blood advances

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Trends in Volumes and Survival After Hematopoietic Cell Transplantation in Racial/Ethnic Minorities

Tracking no: ADV-2023-012469R1

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Abstract:
There has been an increase in volume as well as improvement in overall survival (OS) after hematopoietic cell transplantation (HCT) for hematologic disorders. It is unknown if these changes have impacted racial/ethnic minorities equally. In this observational study from Center for International Blood and Marrow Transplant Research of 79,904 autologous (auto) and 65,662 allogeneic (allo) HCTs, we examined the volume and rates of change of auto HCT and allo HCT over time and trends in OS in 4 racial/ethnic groups: Non-Hispanic Whites (NHWs), Non-Hispanic African Americans (NHAAs), Hispanics across five 2-year cohorts from 2009 to 2018. Rates of change were compared using Poisson model. Adjusted and unadjusted Cox proportional hazards models examined trends in mortality in the 4 racial/ethnic groups over 5 study time periods. The rates of increase in volume were significantly higher for Hispanics and NHAAs vs. NHW for both autoHCT and alloHCT. Adjusted overall mortality after autoHCT was comparable across all racial/ethnic groups. NHAA adults (HR 1.13; 95% CI 1.04-1.22; p=0.004) and pediatric patients (HR 1.62; 95% CI 1.3-2.03; p<0.001 had a higher risk of mortality after alloHCT compared to NHWs. Improvement in OS over time was seen in all 4 groups after both autoHCT and alloHCT.Our study shows the rate of change for the use of autoHCT and alloHCT is higher in NHAAs and Hispanics compared to NHWs. Survival after autoHCT and alloHCT improved over time, however NHAAs have worse OS after alloHCT which has persisted. Continued efforts are needed to mitigate disparities for patients requiring alloHCT.

Conflict of interest: COI declared - see note

COI notes: Dr. Ailawadhi reports consultancy for GSK, Sanofi, BMS, Takeda, Beigene, Janssen, Regeneron, Cellectar, and Pfizer; and research funding from GSK, BMS, Pharmacyclics, Amgen, Janssen, Cellectar, AbbVie, Ascentage, and Sanofi. Dr. Ustun reports honoraria (speakers' bureau) from Takeda. Dr. Ciurea reports advisory board participation for Hansa Therapeutics, CardDx, Spectrum/Acrotech, Kiadis Pharma, Allogene, Celularity, MolMed, and Phamacyclics; and research funding from Miltenyi Biotech, and Kiadis Pharma. Dr. Savani reports a government COI. Dr. Sharma reports compensation (consulting) for Spotlight Therapeutics, Medexus Inc., Vertex Pharmaceuticals, Sangamo Therapeutics, and Editas Medicine; serving as a medical monitor for RCI BMT CSIDE clinical trial which receives financial compensation; research funding from CRISPR Therapeutics; honoraria from Vindico Medical Education; serving as the St. Jude Children's Research Hospital site principal investigator of clinical trials for genome editing of sickle cell disease sponsored by Vertex Pharmaceuticals/CRISPR Therapeutics (NCT03745287), Novartis Pharmaceuticals (NCT04443907) and Beam Therapeutics (NCT05456880). The industry sponsors provide funding for the clinical trial, which includes salary support paid to Dr Sharma's institution. Dr Sharma has no direct financial interest in these therapies. Dr. Cerny reports being a DSMB member for ICON- Allovir Inc., and ICON-Prolacta; being an advisory board member for MERIT CRO, and Bristol-Myers Squibb; and stocks for Actinium Pharmaceuticals Inc., Bluebird Bio, Celectar Biosciences, Danavax Technologies, Gamida Cell, Atyr Pharma, Novavax, Ovid Therapeutics, Sorrento Therapeutics, Very Inc, Viridian Therapeutics, Vaxart Inc, and 2seventy Bio Inc Reg SHS. Dr. Kelkar reports research funding from CareDx. Dr. Kindwall-Keller reports consulting fees (DSMC) from OrcaBio. Dr. Steinberg reports speakers' bureau participation for Jazz Pharmaceuticals and advisory board participation for MorphoSys. Dr. Wood reports research funding (to institution) from Pfizer and Genentech; serving as an advisor for Koneksa Health; and consulting for Teladoc. Dr. Rangarajan reports being a Medical Monitor for the CD33 CAR Study (unpaid); and having a contract with NMDP (unpaid).

Preprint server: No;

Author contributions and disclosures: N.K., S.A., R.B., J.P., B.J., W.S., and T.H. were responsible for conception and design. R.B., J.P., B.J., and W.S. were responsible for acquisition of data. N.K., S.A., R.B., J.P., B.J., WS., and T.H. were responsible for the analysis. R.B., J.P., B.J., and W.S. were responsible for administrative, technical, or material support. All authors were responsible for the interpretation of data and the writing, review, and/or revision of the manuscript.

Non-author contributions and disclosures: No;

Agreement to Share Publication-Related Data and Data Sharing Statement: The final analysis dataset will be posted to the CIBMTR website at: https://cibmtr.org/CIBMTR/Resources/Publicly-Available-Datasets#.

Clinical trial registration information (if any):

Title: Trends in Volumes and Survival After Hematopoietic Cell Transplantation in Racial/Ethnic Minorities

Short Title: Disparities in HCT

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Data Sharing Statement:

The final analysis dataset will be posted to the CIBMTR website at:

https://cibmtr.org/CIBMTR/Resources/Publicly-Available-Datasets#.

Abstract word count: 246

Manuscript Word Count: 3103

Figures/ Tables: 4

Number of References: 50

Key Points

1. The number of autoHCT and alloHCT grew faster in Non-Hispanic African Americans and Hispanics compared to Non-Hispanic Whites.
2. Survival after autoHCT and alloHCT improved over time for all racial/ ethnic groups, though African Americans have worse outcomes.

Abstract

There has been an increase in volume as well as improvement in overall survival (OS) after hematopoietic cell transplantation (HCT) for hematologic disorders. It is unknown if these changes have impacted racial/ethnic minorities equally. In this observational study from Center for International Blood and Marrow Transplant Research of 79,904 autologous (auto) and 65,662 allogeneic (allo) HCTs, we examined the volume and rates of change of auto HCT and allo HCT over time and trends in OS in 4 racial/ethnic groups: Non-Hispanic Whites (NHWs), Non-Hispanic African Americans (NHAAs), Hispanics across five 2-year cohorts from 2009 to 2018. Rates of change were compared using Poisson model. Adjusted and unadjusted Cox proportional hazards models examined trends in mortality in the 4 racial/ethnic groups over 5 study time periods. The rates of increase in volume were significantly higher for Hispanics and NHAAs vs. NHW for both autoHCT and alloHCT. Adjusted overall mortality after autoHCT was comparable across all racial/ethnic groups. NHAA adults (HR 1.13; 95% CI 1.04-1.22; p=0.004) and pediatric patients (HR 1.62; 95% CI 1.3-2.03; p<0.001 had a higher risk of mortality after alloHCT compared to NHWs. Improvement in OS over time was seen in all 4 groups after both autoHCT and alloHCT.Our study shows the rate of change for the use of autoHCT and alloHCT is higher in NHAAs and Hispanics compared to NHWs. Survival after autoHCT and alloHCT improved over time, however NHAAs have worse OS after alloHCT which has persisted. Continued efforts are needed to mitigate disparities for patients requiring alloHCT.

Introduction

The number of autologous (autoHCT) and allogeneic (alloHCT) hematopoietic cell transplants (HCT) continues to increase.[1] Outcomes after autoHCT and alloHCT have improved over time, likely due to improved transplantation techniques and supportive care.[2-8] Racial/ethnic disparities in access and outcomes of HCT are well documented.[9-16] The origin of these inequities is complex and multifactorial: medical (higher comorbidities, lack of optimum donor sources, aggressive biology) and non-medical (socioeconomic and health system/payer related) barriers. Increasing diversity of the US population has increased attention to, and investment in, ensuring equitable access to optimal cancer care.[17] Systematic efforts to reduce gaps in health insurance and eliminate discrimination and bias include national initiatives and policies such as the Affordable Care Act to increase access to medical care. The transplant community has made efforts to mitigate disparities by provider education for improved patient referral and selection, better understanding of financial barriers to transplant and expanding the donor pool by public investment in donor recruitment and use of alternative donor sources.[8,18,19]

It is not known if these efforts have decreased the gap in HCT utilization between different racial/ethnic groups. It is also not known if the improved transplantation techniques and supportive care have benefitted racial/ethnic minorities equally in terms of survival. In other cancers, significant advancements in treatment and outcomes have occurred over time, but racial/ethnic and socioeconomic disparities in outcomes persist.[20-24]

The purpose of this study was to analyze trends over time for the volume and rate of change for autoHCT and alloHCT performed in the U.S for all diseases by racial/ethnic group from 2009 to 2018. We also report trends in survival for those who were transplanted for specific diseases by racial/ethnic group, adjusting for clinical and sociodemographic factors. The results provide a start to understand gaps in real-world access to and outcomes of HCT in the modern era to continue to design future efforts to reduce disparities.

Patients and Methods

About the CIBMTR

Data were obtained from the Center for International Blood and Marrow Transplant Research (CIBMTR) which collects patient data on 90% of autoHCT and nearly all alloHCT recipients in the U.S. The CIBMTR is a research collaboration of the Medical College of Wisconsin and the National Marrow Donor Program (NMDP)/Be The Match. Two hundred six US transplant centers contribute data on consecutive HCTs to the CIBMTR. Observational studies by CIBMTR are compliant with the Privacy Rule as a Public Health Authority and with all applicable federal regulations for protection of human research participants as determined by continuous review of the NMDP Institutional Review Board.

Study Population

For this study, we included all autoHCT (adults) and alloHCTs (adults and children) reported to CIBMTR between 2009 and 2018. Patient selection criteria included first HCTs performed in the U.S, consented for research use of observational data and excluded those with missing race/ethnicity information and multi-race individuals. We compared the volume of autoHCT and alloHCT in 4 different racial/ethnic groups: Non-Hispanic Whites (NHWs), Non-Hispanic African Americans (NHAAs), Hispanics and 'Others' across five 2-year cohorts from 2009 to 2018. 'Others' included American Indians or Alaska Natives, Asians, and Native Hawaiian or Other Pacific Islanders since the numbers in individual categories were too low to be meaningful. Asians formed >80% of the 'Others' category (Supplementary table 1).

Data collection

The CIBMTR collects data at two levels: transplant-essential data (TED) and comprehensive report form (CRF) data before HCT, 100 days and 6 months post-HCT, and annually thereafter until death. TED includes disease type, age, sex, pre-HCT disease status, diagnosis date, graft type, conditioning regimen, relapse and survival. All centers reporting to CIBMTR submit TED-level data. More detailed clinical information is collected for a subset of patients selected for CRF track by a weighted randomization schema. CRF data includes detailed clinical characteristics (disease risk index, Karnofsky performance score, HCT-comorbidity index) and detailed sociodemographic variables including insurance, education, marital status and five-digit zip code. Zip code was used to determine the geographic region per CIBMTR

classification, distance from transplant center and calculate the proportion of the population below national poverty level.[25]

Outcomes

Volume of transplants was assessed using TED forms to get the broadest representation of HCT use. CRF level data was used to enable adjustment for detailed patient level variables for survival analysis for specific diseases: multiple myeloma (MM), non-Hodgkin lymphoma (NHL) and Hodgkin lymphoma (HL) for autoHCT (these 3 diseases account for 90% of autoHCTs) and acute myeloid and lymphoblastic leukemia (AML and ALL), lymphoma (NHL including chronic lymphocytic leukemia and HL) and myelodysplastic syndrome/ myeloproliferative neoplasms (MDS/MPN) for alloHCT (these diseases account for >80% of alloHCTs).

Statistical Analysis

Volume and rates of change for autoHCT and alloHCT for all diagnoses were reported. Descriptive statistics, including proportions, medians, and ranges were calculated for baseline characteristics in all groups. Trends in proportions of racial/ethnic groups over time were assessed using generalization of the Cochran-Armitage test. Poisson model was used to model the overall and race/ethnicity specific rate of change in the number of transplants over time.

Rate of change was calculated as the year-over-year (for each combined 2-year cohort) increase/decrease in volume and was compared between the racial/ethnic groups. Graphical diagnostic tools indicated that the rate of change was constant from one 2-year time period to another. A p-value<0.001 was considered statistically significant for rate of change in the number of transplants. Specific patterns of transplant volumes were examined by age, disease type for both auto and allo HCT and donor type for alloHCT.Overall survival (OS) estimates were calculated using the Kaplan-Meier method. Cox proportional hazards models examined differences in risk of mortality after autoHCT in adult patients (for NHL, HL, and MM), and adult and pediatric (<18 years of age) alloHCT patients (for AML, ALL, lymphoma, and MDS/MPN) in the 4 racial/ethnic groups over 5 study time periods. Models were adjusted for age, sex, Karnofsky/Lansky performance score (KPS/LPS), HCT-comorbidity index, disease, disease status,

geographic region, insurance, marital status, education, distance to the transplant center and median income. Graft type, donor, conditioning, GVHD prophylaxis, donor-recipient CMV match and donor-recipient sex match were considered in alloHCT models. Time from diagnosis was not included in the multivariable analysis because of the heterogeneity of diagnoses. In all models, center effect was accounted for via random effect with log-normal distribution. After stepwise model selection, only variables significant at 0.01 level were retained. The primary variables of interest - race/ethnicity and year of transplantation were included in all models. Interaction between race/ethnicity and year was not significant in any model. Interaction between race and donor type was found to be significant in the Cox model for mortality among alloHCT adult patients, therefore a stratified analysis was performed by donor type in this patient group. Analyses were performed using SAS statistical software (SAS Institute, Cary, NC).

Results

Volumes and Rate of change by race/ ethnicity

From 2009 to 2018, a total of 79,904 autoHCTs and 65,662 alloHCTs were reported to CIBMTR. The volume of autoHCT and alloHCT performed each year increased overall, and within each race/ethnicity group from 2009 to 2018. Figure 1 shows the proportion of autoHCT and alloHCT recipients in each of the 4 racial/ethnic groups in the terminal time cohorts (2009-2010 and 2017-2018), demonstrating an increase in the relative proportion of racial/ethnic minorities and corresponding decrease in the relative proportion of NHW in both autoHCT and alloHCT. The rate of change was two to three times higher in racial/ethnic minorities compared to NHWs for both autoHCT and alloHCT. (Table 1)

The increased rate of change in volume of autoHCTs per time period was significantly higher for Hispanics ($p<0.001$) and NHAAs ($p=0.0001$) compared to NHWs, but not significantly different between NHWs and Others ($p=0.005$) or between NHAAs and Hispanics ($p=0.19$). Similarly, the increased rate of change for alloHCT was significantly higher for Hispanics ($p=0.0002$) and NHAAs ($p=0.0006$) compared to NHW, but not significantly different between NHWs and Others ($p=0.07$) or between NHAAs and Hispanics ($p=0.78$).

Baseline characteristics by race/ethnicity

For autoHCT, MM was more common in NHAAs as compared to all other groups (77% in NHAAs vs 55% in Hispanics, 58% in NHWs and 53% in Others). Most autoHCTs in Hispanics, NHAAs and Others were reported from the West or South regions of the U.S., while NHWs had a more even geographic distribution. Private insurance was more common in NHWs and Others as compared to Hispanics and NHAAs. A higher proportion of NHWs and Others were married as compared to Hispanic and NHAAs (Supplementary tables 2 and 3).

For alloHCT in adult patients, median age at HCT was higher for NHWs as compared to all other groups (55 years in NHWs vs. 31 in Hispanics, 37 in NHAAs and 41 in Others; $p<0.01$). A higher proportion of NHWs who underwent alloHCT had a poor KPS<80 (12% in NHWs vs. 8% in Hispanics, 10% in NHAAs and Others). A higher proportion of Hispanics received myeloablative conditioning than other groups (61% vs. 47% in NHWs, 47% in NHAAs and 52% in Others). Unrelated donor HCTs (both HLA-matched and mismatched) were more common in NHWs than all groups (54% in NHWs vs. 33% in Hispanics, 26% in NHAAs and 35% in Others). Cord blood (16% in Hispanics, 17% in NHAAs, 15% in Others and 7% in NHWs) and haploidentical donors (14% in Hispanics, 25% in NHAAs, 14% in Others and 9% in NHWs) were more common in minority groups compared to NHWs. Geographic distribution was relatively equal amongst U.S. regions for NHWs with a higher proportion of Hispanics and Others in West and NHAAs in South. Private insurance was more common in NHWs and Others (57% in NHWs, 60% in Others vs. 46% and 51% respectively in Hispanics and NHAAs). Higher distance from transplant center was seen in NHWs as compared to other groups (median 42 miles vs. 23 miles in Hispanics, 19 miles in NHAAs and 21 miles in Others) (Supplementary tables 4 and 5).

In pediatric patients, ALL was the indication for alloHCT in a higher proportion of Hispanics (56% in Hispanics vs. 35% in NHWs, 39% in NHAAs and 37% in Others). Cord blood and haploidentical donors were least common in NHWs. Geographic distribution showed higher proportion of Hispanics and NHAAs in West and South, respectively. Distance from transplant center was higher for NHWs (median 47 miles) as compared to Hispanics (26 miles), NHAAs (20 miles) and Others (22 miles). Private

insurance was more common in NHWs (54%) and Others (48%) as compared to Hispanics (23%) and NHAAs (25%) (Supplementary table 6).

Subgroup analysis for volume/ rate of change

For autologous transplants, NHWs experienced lower volumes between 2009-10 and 2017-18 for patients under 40 years, with stable volume in 40-59 years and a 72% increase in auto HCTs for patients >60 years. Auto HCT for MM increased 62% while lymphoma volumes were stable and other diseases decreased.

In contrast to NHW, Hispanics experienced modest increases in volumes for patients under 40 years, while auto HCT for 40-59 years increased 67% and >60 years increased almost 3-fold. Auto HCT volume more than doubled for MM and increased 83% for lymphomas with other diseases staying stable.

Also, in contrast to NHWs, NHAAs experienced modest increases in volumes for patients under 40 years, while auto HCT for 40-59 years increased 48% and more than doubled for >60 years. Auto HCT volume almost doubled for MM and increased 23% for lymphomas with other diseases staying stable.

In case of alloHCT, NHWs had the largest volume increases between 2009-10 and 2017-18 for MDS/MPN (70% increase) and acute leukemias (29% increase) but had a 40% decrease in the volume of allo HCT for lymphomas and 12% decrease for other diseases. NHW saw lower volumes in every age group under 60 years, however the >60 years group increased 74%. The use of HLA-identical siblings decreased by 19% while non-HLA identical sibling donors (including haplo-identical and other related HLA mismatched donors) increased by almost 4-fold. Well matched (HLA 8/8) unrelated donors increased 49% while mismatched unrelated and cord blood transplants all decreased by at least 25%.

Hispanics had larger volume increases than NHWs for MDS/MPN (89% increase), acute leukemias (65% increase) while other diseases had modest increases (<10%). In contrast to NHWs, Hispanics demonstrated increases in volume for all age groups (2.6-fold increase in patients >60 years, 1.7-fold in 40-59 years, 1.5-fold 20-39 years and 1.1-fold increase in <20 years). Most of the volume increases for Hispanics were due to a 7.3-fold increase in the use of non-HLA identical sibling donors (including haplo-identical and other related HLA mismatched donors) and more than doubling the volume of 8/8 HLA matched unrelated donors.

NHAAs had larger volume increases than NHWs for MDS/MPN (81% increase) and acute leukemias (67% increase) and also had a 26% increase in lymphomas and 40% increase in other diseases. In contrast to NHW, NHB saw increases in every age group (2.5-fold increase in patients >60 years, 1.4-fold in 40-59 years, 1.5-fold 20-39 years and 1.4-fold increase in <20 years). The majority of volume increases for NHAAs were due to a 4.3-fold increase in the use of non-HLA identical sibling donors (including haplo-identical and other related HLA mismatched donors) and almost doubling the volume of 8/8 HLA matched unrelated donors Mortality/Survival After AutoHCT using data from patients included in CRFs

Unadjusted analysis showed significantly lower risk of overall mortality in NHAAs, however there was no significant difference in mortality risk by race/ethnicity after multivariable adjustment. Unadjusted analysis also showed significantly lower risk of mortality in the more recent cohorts, which remained significant after adjustment for other significant covariates (Table 2). Other factors associated with higher risk of mortality included older age, male, NHL, not in complete remission at HCT, high HCT-comorbidity index, KPS<80 and being single/divorced or widowed (Supplementary table 7). The adjusted 2-year OS improved over time in all 4 racial/ ethnic groups as depicted in Figure 2A.

Mortality/Survival After AlloHCT in adults using data from patients included in CRFs

Both unadjusted and adjusted analysis showed a significantly higher risk of overall mortality in NHAAs vs. NHWs. There was a significant decrease in risk of overall mortality over time for all alloHCT recipients (Table 2). Other significant factors in the multivariable analysis include age, diagnosis, disease risk, HCT-comorbidity index, KPS, donor type and insurance (Supplementary table 8). Temporal patterns in the adjusted 2-year OS in all racial/ethnic groups showed NHAAs having worse survival than all the other groups (Figure 2B). In the stratified analysis, there was no significant difference in risk of mortality by race/ethnicity for HLA-identical sibling or other related donor alloHCTs. NHAAs had a significantly higher risk of mortality after well-matched and partially matched unrelated donor alloHCT but not after cord blood transplants. Hispanics had a higher risk of mortality only after cord blood transplant. (Supplementary table 9)

Mortality/Survival After AlloHCT in pediatric patients using data from patients included in CRFs

In pediatric patients, there was a significantly higher risk of overall mortality in NHAAs and Others compared to NHWs in unadjusted and multivariable analyses (Table 2). In the adjusted analysis, there was a significantly lower risk of overall mortality in the most recent 3 time periods. Other significant factors in the multivariable analysis include relapsed/refractory disease, recipient CMV serostatus and an HCT-CI>3 (Supplementary table 10). The gaps in OS were more evident with NHAAs and Others doing worse. (Figure 2C)

Discussion

Our large population-based national cohort study of over 145,000 patients shows an increase in the rates of change in volume and improved survival after autoHCT and alloHCT in adults and children from 2009 to 2018 for all racial/ethnic groups despite sociodemographic differences such as age, geographic region, and private vs. public insurance between the groups. Progress is reflected in higher rates of increase in volume for both autoHCT and alloHCT in racial/ethnic minority groups as compared to NHWs, aligned with changes in the proportions of these demographic groups in the U.S. population.There was some variation in patterns of rate of change across the subgroups based on age, disease and donor type across race/ethnicity. Comparable survival was seen across all racial/ethnic groups for autoHCTs. Higher risk of mortality remains a challenge for NHAAs and Others undergoing unrelated donor alloHCT despite improvement in OS over time. Hispanic adults had comparable risk of overall mortality to NHWs unlike previous CIBMTR studies.[13,26]

Racial/ethnic barriers to access and outcomes in autoHCT have been explored in previous studies.[12,27-33]Additionally, studies report improved survival for the more recently treated patients undergoing autoHCT for MM, although not for specific racial/ethnic groups.[34] In our study, the rate of change for increase in autoHCTs over time was significantly higher for NHAAs, Hispanics and Others as compared to NHWs. While some of the increase in autoHCT volume may be attributed to increases in the population of these racial/ethnic groups, factors such as an increase in number of HCT centers, policy changes such as Medicaid expansion etc. may have contributed. Medicaid expansion is associated with improvements in access and health status/outcomes.[35,36]

MM was a common indication for autoHCT in a higher proportion of NHAAs compared to other groups, likely due to its higher incidence in NHAAs as compared to NHWs.[37] Mortality after autoHCT decreased over time and was comparable for all racial/ethnic groups. Prior studies report that race/ethnicity do not affect autoHCT outcomes, especially with access to timely transplant.[27,28]

In addition to socioeconomic barriers, lack of optimal donors may impact access to alloHCT for minority patients with a 75% probability of finding an 8/8 HLA-matched donor for patients of European descent, 16 to 19% for NHAAs and between 27 to 52% for Hispanics, Asian, Pacific Islander, and Native American groups.[11,16,32,38,39]Use of HLA-mismatched unrelated donors, cord blood and haploidentical donors has helped widen the donor pool leading to a significantly higher rate of alloHCT in NHAAs and Hispanics.[1,8,40] In our study, a higher proportion of Hispanics and NHAAs received alternative donor sources (cord blood and haploidentical HCT) as compared to NHWs receiving more HLA-matched sibling and unrelated transplants. Younger age of Hispanics undergoing HCT reflects the overall population demographic. A higher incidence of ALL in Hispanics vs. all other groups (age adjusted rate of 2.9 per 100,000 persons in Hispanics vs 1.8 in NHWs and 1.1 in NHAAs) is a possible reason for ALL being a more common indication for alloHCT in Hispanic children.[41]

Outcomes continue to improve over time for most patients undergoing HCT, similar to Hahn et al.[3] Mortality risk was comparable between NHWs and Hispanics, but higher for NHAAs for unrelated alloHCT only. There are similarities and differences between our results and previous studies.[13-15,42]Minority patients have worse socioeconomic parameters reflected by a higher proportion of those below the national poverty level, lower education and higher proportion of those with public insurance in Hispanics and NHAAs as compared to NHWs in our study. The term 'Hispanic Paradox' is not well understood, but is observed when mortality risk is similar to or better than NHW despite the unfavorable socioeconomic profile of Hispanics.[43] On the other hand, NHAAs with a similar socioeconomic profile to Hispanics, have considerably higher mortality risk than NHWs.[44] Disease biology may have impacted outcomes. Insurance may play a role as well with poor outcomes reported in pediatric patients with Mediciad.[45] Poor survival after alloHCT, but not autoHCT for NHAAs may be due to higher mortality for this group with

unrelated donors, but also likely due to the more complicated and prolonged post HCT recovery period after alloHCT, prone to disparities in quality of care and difficulty participating in follow-up (distance, financial toxicity, availability of caregiver support, etc).

There are certain limitations to our study. The numbers of HCT in Asian, Native American and Pacific Islander groups were not enough to provide meaningful results, so they were combined as an 'Others' category. The CIBMTR collects data only for patients who undergo transplant with no information about the denominator as to how many patients would be optimal candidates for transplant. Hence, we report only on rate of change, rather than true utilization, which we are investigating in a separate ongoing study using data from Surveillance, Epidemiology, and End Results (SEER) Program and the U.S. Census to calculate the denominator. Attribution of patient race/ethnicity in the CIBMTR provided by the transplant centers is self-reported and centers are regularly audited on this critical data field. We did not have the detailed sociodemographic data in the TED forms to adjust the rate of change analysis. Finally, we acknowledge that this is a quantitative study describing the change in volume and outcomes over time. But our results can help understand gaps that drive disparities and provide a foundation for qualitative work to understand the impact of implicit bias and quality of care on post-HCT survival when treating minority groups specifically NHAAs.[46] We hope that this study will be pivotal in distributing resources and/or strategizing future actions to improve on the progress already made.

The U.S. population has become more diverse with the proportion of NHW decreasing from 64% in 2010 to 58% in 2020.[47] The increasing diversity compels us to strengthen our efforts to improve access to and outcomes after HCT, both in routine practice and clinical trials. Disparities in access will be more complicated with highly expensive and complex cellular therapies, thus efforts will be needed to narrow the gap for patients requiring these treatments, irrespective of their socioeconomic characteristics.[48,49] Leveraging advanced genomics and molecular technologies and computational tools to better understand the interaction of biological factors and social determinants of health can help decrease disparities in outcomes. The recent ACCESS initiative is a timely multi-stakeholder initiative to reduce barriers and outcome disparities in HCT/cellular therapy.[50]

Our study highlights the progress in increasing the rate of change in autoHCT and alloHCT for everyone and in narrowing the gap in survival between race/ethnicity groups for certain diseases. However, the risk of overall mortality for NHAAs remains high, indicating the need for investment in research, training, practice and community engagement to address the remaining disparities and enable everyone to enjoy the benefits from scientific advances.

Acknowledgments

Funding:

The CIBMTR is supported primarily by the Public Health Service U24CA076518 from the National Cancer Institute (NCI), the National Heart, Lung and Blood Institute (NHLBI) and the National Institute of Allergy and Infectious Diseases (NIAID); 75R60222C00011 from the Health Resources and Services Administration (HRSA); N00014-21-1-2954 and N00014-23-1-2057 from the Office of Naval Research; Support is also provided by Be the Match Foundation, the Medical College of Wisconsin, the National Marrow Donor Program, Gateway for Cancer Research, Pediatric Transplantation and Cellular Therapy Consortium and from the following commercial entities: AbbVie; Actinium Pharmaceuticals, Inc.; Adaptimmune; Adaptive Biotechnologies Corporation; ADC Therapeutics; Adienne SA; Allogene; Allovir, Inc.; Amgen, Inc.; Angiocrine; Astellas Pharma US; Atara Biotherapeutics; BeiGene; bluebird bio, inc.; Bristol Myers Squibb Co.; CareDx Inc.; CSL Behring; CytoSen Therapeutics, Inc.; Elevance Health; Eurofins Viracor, DBA Eurofins Transplant Diagnostics; Gamida-Cell, Ltd.; GlaxoSmithKline; HistoGenetics; Incyte Corporation; Janssen Research & Development, LLC; Janssen/Johnson & Johnson; Jasper Therapeutics; Jazz Pharmaceuticals, Inc.; Karius; Kiadis Pharma; Kite, a Gilead Company; Kyowa Kirin; Legend Biotech; Magenta Therapeutics; Mallinckrodt Pharmaceuticals; Merck & Co.; Mesoblast; Millennium, the Takeda Oncology Co.; Miltenyi Biotec, Inc.; MorphoSys; Novartis Pharmaceuticals Corporation; Omeros Corporation; OptumHealth; Orca Biosystems, Inc.; Ossium Health, Inc.; Pfizer, Inc.; Pharmacyclics, LLC, An AbbVie Company; PPD Development, LP; Regimmune; Sanofi; Sarah Cannon; Sobi, Inc.; Stemcyte; Takeda Pharmaceuticals; Talaris Therapeutics; Vertex Pharmaceuticals; Vor Biopharma Inc.; Xenikos BV.

Data Use Statement:

CIBMTR supports accessibility of research in accord with the National Institutes of Health (NIH) Data Sharing Policy and the National Cancer Institute (NCI) Cancer Moonshot Public Access and Data Sharing Policy. The CIBMTR only releases de-identified datasets that comply with all relevant global regulations regarding

privacy and confidentiality.

Data Sharing Statement:

The final analysis dataset will be posted to the CIBMTR website at: https://cibmtr.org/CIBMTR/Resources/Publicly-Available-Datasets#.

Author Contributions:

NK, SA, RB, JP, BJ, WS, and TH were responsible for conception and design. RB, JP, BJ, and WS were responsible for acquisition of data. NK, SA, RB, JP, BJ, WS, and TH were responsible for the analysis. RB, JP, BJ, and WS were responsible for administrative, technical, or material support. All authors were responsible for the interpretation of data and the writing, review, and/or revision of the manuscript.

Conflict of Interest and Financial Disclosures:

Dr. Ailawadhi reports consultancy for GSK, Sanofi, BMS, Takeda, Beigene, Janssen, Regeneron, Cellectar, and Pfizer; and research funding from GSK, BMS, Pharmacyclics, Amgen, Janssen, Cellectar, AbbVie, Ascentage, and Sanofi.

Dr. Ustun reports honoraria (speakers' bureau) from Takeda.

Dr. Ciurea reports advisory board participation for Hansa Therapeutics, CardDx, Spectrum/Acrotech, Kiadis Pharma, Allogene, Celularity, MolMed, and Phamacyclics; and research funding from Miltenyi Biotech, and Kiadis Pharma.

Dr. Savani reports a government COI.

Dr. Sharma reports compensation (consulting) for Spotlight Therapeutics, Medexus Inc., Vertex

Pharmaceuticals, Sangamo Therapeutics, and Editas Medicine; serving as a medical monitor for RCI BMT CSIDE clinical trial which receives financial compensation; research funding from CRISPR Therapeutics; honoraria from Vindico Medical Education; serving as the St. Jude Children's Research Hospital site principal investigator of clinical trials for genome editing of sickle cell disease sponsored by Vertex Pharmaceuticals/CRISPR Therapeutics (NCT03745287), Novartis Pharmaceuticals (NCT04443907) and Beam Therapeutics (NCT05456880). The industry sponsors provide funding for the clinical trial, which includes salary support paid to Dr Sharma's institution. Dr Sharma has no direct financial interest in these therapies.

Dr. Cerny reports being a DSMB member for ICON- Allovir Inc., and ICON- Prolacta; being an advisory board member for MERIT CRO, and Bristol-Myers Squibb; and stocks for Actinium Pharmaceuticals Inc., Bluebird Bio, Celectar Biosciences, Danavax Technologies, Gamida Cell, Atyr Pharma, Novavax, Ovid Therapeutics, Sorrento Therapeutics, Very Inc, Viridian Therapeutics, Vaxart Inc, and 2seventy Bio Inc Reg SHS.

Dr. Kelkar reports research funding from CareDx.

Dr. Kindwall-Keller reports consulting fees (DSMC) from OrcaBio.

Dr. Steinberg reports speakers' bureau participation for Jazz Pharmaceuticals and advisory board participation for MorphoSys.

Dr. Wood reports research funding (to institution) from Pfizer and Genentech; serving as an advisor for Koneksa Health; and consulting for Teladoc.

Dr. Rangarajan reports being a Medical Monitor for the CD33 CAR Study (unpaid); and having a contract with NMDP (unpaid).

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Table 1: Rate of change for autoHCT and alloHCT in different racial/ethnic groups from 2009 to 2018 using data from Transplant Essential Data (TED) forms

Race/ethnicity	Rate of change of autoHCT from one time period to another (95% CI)	p-value for trend	Rate of change of alloHCT from one time period to another (95% CI)	p-value for trend
Non-Hispanic Whites	1.06 (1.05-1.08)*	<.0001	1.04 (1.02-1.05)	<.0001
Non-Hispanic African Americans	1.14 (1.10-1.17)	<.0001	1.11 (1.07-1.16)	<.0001
Hispanics	1.18 (1.13-1.22)	<.0001	1.11 (1.07-1.14)	<.0001
Other	1.17 (1.09-1.25)	<.0001	1.09 (1.04-1.15)	0.0009
Total (adjusted for race)	1.08 (1.06-1.11)	<.0001	1.06 (1.04-1.07)	<.0001

* A rate of change of 1.06 means that the number of transplants grew on average 6% from one 2-year time period to another

Table 2: Unadjusted and Adjusted models for Overall Mortality (using data from comprehensive report forms (CRF))

	Autologous HCT (n=7,888)		**Adult Allogeneic HCT (n=16,558)**		**Pediatric Allogeneic HCT (n=1,820)**	
Variable	**Unadjusted HR (95% CI); p value**	**Adjusted HR[a] (95%CI); P value**	**Unadjusted HR (95% CI); p value**	**Adjusted HR[b] (95%CI); P value**	**Unadjusted HR (95% CI); p value**	**Adjusted HR[c] (95%CI); P value**
Race						
Non-Hispanic Whites	1.00	1.00	1.00	1.00	1.00	1.00
Non-Hispanic African Americans	0.85 (0.76-0.95); 0.004	0.91 (0.81-1.03); 0.12	1.12 (1.03-1.21); 0.005	1.13 (1.04-1.22); 0.004	1.76 (1.4-2.2); <0.001	1.62 (1.3-2.03); <0.001
Hispanics	0.93 (0.77-1.11); 0.41	1.04 (0.87-1.25); 0.66	0.91 (0.84-0.99); 0.03	1.01 (0.92-1.1); 0.89	1.22 (1.02-1.46); 0.03	1.17 (0.97-1.41); 0.10
Others	0.81 (0.64-1.030; 0.09	0.83 (0.65-1.05); 0.13	0.91 (0.82-1.01); 0.08	0.97 (0.87-1.07); 0.50	1.52 (1.15-2.02); 0.004	1.47 (1.11-1.96); 0.008
Year of transplant						
2009-10	1.00	1.00	1.00	1.00	1.00	1.00
2011-12	0.78 (0.68-0.9); 0.0006	0.89 (0.77-1.03); 0.13	1.01 (0.94-1.08); 0.84	0.91(0.85-0.98); 0.014	1.00 (0.79-1.26); 0.99	1.05 (0.83-1.32); 0.71
2013-14	0.77 (0.67-0.87);	0.78 (0.69-0.9);	0.93 (0.87-0.99); 0.015	0.81(0.76-0.86);	0.77(0.63-0.94); 0.01	0.75 (0.6-0.93);

	<0.001	0.0004		<0.001		0.008
2015-16	0.75(0.65-0.86); <0.001	0.72 (0.62-0.83); <0.001	0.91 (0.85-0.97); 0.003	0.78(0.73-0.83); <0.001	0.56 (0.44-0.7); <0.001	0.53 (0.42-0.68); <0.001
2017-18	0.60(0.5-0.72); <0.001	0.60 (0.5-0.72); <0.001	0.75 90.7-0.81); <0.001	0.66 (0.61-0.71); <0.001	0.74 90.57-0.96); 0.03	0.71 (0.54-0.92); 0.01

[a]Other significant variables include patient age, sex, diagnosis, disease status, HCT-CI, KPS, and marital status

[b]Other significant variables include patient age, diagnosis, disease risk, HCT-CI, KPS, insurance and donor type

[c]Other significant variables include disease status at HCT, HCT-CI and recipient CMV status

Figure 1: Proportion of HCT by race/ethnicity in 2009-2010 and 2017-2018 using data from Transplant Essential Data (TED) forms

Figure 2: Temporal trends in adjusted overall survival at 2 years after HCT in different racial/ ethnic groups (using data from comprehensive report forms (CRF)).

2A: Temporal trends in adjusted overall survival at 2 years after auto HCT in different racial/ ethnic groups.

2B: Temporal trends in adjusted overall survival at 2 years after allo HCT in adults in different racial/ ethnic groups.

2C: Temporal trends in adjusted overall survival at 2 years after allo HCT in pediatric patients in different racial/ ethnic groups.

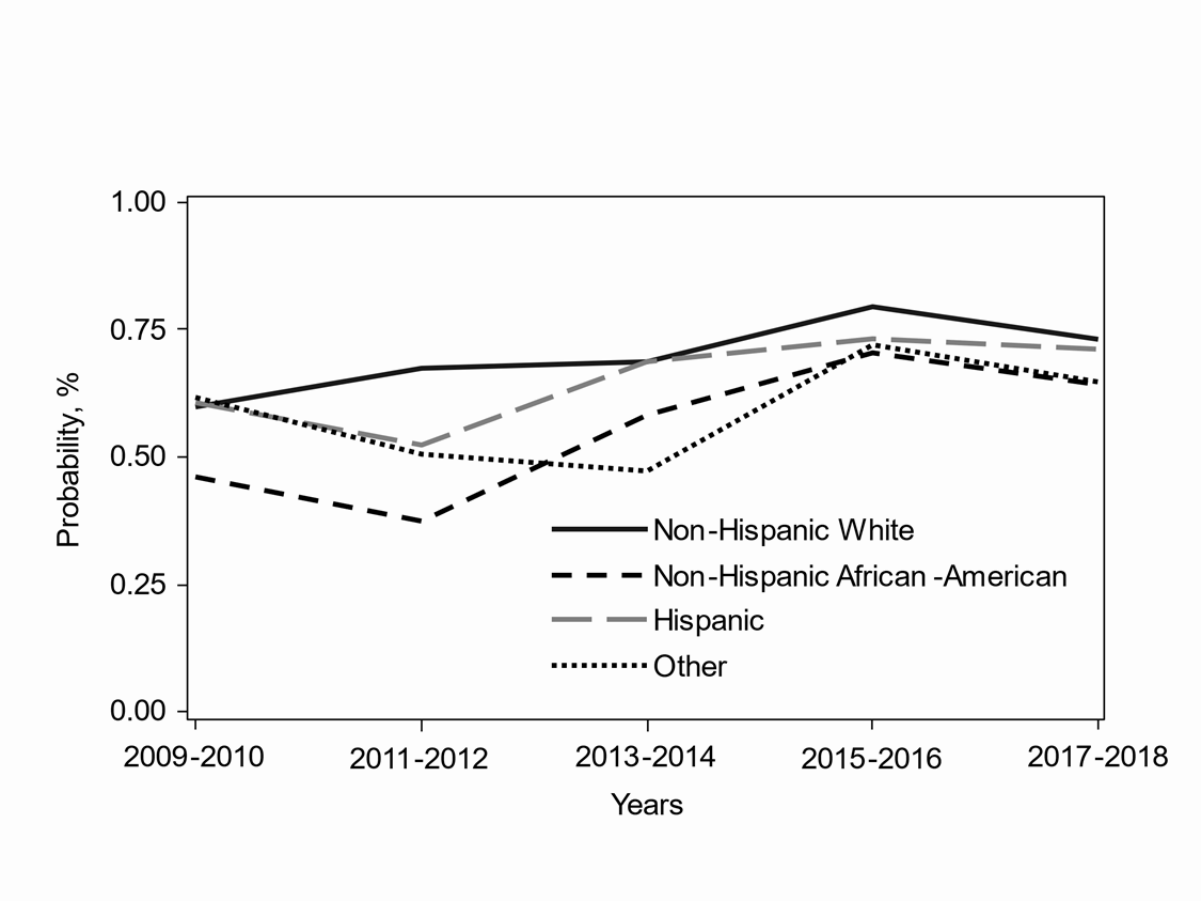

Figure 1

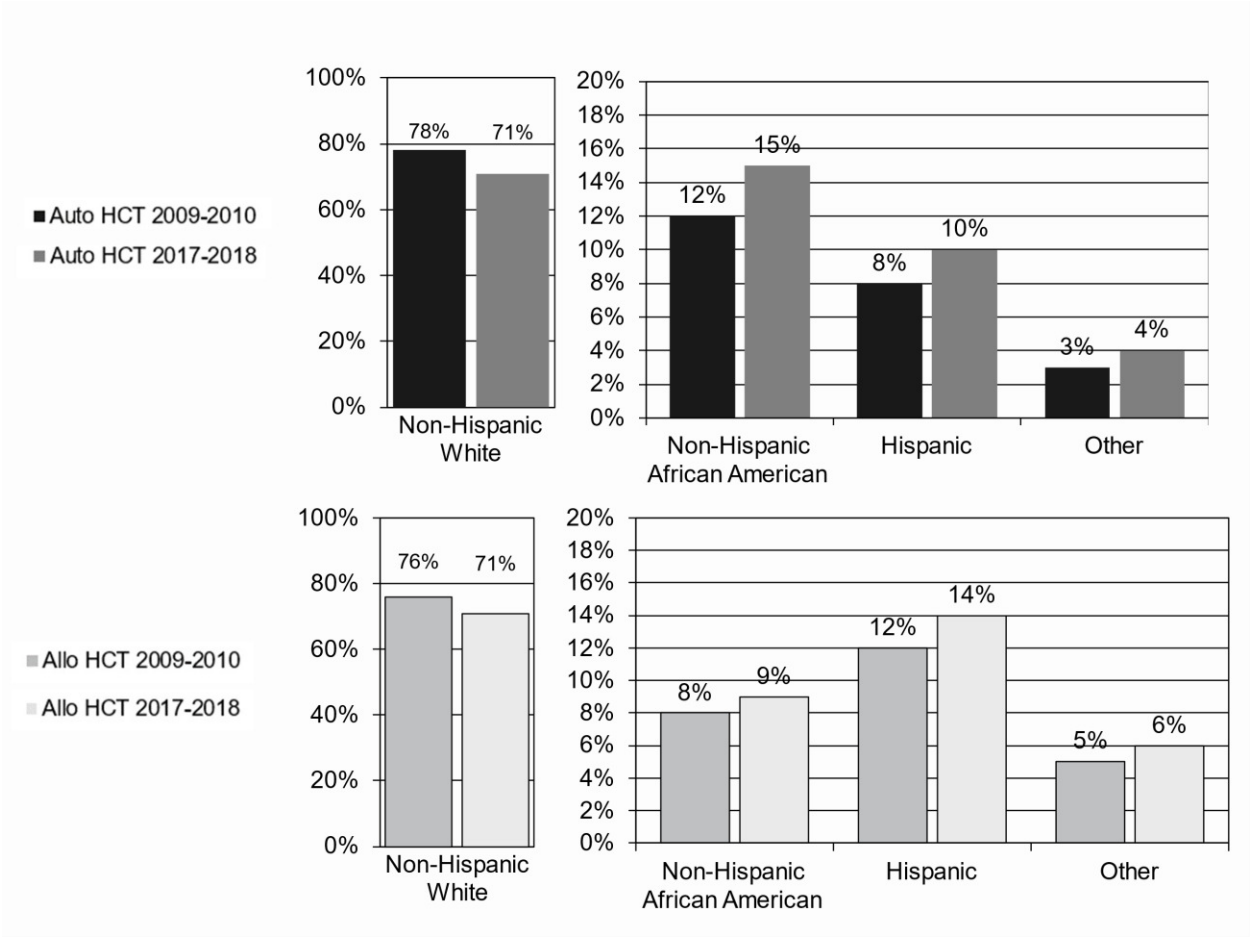

Figure 2a

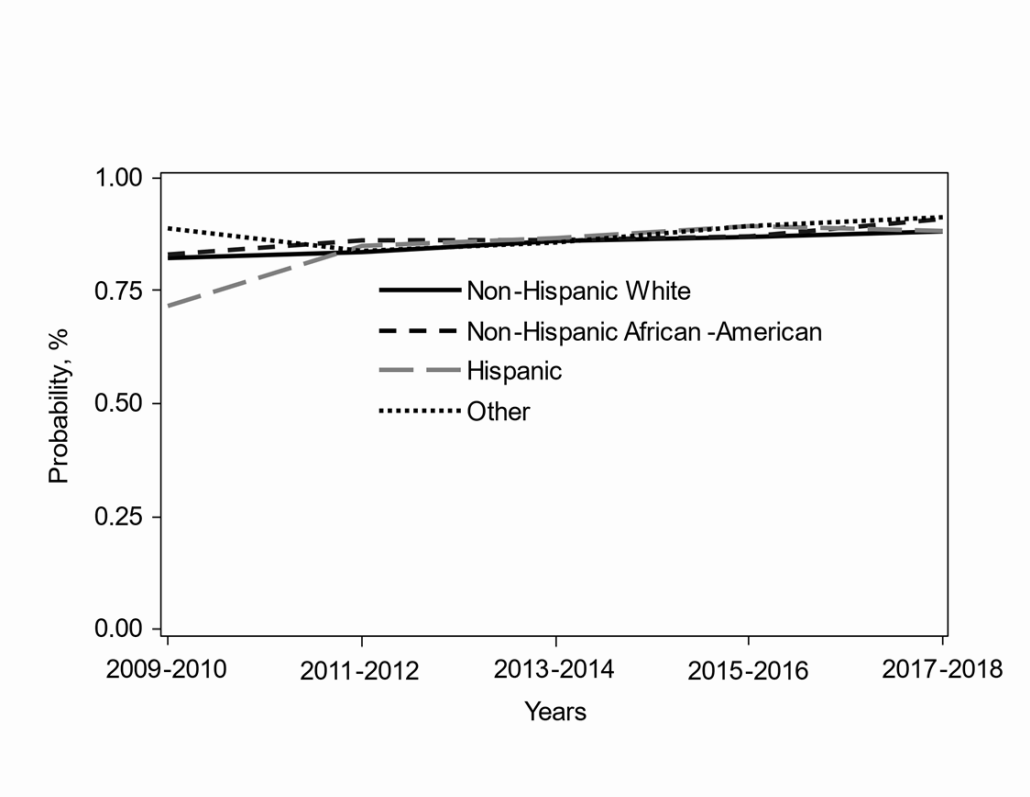

Figure 2b