

Single-dose pegylated versus daily G-CSF for stem cell mobilization in allogeneic donors

Ryo Sato¹, Masatoshi Narasaki², Sae Ushio³, Saki Shibata², Mikiya Kato¹, Yuki Ishizawa¹, Ryo Takahashi¹, Yusuke Nagano¹, Masashi Hosokawa¹, Akane Yamada¹, Takuma Suzuki¹, Keiko Aizawa¹, Satoshi Ito¹, Daniel Peltier⁴, Daichi Sadato⁵, Hisayuki Yokoyama¹, Tetsuo Mitsui^{2,6}, Tomomi Toubai^{1,2,5}

¹Department of Internal Medicine III, Division of Hematology and Cell Therapy, Yamagata University Faculty of Medicine, Yamagata, Japan, ²Division of Transfusion and Cell Therapy, Yamagata University Hospital, Yamagata, Japan, ³Yamagata University Faculty of Medicine, Yamagata, Japan, ⁴Department of Pediatrics, Division of Hematology/Oncology and Stem Cell Transplantation, Wells Center for Pediatric Research, Melvin and Bren Simon Cancer Center, Indiana University School of Medicine, Indianapolis, USA, ⁵Clinical Research and Trials Center, Tokyo Metropolitan Cancer and Infectious Diseases Center, Komagome Hospital, Tokyo, Japan, ⁶Department of Pediatrics, Yamagata University Faculty of Medicine, Yamagata, Japan

Abstract

Introduction: A single-dose regimen of pegylated granulocyte colony-stimulating factor (Peg-G) may reduce the physical and logistical burden of peripheral blood stem cell (PBSC) mobilization compared to a conventional regimen of daily G-CSF (Daily G) for allogeneic hematopoietic cell transplantation (allo-HCT) donors. However, comparative data on PBSC mobilization for donors and subsequent engraftment outcomes in recipients remain limited.

Methods: We retrospectively analyzed 40 donor-recipient pairs who underwent their first PBSC collection and first allo-HCT at our institution between 2017 and 2024 (Daily G: n=20; Peg-G: n=20).

Results: Median donor ages were 37 and 36 years-old in the Daily G and Peg-G groups, respectively, while median recipient ages were 44 and 57 years-old. Compared with Daily G, Peg-G was associated with a significantly shorter median total apheresis time (213 vs. 157 min; $p < 0.0001$), a higher median CD34⁺ cell yield (3.3×10^6 /kg vs. 5.9×10^6 /kg; $p=0.0009$), and a lower product volume (247 mL vs. 150 mL; $p < 0.0001$). One donor in the Peg-G group experienced self-limited splenic rupture, that did not require transfusion or surgical intervention. Among recipients, median times to neutrophil and platelet engraftment were longer in the Peg-G group, which may have been partly attributable to the higher proportion of haploidentical transplants using post-transplant cyclophosphamide (PTCy) for graft-versus-host disease (GVHD) prophylaxis in this group.

Conclusion: Peg-G provided effective PBMC mobilization, yielding higher CD34⁺ cell doses with shorter apheresis times and smaller collection volumes than Daily G. Although a self-resolving splenic rupture occurred in one donor, Peg-G was generally well tolerated. These findings suggest Peg-G is a practical and feasible mobilization strategy that warrants further confirmation in larger prospective studies.

Key words pegylated G-CSF, daily G-CSF, stem cell mobilization, allogeneic donors, allogeneic hematopoietic cell transplantation

Submitted April 30, 2026; Accepted July 9, 2026; Published online September 11, 2026

Correspondence: Tomomi Toubai, Clinical Research and Trials Center, Tokyo Metropolitan Cancer and Infectious Diseases Center, Koma-gome Hospital, 3-18-22 Honkomagome, Bunkyo-City, Tokyo, 113-8677, Japan, E-mail: toubai@med.id.yamagata-u.ac.jp

Introduction

Allogeneic hematopoietic cell transplantation (allo-HCT) is a curative therapy for a wide range of hematologic malignancies, bone marrow failure syndromes, and congenital immunodeficiencies¹⁻³. Advances in

transplant techniques and supportive care have substantially broadened both access to and indications for allo-HCT over the past decade. Although bone marrow was historically the primary source of hematopoietic stem cells, granulocyte colony-stimulating factor (G-CSF)-mobilized peripheral blood stem cells (PBSCs) have be-

come the predominant graft source because of their ease of collection and more rapid hematopoietic recovery after transplantation⁴.

Conventional PBSC mobilization requires daily subcutaneous administration of G-CSF over several consecutive days (Daily G), which may impose considerable physical and logistical burdens on healthy donors⁵. Pegylated G-CSF (Peg-G), a long-acting formulation of G-CSF, has emerged as an alternative approach that enables PBSC mobilization with a single injection^{5,6}. In Japan, Peg-G was approved for allogeneic PBSC mobilization in 2021⁵. Previous studies demonstrated that Peg-G is safe and effective for allogeneic stem cell mobilization⁵⁻⁹.

Nevertheless, comparative data using either Daily G or Peg-G on donor collection outcomes and post-transplant recipient outcomes remain limited. Therefore, we conducted a single-center retrospective study to evaluate the impact of Peg-G versus Daily G mobilization on donor collection efficacy and recipient engraftment outcomes after allo-HCT.

Materials and Methods

Patient cohort

Patients were eligible if they underwent a first allo-HCT for hematopoietic diseases at our institution between 2017 and 2024. The choice of G-CSF formulation for donor mobilization was made jointly by the treating physician and donor. Following its approval in Japan in 2021, the use of Peg-G increased substantially. A total of 40 donor-recipient pairs were included in the analysis (Daily G: n=20; Peg-G: n=20). The Hematopoietic Cell Transplantation-Specific Comorbidity Index (HCT-CI) and Disease Risk Index (DRI) were calculated as previously described^{10,11}. Adverse events were graded according to the Common Terminology Criteria for Adverse Events version 5.0 (CTCAE v5.0). This study was approved by the Ethics Committee of Yamagata University Hospital (approval numbers 2024-321 and 2025-108) and conducted in accordance with the Declaration of Helsinki. The requirement for written informed consent was waived owing to the retrospective nature of the study, and an opt-out consent process was implemented in accordance with institutional policy.

Donor stem cell mobilization and collection

All donors underwent PBSC collection using the Spectra Optia[®] apheresis system. In this study, day 1 was defined as the first day of G-CSF administration. In the Daily G group, either filgrastim or lenograstim was administered daily until completion of apheresis in accordance with Japanese prescribing and licensing guidance. Filgrastim was administered at 400 µg/m²/day

and lenograstim at 10 µg/kg/day for 4–6 days. The dose was reduced if the white blood cell (WBC) count exceeded 50,000/µL before apheresis and discontinued when the WBC count reached 75,000/µL. Leukapheresis was planned for day 4 or 5 and adjusted according to the peripheral blood CD34⁺ cell count. In the Peg-G group, pegfilgrastim was administered as a single 7.2 mg subcutaneous injection on day 1. Donors were admitted on day 4, and leukapheresis was started on day 5 if peripheral blood CD34⁺ cell counts measured on the morning of day 5 were approximately ≥ 30/µL. The minimum target yield for successful collection was defined as 2.0×10^6 CD34⁺ cells/kg recipient body weight. Since 2022, all collections have been performed using the continuous mononuclear cell collection (CMNC) mode of the Spectra Optia[®] system. The target processed blood volume was generally set at approximately twice the donor's total blood volume (TBV), with adjustments made based on the peripheral blood CD34⁺ cell count on the day of collection and the target CD34⁺ cell dose required for transplantation.

Approximately 1 hour before the planned completion of apheresis, an intermediate product sample was obtained to estimate the final CD34⁺ cell yield. Collection was terminated when the target CD34⁺ cell dose had been achieved or was predicted to be achieved based on the interim assessment. If the projected yield was insufficient, apheresis was extended within acceptable limits after consideration of donor fatigue and procedural safety.

Recipient conditioning and GVHD prophylaxis regimens

Conditioning regimens were selected according to performance status (PS), underlying disease, disease status, and stem cell source. PS was estimated using the Eastern Cooperative Oncology Group performance status scale¹². Patients with hematologic malignancies received either a myeloablative total body irradiation (TBI)-based regimen or a reduced-intensity conditioning (RIC) regimen. Patients with nonmalignant disorders, including severe aplastic anemia, received RIC regimens. The most commonly used graft-versus-host disease (GVHD) prophylaxis consisted of tacrolimus (TAC) or cyclosporine A (CsA) combined with methotrexate (MTX) and/or mycophenolate mofetil (MMF). Post-transplant cyclophosphamide (PTCy)-based GVHD prophylaxis was used for haploidentical hematopoietic cell transplantation (haplo-HCT).

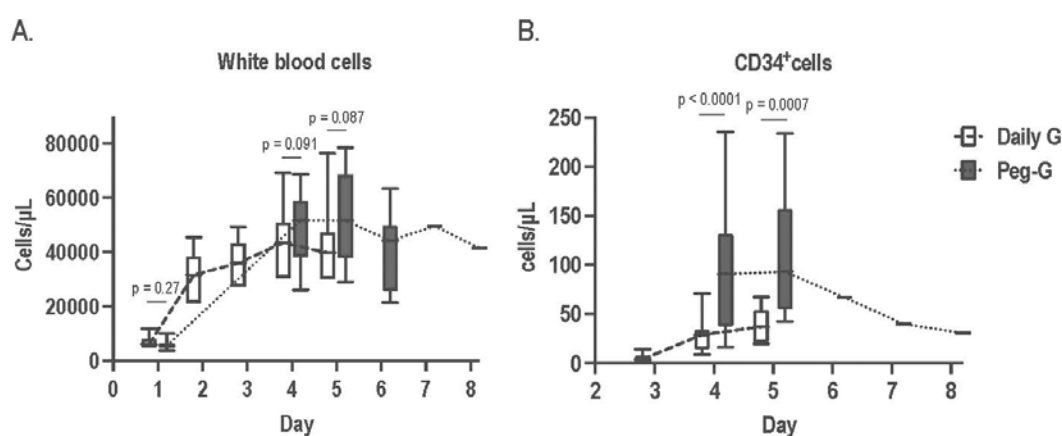
Recipient engraftment outcome definitions

Neutrophil engraftment was defined as the first of 3 consecutive days with an absolute neutrophil count ≥ 500/µL. Reticulocyte recovery was defined as a re-

Table 1. Donor characteristics

Donor characteristics	Daily G (n=20)	Peg-G (n=20)	p value
Age (years), median (range)	37 (24–64)	36 (21–59)	0.31
Sex, n (%)			
Male	11 (55%)	8 (40%)	0.53
Female	9 (45%)	12 (60%)	0.53
Body weight (kg), median (range)	70.0 (46.0–123)	58.8 (42.5–100)	0.17
BMI (kg/m ²), median (range)	25.2 (18.7–40.2)	21.8 (18.3–31.9)	0.21
G-CSF formulation, n			
Filgrastim	10	0	
Lenograstim	10	0	
Pegfilgrastim	0	20	

Comparisons of categorical variables were performed using Fisher's exact test, whereas comparisons of continuous variables were performed using the Mann-Whitney U test. BMI, body mass index.

**Figure 1. White blood cells (WBC) and CD34⁺ cells in donor peripheral blood**

(A) Box plot showing WBC (/μL) trends. (B) Box plot showing CD34⁺ cells (/μL) trends. All statistical comparisons between groups were performed using the Mann-Whitney U test.

ticulocyte count $\geq 1\%$ for 2 consecutive days. Platelet engraftment was defined as a platelet count $\geq 2 \times 10^4/\mu\text{L}$ without transfusion support for 7 consecutive days.

Statistical analyses

Continuous variables were compared using the Mann-Whitney U test, and categorical variables were compared using Fisher's exact test. Missing data were not imputed, and analyses were conducted using complete-case data. All statistical analyses were performed using EZR software (version 1.27)¹³ and Graph-Pad Prism (version 10).

Results

Donor characteristics, peripheral blood cell counts, and safety

The characteristics of donors mobilized with Daily G or Peg-G are summarized in **Table 1**. The median age was 37 years (range, 24–64) in the Daily G group and 36 years (range, 21–59) in the Peg-G group ($p=0.31$).

Median body weight was 70.0 kg (range, 46.0–123.0) and 58.8 kg (range, 42.5–100.0), respectively ($p=0.17$).

Peripheral blood WBC and CD34⁺ cell counts are shown in **Figure 1**. WBC counts on day 4 and day 5 tended to be higher in the Peg-G group than in the Daily G group, although the differences did not reach statistical significance (day 4: 43,400/ μL [range, 25,560–69,160] vs. 51,605/ μL [range, 26,040–68,620], $p=0.09$; day 5: 39,770/ μL [range, 25,950–76,350] vs. 51,640/ μL [range, 28,950–78,530], $p=0.09$) (**Figure 1 A**). By contrast, peripheral blood CD34⁺ cell counts were significantly higher in the Peg-G group on both day 4 and 5 (day 4: 29.0/ μL [range, 8.7–71.0] vs. 90.8/ μL [range, 16.3–236.0], $p < 0.01$; day 5: 36.9/ μL [range, 19.9–67.6] vs. 93.0/ μL [range, 42.7–234], $p < 0.01$) (**Figure 1B**).

Donor adverse events are summarized in **Table 2**. Most adverse events were grade 1–2 in both groups. Elevations in liver- and tissue-associated enzymes were more frequently observed in the Peg-G group, with significantly higher incidences of aspartate aminotrans-

Table 2. Donor adverse events

Adverse events		Daily G	Peg-G	p value
Grade 3–4 AE during mobilization, n (%)		0 (0%)	0 (0%)	-
AE leading to discontinuation, n (%)		0 (0%)	0 (0%)	-
Serious AE after mobilization, n (%)		0 (0%)	1 [†] (5%)	> 0.99
Most common AEs during mobilization				
AST	Grade 1–2	1 (5%)	7 (35%)	0.04
	Grade 3–4	0	0	-
ALT	Grade 1–2	3 (15%)	5 (25%)	0.69
	Grade 3–4	0	0	-
γ-GTP	Grade 1–2	1 (5%)	2 (10%)	> 0.99
	Grade 3–4	0	0	-
LDH	Grade 1–2	13 (65%)	20 (100%)	0.0083
	Grade 3–4	0	0	-
ALP	Grade 1–2	7 (35%)	20 (100%)	< 0.0001
	Grade 3–4	0	0	-
	Not assessed	5 (25%)	0	0.047
Bone/ Back Pain	Grade 1–2	14 (70%)	16 (80%)	0.72
	Grade 3–4	0	0	-
Fever	Grade 1–2	0	1 (5%)	> 0.99
	Grade 3–4	0	0	-
Headache	Grade 1–2	1 (5%)	2 (10%)	0.69
	Grade 3–4	0	0	-

Comparisons of categorical variables were performed using Fisher's exact test, whereas comparisons of continuous variables were performed using the Mann-Whitney U test. Not assessed indicates that the laboratory test was not performed.

AE, adverse event; AST, aspartate aminotransferase; ALT, alanine aminotransferase; γ-GTP, γ-glutamyl transpeptidase; LDH, lactate dehydrogenase; ALP, alkaline phosphatase.

[†] Splenic rupture occurred in one donor.

ferase (AST) elevation (1 vs. 7 donors, $p=0.04$), lactate dehydrogenase (LDH) elevation (13 vs. 20 donors, $p=0.0083$), and alkaline phosphatase (ALP) elevation (7 vs. 20 donors, $p < 0.0001$). No significant difference was observed in alanine aminotransferase (ALT) elevation (3 vs. 5 donors, $p=0.69$). Bone pain was also more common in the Peg-G group, although the difference was not statistically significant (14 vs. 16 donors, $p=0.72$). One serious adverse event, namely splenic rupture, occurred in the Peg-G group. This occurred shortly after PBSC collection on day 5 following Peg-G administration and presented with left upper quadrant abdominal pain. Computed tomography (CT) revealed splenomegaly with a mild splenic rupture and a small volume of perisplenic and pelvic hemoperitoneum. The donor was managed conservatively with close observation. A follow-up CT demonstrated no progression of the splenic injury and symptoms resolved without invasive intervention or need for transfusion. A repeat CT scan 1 month later confirmed complete resolution¹⁴.

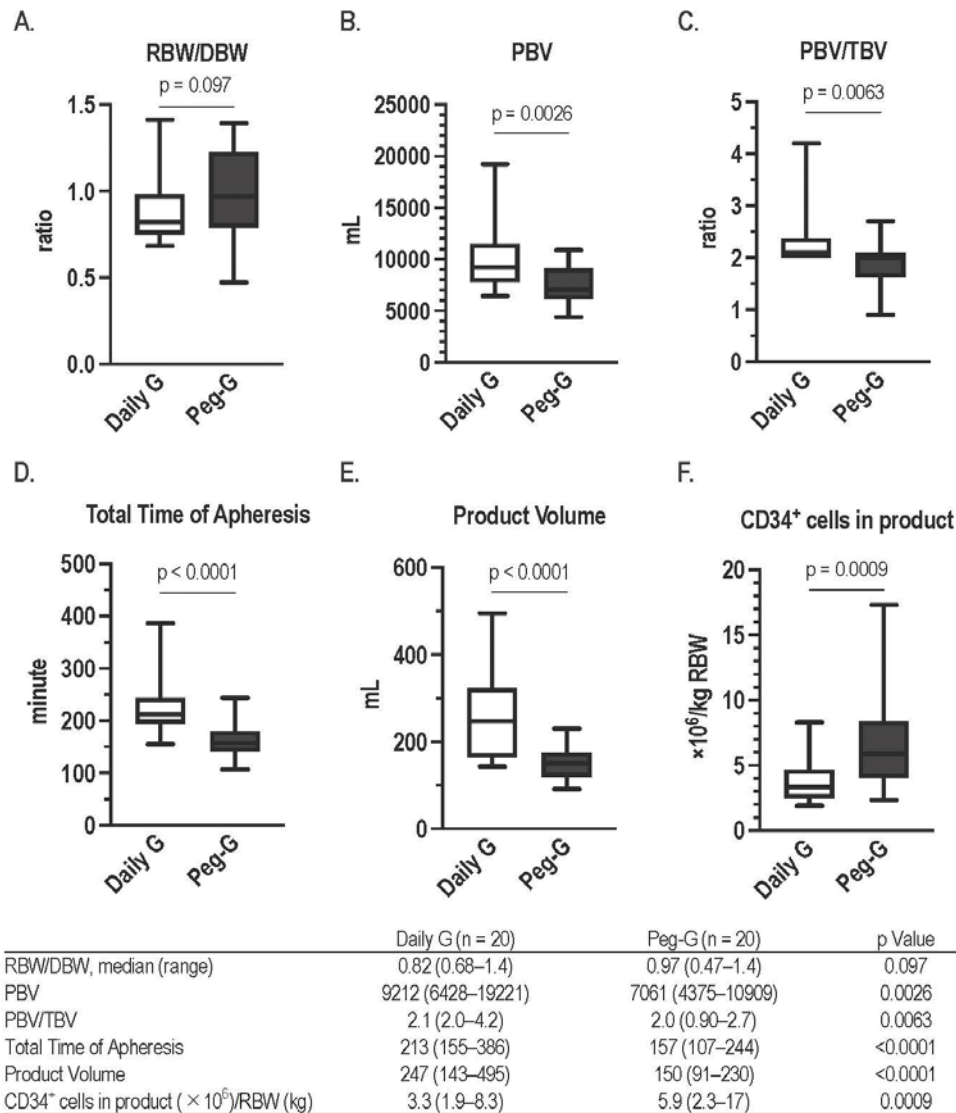
Leukapheresis products

In the Daily G group, leukapheresis was performed on day 4 only in 8 donors (40%), on day 5 only in 11

donors (55%), and on both days 4 and 5 in one donor (5%). In the Peg-G group, all donors underwent leukapheresis on day 5 as scheduled. Leukapheresis outcomes are summarized in **Figure 2**. There was no significant difference in the recipient-to-donor body weight ratio (RBW/DBW) between the two groups (**Figure 2 A**). The median processed blood volume (PBV), PBV relative to total blood volume (PBV/TBV), and total time of apheresis (TTA) were significantly lower in the Peg-G group than in the Daily G group (PBV: 9,212 mL [range, 6,428–19,221] vs. 7,061 mL [range, 4,375–10,909], $p=0.0026$; PBV/TBV: 2.1 [range, 2.0–4.2] vs. 2.0 [range, 0.90–2.7], $p=0.0063$; TTA: 213 min [range, 155–386] vs. 157 min [range, 107–244], $p < 0.0001$) (**Figure 2B–D**). The median product volume was significantly lower, and the median CD34⁺ cell yield was significantly higher in the Peg-G group than in the Daily G group (product volume: 247 mL vs. 150 mL, $p < 0.0001$; CD34⁺ cell yield: 3.3×10^6 vs. 5.9×10^6 CD34⁺ cells/kg RBW, $p=0.0009$) (**Figure 2E, F**).

Recipient characteristics

Recipient characteristics are summarized in **Table 3**. The median age was 44 years (range, 20–67) in the



Abbreviations: RBW, recipient body weight; DBW, donor body weight; PBV, processed blood volume; TBV, total blood volume.

Figure 2. Leukapheresis outcomes

(A) Ratio of recipient body weight to donor body weight (RBW/DBW). (B) Processed blood volume (PBV, mL). (C) Ratio of processed blood volume to total blood volume (PBV/TBV). (D) Total time of apheresis (TTA, minutes). (E) Leukapheresis product volume (PV, mL). (F) CD34⁺ cell count in the leukapheresis product, expressed as $\times 10^6$ cells per kg of recipient body weight ($\times 10^6$ /kg RBW). One donor in the Daily G group underwent leukapheresis on two consecutive days. All statistical comparisons between groups were performed using the Mann-Whitney U test.

Daily G group and 57 years (range, 24–72) in the Peg-G group ($p=0.12$). Because the introduction of haplo-HCT with PTCy at our institution coincided with the adoption of Peg-G mobilization, the Daily G group tended to include more matched sibling donor transplants (13 vs. 6, $p=0.056$), whereas the Peg-G group tended to include more haploidentical donor transplants (7 vs. 14, $p=0.056$). Disease status at transplantation was comparable between the two groups, with similar proportions of patients transplanted in complete remission (CR) and non-CR. HCT-CI scores were predominantly low in both groups. Although not statistically

significant (11 vs. 15 recipients, $p=0.32$), post-transplant G-CSF administration was more frequent in the Peg-G group, likely reflecting a higher proportion of PTCy-based haplo-HCT.

Recipient engraftment outcomes

Times-to-engraftment analyses are shown in **Figure 3**. Median time to neutrophil engraftment was significantly shorter in the Daily G group than in the Peg-G group (14 days [range, 4–25] in Daily G vs. 18 days [range, 13–27] in Peg-G, $p=0.012$). These differences should be interpreted with caution because of the higher

Table 3. Allo-HCT recipient characteristics

Recipient characteristics	Daily G (n=20)	Peg-G (n=20)	p value
Age, median (range)	44 (20–67)	57 (24–72)	0.12
Sex, n (%)			
Male	9 (45%)	12 (60%)	0.53
Female	11 (55%)	8 (40%)	0.53
Body weight (kg), median (range)	58.5 (41.0–86.8)	65.9 (35.4–92.2)	0.63
Disease, n (%)			
AML/High-risk MDS	11 (55%)	10 (50%)	> 0.99
ALL	2 (10%)	5 (25%)	0.41
ML	2 (10%)	1 (5%)	> 0.99
CML	3 (15%)	2 (10%)	> 0.99
MPN	1 (5%)	1 (5%)	> 0.99
AA	1 (5%)	1 (5%)	> 0.99
Donor type, n (%)			
Matched related	13 (65%)	6 (30%)	0.056
Haploidentical	7 (35%)	14 (70%)	0.056
ABO matched, n (%)			
Matched	11 (55%)	15 (75%)	0.32
Major mismatched	4 (20%)	3 (15%)	> 0.99
Minor mismatched	5 (25%)	1 (5%)	0.18
Major-minor mismatched	0 (0%)	1 (5%)	> 0.99
Disease status at HCT, n (%)			
CR	8 (40%)	11 (55%)	0.53
CP	3 (15%)	2 (10%)	> 0.99
non-CR	5 (25%)	4 (20%)	> 0.99
PR	1 (5%)	1 (5%)	> 0.99
NA	3 (15%)	2 (10%)	> 0.99
HCT-CI, n (%)			
0	17 (85%)	14 (70%)	0.45
1	1 (5%)	2 (10%)	> 0.99
2	1 (5%)	1 (5%)	> 0.99
3	0 (0%)	1 (5%)	> 0.99
4	1 (5%)	1 (5%)	> 0.99
5	0 (0%)	1 (5%)	> 0.99
DRI, n (%)			
Very High	2 (10%)	2 (10%)	> 0.99
High	8 (40%)	11 (55%)	0.53
Intermediate	9 (45%)	5 (25%)	0.32
NA	1 (5%)	2 (10%)	0.55
Conditioning regimen, n (%)			
MAC	8 (40%)	4 (20%)	0.30
RIC	12 (60%)	16 (80%)	0.30
TBI, n (%)			
Yes	16 (80%)	18 (90%)	0.66
No	4 (20%)	2 (10%)	0.66
GVHD prophylaxis, n (%)			
TAC/sMTX	7 (35%)	5 (25%)	0.73
CsA/sMTX	6 (30%)	0 (0%)	0.02
TAC/MMF/PTCy	6 (30%)	14 (70%)	0.026
TAC/sMTX/MMF/PTCy	1 (5%)	0 (0%)	> 0.99
TAC/ATG/sMTX	0 (0%)	1 (5%)	> 0.99
G-CSF post HCT, n (%)			
Yes	11 (55%)	15 (75%)	0.32
No	9 (45%)	5 (25%)	0.32

Comparisons of categorical variables were performed using Fisher's exact test, whereas comparisons of continuous variables were performed using the Mann-Whitney U test.

AML, acute myeloid leukemia; MDS, myelodysplastic syndromes; ALL, acute lymphoblastic leukemia; ML, malignant lymphoma; CML, chronic myelogenous leukemia; MPN, myeloproliferative neoplasms; AA, aplastic anemia; HCT, hematopoietic cell transplantation; CR, complete remission; CP, chronic phase of CML; PR, partial remission; NA, not applicable; HCT-CI, hematopoietic cell transplantation-specific comorbidity index; DRI, disease risk index; MAC, myeloablative conditioning; RIC, reduced-intensity conditioning; TBI, total body irradiation; GVHD, graft-versus-host disease; TAC, tacrolimus; CsA, cyclosporine A; sMTX, short-term methotrexate; MMF, mycophenolate mofetil; PTCy, post-transplant cyclophosphamide; ATG, anti-thymocyte globulin.

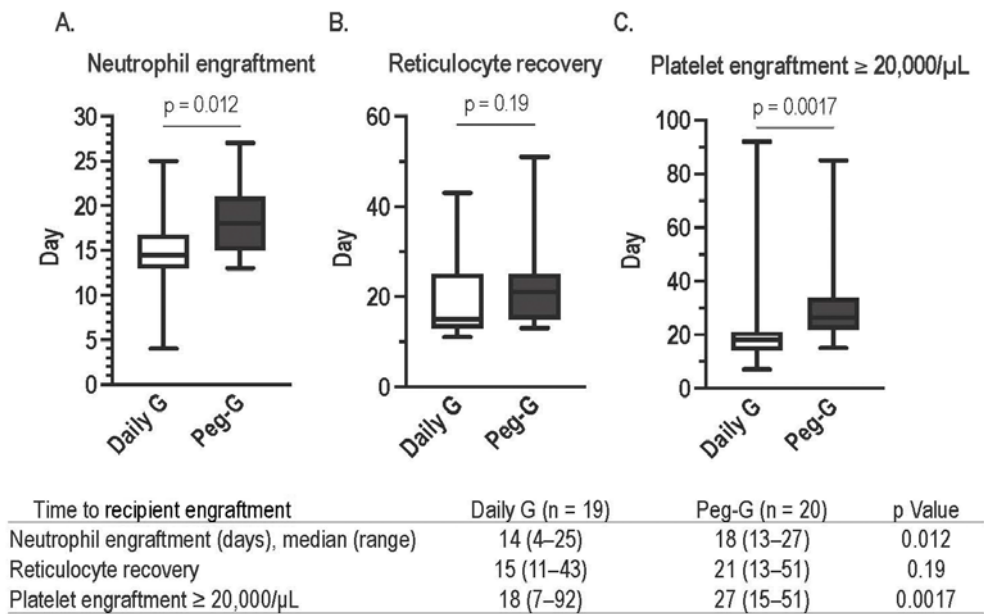


Figure 3. Recipient engraftment
(A) Median day of neutrophil engraftment ($\geq 500/\mu\text{L}$) post-HCT. (B) Median day of reticulocyte recovery ($\geq 1\%$) post-HCT. (C) Median day of platelet engraftment ($\geq 20,000/\mu\text{L}$) post-HCT. One patient who did not recover blood cell counts is excluded. All statistical comparisons between groups were performed using the Mann-Whitney U test.

proportion of haplo-HCTs with PTCy, which is known to delay engraftment¹⁵⁻¹⁷, in the Peg-G group. Nevertheless, neutrophil engraftment was achieved in all evaluable patients except for one patient who died of liver failure on day 19 before engraftment. To explore the potential impact of post-transplant G-CSF administration on engraftment kinetics, recipients were further stratified according to whether post-HCT G-CSF was administered (**Supplementary Table 1**). Delayed engraftment was observed among patients who did not receive post-transplant G-CSF, particularly with respect to platelet recovery.

Discussion

In our cohort, peripheral blood CD34⁺ cell counts in the Peg-G group were markedly higher on day 5, consistent with previous reports showing that CD34⁺ cell mobilization following single-dose Peg-G peaks around day 5 in healthy allogeneic donors^{5,8}. These findings support the rationale for scheduling leukapheresis on day 5 after Peg-G administration. The enhanced mobilization observed with Peg-G translated into higher CD34⁺ cell yields, lower processed blood volumes, and shorter apheresis times compared with Daily G, suggesting improved collection efficiency and a reduced procedural burden for donors.

Peg-G was generally well tolerated in our cohort. Musculoskeletal symptoms, including bone and back pain, were numerically more frequent in the Peg-G

group, although all events were grade 1–2 and resolved spontaneously. Previous studies have identified younger age and female sex as risk factors for G-CSF-related bone pain¹⁸. Because donors in the Peg-G group tended to be younger and more frequently female, these characteristics may have contributed to the higher incidence of pain observed in our study. We also observed more frequent elevations in liver and tissue-associated enzymes in the Peg-G group. This finding may partly reflect the fixed-dose administration of pegfilgrastim irrespective of body weight, resulting in relatively greater drug exposure among lighter donors. Alternatively, the greater mobilization efficiency of Peg-G may transiently affect progenitor-cell trafficking and tissue turnover, although the underlying mechanism remains unclear^{19,20}. One serious adverse event, namely mild splenic rupture, occurred in the Peg-G group¹⁴. This finding is consistent with previous reports describing splenic rupture after G-CSF administration²¹⁻²⁸. The donor recovered uneventfully with conservative management alone. Overall, our findings are consistent with previous studies demonstrating the efficacy of Peg-G for PBSC mobilization in healthy donors.

There are important limitations of this study to acknowledge. First, this was a small single-center retrospective study with heterogenous recipient groups, which limited our ability to robustly evaluate donor mobilization-dependent recipient outcomes. The principal difference was the imbalance in donor type between the study groups that likely caused substantial con-

founding. This imbalance reflected the increasing adoption of PTCy-based haplo-HCT in Japan after approximately 2020²⁹. Consequently, the delayed engraftment observed in the Peg-G group should be interpreted with caution, as it may have been attributable to the higher proportion of PTCy-haploidentical transplantation rather than to differences in the donor mobilization strategy itself¹⁵⁻¹⁷. Several recent reports have suggested that a higher infused CD34⁺ cell dose (approximately $4-5 \times 10^6/\text{kg}$ RBW) may improve transplant outcomes in PTCy-based haploidentical peripheral blood stem cell transplantation without increasing GVHD^{30,31}. However, during the study period, our institutional minimum target yield remained 2.0×10^6 CD34⁺ cells/kg RBW. Based on these recent publications^{30,31}, we are reconsidering the appropriate minimum target CD34⁺ cell dose for future practice. In addition, prospective multicenter studies are warranted to further clarify the impact of Peg-G mobilization on donor collection efficiency and recipient post-transplant outcomes.

Conclusion

Compared with conventional Daily G, Peg-G was associated with greater CD34⁺ cell mobilization and more efficient stem cell collection. Peg-G was generally well tolerated by donors, although careful monitoring for rare but potentially serious adverse events, such as splenic rupture, remains warranted. These findings support the feasibility of Peg-G as a mobilization strategy for allogeneic PBSC mobilization. Further studies with larger, more uniform recipient cohorts are needed to clarify its impact on recipient outcomes.

Conflicts of Interest

RS, MN, SU, SS, MK, YI, RT, YN, MH, AY, TS, KA, DP, DS, and TM declare no conflicts of interest.

SI has received research funding from Chugai. HY has received honoraria from Kyowa Kirin and Chugai and is an editor of the International Journal of Hematology. TT has received research funding from Chugai. Disclosure forms provided by the authors are available on the website.

Author Contributions

RS collected and analyzed the data and drafted the manuscript. MN, SU, SS, MK, YI, RT, YN, MH, AY, TS, KA, and SI contributed to data collection and interpretation. DP, DS, HY, and TM contributed to study design, data interpretation, and critical revision of the manuscript. TT conceived and supervised the study, interpreted the data, and critically revised the manuscript.

All authors reviewed and approved the final manuscript.

Data Availability Statement

The data that support the findings of this study are not publicly available because they contain information that could compromise the privacy of research participants. The data are available from the corresponding author upon reasonable request, subject to institutional and ethical approval.

References

1. Appelbaum FR. Hematopoietic-cell transplantation at 50. *N Engl J Med*. 2007; **357**: 1472-5.
2. Bakhtiar S, Fekadu J, Seidel MG, Gambineri E. Allogeneic Hematopoietic Stem Cell Transplantation for Congenital Immune Dysregulatory Disorders. *Front Pediatr*. 2019; **7**: 461.
3. Copelan EA. Hematopoietic stem-cell transplantation. *N Engl J Med*. 2006; **354**: 1813-26.
4. Morton J, Hutchins C, Durrant S. Granulocyte-colony-stimulating factor (G-CSF)-primed allogeneic bone marrow: significantly less graft-versus-host disease and comparable engraftment to G-CSF-mobilized peripheral blood stem cells. *Blood*. 2001; **98**: 3186-91.
5. Goto H, Sugita J, Hasegawa Y, Hayasaka K, Sunagoya K, Hatase R, et al. Efficacy and Safety of Single-dose Pegfilgrastim for CD34 + Cell Mobilization in Healthy Volunteers: A Phase 2 Study. *Transplantation*. 2024; **108**: 996-1003.
6. Hill GR, Morris ES, Fuery M, Hutchins C, Butler J, Grigg A, et al. Allogeneic stem cell transplantation with peripheral blood stem cells mobilized by pegylated G-CSF. *Biol Blood Marrow Transplant*. 2006; **12**: 603-7.
7. Cao J, Li A, Pei R, Lu Y, Chen D, Du X, et al. Effectiveness of single-dose 6 mg pegfilgrastim in mobilizing peripheral blood stem cells in allogeneic hematopoietic cell transplantation donors. *Ann Hematol*. 2023; **102**: 3567-73.
8. Kroschinsky F, Hölig K, Poppe-Thiede K, Zimmer K, Ordemann R, Blechschmidt M, et al. Single-dose pegfilgrastim for the mobilization of allogeneic CD34+ peripheral blood progenitor cells in healthy family and unrelated donors. *Haematologica*. 2005; **90**: 1665-71.
9. Li L, Yin J, Li Y, Wang C, Mao X, Wei J, et al. Allogeneic Hematopoietic Stem Cell Transplantation Mobilized With Pegylated Granulocyte Colony-Stimulating Factor Ameliorates Severe Acute Graft-Versus-Host Disease Through Enrichment of Monocytic Myeloid-Derived Suppressor Cells in the Graft: A Real World Experience. *Front Immunol*. 2021; **12**: 621935.
10. Armand P, Kim HT, Logan BR, Wang Z, Alyea EP, Kalaycio ME, et al. Validation and refinement of the Disease Risk Index for allogeneic stem cell transplantation. *Blood*. 2014; **123**: 3664-71.
11. Sorror ML, Maris MB, Storb R, Baron F, Sandmaier BM, Maloney DG, et al. Hematopoietic cell transplantation (HCT)-specific comorbidity index: a new tool for risk assessment before allogeneic HCT. *Blood*. 2005; **106**: 2912-9.
12. Oken MM, Creech RH, Tormey DC, Horton J, Davis TE,

- McFadden ET, et al. Toxicity and response criteria of the Eastern Cooperative Oncology Group. *Am J Clin Oncol*. 1982; **5**: 649-55.
13. Kanda Y. Investigation of the freely available easy-to-use software 'EZ' for medical statistics. *Bone Marrow Transplant*. 2013; **48**: 452-8.
 14. Takahashi R, Oya K, Ishizawa Y, Nagano Y, Sato R, Hosokawa M, et al. Splenic rupture secondary to pegfilgrastim in a healthy allogeneic peripheral blood hematopoietic stem cell donor. *Int J Hematol*. 2026; **124**: 143-47.
 15. Bolaños-Meade J, Hamadani M, Wu J, Al Malki MM, Martens MJ, Runaas L, et al. Post-Transplantation Cyclophosphamide-Based Graft-versus-Host Disease Prophylaxis. *N Engl J Med*. 2023; **388**: 2338-48.
 16. Chiusolo P, Bacigalupo A, Salit R, Schroeder T, Finazzi MC, Gurnari C, et al. PTCy or ATG for Matched Transplantation in Myelofibrosis. *Am J Hematol*. 2026; **101**: 1192-5.
 17. Kim HT, Liney DJ, Rizza K, Cutler CS, Koreth J, Nikiforow S, et al. Poor Engraftment After Posttransplant Cyclophosphamide Graft-Versus-Host Disease Prophylaxis in Patients With Myelofibrosis. *Am J Hematol*. 2025; **100**: 1513-22.
 18. Tsuboi S, Hayama T, Miura K, Uchiike A, Tsutsumi D, Yamauchi T, et al. Higher incidence of pegfilgrastim-induced bone pain in younger patients receiving myelosuppressive chemotherapy: a real-world experience. *J Pharm Health Care Sci*. 2023; **9**: 2.
 19. Li N, Zhang L, Li H, Fang B. Human CD34+ cells mobilized by granulocyte colony-stimulating factor ameliorate radiation-induced liver damage in mice. *Stem Cell Res Ther*. 2010; **1**: 22.
 20. Petit I, Szyper-Kravitz M, Nagler A, Lahav M, Peled A, Habler L, et al. G-CSF induces stem cell mobilization by decreasing bone marrow SDF-1 and up-regulating CXCR4. *Nat Immunol*. 2002; **3**: 687-94.
 21. Kröger N, Renges H, Sonnenberg S, Krüger W, Gutensohn K, Dielschneider T, et al. Stem cell mobilisation with 16 microg/kg vs 10 microg/kg of G-CSF for allogeneic transplantation in healthy donors. *Bone Marrow Transplant*. 2002; **29**: 727-30.
 22. Nuamah NM, Goker H, Kilic YA, Dagmoura H, Cakmak A. Spontaneous splenic rupture in a healthy allogeneic donor of peripheral-blood stem cell following the administration of granulocyte colony-stimulating factor (g-csf). A case report and review of the literature. *Haematologica*. 2006; **91** (5_Suppl): ECR08.
 23. Akyol G, Pala C, Yildirim A, Keklik M, Demir K, Dortdudak S, et al. A rare but severe complication of filgrastim in a healthy donor: splenic rupture. *Transfus Apher Sci*. 2014; **50**: 53-5.
 24. Balaguer H, Galmes A, Ventayol G, Bargay J, Besalduch J. Splenic rupture after granulocyte-colony-stimulating factor mobilization in a peripheral blood progenitor cell donor. *Transfusion*. 2004; **44**: 1260-1.
 25. Becker PS, Wagle M, Matous S, Swanson RS, Pihan G, Lowry PA, et al. Spontaneous splenic rupture following administration of granulocyte colony-stimulating factor (G-CSF): occurrence in an allogeneic donor of peripheral blood stem cells. *Biol Blood Marrow Transplant*. 1997; **3**: 45-9.
 26. Daniel JA, Roth KR, Patel PV, Schultz KL. Atraumatic splenic rupture secondary to granulocyte-colony stimulating factor medication exposure. *Am J Emerg Med*. 2024; **80**: 228.e1-4.
 27. Dincer AP, Gottschall J, Margolis DA. Splenic rupture in a parental donor undergoing peripheral blood progenitor cell mobilization. *J Pediatr Hematol Oncol*. 2004; **26**: 761-3.
 28. Falzetti F, Aversa F, Minelli O, Tabilio A. Spontaneous rupture of spleen during peripheral blood stem-cell mobilisation in a healthy donor. *Lancet*. 1999; **353**: 555.
 29. Sugita J, Yanada M. Current status of conditioning regimens in haploidentical hematopoietic cell transplantation. *Hematology*. 2024; **29**: 2332866.
 30. Harada N, Okamura H, Kanda J, Hayashi H, Inamoto Y, Fukuda T, et al. Evaluation of the Prognostic Impact of Infused CD34 Positive Cell Dose in Haplo-Peripheral Blood Stem Cell Transplantation with Post-Transplantation Cyclophosphamide Using a Restricted Cubic Spline Curve. *Transplant Cell Ther*. 2025; **31** (Suppl): S262.
 31. Maruyama Y, Nishikii H, Kurita N, Sakamoto T, Hattori K, Suehara Y, et al. Impact of CD34 positive cell dose in donor graft on the outcomes after haploidentical peripheral blood stem cell transplantation with post-transplant cyclophosphamide - A retrospective single-center study with a Japanese cohort. *Blood Cells Mol Dis*. 2024; **105**: 102820.

<https://doi.org/10.31547/bct-2026-017>

Copyright ©2026 Asia-Pacific Blood and Marrow Transplantation Group (APBMT). This is an open access article distributed under CC BY-NC license (<https://creativecommons.org/licenses/by-nc/4.0/>).