RESEARCH ARTICLE

Red blood cell and platelet transfusion support in the first 30 days after autologous stem cell transplantation: Real-world data

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Abstract

Objective: To assess data on transfusion requirements and burdens after autologous stem cell transplantation for haematological malignancy, and to investigate the impact of transfusion requirements and burdens on patient survival outcomes.

Method: The retrospective, single-centre study was conducted at Koç University Hospital, Istanbul, Turkiye, and comprised transfusion data of adult patients who underwent autologous stem cell transplantation for haematological malignancies between October 2016 and July 2023. The relationship of transfusion data with transplant and demographic characteristics of the patients was examined along with their impact on patient survival outcomes. Data was analysed using SPSS 21.

Results: Of the 331 patients, 176(53%) were male and 155(47%) were female. The median age of the cohort was 56 years (interquartile range: 46-64 years). Overall, 198(59.8%) patients required red blood cell transfusion support, and management of 328(99.1%) necessitated platelet transfusion support. Advanced age, female gender, low pre-transplant haemoglobin levels and a diagnosis of non-Hodgkin's lymphoma were significantly associated with increased red blood cell transfusion requirements ($p<0.05$). A diagnosis of non-Hodgkin's lymphoma and low pre-transplant platelet levels were significantly associated with platelet transfusion burden ($p<0.05$). A significant difference in overall survival was observed between red blood cell transfused and non-transfused patients ($p=0.031$). A high transfusion burden of platelets did not significantly impact overall survival ($p=0.109$).

Conclusion: In patients having undergone autologous stem cell transplantation, increased red blood cell transfusion requirement was associated with survival outcome.

Keywords: Autologous stem cell transplantation, Red blood cell transfusion, Platelet transfusion. (JPMA 76: 844; 2026)

DOI: https://doi.org/10.47391/JPMA.22336

Introduction

High-dose chemotherapy (HDC) followed by autologous stem cell transplantation (ASCT) is a well-established treatment approach for patients with relapsed/refractory non-Hodgkin's lymphoma (NHL) and Hodgkin's lymphoma (HL) disease.[1] ASCT has been shown to improve survival in patients with multiple myeloma (MM).[2] Most ASCT patients develop severe cytopenias as a consequence of HDC. Red blood cell (RBC) and platelet (PLT) transfusions are a critical part of supportive care during the pancytopenic period. The frequency and quantity of transfusions can be influenced by various factors, including the patient's age, gender, diagnosis, stem cell dose, and the conditioning regimens used.

While the thresholds for RBC transfusions can vary across institutions and countries, a general consensus exists to initiate transfusions when haemoglobin (Hb) levels fall below 7-8g/dL in clinically stable patients.[3]

PLT transfusions can be administered either as a prophylactic measure to prevent bleeding, or as a therapeutic option to control bleeding.[4] The prophylactic PLT transfusion threshold in current practice is $<10x10^9$/L in the absence of bleeding risk factors. This threshold is increased to $<20x10^9$/L if additional bleeding risk factors are present.[5] It has been suggested that ASCT patients have a lower bleeding risk compared to patients receiving intensive chemotherapy or allogeneic transplantation.[6] Despite this observation, prophylactic PLT transfusions remain a prevalent practice in many transplant centres.

The current study was planned to assess data on transfusion requirements and burdens after ASCT for haematological malignancy, and to investigate the impact of transfusion requirements and burdens on patient survival outcomes.

Materials and Methods

This retrospective, single-center study was conducted at Koç University Hospital, Istanbul, Turkiye, and comprised data of adult patients who underwent ASCT for haematological malignancies between October 2016 and July 2023. Approval was obtained from the institutional

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Submission completed: 22-11-2024 **1st Revision received:** 04-03-2025

Acceptance: 11-02-2026 **Last Revision received:** 10-02-2026

ethics review board which also granted a waiver of written informed consent owing to the retrospective design of the study.

Patients had received HDC based on their underlying primary disease. Antimicrobial prophylaxis and granulocyte colony stimulating factor (G-CSF) had been administered to all the patients. Peripheral blood stem cells were used as the graft source in all the patients. The day of graft infusion was defined as day 0. Neutrophil (NEU) and PLT engraftment was defined as two consecutive days with an absolute NEU count of $\geq 10^6$/L and PLT count of $\geq 10^9$/L without transfusion.

Patient demographic and transplant-related data was extracted from the institution's electronic medical database. Detailed information regarding RBC and PLT transfusions for each patient was obtained from the blood bank database. The total number of transfusion events, as well as the units of PLTs and RBCs transfused from day 0 to day 30 were recorded for each patient.

Transfusion decisions were based on the patient's morning complete blood count (CBC) results. RBC transfusions were administered when Hb levels were <8g/dL in clinically stable patients. However, transfusions were permitted for patients with cardiovascular diseases or symptoms of anaemia even when Hb levels exceeded 8g/dL. A single-unit RBC transfusion policy was implemented as the standard practice.

For ASCT patients, a prophylactic PLT transfusion strategy was employed. The PLT transfusion threshold was set at $<10\times10^9$/L for patients without bleeding risk factors. In the presence of risk factors, such as fever >38°C, severe mucositis, infection, uraemia, anticoagulation therapy, or coagulopathy, the PLT transfusion threshold was increased to 20×10^9/L. For patients undergoing invasive procedures or experiencing active bleeding, a higher threshold of $\geq30\times10^9$/L was considered.

Both pooled random donor (PRD) PLTs (4 pooled platelet concentrates) and single donor apheresis (SDA) PLTs were used without discrimination. It was established that an SDA unit of PLTs is equivalent to six PRD PLTs based on quality control data from the institution's blood bank. Both products were considered to have a comparable number of PLTs (at least 3x1011 platelets).[7] For statistical analysis, a therapeutic PLT unit was considered to have either an SDA unit or 1.5 units of PRD PLTs. All transfused RBC and PLT units were leucodepleted, and irradiated with 25Gy.

Data was analysed using SPSS 21. Categorical variables were presented as frequencies and percentages, and comparisons among different patient groups were performed using the chi-square or Fisher's exact test. Continuous variables were reported as medians with interquartile range (IQR: 25-75th percentile). Group comparisons for continuous variables were conducted using the Mann-Whitney U or Kruskal-Wallis tests. Spearman's rank correlation coefficient was used to evaluate relationships among continuous variables.

Patients were categorised based on transfusion burden, with those who received fewer than the median number of RBC and PLT transfusions being classified as having a low transfusion burden (LTB), and those who received the median or a greater number of transfusions being classified as having a high transfusion burden (HTB). Univariable and multivariable logistic regression analyses were performed to identify potential factors associated with RBC transfusion requirements and HTB for RBC and PLT transfusions. Variables having $p\leq0.15$ in the univariable logistic regression analysis were included in the multivariable logistic regression model.

Overall survival (OS) was defined as the time from transplantation to death or the last follow-up visit. The Kaplan-Meier method was used to estimate survival probabilities, and comparisons were made using the log-rank test. OS was analysed based on RBC and PLT transfusion requirements and burden. Two-sided $p<0.05$ was taken as statistically significant.

Results

There were 308 patients who underwent 331 ASCT procedures as 23 MM patients underwent a second ASCT procedure. Of the total cases, 176(53%) related to male patients and 155(47%) to female patients. The median age of the cohort was 56 years (IQR: 46-64 years), with 137(41.2%) being aged ≥60 years, and 194(58.8%) being <60 years.

The most common indication for ASCT was MM 144 (43.5%), followed by NHL 117(35.3%), HL 46(13.9%) and primary central nervous system lymphoma (PCNSL) 24(7.3%) (Table 1). Patients with HL were significantly younger than those with other diagnoses, having a median age of 32 years (IQR: 23-46 years) compared to a median age of 59 years (IQR: 51-64) for NHL patients ($p<0.001$).

The median number of infused cluster of differentiation-34 (CD34) (+) cells was 5.8×10^6/kg (IQR: 4.9-7.8). The infused CD34(+) cell dose was significantly higher in patients with PCNSL compared to other patients undergoing ASCT with median 8.1×10^6/kg (IQR: 6.0-16.9) compared to 5.7×10^6/kg (IQR: 4.8-7.5) ($p<0.001$). Conversely, patients with MM received a significantly lower infused stem cell dose compared to other ASCT patients with median 5.4×10^6/kg

(IQR: 4.6-6.7) compared to 6.5×10^6/kg (IQR: 5.0-9.6) ($p<0.001$).

The median time to engraftment was 10 days (IQR: 10-11) for NEU and 11 days (IQR: 10-14) for PLT. The median time to NEU engraftment was comparable across all patient groups ($p>0.5$). However, the median PLT engraftment time was significantly prolonged in patients with NHL compared to other ASCT recipients, with (median value being 13 days (IQR: 10-15) compared to 11 days (IQR: 10-13) ($p=0.009$). A weak but significant negative correlation was observed between the CD34(+) cell dose and the time to both NEU and PLT engraftment ($r=-0.376$, $p<0.001$, and $r=-0.266$, $p<0.001$, respectively).

Before the initiation of HDC, the median Hb, PLT and NEU counts were 10.7g/dL (IQR: 9.6-12.0), 205×10^9/L (IQR: 164-258) and 2.6×10^6/L (IQR: 1.9-3.6), respectively. Pre-transplant NEU counts were comparable across all patient groups ($p>0.05$). However, pre-transplant Hb levels were significantly higher in patients with MM compared to other ASCT patients, with median value being 11g/dL (IQR: 10-12.3) compared to 10.5g/dL (IQR: 9.3-11.9) ($p=0.003$). Pre-transplant platelet counts were significantly lower in patients with NHL compared to other ASCT recipients, with median value being 193×10^9/L (IQR: 139-238) compared to 215×10^9/L (IQR: 170-274) ($p=0.006$).

During the first 30 days following ASCT, 198(59.8%) cases required RBC transfusion support, while 328(99.1%) required PLT transfusion support. Only 2(0.6%) patients did not require either RBC or PLT transfusion support.

Among the 176 male cases, 86(48.9%) received RBC transfusions, whereas 112(72.3%) of the female cases required RBC transfusion support ($p<0.001$). No significant association was observed for RBC transfusion requirement with patient age ($p=0.067$) or the infused CD34(+) stem cell dose ($p=0.592$).

A significant association was identified between the underlying diagnosis and transfusion requirements. Specifically, the proportions of patients requiring RBC

Table-1: Demographic and transplant characteristics of the patients.

	All ASCT n=331 (100%) [n (%)]	**MM n=144** (43.5%) [n (%)]	**NHL n=117** (35.3%) [n (%)]	**HL n=46** (13.9%) [n (%)]	**PCNSL n=24** (7.3%) [n (%)]
Age at transplantation (years)					
Median (IQR)	56 (46-64)	61 (54-66)	57 (45-64)	32 (23-46)	55 (48-60)
<40	52 (15.7)	5 (1.5)	15 (4.5)	30 (9.1)	2 (0.6)
40-59	142 (42.9)	55 (16.6)	57 (17.2)	14 (4.2)	15 (4.6)
60-69	120 (36.2)	73 (22.1)	40 (12.1)	2 (0.6)	6 (1.8)
>69	17 (5.2)	11 (3.3)	5 (1.5)	-	1 (0.3)
Gender n (%)					
Male	176 (53)	79 (55)	62 (53)	20 (43)	15 (63)
Female	155 (47)	65 (45)	55 (47)	26 (57)	9 (37)
Infused CD34+ cells					
Median (IQR) $\times 10^6$/kg	5.8 (4.9-7.8)	5.4 (4.6-6.7)	6.2 (4.9-9.0)	7.2 (5.0-10.1)	8.1 (6.0-16.9)
Conditioning					
BEAM	150 (45.3)	-	104 (88.9)	46 100)	-
TEAM	5 (1.5)	-	5 (4.3%)	-	-
MEL200	104 (31.4)	104 (72)	-	-	-
MEL140	40 (12.1)	40 (28)	-	-	-
CT	30 (9.1)	-	6 (5.1)	-	24 (100)
TBI/CY	2 (0.6)	-	2 (1.7)	-	-
Pretransplant					
Hb Median (IQR), g/dL	10.7 (9.6-12.0)	11.0 (10.0-12.3)	10.4 (9.3-11.7)	10.5 (9.5-12.1)	10.7 (9.4-12.1)
Plt Median (IQR), 10^9/L	205 (164-258)	209 (172-264)	193 (139-238)	238 (161-326)	208 (139-241)
Neu Median (IQR), 10^6/L	2.6 (1.9-3.6)	2.7 (2.0-3.6)	2.4 (1.8-3.6)	2.9 (1.9-3.0)	2.3 (1.4-3.5)
Neutrophil engraftment					
Median (IQR), days	10 (10-11)	11 (10-11)	10 (9-11)	10 (9-10)	9 (9-11)
Platelet engraftment					
Median (IQR), days	11 (10-14)	11 (10-13)	13 (10-15)	11 (9-12)	10 (9-13)
Stay Hospital, days					
Median (IQR), days	16 (14-20)	17 (15-20)	17 (15-20)	14 (13-15)	17 (14-23)

ASCT: Autologous stem cell transplantation, NHL: Non-Hodgkin's lymphoma, HL: Hodgkin's lymphoma, MM: Multiple myeloma, PCNSL: Primary central nervous system lymphoma, Hb: Haemoglobin, BEAM: Carmustine, etoposide, cytarabine, melphalan, Mel 200: Melphalan 200 mg/m2, Mel 140: Melphalan 140 mg/m2, TEAM: Thiotepa, etoposide, cytarabine, melphalan, CT: Carmustine, thiotepa, TBI/CY: Total body irradiation, cyclophosphamide, IQR: Interquartile range.

Table-2: RBC transfusion requirement and number of RBC and PLT units transfused in patients diagnosis groups.

	All Patients n=331 [n (%)]	MM n=144 [n (%)]	NHL n=117 [n (%)]	HL n=46 [n (%)]	PCNSL n=24
RBC Transfusion					
Yes	198 (59.8)	74 (51.4)	86 (73.5)	27 (58.7)	11 (45.8)
No	133 (40.2)	70 (48.6)	31 (26.5)	19 (41.3.)	13 (54.2)
PLT Transfusion					
Yes	328 (99.1)	141 (97.9)	117 (100)	46 (100)	24 (100)
No	3 (0.9)	3 (2.1)	0 (0)	0 (0)	0 (0)
Median (IQR) RBC units in transfused patients (n=198)					
	2 (1-3)	2 (1-3)	2 (1-3)	1 (1-2)	3 (1-4)
Median (IQR) PLT units in transfused patients (n=328)					
	3.3 (2.3-5)	2.7 (2-4)	4 (3-7)	3.3 (2.3-4)	3.5 (2-5)

ASCT: Autologous stem cell transplantation, NHL: Non-Hodgkin's lymphoma, HL: Hodgkin's lymphoma, MM: Multiple myeloma, PCNSL: Primary central nervous system lymphoma, RBC: Red blood cells, PLT: Platelets, IQR: Interquartile range; The proportion of NHL patients who did not receive RBC transfusion support was significantly lower than that of patients with other diagnoses (26.5% vs. 47.7%; $p<0.001$).

transfusion support were 86 (73.5%) for NHL, 74 (51.4%) MM, 27 (58.7%) for HL, and 11(45.8%) PCNSL. The proportion of NHL patients who did not receive RBC transfusion support was significantly lower than that of patients with other diagnoses (31 of 117 patients (26.5%) vs 102 of 214 patients (47.7%); $p<0.001$). Additionally, no significant difference in RBC transfusion requirements was observed between MM patients undergoing their first (n=121) and second (n=23) transplants ($p=0.139$).

Pre-transplant Hb levels were significantly associated with the need for RBC transfusion. Patients who required RBC transfusions had a significantly lower median pre-transplant Hb level compared to those who did not, with median values being 10.0g/dL (IQR: 9.1-10.8) compared to 12.1g/dL (IQR: 11.2-12.8] ($p<0.001$). Among patients with pre-transplant Hb levels >10.7g/dL, 56(32.4%) of 173 patients required RBC transfusion compared to 142(89.9%) of 158 patients with Hb levels <10.7 g/dL who required RBC transfusion support ($p<0.001$).

Multivariable logistic regression analysis identified advanced age (>60 years), female gender, low pre-transplant Hb levels (<11g/dL), and a diagnosis of NHL as significant predictors of increased RBC transfusion requirements. Given that 328(99.1%) of the patients required PLT transfusion, no statistical analysis was performed regarding PLT transfusion requirements.

A total of 444 RBC units were transfused to 198 (59.8%) patients across 428 transfusion episodes. The majority of transfused patients received a single RBC unit per episode 412 (96.3%). Among those requiring RBC transfusion, the median number of transfused RBC units was 2 (IQR: 1-3). Most transfused cases 127(64.1%) received 1 or 2 RBC units, while 71(35.9%) required >2 RBC units. A smaller subset, comprising 31(15.7%) cases, required ≥4 RBC units. Patients with NHL undergoing ASCT required a significantly higher number of RBC units compared to those with other diagnoses ($p<0.001$). A moderate negative correlation was observed between the number of RBC units transfused and pre-transplant Hb levels ($r=-0.661$; $p<0.001$). Multivariable logistic regression analysis identified advanced age (>60 years), female gender, low pre-transplant Hb levels (<11g/dL), and a diagnosis of NHL as significant predictors of a HTB of RBC units.

Table-3 A: Pre-transfusion haemoglobin (Hb) levels in 428 transfusion episodes.

	n (%)
Transfused <7.0 g/dL	126 (29.4)
Transfused between 7 and 7.9 g/dL	235 (54.9)
Transfused between 8 and 8.9 g/dL	61 (14.3)
Transfused ≥9.0 g/dL	6 (1.4)

Table-3 B: Pre-transfusion platelet (PLT) levels in 1,200 transfusion episodes.

	n (%)
Transfused <10x10^9/L	134 (11.2)
Transfused between 10x10^9/L and 19x10^9/L	596 (49.7)
Transfused between 20x10^9/L and 29x10^9/L	390 (32.5)
Transfused ≥30x10^9/L	80 (6.6)

Among the 328 (99.1%) patients requiring PLT transfusion, the median number of transfused PLT units was 3.3 (IQR: 2.3-5). Of these, 70(21.3%) cases received 0-2 PLT units, 186(56.7%) received 3-5 PLT units, and 72(22%) required ≥6 PLT units. Patients with NHL received a significantly higher number of PLT units compared to those with other diagnoses, with median values being 4 units (IQR: 307) compared to 3 units (IQR: 2-4) ($p<0.001$). Conversely, patients with MM required significantly fewer PLT transfusions compared to those with other diagnoses, with median values being 2.7 units (IQR: 2-4) compared to 3 units (IQR: 2.306.3) ($p<0.001$). A weak negative correlation was observed between the number of PLT units transfused and pre-transplant PLT levels ($r=-0.217$; $p<0.001$). In multivariable logistic regression analysis, a diagnosis of NHL and low pre-transplant PLT levels (<150×10^9/L) were significantly associated with an increased HTB of PLT units.

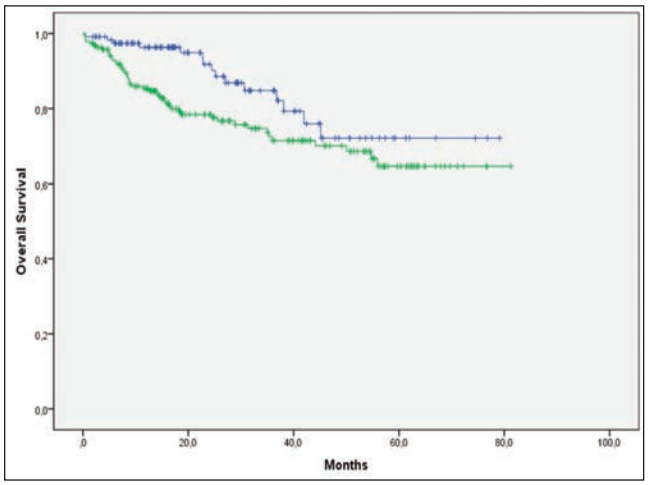

Figure: Cumulative overall survival in RBC-transfused and not-transfused ASCT patients. *ASCT: Autologous stem cell transplantation, RBC: Red blood cell.*

The median number of transfused RBC and PLT units were stratified by diagnosis (Table 2).

Across 428 transfusion episodes involving 198(46.3%) cases, the median pre-transfusion Hb level was 7.3g/dL (IQR: 6.9-7.8). Following transfusion, the median Hb value increased to 8.5g/dL (IQR: 8.0-9.1). In the 412 transfusion episodes where a single RBC unit was administered, the median Hb increase was 1.1g/dL (IQR: 0.7-1.5). Notably, 126 (29.4%) and 235 (54.9%) of RBC transfusions occurred when the pre-transfusion Hb level was <7g/dL and between 7-7.9g/dL, respectively (Table 3A).

A total of 1,200 transfusion episodes were recorded, comprising 668(55.7%) units of SDA platelets and 532(44.3%) units of PRD platelet concentrates. The median pre-transfusion PLT count was 18×10^9/L (IQR: 14-22), which increased to 31×10^9/L (IQR: 22-33) following transfusion. The median post-transfusion PLT increment was 13×10^9/L (IQR: 5-23).

Out of the total PLT transfusion episodes, 134 (11.2%) occurred when the pre-transfusion PLT count was $<10\times10^9$/L, whereas 596 (49.7%) occurred when the pre-transfusion PLT count ranged between 1×10^9/L and 19×10^9/L (Table 3B).

At the time of data analysis, 62(20%) out of 308 patients had died. The median follow-up duration was 23.1 months (IQR: 11.3-42.5). For the entire cohort, the OS rate was 89.5% at one year and 83.5% at two years.

Among patients who required RBC transfusion, the one-year and two-year OS rates were 85.4% and 78.5%, respectively. In contrast, patients who did not require RBC transfusion exhibited significantly higher OS rates of 96.3% at one year and 91.8% at two years. The difference in OS between RBC-transfused and non-transfused patients was statistically significant (p=0.031) (Figure).

Furthermore, OS was analysed based on transfusion burden. Patients with HTB of RBC (≥2 units) and PLT (≥3.33 units) were compared to those with LTB of RBC (<2 units) and PLT (<3.33 units). Patients with an HTB of RBC transfusions had a significantly lower OS (p=0.016), but no significant difference in OS was observed between patients with an HTB of PLT transfusions and those with an LTB of PLT transfusions (p=0.109).

Discussion

Published data on transfusion requirements and burdens and their impact on survival in the context of ASCT remain limited, and many studies often combine both allogeneic and ASCT patients.[3] The current retrospective study focussed specifically on ASCT patients.

Current recommendations for RBC transfusion trigger in ASCT patients are based on low-quality evidence. Randomised trials have demonstrated that a lower Hb threshold (7-9g/dL) for RBC transfusion is equally effective as higher thresholds (10-12g/dL).[4,8] The guideline from the American Association of Blood Banks recommends a restrictive RBC transfusion strategy with a threshold <7.0g/dL for stable hospitalised patients.[9] Most transplant centres generally adopt an Hb level <7-8g/dL as a trigger for initiating RBC transfusion.[10] The current study revealed that 15.2% of RBC transfusions were administered above the established threshold of 8g/dL. Similar observations were made in a Canadian study where around 20% of RBC transfusions were given above the 8g/dL threshold.[3]

Among the 331 ASCT patients in the present study, 59.8% required RBC transfusion support, and almost all (99.1%) required PLT transfusion support. In contrast, Kekre et al. reported that 88% of 355 ASCT patients required RBC transfusion support.[11] Another study involving 259 ASCT patients found that 80% required RBC support, and 88.4% needed PLT support.[12] A recent Australian study reported that 44% of ASCT patients required RBC transfusions, and 90% required PLT transfusions.[13] The current study found that older age, female gender, a diagnosis of NHL, and notably lower pre-transplant Hb levels were significantly associated with increased RBC transfusion needs. This is consistent with previous research showing a strong connection between low pre-transplant Hb levels and increased RBC transfusion requirements.[11,14]

The median number of RBC and PLT units transfused in ASCT patients has been previously reported to be around 1-2 units and 2-6 units, respectively.[15-17] Consistent with these findings, the current study found a median of 1 units

(IQR: 0-2) of RBC transfusion and 3.3 units (IQR: 2.3-5) of PLT transfusion. It also found that age >60 years, a diagnosis of NHL and low pre-transplant Hb (<11gr/dL) level were significantly associated with HTB of RBC transfusions in multivariate logistic regression analysis.

Previous studies have shown that the bleeding risk following ASCT is significantly lower compared to acute leukaemia or allogeneic SCT.[18] Current guidelines recommend against prophylactic PLT transfusions for clinically stable ASCT patients.[19,20] Despite this recommendation, a prophylactic PLT transfusion strategy remains a common practice in most transplant centres. In the present study, 49.7% of the PLT transfusions were administered when the pre-transfusion PLT count was 10-20x10^9/L, and only 11.4% were given when the PLT count was <10x10^9/L. A substantial proportion (39.1%) of transfusions was transfused at PLT thresholds >20x10^9/L. Previous audits and studies in haematological services demonstrated that in clinical practice, a significant proportion of PLT transfusions (30-40%) is administered outside the guideline-recommended PLT count thresholds.[21-23]

Several factors may contribute to the observed non-compliance with guidelines in the current study. ASCT recipients often experienced high fever, infections, mucositis, and coagulation abnormalities. Additionally, certain patients required invasive procedures that could influence transfusion decisions. Although PLT counts were slightly above 10x10^9/L or 20x10^9/L, it was expected that the PLT count would decline rapidly below these counts. In situations where platelet concentrates were not readily accessible and could not be transfused on the same day, physicians might have preferred transfusion at higher PLT transfusion triggers. Moreover, some patients exhibited low PLT counts prior to discharge.

A few previous studies have demonstrated that increased RBC and PLT transfusion requirements and burden have been associated with reduced survival after ASCT.[21] However, the current study found only a significant difference in OS among patients based on their RBC transfusion requirements and burden. OS was similar between patients with HTB and those with LTB of PLT transfusions.

Conclusion

Higher pre-transplant Hb level was found to be the main factor associated with RBC transfusion avoidance. NHL was associated with higher RBC and PLT transfusion needs compared to other diagnoses. Increased RBC transfusion requirement and burden was associated with decreased survival in patients undergoing ASCT.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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Author Contribution:
OS & UBU: Concept, design, data acquisition, analysis, interpretation, drafting, revision, final approval and agreement to be accountable for all aspects of the work.