in the hospital and length of stay (LOS) in the hospital was calculated from the day of surgery.

The Maximum Surgical Blood Order Schedule (MSBOS) for a liver transplant surgery in our institute consists of 10 units of cross matched PRCs, 4 units of cryo, 10 units of FFP, 2 units of single donor apheresis plasma, and 2 units of apheresis platelets. All the blood components are kept ready, one day prior to surgery, and if any further blood components are required, a new form requesting the same is sent to the department. During a liver transplant, Thromboelastography (TEG®, Haemoscope Corporation, Niles, Illinois, USA) is used to guide intraoperative blood component transfusions. Tranexamic acid is used initially at time of induction of anesthesia (15 mg/kg) and is repeated whenever there is an evidence of excessive fibrinolysis.

For the ease of statistical analyses, number of units of FFPs and single donor plasma transfused to liver graft recipient were converted into plasma volume in milliliters (ml). To calculate the plasma volume, 1 unit of FFP was taken as equivalent to 200 ml, which is the average volume of a unit of FFP as per our quality control measurements. The single donor apheresis plasma is prepared on an automated cell separator (MCS+ 9000, Hemonetics, Braintree, Massachusetts, USA) and the final product quantity of each unit of plasma is approximately 600 ml.

Calculation of model for end-stage liver disease (MELD) score

Preoperative laboratory values of T. bilirubin, S. creatinine, INR, and history of dialysis in the week prior to surgery were used to calculate recipient's preoperative MELD score based on the following formula:[8]

$$\text{MELD Score} = 9.57 \times \log_e[\text{creatinine mg/dl}] + 3.78 \times \log_e[\text{bilirubin mg/dl}] + 11.20 \times \log_e[\text{INR}] + 0.643$$

Statistical analysis

Univariate statistical analysis was performed, using Pearson's correlation coefficients to determine significance of correlation of recipient's age, BSA, PAS, and preoperative laboratory parameters including Hb, Hct, Plt, TLC, aPTT, INR, T. bilirubin, T. proteins, A/G ratio, S. creatinine, B. urea, Na^+, K^+, Cl^-, and MELD score with intraoperative and postoperative consumption of units of PRCs, cryoprecipitates, apheresis platelets, and volume of FFP. Independent *t*-test and Mann-Whitney test were employed to determine significance of correlation between blood component use and recipient's gender. To analyze the significance of correlation between blood component use and etiology of liver disease, analysis of variance (ANOVA)/Kruskal-Wallis tests were used. In order to find the best model that would predict blood component transfusion requirements, a stepwise regression analysis was performed using all the predictors that were employed in univariate analysis. Multivariate logistic regression was performed to analyze the effect of MELD score and PRC use (intraoperative, postoperative, and total) on mortality during the hospital stay and a stepwise regression analysis was performed to analyze the effect of MELD score and number of units of intraoperative and postoperative PRCs transfused, on LOS in the hospital. All statistical analysis was performed with SPSS software version 15.0 (Chicago, Illinois, USA). Correlations were defined as significant at P-value < 0.05.

Results

Out of 152 patients in the study population, 125 (82.2%) were males and 27 (17.8%) were females. The age of patients included in the study ranged from 18 to 69 years, with a mean age of 48.5 years (standard deviation; SD = 9.54). Table 1 shows descriptive characteristics of various parameters assessed in the study.

The most common preoperative diagnosis in patients undergoing LDLT was chronic liver disease secondary to infection with hepatitis C virus (HCV) (n = 61, 40.13%) followed by alcohol related liver disease (n = 28, 18.42%), infection with hepatitis B virus (HBV) (n = 24, 15.8%), cryptogenic (n = 23, 15.13%), miscellaneous causes (n = 14, 9.21%), and co-infection with HCV and HBV (n = 2, 1.31%). The miscellaneous category comprised of one case each of extra hepatic biliary atresia (EHBA), Budd-Chiari syndrome, PTBD, antitubercular therapy (ATT) induced, primary

Table 1: Descriptive characteristics of various parameters evaluated

Parameter	Mean	SD	Median
Age (years)	48.55	9.54	49.00
BSA (m^2)	1.82	0.19	1.80
Hb (g/l)	93.3	19.5	91.0
Hct	0.28	0.06	0.27
Plt ($\times 10^9$/l)	78.72	49.18	66.00
TLC ($\times 10^9$/l)	5.33	3.38	4.25
aPTT (seconds)	48.32	1.38	43.30
INR	1.98	0.95	1.80
T. bilirubin (mmol/l)	121.01	175.94	51.30
T. protein (g/l)	65.31	8.55	66.00
S. albumin (g/l)	27.41	4.84	27.00
A/G	0.79	0.36	0.70
B. urea (mg/dl)	42.66	36.66	29.00
S. creatinine (mmol/l)	82.86	44.02	66.64
S. Na^+ (mmol/l)	136.03	5.40	136.00
S. K^+ (mmol/l)	4.02	0.58	3.90
S. Cl^- (mmol/l)	106.89	5.25	107.00
ALOS (days)	20.47	8.91	18.00
MELD score	19.70	8.19	18.00

SD = Standard deviation, BSA = body surface area, Hb = hemoglobin, Hct = hematocrit, Plt = platelet count, TLC = total leukocyte count, aPTT = activated partial thromboplastin time, INR = international normalized ratio, T. bilirubin = total serum bilirubin, T. proteins = total proteins, A/G ratio = albumin to globulin ratio, S. creatinine = serum creatinine, B. urea = blood urea, ALOS = average length of stay, MELD = model for end-stage liver disease

sclerosing cholangitis, and gallstone related cirrhosis; two cases each of Wilson's disease and autoimmune liver disease; and four cases of acute liver failure.

The average number of PRCs transfused per liver transplant was 8.48 units. Most of these were transfused during intraoperative phase (mean = 6.06 units) of liver transplantation, as compared to the postoperative phase (mean = 2.42 units) [Table 2]. In nine of our liver graft recipients, no PRC was transfused intraoperatively, while in five of these patients, no PRC was transfused at all during the hospital stay. On an average 2.2 units of cryoprecipitates were transfused per surgery. The average consumption of cryoprecipitates was 1.95 units intraoperatively and 0.26 units postoperatively [Table 2]. The average number of single donor apheresis platelets transfused per surgery was 0.9 units of which 0.49 units were used intraoperatively and 0.47 units postoperatively [Table 2]. The mean volume of plasma transfused per liver transplant was 2,025 ml. Most of the plasma was transfused during intraoperative phase (mean = 1,678 ml) of liver transplantation as compared to postoperative phase (mean = 354 ml) [Table 2].

In univariate analysis, the only nonsignificant factors ($P > 0.05$) were recipient's age, BSA, history of PAS, and serum electrolytes. All other variables showed significant correlation ($P < 0.05$) with intraoperative and/or postoperative transfusion of at least one or more blood components [Table 3]. Although, a statistically significant correlation could not be established between blood component use and recipient's gender ($P > 0.05$), significant correlations were observed between disease etiology and intraoperative transfusion of PRCs ($P = 0.014$), postoperative use of

Table 2: Blood component use in liver transplant

Blood Component	Mean	SD	Median	Minimum	Maximum
Intraoperative	6.06	3.70	6.00	0.00	18.00
PRC (units)	1.95	2.49	0.00	0.00	13.00
Cryo (units)	1677.63	793.70	1600.00	0.00	4400.00
FFP (ml)	0.49	0.70	0.00	0.00	3.00
Platelets (units)					
Postoperative	2.42	4.42	1.00	0.00	31.00
PRC (units)	0.26	1.67	0.00	0.00	16.00
Cryo (units)					
FFP (ml)	353.95	774.92	0.00	0.00	6000.00
Platelets (units)	0.47	1.17	0.00	0.00	6.00
Total	8.48	6.28	7.00	0.00	33.00
PRC (units)	2.19	3.00	0.00	0.00	16.00
Cryo (units)					
FFP (ml)	2025.00	1182.05	1900.00	0.00	8800.00
Platelets (units)	0.93	1.42	0.00	0.00	7.00

SD = Standard deviation, PRC = Packed red cells, Cryo = Cryoprecipitates, FFP = Fresh frozen plasma

Table 3: Univariate analysis of various parameters with blood component transfusion

Parameter	*P*-value							
	Intraperative				Postoperative			
	PRC (units)	Cryo (units)	FFP (ml)	Platelets (units)	PRC (units)	Cryo (units)	FFP (ml)	Platelets (units)
Age (years)	0.902	0.184	0.068	0.569	0.333	0.222	0.071	0.713
BSA (m^2)	0.179	0.465	0.520	0.650	0.229	0.484	0.378	0.877
PAS	0.587	0.120	0.074	0.516	0.262	0.358	0.204	0.963
Hb (g/l)	0.000	0.006	0.003	0.200	0.037	0.633	0.034	0.003
Hct	0.000	0.001	0.001	0.105	0.038	0.634	0.055	0.003
Plt ($\times 10^9$/l)	0.279	0.019	0.608	0.000	0.725	0.430	0.376	0.154
TLC ($\times 10^9$/l)	0.003	0.050	0.015	0.556	0.063	0.492	0.033	0.073
aPTT (s)	0.001	0.000	0.000	0.502	0.016	0.657	0.206	0.104
INR	0.042	0.000	0.000	0.891	0.028	0.190	0.002	0.391
T. bilirubin (mmol/l)	0.000	0.000	0.000	0.957	0.002	0.932	0.109	0.076
T. protein (g/l)	0.372	0.003	0.108	0.778	0.270	0.657	0.758	0.397
A/G Ratio	0.003	0.010	0.025	0.925	0.547	0.886	0.681	0.689
B. urea (mg/dl)	0.000	0.004	0.002	0.023	0.000	0.615	0.001	0.000
S. creatinine (mmol/l)	0.015	0.236	0.049	0.018	0.008	0.341	0.005	0.000
Na^+ (mmol/l)	0.655	0.263	0.695	0.080	0.768	0.266	0.828	0.549
K^+ (mmol/l)	0.356	0.725	0.658	0.064	0.514	0.814	0.533	0.353
Cl^- (mmol/l)	0.193	0.563	0.580	0.485	0.407	0.812	0.428	0.826
MELD	0.000	0.000	0.000	0.138	0.000	0.430	0.004	0.006

PRC = Packed red cells, Cryo = Cryoprecipitates, FFP = Fresh frozen plasma, BSA = Body surface area, Hb = Hemoglobin, Hct = Hematocrit, Plt = Platelet count, TLC = Total leukocyte count, aPTT = Activated partial thromboplastin time, INR = International normalized ratio, T. bilirubin = Total serum bilirubin, T. proteins = Total proteins, A/G ratio = Albumin to globulin ratio, S. creatinine = Serum creatinine, B. urea = Blood urea, PAS = Previous abdominal surgery, MELD = Model for end-stage liver disease

PRCs ($P = 0.027$), cryoprecipitates ($P = 0.029$), platelets ($P = 0.006$), and FFP ($P = 0.027$) as shown in Table 4. In general, alcoholic liver disease accounted for maximum consumption of most of blood components, sparing a few [Table 4].

As shown in Table 5, the stepwise discriminant analysis, identified those factors which could finally be used to predict the consumption of each blood component during the intraoperative and postoperative phase of liver transplantation and separate prediction models derived from different combinations out of these variables were constructed. The R^2 value for each model was determined. Even though the calculated R^2 values are low for prediction models, they are highly significant. It was also observed that predictability of preoperative factors, as depicted by the R^2 values, decreases in postoperative period, although, the relationship still remains significant. Since, cryoprecipitates are rarely transfused during postoperative period; a prediction model for the same could not be constructed.

A multivariate analysis revealed a significant statistical correlation of postoperative mortality with total units of PRCs transfused. We also evaluated that an increase in 1 unit of total PRCs transfused, led to an increase in probability of mortality by 17.2%. Stepwise discriminant analysis, demonstrated that LOS in hospital was significantly correlated to postoperative PRC consumption only and a model was constructed to predict LOS, as shown below:

Predicted LOS = 19.163 + 0.538 × number of units of postoperative

Table 4: Blood component use according to diagnosis

Blood Component	Diagnosis	Number	Mean	*P*-value
Intraoperative	HCV	61	5.29	0.014
PRC (units)	HBV	24	5.50	
	Alcoholic	28	7.61	
	Cryptogenic	23	7.43	
	Miscellaneous	14	5.00	
	Coinfection	02	6.00	
Cryo (units)	HCV	61	1.87	0.280
	HBV	24	1.96	
	Alcoholic	28	2.86	
	Cryptogenic	23	1.52	
	Miscellaneous	14	1.43	
	Coinfection	02	0.00	
FFP (ml)	HCV	61	1521.31	0.172
	HBV	24	1683.33	
	Alcoholic	28	1964.29	
	Cryptogenic	23	1713.04	
	Miscellaneous	14	1800.00	
	Coinfection	02	1100.00	
Platelets (units)	HCV	61	0.48	0.295
	HBV	24	0.54	
	Alcoholic	28	0.50	
	Cryptogenic	23	0.65	
	Miscellaneous	14	0.14	
	Coinfection	02	1.00	
Postoperative	HCV	61	1.41	0.027
PRC (units)	HBV	24	1.83	
	Alcoholic	28	4.36	
	Cryptogenic	23	3.69	
	Miscellaneous	14	2.21	
	Coinfection	02	0.00	
Cryo (units)	HCV	61	0.07	0.029
	HBV	24	0.00	
	Alcoholic	28	0.07	
	Cryptogenic	23	1.30	
	Miscellaneous	14	0.29	
	Coinfection	02	0.00	
FFP (ml)	HCV	61	180.33	0.027
	HBV	24	158.33	
	Alcoholic	28	628.57	
	Cryptogenic	23	573.91	
	Miscellaneous	14	557.14	
	Coinfection	02	200.00	
Platelets (units)	HCV	61	0.29	0.006
	HBV	24	0.17	
	Alcoholic	28	1.07	
	Cryptogenic	23	0.83	
	Miscellaneous	14	0.07	
	Coinfection	02	0.48	

PRC = Packed red cells, Cryo = Cryoprecipitates, FFP = Fresh frozen plasma, HCV= Hepatitis C virus, HBV = Hepatitis B virus

PRCs transfused However, this model could predict LOS in only 7.1% (R^2 = 7.1%) of the patients.

Discussion

Our hospital is a well-established and recognized organ transplant center, providing transplant services for patients from all across the country, as well from neighboring countries, and several other countries of the Asian and the African continent. Being one of the busiest liver transplant centers in Asia, our institute becomes a perfect place to conduct such a study. Also, to the best of our knowledge, no similar single center study has been conducted on liver transplant cases, at national level.

We observed that average utilization of PRCs was 8.48 units while that of cryoprecipitates was 2.19 units. On an average, 2,025 ml of plasma and 0.93 units of apheresis platelets were consumed in liver transplants [Table 2].

It has been reported that blood utilization during liver transplantation has significantly declined over time. The reported median utilization of PRCs was 10–12 units in the 1990s and a further reduction has been documented.[9] This has largely been achieved by improvements in surgical and anesthetic techniques, better graft preservation, and organ allocation.[10] In a study done by Frasco *et al*., the intraoperative blood component consumption in LDLT was relatively lower than ours with a mean consumption of 1, 0.8, 0.37, and 0.19 units for PRCs, FFP, platelets, and cryoprecipitates, respectively. This was probably because they were using the piggyback technique for surgery and intraoperative blood salvage.[11] Moreover, the mean MELD score in their patient population was lower (13.2, SD = 4.2) as compared to ours (19.7, SD = 8.19).

We also observed a significant correlation between etiology of liver disease and blood component consumption. Alcoholic liver disease accounted for maximum consumption of blood components, including PRCs in intraoperative (P = 0.014) and postoperative phase (P = 0.027), in addition to consumption of platelets (P = 0.006) and FFP (P = 0.027), postoperatively [Table 4]. This was probably because, among the various etiologies of liver disease, patients with alcohol related liver disease had a greater severity of liver dysfunction as shown by their mean preoperative MELD score (24.39, SD = 1.78), which was the highest. In the postoperative period, cryoprecipitates were transfused to only seven (0.05%) of the liver graft recipients, therefore, it would not be accurate to conclude that cryptogenic liver disease is associated with a higher consumption of cryoprecipitates [Table 4].

For the ease of explanation we have divided the predictive factors which were identified in the stepwise discriminant analysis under four categories, namely, general patient factors, hematological factors, biochemical factors, and the MELD score, as discussed below.

General patient factors

Out of the general patient factors, BSA showed a significant negative correlation with intraoperative utilization of PRCs [Table 5]. This may have been because patients with a more severe liver disease are generally malnourished and emaciated[12] and have a lower BSA. Since, ESLD is associated with excessive bleeding due to portal hypertension[13] and abnormalities of hemostatic system,[14,15] these may necessitate excessive transfusion of blood components. Moreover, chronic liver disease leads to certain hematologic manifestations like anemia[16] and thrombocytopenia.[13] Hence, patients with a more severe liver disease are likely to require more transfusions.

Table 5: Blood component prediction models

Predicted Blood Component	Predicting Factors	R^2 (%)	Prediction Model	*P*-value
Intraoperative	Hematocrit	37.1	17.032 - 030.2 × Hct +	0.000
PRC (units)	MELD score		0.131 × MELD - 2.837	
	BSA (m^2)		× BSA	
Cryo (units)	MELD score	29.7	0.620 + 0.148 × MELD -	0.000
	Plt (×10^9/l)		0.011 × Plt - 0.0486 × T.	
	T. protein (g/l)		Protein + 0.024 x Cl^-	
	Cl^- (mmol/l)			
FFP (ml)	MELD score	25.9	1561.461 + 43.904 ×	0.000
	Hb (g/l)		MELD - 8.0361 × Hb	
Platelets (units)	Plt (×10^9/l)	25.1	-2.566 - 0.0057 × Plt +	0.000
	Na^+ (mmol/l)		0.024 × Na^+ + 0.253 ×	
	S. creatinine (mmol/l)		(S. Creatinine/83.3)	
Postoperative	B. urea (mg/dl)	15.8	-7.264 + 0.032 × B. Urea	0.000
PRC (units)	Cl^- (mmol/l)		+ 0.058 × Cl^- + 0.114 ×	
	MELD score		MELD	
FFP (ml)	INR	18.4	-2117.841 + 205.246	0.000
	Cl^- (mmol/l)		× INR + 14.817 ×	
	S. creatinine (mmol/l)		Cl^- + 492.136 × (S.	
			Creatinine/83.3)	
Platelets (units)	B. urea (mg/dl)	16.3	-1.421 + 0.013 × B. Urea	0.000
	Cl^- (mmol/l)		+ 0.013 × Cl^-	

PRC = Packed red cells, Cryo = Cryoprecipitates, FFP = Fresh frozen plasma, BSA = Body surface area, Hb = Hemoglobin, Hct = Hematocrit, Plt = Platelet count, TLC = Total leukocyte count, aPT = activated partial thromboplastin time, INR = International normalized ratio, T. bilirubin = Total serum bilirubin, T. proteins = Total proteins, A/G ratio = Albumin to globulin ratio, S. creatinine = Serum creatinine, B. urea = Blood urea, MELD = Model for end-stage liver disease

Hematological factors

The various hematological factors identified as significant predictors of transfusion requirements were preoperative Hct, hemoglobin (Hb), Plt, and INR [Table 5]. Preoperative Hct negatively correlated with intaoperative requirement of PRCs, that is, patients with a lower Hct consumed more PRCs intraoperatively. This has also been reported in some other studies which observed that preoperative Hb and Hct significantly predicted the need for PRC transfusion in liver transplantation.[17,18]

We also observed a strong negative correlation between preoperative Hb levels and volume of FFP transfused intraoperatively, which may have been because the extent of anemia, probably represents generalized liver function abnormality. INR, which represents the patient's hemostatic status and also serves as a guide for transfusion of plasma[19] was found to be positively correlated with postoperative transfusion of FFP.

Biochemical factors

As seen in Table 5, among the various biochemical parameters evaluated, renal parameters demonstrated a statistically significant correlation with intraoperative and postoperative consumption of various blood components. Several independent studies in patients undergoing liver transplantation have also reported that renal function is an important predictor of intraoperative blood loss and transfusion requirements.[20-22]

ESLD is commonly accompanied by renal dysfunction and uremia. Uremia, in turn results in platelet dysfunction, abnormalities of hemostasis, and bleeding.[23,24] This, coupled with anemia associated with renal disease, secondary to decreased erythropoietin production could account for increased blood component consumption observed in our study.[25]

MELD score

The value of preoperative MELD score positively influenced consumption of various blood components, both intraoperatively and postoperatively [Table 5]. Various other studies have also found MELD score as an important determinant of blood component consumption during liver transplantation.[26-28] Since MELD score includes parameters like S. creatinine which is an indicator for the renal function, T. bilirubin that represents liver function, and INR which is a measure of hemostatic status, it can be considered as a marker of multisystem dysfunction and coagulopathy.[29]

Although, this is a comprehensive review of intraoperative and postoperative consumption of various blood components in liver transplantation procedures, our study has certain limitations. Firstly, it is a single center study. Therefore, our results cannot be generalized to other centers that follow different transfusion and technical protocols for liver transplantation procedures. Secondly, since we have included only LDLTs in our study, our findings may not be applicable to centers performing cadaveric donor liver transplants, as well. Thirdly, we did not analyze the role of intraoperative and technical factors which might have been the reason for low predictive value of our models as depicted by low R^2 values. However, the main purpose of our study was to improve our preparedness for such a major surgical procedure by being better able to predict blood component transfusion requirements before the start of a liver transplant. Therefore, we restricted our study to preoperative parameters only.

In conclusion, we have evaluated our blood component transfusion requirements during intraoperative and postoperative phases of liver transplantation. Our study has demonstrated that the etiology of liver disease, BSA, certain preoperative hematological factors, biochemical factors, and MELD score are significantly correlated with blood component requirements during liver transplantation. We have also been able to identify certain variables which may influence the patient mortality and LOS in hospital, which are considered to be important performance indicators for any liver transplant programme. With our results, we may also recommend that blood component arrangement forms sent to the blood bank for liver transplant surgeries must contain necessary information like preoperative laboratory parameters whenever available, which may help us in better streamlining of our resources in order to provide adequate and timely services during major procedures like liver transplant surgeries.

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