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Factors influencing survival after allogeneic stem cell transplantation for hematologic malignancies in adult patients: A retrospective cohort study

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Allogeneic stem cell transplantation (alloSCT) remains the established main treatment option with curative potential for many hematologic malignancies. We conducted a retrospective analysis of 104 adult patients who underwent alloSCT between March 2013 and November 2023. Kaplan-Meier survival analysis, the chi-square test, and Cox regression models were used to identify risk factors and outcomes. The median follow-up of the cohort was 19 (0.3–128.1) months. The median age of the recipients was 49 (19–65) years, and 57 (54.8%) recipients were males. Ninety (86.5%) patients had a matched sibling, and 14 (13.5%) had a haploidentical donor. According to the multivariable analysis, a body mass index (BMI) ≥30 kg/m^2 (p=0.02) and status without chronic graft-versus-host disease (cGVHD) (p=0.04) were significantly associated with worse overall survival (OS). A BMI ≥30 kg/m^2 was also predictive of worse relapse-free survival (p=0.01). The cumulative incidence rates of nonrelapse mortality (NRM) and relapse mortality (RM) at 1 year were 8.5% (95% CI: 4.3–16.5%) and 26.7% (95% CI: 19.1–37.4%), respectively. Patients without cGVHD had significantly higher RM than patients with cGVHD (p<0.001), whereas patients with cGVHD had significantly higher NRM (p=0.01). Patients with a BMI ≥30 kg/m^2 had significantly more posttransplant fatal events (p<0.001). Our analysis revealed that a BMI ≥30 kg/m^2 and a status without cGVHD were significantly associated with worse OS. NRM was higher in patients with cGVHD, whereas patients without cGVHD died mostly from relapses.

Key words: graft versus host disease; cGVHD; allogeneic stem cell transplantation; relapse; nonrelapse mortality

Hematopoietic cell transplantation (HCT) is an established curative procedure for various hematological diseases. Since the first published report from the European Society for Bone Marrow Transplantation (EBMT) describing activity in hematopoietic stem cell transplant centers in Europe in 1991, this survey has been published annually by the EBMT and currently includes data from more than 800,000 transplants [1, 2]. The number of HCTs in European centers and collaborating countries is increasing, with approximately 20,000 (41%) allogeneic transplantations (alloSCTs) per year, although we can observe the development of novel therapies, especially targeted immunotherapies and chimeric antigen receptor T-cell therapies [2]. Long-term survival and outcomes are affected by considerable early and late transplantation-related mortality (TRM) and morbidity, which are caused mainly by infections, acute and chronic graft-versus-host disease (aGVHD, cGVHD), and toxicity related to conditioning regimens. Especially, cGVHD is a particularly devastating syndrome, typically requiring prolonged use of immunosuppressive agents, with a median duration of 2 to 3.5 years [3]. cGVHD is therefore associated not only with increased late mortality but also with a significant impact on long-term quality of life and functional status among HCT survivors [4, 5]. Improvements in HLA typing, earlier patient referrals, supportive care, and the development of nonmyeloablative and reduced-intensity conditioning regimens have been achieved over the years, increasing the age limit of alloSCT to above 70 years [6–10].

Our transplantation center was established in 1992 and started with autologous and later alloSCTs with matched related donors, and as of 2021, we have started to perform haploidentical stem cell transplantations (haploSCTs). Since

2021, our institution has reported annual activity to the EBMT Activity Survey. Here, we present our transplantation experiences between 2013 and 2023 concerning alloSCTs for various onco-hematological diseases. We focused on biological and transplantation variables in the cohort, analyzed their impact on survival in recipients after alloSCT, and identified the primary causes of posttransplant mortality.

Patients and methods

Study design and data collection. This was a retrospective single-center analysis of all adult patients (aged >18) who received their first alloSCT for various onco-hematological diseases at the National Cancer Institute in Slovakia from March 2013 until November 2023. This study exclusively included alloSCT recipients from fully matched sibling and haploidentical family donors. All data collection was performed via the National Cancer Institute and the University Hospital in Bratislava medical records database of transplanted patients. The study was approved by the Institutional Review Board (Approval No. aloHTC01/2022/a), and a waiver of consent was granted.

The data collected included biological and transplantation recipient and donor characteristics (age, sex, cytomegalovirus serostatus, body mass index (BMI) at the time of diagnosis, Karnofsky performance status, HCT-CI, diagnosis and status at transplantation, and transplantation-related factors, including baseline cytomegalovirus (CMV) serostatus of the donor and recipient, intensity of the conditioning regimen, graft source, dose of CD34+ cells, GVHD prophylaxis, incidence and severity of aGVHD and cGVHD, length of hospitalization, relapses, and mortality.

Definitions. Grading of aGVHD (classic, persistent, recurrent, late-onset) and cGVHD (classic and overlap) was performed according to criteria established at a given time (Przepiorka et al.; Harris et al.; Mount Sinai Acute GVHD International Consortium = MAGIC; National Institutes of Health (NIH) Consensus Development Projects on Criteria for Clinical Trials in Chronic GVHD 2005 and 2014) [11–14]. Patients had to survive more than 100 days to be included in the assessment of cGVHD (87 patients).

In the case of relapses and mortality, we monitored the time from alloSCT to relapse (TTR) and the time from relapse to death (TTD), relapse mortality (RM), and nonrelapse mortality (NRM). NRM was defined as any cause of death without evidence of relapse/persistence/progression, and RM was defined as death from relapse/persistence/progression as the primary or secondary cause of death. OS was defined as the time from alloSCT until death from any cause, and RFS was defined as the time from alloSCT until relapse/progression or death from any cause. Patients alive without evidence of disease relapse, persistence, or progression were censored on November 30, 2023.

The myeloablative conditioning regimen consisted of busulfan + cyclophosphamide, cyclophosphamide + total body irradiation (TBI), or fludarabine + TBI. The following reduced-intensity and nonmyeloablative regimens were used: fludarabine + melphalan, fludarabine + busulfan, or combinations of cyclophosphamide or fludarabine with a lower dose of TBI. The standard GVHD prophylaxis was cyclosporin (CyA) in combination with methotrexate or mycophenolate mofetil, and five patients were administered rabbit antithymocyte-globulin (ATG). GVHD prophylaxis for haploidentical transplant consisted of tacrolimus, MMF, and posttransplantation cyclophosphamide.

According to the World Health Organization (WHO) international BMI classification, patients were classified as obese when their BMI was ≥30 kg/m^2 [15]. We divided patients into 2 groups: BMI <30 kg/m^2 and BMI ≥30 kg/m^2.

Statistical methods. Biological characteristics were described by using an editor, MS Excel v365. We described continuous variables as medians (ranges) and categorical variables as numbers and percentages. The Kaplan-Meier method was used to estimate OS and RFS, and the results are reported as medians with 95% confidence intervals (CIs) and survival percentages.

Cumulative incidence functions were used to estimate the incidence of relapse, NRM, aGVHD, and cGVHD. The results are reported as hazard ratios (HRs) and 95% CIs.

For univariable analysis, categorical variables were compared via the chi-square test or Fisher's exact test (as appropriate), and time-to-event variables were compared via the log-rank test. Multivariable analyses were performed via the Cox regression test for all factors with p-values <0.2 from univariable analysis with potential risks for OS and RFS, and the logistic regression test was used for categorical variables with potential risks of cGVHD and a BMI ≥30 kg/m^2. A p-value ≤0.05 was considered statistically significant. Statistical analyses were performed with Statistical and Power Analysis Software, NCSS 2025.

Results

Patient and transplant characteristics. At a median follow-up of 19 (0.3–128.1) months, all 104 transplanted patients were included in the analysis. The median age of the recipients at alloSCT was 49 (19–65) years, and 57 (54.8%) recipients were male. The stem cell source was exclusively peripheral blood (PB) in 100% of the patients. The median dose of CD34+ cells used for alloSCT was 4.9×10^6/kg. The distributions of patients according to diagnosis and other cohort demographic and transplant characteristics are described in Table 1.

Graft-versus-host disease. We recorded aGVHD of any grade in 52 (50%) patients, and the most common grade was Grade II in 19 (18.3%) patients. The distribution of patients according to grade is reported in Table 2, and Figure 1 shows the percentage of patients according to organ involvement for aGVHD. The onset of aGVHD occurred at a median of 54.5 (15–241) days. The cumulative incidence of aGVHD on

day +100, Grades II–IV, was 25.3% (95% CI: 17.8–35.8%), and that of Grades III–IV was 12.8% (95% CI: 7.2–23.0%).

Forty-four (50.6%) patients developed cGVHD, with a median time from alloSCT to the onset of cGVHD of 8.6 months (3.6–44.3). At the time of cGVHD onset, 3 (6.8%) patients had overlapping cGVHD, and 41 (93.2%) had classic cGVHD. Severe cGVHD appeared in 26 (59.1%) patients. The severity of cGVHD, organ manifestations, and NIH scores are shown in Table 2 and Figure 2. The cumulative incidences of cGVHD 1, 2, and 3 years after alloSCT were 46.3% (95% CI: 35.9–59.6%), 62.4% (95% CI: 51.0–76.4%), and 65.6% (95% CI: 53.8–79.9%), respectively. Due to the high cumulative incidence of cGVHD, we investigated potential corre-

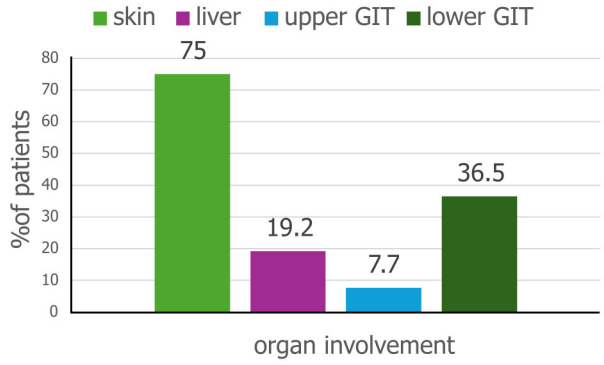

Figure 1. Organ involvement in aGVHD.

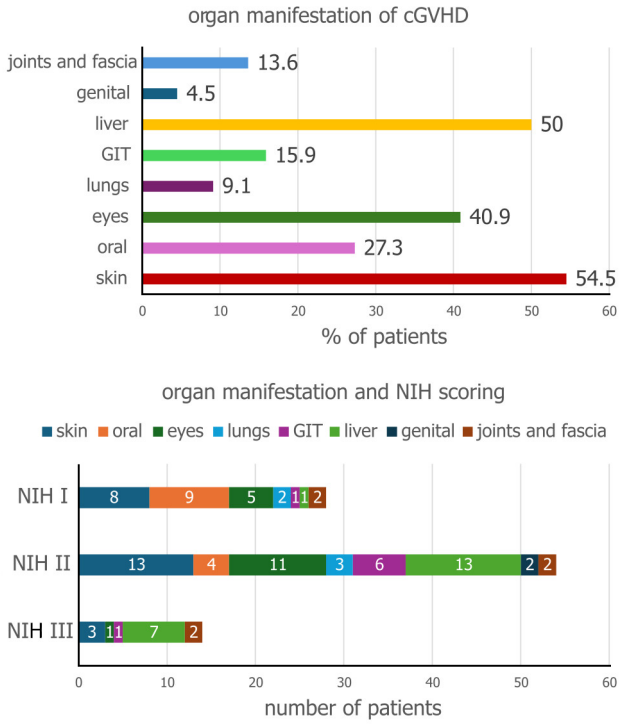

Figure 2. The organ manifestation and NIH scoring of cGVHD.

Table 1. Patient and transplant characteristics of the cohort.

Patients' characteristics	N (%)
number of transplanted patients, N (%)	104 (100%)
age of recipient/donor, years	
median (range)	49 (19-65)/46 (18-69)
<40, N (%)	28 (26.9%)/32 (30.8%)
≥40, N (%)	76 (73.1%)/72 (69.2%)
sex, recipient/donor, N (%)	
male	57 (54.8%)/56 (53.8%)
female	47 (45.2%)/48 (46.2%)
diagnosis, N (%)	
AML	35 (33.7%)
ALL	13 (12.5%)
MDS	6 (5.8%)
NHL	17 (16.3%)
HL	12 (11.6%)
CML	4 (3.8%)
other MPN	4 (3.8%)
CLL	5 (4.8%)
MPAL, BPDCN	3 (2.9%)
T-PLL	3 (2.9%)
MM	2 (1.9%)
Karnofsky performance status at the time of alloSCT, N (%)	
90–100%	60 (57.7%)
<90%	44 (42.3%)
median (range)	90 (60-100%)
BMI at alloSCT, N (%)	
<18.5 kg/m^2	6 (5.8%)
18.5–24.9 kg/m^2	50 (48.1%)
25–29.9 kg/m^2	30 (28.8%)
≥30 kg/m^2	18 17.3%)
baseline CMV serostatus, N (%)	
recipient+ donor+	84 (80.8%)
recipient– donor+	3 (2.9%)
recipient+ donor–	10 (9.6%)
recipient– donor–	7 (6.7%)
Transplant characteristics	**N (%)**
Donor	
MSD	90 (86,5%)
haplo	14 (13,5%)
HCT-CI score, N (%)	
0	33 (31.7)
1/2	37 (35.6%)
≥3	34 (32.7)
conditioning, N (%)	
MAC	41 (39.4%)
RIC+NMA	63 (60.6%)
GVHD prophylaxis	
MTX based	64 (61.6%)
MMF based	28 (26.9%)
other	12 (11.5%)
disease status before alloSCT, N (%)	
CR	54 (51.9%)
no CR	50 (48.1%)
disease status after alloSCT, N (%)	
CR	80 (76.9%)
no CR	20 (19.2%)
NA	4 (3.9%)

Abbreviations: MPAL-mixed-phenotype acute leukemia; BPDCN-blastic plasmacytoid dendritic cell neoplasm; MM-multiple myeloma; T-PLL-T-prolymphocytic leukemia; aGVHD-acute graft-versus-host disease; cGVHD-chronic graft-versus-host disease; CMV-cytomegalovirus; MTX-methotrexate; MMF-mycophenolate mofetil; CR-complete remission

Table 2. Characteristics of patients with aGVHD and cGVHD and causes of death.

Parameter	N (%)
aGVHD, N (%) according to MAGIC	52 (50%)
Gr I (% of patients with aGVHD/% of all patients)	12 (23.1%/11.5%)
Gr II	19 (36.5%/18.3%)
Gr III	18 (34.6%/17.3%)
Gr IV	3 (5.8%/2.9%)
NIH severity of cGVHD at maximum severity, only patients alive after 3 months after alloSCT; (87 patients)	44 (50.6%)
any severity	2 (4.5%)
mild	16 (36.4%)
moderate	26 (59.1%)
severe	
causes of death	
relapse and persistence/progression related	42 (70%)
relapse	28 (46.7%)
persistence/progression	14 (23.3%)
non-relapse-related	18 (30%)
aGVHD	2 (3.3%)
cGVHD	1 (1.7%)
infections	11(18.3%)
others	4 (6.7%)

Abbreviations: aGVHD-acute graft-versus-host disease; cGVHD-chronic graft-versus-host disease

lations between cGVHD and monitored clinical variables (donor type, donor sex, conditioning regimen, complete remission status before alloSCT, age < 40 vs. ≥40, age < 50 vs. ≥50, Karnofsky performance status, BMI, and prior aGVHD) using the chi-square test. However, no statistically significant associations were found.

Survival. The median OS and RFS after transplantation were 28.6 months (95% CI: 17.0–51.6) and 15.1 months (95% CI: 10.1–26.2), respectively. The 3- and 5-year OS rates for the entire patient group were 44.7% (95% CI: 34.3–55.1%) and 38.6% (95% CI: 28.0–49.1%), respectively, and the RFS rates were 36.6% (95% CI: 26.6–46.6%) and 30.5% (95% CI: 20.5–40.5%), respectively (Figure 3). Univariable analysis revealed several risk factors for worse OS and RFS. Karnofsky score <90% (p=0.02; p=0.01), status without complete remission before alloSCT (p=0.01; p<0.001), BMI ≥30 kg/m^2 (p<0.001; p<0.001) and status without cGVHD (p=0.01; p=0.03) were associated with worse OS and RFS (Table 3, Figure 4). The results of the multivariable analysis for OS and RFS are shown in Table 4. BMI ≥30 kg/m^2 (p=0.02) and status without cGVHD (p=0.04) were significantly associated with worse OS. A BMI ≥30 kg/m^2 (p=0.01) also significantly worsened RFS, whereas it was not confirmed for patients without cGVHD (0.08). A Karnofsky score < 90% and status without complete remission were not predictors of OS or RFS in the multivariable analysis.

Relapse analysis, relapse mortality, and nonrelapse mortality. At a median of 5.1 months (1.4–61.6), 35 (33.7%) patients experienced relapse after alloSCT, 18 (17.3%) patients experienced persistence/progression of the disease, and evaluations were not available for 4 (3.9%) patients. The median time to death of patients who experienced relapse after alloSCT was 4.3 months (0.2–103.7). The cumulative incidence rates of relapse were 29.5% (95% CI: 21.3–40.8%) and 35.3% (95% CI: 26.3–47.4%) at 1 and 2 years, respectively.

At the end of follow-up, 44 (42.3%) patients were alive, and 60 (57.7%) patients had died. Disease-related causes of death (relapse/progression/persistence) and NRM are shown in Table 2. In terms of NRM, in addition to infection and GVHD, 4 (6.7%) other causes of death were noted: hepatorenal failure due to drug-induced liver injury, diffuse alveolar damage due to hemorrhage, thrombotic microangiopathy, and secondary graft failure. The cumulative incidence rates of 1-year NRM and RM were 8.5% (95% CI: 4.3–16.5%) and 26.7% (95% CI: 19.1–37.4%), respectively.

Since a BMI ≥30 kg/m^2 and status without cGVHD adversely affected patient survival, we analyzed mortality in these patient groups. According to the univariable analysis, obese patients did not have significantly more cases of RM (p=0.25) or NRM (p=0.08; (infection, GVHD, other)) than patients with a BMI <30 kg/m^2, but as a whole group, they had significantly more posttransplant events (p<0.001).

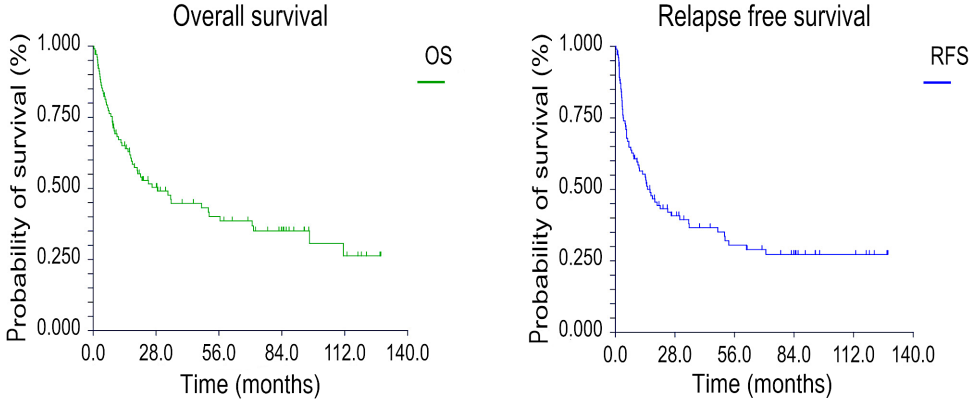

Figure 3. OS and RFS of the cohort.

Table 3. Univariate analysis of biological and transplant characteristics and correlations with OS and RFS (log-rank test).

Characteristic	Number of patients	HR (95% CI)	p-value OS	HR (95% CI)	p-value RFS
age of recipient					
< 40, N (%)	28	0.76 (95% CI: 0.44–1.31)	0.35	0.88 (95% CI: 0.53–1.48)	0.64
≥ 40, N (%)	76				
sex, recipient/donor, N (%)					
male	57	1.04 (95% CI: 0.62–1.72)	0.89	0.84 (95% CI: 0.59–1.54)	0.84
female	47				
Karnofsky index (%)					
90-100%	60	0.56 (95% CI: 0.33–0.94)	0,02	0.55 (95% CI: 0.33–0.91)	0.01
< 90%	44				
HCT-CI score, N (%)					
0-2	69	0.83 (95% CI: 0.48–1.43)	0.48	1.05 (95% CI: 0.63–1.75)	0.85
≥ 3	34				
BMI at alloSCT, N (%)					
< 30 kg/m^2	86	0.31 (95% CI: 0.13–0.71)	<0.001	0.34 (95% CI: 0.15–0.77)	<0.001
≥ 30 kg/m^2	18				
conditioning, N (%)					
MAC	41	1.13 (95% CI: 0.67–1.9)	0.65	1.10 (95% CI: 0.67–1.81)	0.69
RIC+NMA	63				
donor type, N (%)					
match sibling	90	1.07 (95% CI: 0.44–2.61)	0,88	1.53 (95% CI: 0.71–3.29)	0.35
haploidentical	14				
disease status before alloSCT, N (%)					
CR	77	0.54 (95% CI: 0.33–0.90)	0.02	0.44 (95% CI: 0.27–0.72)	<0.001
no CR	23				
ABO matching					
matched	61				
major mismatched	17		0.70		0.27
minor mismatched	23				
bidirectional	3				
aGVHD, N (%) according to MAGIC					
yes	53	1.23 (95% CI: 0.74–2.05)	0.52	1.2 (95% CI: 0.74–1.94)	0.45
no	51				
cGVHD according to NIH, N (%)					
yes	44	0.46 (95% CI: 0.26–0.84)	0.01	0.55 (95% CI: 0.32–0.94)	0.02
no	44				

Abbreviations: MAC-myeloablative; RIC+NMA-reduced intensity and nonmyeloablative; CR-complete remission; aGVHD-acute graft-versus-host disease; cGVHD-chronic graft-versus-host disease; OS-overall survival; RFS-relapse-free survival

Table 4. Multivariable analysis of transplant outcomes (Cox regression test).

Variable	OS		RFS	
	RR (95% CI)	p-value	RR (95% CI)	p-value
Karnofsky index (%)				
90–100%	1.3 (0.7–2.6)	0.38	1.3 (0.7–2.4)	0.41
<90%				
BMI at alloSCT, N (%)				
<30 kg/m^2	2.6 (1.2–5.6)	0.02	2.6 (1.2–5.5)	0.01
≥30 kg/m^2				
disease status before alloSCT, N (%)				
CR	1.2 (0.7–2.2)	0.67	1.4 (0.8–2.6)	0.27
no CR				
cGVHD according to NIH, N (%)				
yes	0.5 (0.3–1.0)	0.04	0.6 (0.4–1.1)	0.08
no				

Abbreviations: OS-overall survival; RFS-relapse-free survival; RR-risk ratio; BMI-body mass index; CR-complete remission

According to the univariable analysis, patients without cGVHD had significantly higher RM than patients with cGVHD (p<0.001). We found significantly higher NRM in patients with cGVHD (p=0.01), especially mortality due to infections, which was close to statistical significance (p=0.06). The 3-year OS in the groups of patients without cGVHD and with mild, moderate, and severe cGVHD was 38.7% (95% CI: 22.9–54.4%), 100%, 66.2% (95% CI:

41.6–90.8%), and 62.3% (95% CI: 42.6–81.9%), respectively, with a median OS of 18.3 months, not reached, 96.3 months, and 56.5 months, respectively, with evidence of statistical significance (log-rank test p=0.05). The difference in 5-year RFS between the groups of patients was not significant (p=0.11).

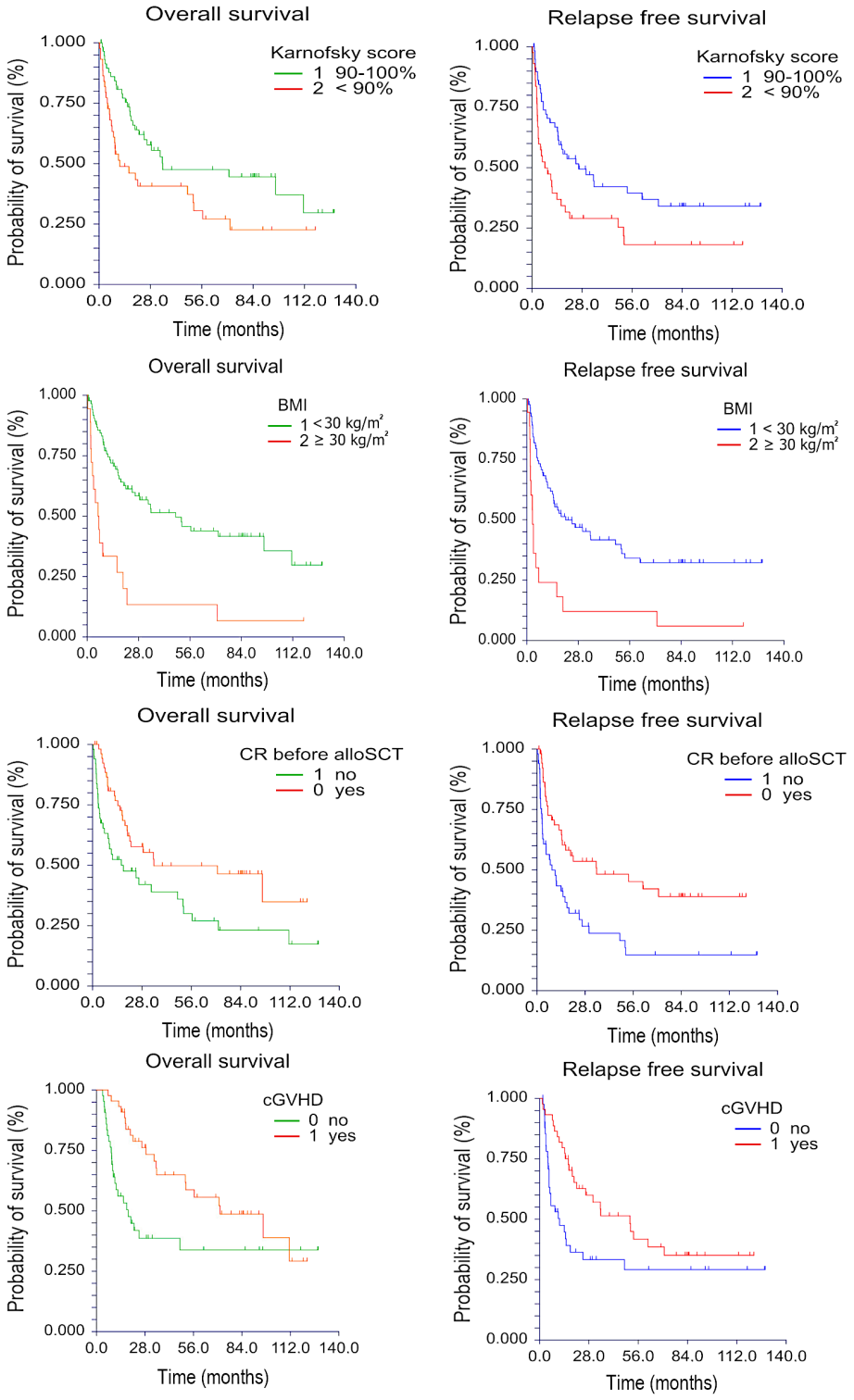

Figure 4. OS and RFS according to Karnofsky score, status of complete remission before alloSCT, BMI, and presence of cGVHD.

Discussion

This analysis summarizes the real-life data of alloSCT from a single center in Slovakia.

A recent survey by the EBMT describing activity in HCT centers in Europe reported that the main diagnoses with indications for alloSCT were acute myeloid leukemia (AML, 39%), acute lymphoblastic leukemia (ALL, 17%), and myelodysplastic syndrome or myelodysplastic/myeloproliferative neoplasm overlap (13%) [16]. In our cohort, the most frequently represented diagnoses were AML (33.7%), NHL (16.3%), and ALL (12.5%). The higher number of NHLs in our study reflects the 10-year follow-up, while the EBMT reported annual data. Notably, the number of NHLs indicated for alloSCT in our center decreased with the start of CAR-T-cell therapy in 2023.

The cumulative incidence rates of aGVHD at days +100, Grades II–IV (25.3%) and Grades III–IV (12.8%) correspond to the results of Greinix et al. [17], with reported incidences of 28% and 11%, respectively. aGVHD of the skin is reported to be the most affected organ, followed by the GIT and liver [18]. The same order of organ involvement in aGVHD was confirmed in our analysis (skin, lower GIT, liver, upper GIT). cGVHD is associated with declines in all aspects of life across all age groups. It also leads to increased late mortality [19, 20]. The cumulative incidence of cGVHD at 1 year after alloSCT was 46.3%, which was similar to the 42.3% reported in the study of Langer et al. [18]. The 2-year cumulative incidence of cGVHD was 62.4% higher than that reported by Arora et al. (47%) [21]. In that study, correlations between the incidence of cGVHD and the type of donor, CMV serostatus, disease diagnosis, and race/ethnicity were found. In our study, chi-square analysis revealed that none of the monitored variables (donor type, donor/recipient sex, conditioning regimen, CR before alloSCT, age, Karnofsky index, BMI, previous aGVHD) were predictive of cGVHD. Potential explanations for the higher cumulative incidence of cGVHD could be the 100% use of PB as a stem cell source and the limited use of ATG – administered in only 5 patients. The majority of sibling transplants (within the total cohort of 104 patients) were performed without ATG, a well-established agent for reducing the risk of cGVHD. Following the EBMT guidelines introduced in 2020, we have progressively adopted ATG as a standard component of GVHD prophylaxis in matched related and unrelated donor transplants. We also refer to a multicenter prospective study evaluating the 2-year cumulative incidence of cGVHD, where in the whole cohort, it was 35%, with the highest incidence in PB recipients at 43.7%, compared with 34.4% for bone marrow and 31.6% for cord blood, although the difference was not statistically significant (p=0.26) [22]. In our cohort, patients with cGVHD of any severity had longer 5-year OS than patients without cGVHD. A possible explanation, consistent with previously published data, is that patients with cGVHD had a protective graft-versus-tumor effect, as they had a significantly lower number of relapses and lower RM compared to patients without cGVHD [18, 23]. Patients with cGVHD primarily died from nonrelapse causes, especially infections, supporting the notion that cGVHD contributes to transplantation-related mortality. This observation is in correlation with the findings of Bhatt et al., who reported that cGVHD was significantly associated with a higher risk of NRM and lower risk of relapse, regardless of age [24]. Furthermore, they also reported that severe cGVHD was associated with shorter OS, whereas mild and moderate cGVHD were associated with longer OS. These results are consistent with our findings, where patients with mild and moderate cGVHD had longer 3-year OS compared to those without cGVHD or with severe cGVHD.

With respect to 3-year and 5-year OS and RFS, our analysis demonstrated that a BMI ≥30 kg/m^2 was significantly associated with worse OS and RFS. We confirmed that this group of patients had more posttransplant events of any type in relation to higher RM and NRM than did patients with a BMI < 30 kg/m^2. Doney et al. reported that very obese patients (BMI ≥35 kg/m^2) had increased NRM, which was associated with the intensity of the conditioning regimen, and with long-term follow-up, they reported increased NRM in obese patients (BMI 30.0–34.9) [25]. In our study, we did not find any correlation between BMI or NRM and the intensity of the conditioning regimen. We agree with Doney et al. that patients need to be informed of their increased risk of NRM based on their BMI and need to be controlled in their comorbidities, such as hypertension, diabetes, and hyperlipidemia.

The lower OS and RFS in our cohort may have been affected by the greater proportion of patients without CR before alloSCT, and therefore, the greater number of patients who died from relapse and persistence/progression in the first year after transplantation.

The reported data summarize more than 10 years of activity and outcomes of HSCT within an unselected patient cohort from a single transplantation center in Slovakia. Our analysis has several limitations; thus, the results must be interpreted with caution. These include the retrospective design of the study, the small number of patients in a single institution, slow patient recruitment in a low population country, a nonhomogeneous cohort: various diagnoses, the use of different treatment protocols that change over time according to the availability of innovative drugs, and new treatment possibilities for GVHD.

This study identified important factors that negatively affect OS and RFS, namely, status without cGVHD and BMI ≥30 kg/m^2, and revealed that obese patients had more posttransplant complications associated with mortality. Patients with cGVHD died mostly from nonrelapse causes, especially infections, whereas patients without cGVHD had significantly higher RM.

The factors affecting OS and RFS are potentially modifiable, but further improvements in transplant practices and

supportive care are needed to decrease relapses and other transplant complications, especially cGVHD. Some patients, however, benefit from transplantation. An evaluation of the quality of life before and after alloSCT would also be meaningful.

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