Original Article

Association Between Race and Treatment Patterns and Survival Outcomes in Multiple Myeloma: A Connect MM Registry Analysis

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BACKGROUND: Studies have reported racial disparities in access to and use of multiple myeloma (MM) treatments between African American (AA) and White patients. Although AA patients demonstrate longer disease-specific survival, this has not uniformly translated into improved survival over time. The association between race and treatment patterns and survival outcomes was analyzed using data from the Connect MM Registry. **METHODS:** The Connect MM Registry is a large US, multicenter, prospective observational cohort study of patients with newly diagnosed MM. Patients who received first-line (1L) stem cell transplantation (SCT) or who did not receive SCT (non-SCT or non–stem cell transplantation [NSCT]) were grouped by raceEffects of race and transplantation status on the use of triplet treatment were estimated using logistic regression. **RESULTS:** Treatment patterns in 1L (types and duration of induction, posttransplantation maintenance) were similar between AA and White patients. SCT rates in 1L (32% vs 36%) and triplet treatment use (AA: 44% for NSCT patients and 72% for SCT patients; and White: 48% for NSCT patients and 72% for SCT patients) during first induction were similar. No significant effect of race or transplantation status on 1L triplet treatment use was observed. Race was not found to be associated with survival outcomes among patients who underwent NSCT; however, AA patients who received SCT had significantly longer overall survival compared with White patients who underwent SCT (not reached vs 88.2 months; hazard ratio, 0.56; 95% CI, 0.35-0.89 [$P = .0141$]). **CONCLUSIONS:** AA and White patients were found to have similar treatment patterns in the Connect MM Registry, suggesting that both groups had equal access to health care. In this real-world setting, AA patients received standard-of-care treatment, which might have contributed to better MM-specific survival compared with White patients. ***Cancer* 2020;126:4332-4340**.

KEYWORDS: African American, myeloma, race, treatment, survival.

INTRODUCTION

Multiple myeloma (MM) is a clonal plasma cell neoplasm and the most common hematologic malignancy diagnosed among African American (AA) individuals.[1] AA patients are 2 to 3 times more likely to be diagnosed with MM than White patients and are younger at the time of diagnosis (median reported age at the time of diagnosis: 66 years vs 70 years, respectively; $P = .002$).[2-4] The higher incidence of MM among AA patients has been attributed to a higher prevalence of the precursor lesion (monoclonal gammopathy of undetermined significance), obesity, immunological factors, and tumor heterogeneity.[1,5]

Analyses of data from the Surveillance, Epidemiology, and End Results (SEER) registry have indicated that AA patients may have an indolent disease subtype. An analysis of the SEER 17 registry data set (covering approximately 26% of the US population) demonstrated that AA patients diagnosed between 1992 and 2007 had better

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MM-specific survival compared with White patients ($P < .001$).[2] In addition, only AA patients aged 50 to 69 years and those aged ≥70 years were found to have higher disease-specific survival ($P < .001$). However, when the SEER 9 registry (covering approximately 10% of the US population) was used to compare changes in 5-year relative survival rates between 1973 and 1993 (after the advent of autologous stem cell transplantation [SCT]) and 1999 and 2005 (after the introduction of novel drugs), AA patients, especially those aged <70 years, demonstrated only small, nonsignificant improvements in survival over time compared with White patients (<50% than that observed in White patients), which was attributed to less access to newer therapies.[4]

Underuse of treatment modalities such as SCT and novel drugs has been reported in AA patients compared with White patients with MM.[6-9] In a SEER-Medicare–linked database (including patients aged ≥65 years), underuse of SCT and bortezomib in AA patients was found to be associated with a 12% increased risk of death in AA patients compared with White patients ($P = .0007$).[7] In another study using data from this database, researchers found that among all racial groups, AA patients were least likely to receive treatment with lenalidomide ($P < .01$) and did not demonstrate increased SCT use over time.[6] These treatment disparities, which could contribute to survival gaps between AA and White patients, have been attributed to the poor socioeconomic status of AA patients and their potential lack of access to health resources.[6-9] Thus, it is important to assess MM treatment patterns and subsequent survival outcomes among AA and White patients using a study design that is less likely to exclude patients due to potential treatment disparities and socioeconomic factors.

The Connect MM Registry (ClinicalTrials.gov identifier NCT01081028) is a large US, multicenter, prospective observational cohort study of patients with newly diagnosed MM that was designed to examine real-world diagnostic patterns, treatment patterns, clinical outcomes, and health-related quality of life patient–reported outcomes. The majority of the enrolled patients (84%) are from community sites (with the remainder being from academic [15%] and government [1%] sites), which is in keeping with treatment settings for typical clinical practice. The Connect MM Registry collects patient data in an electronic data capture system at baseline and every 3 months. These longitudinal data have been used previously to describe various aspects of MM treatment patterns, survival outcomes, and health-related quality of life.[10]

The current analysis reviewed treatment patterns (induction therapy, transplantation, and maintenance therapy) and survival outcomes by race (AA vs White patients) in patients with newly diagnosed MM who were enrolled in the Connect MM Registry.

MATERIALS AND METHODS

Study Design and Patients

Details of the study design and patient population of the Connect MM Registry have been published previously.[11] Eligible patients included adults aged ≥18 years with symptomatic MM that was diagnosed ≤2 months prior to enrollment, as defined by International Myeloma Working Group criteria[12]; no exclusion criteria were applied. Patients were enrolled from 250 mostly community sites: cohort 1 (1493 patients) was enrolled from September 2009 to December 2011 and cohort 2 (1518 patients) was enrolled from December 2012 to April 2016. Enrollment was competitive to minimize enrollment bias, with all consecutive patients with MM who presented to the sites evaluated for potential enrollment. The median time from diagnosis to enrollment was 25 days. All patients were required to provide written informed consent. The Connect MM Registry was approved by a central institutional review board (Advarra, Columbia, Maryland) or the institutional review boards at the individual study sites.

The Connect MM Registry is noninterventional and therefore all medical care was performed solely at the discretion of the treating clinician in accordance with standard clinical practice at each site. Participation is voluntary and patients can withdraw at any time without it affecting their ongoing medical care. Patients are to be followed for treatment and outcomes until early discontinuation (due to death or patient withdrawal) or the end of the study (expected to occur in 2024).

Analysis Population and Study Endpoints

The current analysis included treated patients who did or did not receive SCT (SCT and non–stem cell transplantation [NSCT], respectively) in first-line (1L) anti-MM therapy. Study endpoints were compared among White and AA patients; Asian and Hispanic patients were not included due to smaller patient numbers. Study endpoints included duration of induction in 1L (NSCT patients) and duration of posttransplantation maintenance (patients treated with SCT), triplet treatment use in 1L (first induction), and survival outcomes (progression-free survival [PFS] and overall survival [OS]). Duration of induction in 1L was defined as the time between initiation of the 1L induction regimen until the time of the event (end of the induction period in 1L, first instance of progressive disease,

TABLE 1. Baseline Characteristics and Medical History by Racial Groups and Transplantation Category

Characteristic	SCT		NSCT		Total
	AA n = 126	White n = 878	AA n = 271	White n = 1562	N = 2837
Age, y					
Median (range)	57.5 (27-80)	61.0 (24-79)	68 (38-93)	72 (34-94)	67 (24-94)
<65	98 (77.8)	581 (66.2)	109 (40.2)	416 (26.6)	1204 (42.4)
≥65 to <75	27 (21.4)	278 (31.7)	93 (34.3)	530 (33.9)	928 (32.7)
≥75	1 (0.8)	19 (2.2)	69 (25.5)	616 (39.4)	705 (24.9)
Male sex, no. (%)	62 (49.2)	540 (61.5)	132 (48.7)	899 (57.6)	1633 (57.6)
ECOG PS, no. (%)					
0-1	85 (67.5)	525 (59.8)	133 (49.1)	814 (52.1)	1557 (54.9)
2-4	8 (6.3)	65 (7.4)	42 (15.5)	200 (12.8)	315 (11.1)
Not specified/data not provided	33 (26.2)	288 (32.8)	96 (35.4)	548 (35.1)	965 (34.0)
Calculated ISS stage, no. (%)					
I	26 (20.6)	212 (24.1)	46 (17.0)	226 (14.5)	510 (18.0)
II	41 (32.5)	255 (29.0)	57 (21.0)	431 (27.6)	784 (27.6)
III	22 (17.5)	223 (25.4)	79 (29.2)	459 (29.4)	783 (27.6)
Not specified	37 (29.4)	188 (21.4)	89 (32.8)	446 (28.6)	760 (26.8)
Calcium ≥11.5 mg/dL, no. (%)	10 (7.9)	63 (7.2)	17 (6.3)	163 (10.4)	253 (8.9)
Creatinine >2.0 mg/dL, no. (%)	22 (17.5)	135 (15.4	78 (28.8)	343 (22.0)	578 (20.4)
Hemoglobin; <10 g/dL or >2 g/dL <LLN, no. (%)	68 (54.0)	355 (40.4)	178 (65.7)	743 (47.6)	1344 (47.4)
MM bone involvement, no. (%)	104 (82.5)	728(82.9)	192 (70.8)	1200 (76.8)	2224 (78.4)
Transplantation intent, no. (%)	113 (89.7)	812 (92.5)	77 (28.4)	456 (29.2)	1458 (51.4)
Triplet treatment, no. (%)	91 (72.2)	636 (72.4)	120 (44.3)	747 (47.8)	1594 (56.2)
Hyperdiploidy, no. (%)	8 (6.3)	67 (7.6)	15 (5.5)	108 (6.9)	198 (7.0)
Del 17p, no. (%)	8 (6.3)	110 (12.5)	23 (8.5)	171 (10.9)	312 (11.0)
t(11;14), no. (%)	24 (19.0)	112 (12.8)	31 (11.4)	196 (12.5)	363 (12.8)
t(4;14), no. (%)	10 (7.9)	55 (6.3)	13 (4.8)	93 (6.0)	171 (6.0)
Medical history, no. (%)					
Diabetes	24 (19.0)	111 (12.6)	81 (29.9)	306 (19.6)	522 (18.4)
Hypertension requiring treatment	66 (52.4)	409 (46.6)	206 (76.0)	962 (61.6)	1643 (57.9)
MGUS	12 (9.5)	65 (7.4)	34 (12.5)	170 (10.9)	281 (9.9)
Smoldering myeloma	9 (7.1)	36 (4.1)	14 (5.2)	79 (5.1)	138 (4.9)
Family history of other cancers	56 (44.4)	522 (59.5)	108 (39.9)	840 (53.8)	1526 (53.8)

Abbreviations: AA, African American; ECOG PS, Eastern Cooperative Oncology Group performance status; ISS, International Staging System; LLN, lower limit of normal; MGUS, monoclonal gammopathy of undetermined significance; MM, multiple myeloma; NSCT, non–stem cell transplantation; SCT, stem cell transplantation.

or death), discontinuation, or data cutoff. The duration of posttransplantation maintenance was defined as the start of maintenance therapy in 1L or the transplantation date plus 100 days (for SCT patients who did not receive maintenance; whichever occurred later) until the time of the event (end of last maintenance in 1L, first instance of progressive disease, or death), discontinuation, or data cutoff.

Statistical Analyses

Endpoints were compared using self-identified race (AA vs White) or transplantation status (SCT or NSCT). Logistic regression was used to estimate the effect of race (AA vs White) and transplantation status (SCT or NSCT) on triplet treatment use adjusting for covariates (to reduce bias introduced by variables that significantly differed between groups), such as history of monoclonal gammopathy of undetermined significance, t(4;14), and International Staging System stage. PFS and OS estimates were obtained using a Cox regression model adjusted for the following covariates: Connect MM Registry cohort (cohort 1 vs cohort 2); age; history of asymptomatic myeloma; family history of other cancers; sex; laboratory values at the time of diagnosis of MM, including serum calcium, creatinine, and hemoglobin; International Staging System stage; and pathological fractures using the direct adjusted method of Zhang et al.[13] Hazard ratios (HRs) of PFS and OS were adjusted with the aforementioned covariates and were estimated using a Cox proportional hazards model stratified by race and transplantation status. Multiple imputation was used to mitigate missing data.

RESULTS

A total of 2837 patients, including 397 AA patients and 2440 White patients, were included in the analysis; the data cutoff date was August 8, 2018. The median follow-up in the SCT group was 48.4 months and 47.3 months, respectively, in AA and White patients; the NSCT group had a median follow-up of 28.8 months and 30.1 months, respectively. Of the

TABLE 2. Most Common 1L First Regimen by Race and Transplantation Status and Most Common Posttransplantation Maintenance Regimen by Race

	SCT			NSCT		
1L First Regimen, No. (%)						
	AA n = 126	White n = 878	Total N = 1004	AA n = 271	White n = 1562	Total N = 1833
RVd	52 (41)	386 (44)	438 (44)	58 (21)	376 (24)	434 (24)
CyBorD	24 (19)	184 (21)	208 (21)	41 (15)	206 (13)	247 (13)
Vd	20 (16)	135 (15)	155 (15)	72 (27)	402 (26)	474 (26)
Rd	10 (8)	65 (7)	75 (7)	52 (19)	296 (19)	348 (19)
VTd	4 (3)	14 (2)	18 (2)	5 (2)	17 (1)	22 (1)
V	4 (3)	25 (3)	29 (3)	12 (4)	62 (4)	74 (4)
VMd	2 (2)	0	2 (0.2)	0	8 (0.5)	8 (0.4)
CyBor	2 (2)	3 (0.3)	5 (0.5)	0	8 (0.5)	8 (0.4)
RV	2 (2)	9 (1)	11 (1)	5 (2)	22 (1)	27 (1)
Vd-Dox	2 (2)	14 (2)	16 (2)	3 (1)	35 (2)	38 (2)
Posttransplantation Maintenance Regimen, No. (%)						
	AA n = 69	White n = 488	Total N = 557			
R	49 (71)	319 (65)	368 (66)			
V	11 (16)	64 (13)	75 (13)			
Rd	4 (6)	40 (8)	44 (8)			
RVd	4 (6)	16 (3)	20 (4)		NA	
Vd	2 (3)	23 (5)	25 (5)			
KRd	1 (1)	7 (1)	8 (1)			
Kd	1 (1)	5 (1)	6 (1)			
Elo-Rd	1 (1)	3 (0.6)	4 (0.7)			
Ixa	1 (1)	2 (0.4)	3 (0.5)			
RV	0	10 (2)	10 (2)			

1L, first-line; AA, African American; CyBor, bortezomib and cyclophosphamide; CyBorD, bortezomib, cyclophosphamide, and dexamethasone; Dox, liposomal doxorubicin; Elo, elotuzumab; Elo-Rd, elotuzumab, lenalidomide, and dexamethasone; Ixa, ixazomib; Kd, carfilzomib and dexamethasone; KRd, carfilzomib, lenalidomide, and dexamethasone; NA, not applicable; NSCT, non–stem cell transplantation; R, lenalidomide; Rd, lenalidomide and dexamethasone; RV, lenalidomide and bortezomib; RVd, lenalidomide, bortezomib, and dexamethasone; SCT, stem cell transplantation; V, bortezomib; Vd, bortezomib and dexamethasone; Vd-Dox, bortezomib, dexamethasone, and liposomal doxorubicin; VMd, bortezomib, melphalan, and dexamethasone; VTd, bortezomib, thalidomide, and dexamethasone.

2837 treated patients, 1004 (35%) received SCT. Of these 1004 patients who underwent SCT, 126 (13%) were AA and 878 (87%) were White, and of the 1833 patients who underwent NSCT, 271 (15%) were AA and 1562 (85%) were White. Of the patients who received SCT, 628 (63%) also received maintenance therapy. Regardless of transplantation status, AA patients generally were younger than White patients and had a higher incidence of anemia (Table 1).

Treatment patterns (induction, including 1L induction regimens received [Table 2]; SCT; and maintenance therapy) in 1L were similar between AA and White patients. The median durations of 1L induction in patients undergoing NSCT were similar between the AA and White patients (5.4 months vs 5.8 months, respectively; HR, 0.99 [95% CI, 0.86-1.13; $P = .8778$]) (Fig. 1A). Common induction regimens in both patient groups included lenalidomide, bortezomib, and dexamethasone (RVd); bortezomib, cyclophosphamide, and dexamethasone; bortezomib and dexamethasone; and lenalidomide and dexamethasone, with RVd being the most common regimen used in patients undergoing SCT (44%) and RVd or bortezomib and dexamethasone the most common regimen used in patients undergoing NSCT (24% and 26%, respectively), regardless of race.

The percentages of AA and White patients who received triplet treatment were similar (44% of patients undergoing NSCT and 72% of patients undergoing SCT among AA patients vs 48% of patients undergoing NSCT and 72% of patients undergoing SCT among White patients). Logistic regression analysis demonstrated that race or transplantation status did not significantly affect use of triplet treatment for 1L induction therapy (for overall race effect: odds ratio [OR], 0.98 [95% CI, 0.81-1.19; $P = .8375$]; for SCT: OR, 1.01 [95% CI, 0.79-1.30; $P = .9220$]; and for NSCT: OR, 0.95 [95% CI, 0.82-1.10; $P = .4922$]). The interaction between race and transplantation status also was not found to be statistically significant (OR, 1.07 [95% CI, 0.92-1.24; $P = .3874$]). Rates of SCT in 1L were found to be similar among AA and White patients (32% and 36%, respectively; chi-square P value = .101). Posttransplantation maintenance regimens also were found to be similar between the 2

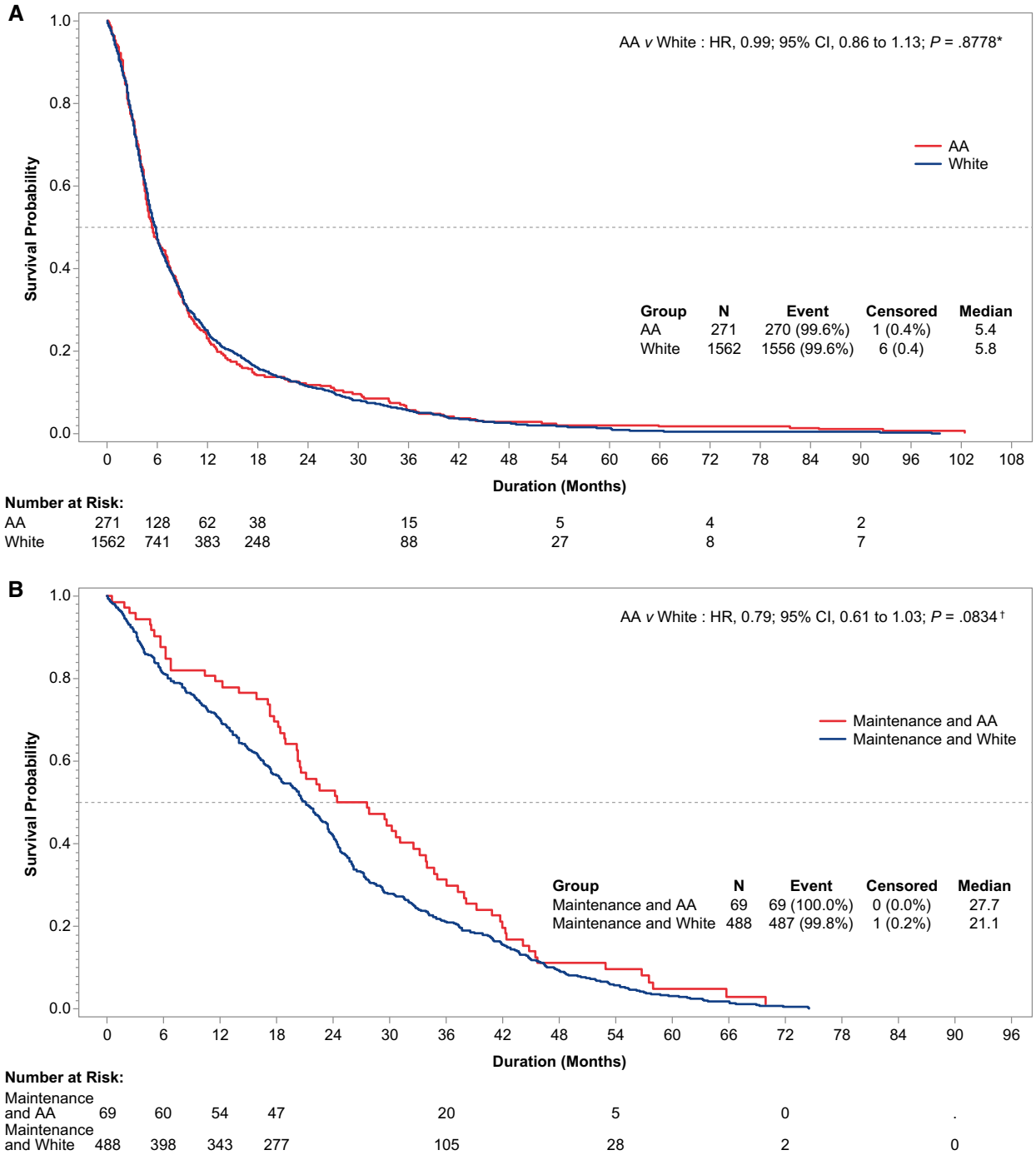
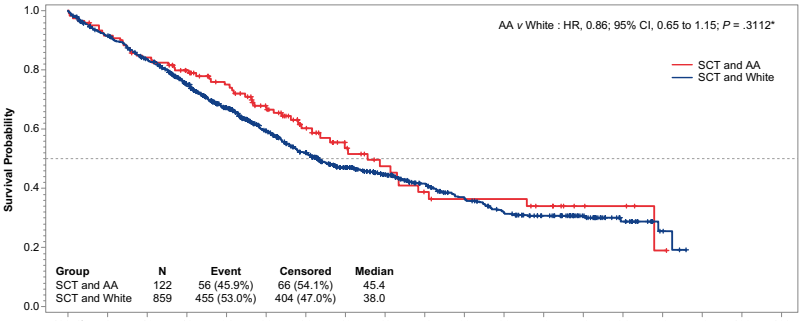


FIGURE 1. Adjusted duration of (A) induction therapy in patients who underwent non–stem cell transplantation* and (B) posttransplantation maintenance therapy in patients who underwent stem cell transplantation† by racial group. *Adjusted for the following covariates: cohort, age group, history of asymptomatic myeloma, family history of other cancers, sex, calcium, creatinine, hemoglobin, calculated ISS stage, pathological fractures. †Adjusted for the following covariates: cohort, age group, bone lesions/osteopenia/fractures, calculated ISS stage, family history of other cancers, pathological fractures. AA indicates African American; HR, hazard ratio; ISS, International Staging System.

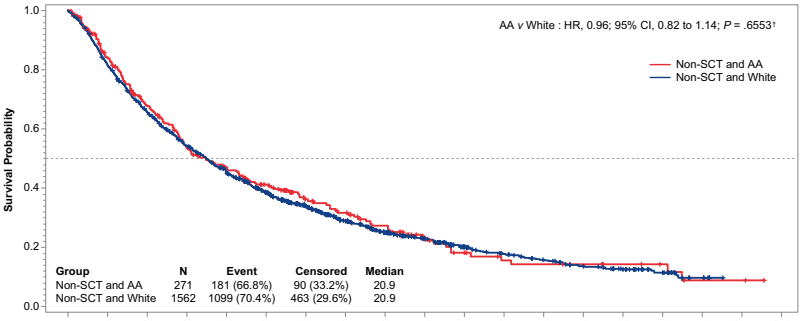
groups (Table 2), with lenalidomide being the most common (71% for AA patients and 65% for White patients), followed by bortezomib (16% for AA patients and 13% for White patients). The median duration of posttransplantation maintenance therapy in patients who received SCT did not differ significantly between AA and White

A



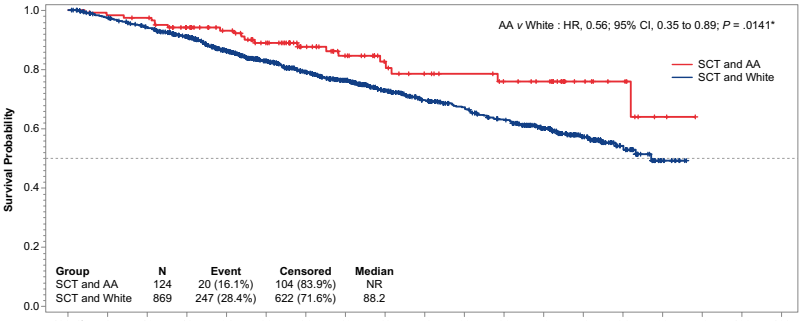
Number at Risk:								
SCT and AA	122	111	101	88	40	15	10	1
SCT and White	859	772	689	590	294	139	66	4

B



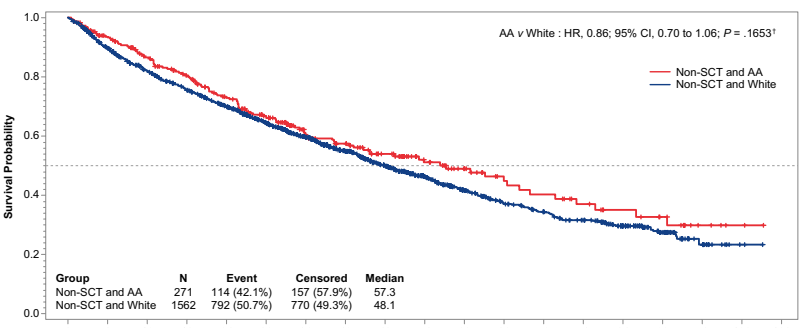
Number at Risk:								
Non-SCT and AA	271	217	165	127	59	23	11	5
Non-SCT and White	1562	1234	951	760	362	150	66	22

C



Number at Risk:								
SCT and AA	124	121	119	106	62	34	24	2
SCT and White	869	833	788	729	452	252	147	10

D



Number at Risk:								
Non-SCT and AA	271	242	214	191	105	54	28	13
Non-SCT and White	1562	1356	1193	1060	649	310	154	53

FIGURE 2. Adjusted (A and B) progression-free survival (PFS) in patients who underwent stem cell transplantation (SCT)* and non–stem cell transplantation (NSCT)† and (C and D) overall survival (OS) in patients who underwent SCT* and NSCT† by racial group. *100 days postSCT. Patients with first disease progression/death before transplant + 100 days (n = 23 for PFS, n = 11 for OS) were excluded. Adjusted for the following covariates: cohort, age group, family history of other cancers, history of MGUS, history of smoldering myeloma, hemoglobin, calculated ISS stage, sex. †Adjusted for the following covariates: cohort, age group, history of asymptomatic myeloma, history of amyloidosis, family history of other cancers, sex, calcium, hemoglobin, calculated ISS stage. AA indicates African American; HR, hazard ratio; ISS, International Staging System; MGUS, monoclonal gammopathy of undetermined significance; NR, not reported.

patients (27.7 months vs 21.1 months, respectively; HR, 0.79 [95% CI, 0.61-1.03; $P = .0834$]) (Fig. 1B).

Among patients undergoing SCT and NSCT, the adjusted PFS did not appear to differ significantly by race (Fig. 2A,B). However, the adjusted OS for patients undergoing SCT was significantly longer in AA patients compared with White patients (not reached vs 88.2 months; $P = .0141$) (Fig. 2C). The adjusted OS in patients undergoing NSCT did not significantly differ by race (Fig. 2D).

DISCUSSION

Real-world data from population-based studies and claims analyses have uniformly shown significant racial differences in MM treatment patterns in terms of SCT and the use of novel therapies that mainly are attributable to socioeconomic factors.[4,8,14] The current analysis, using real-world data from the Connect MM Registry, demonstrated that treatment patterns in 1L (induction, SCT, and maintenance therapy) were similar between AA and White patients. Consistent with published data,[2-4,14] AA patients with MM were younger than White patients at baseline and were more likely to be anemic. No significant effect of race or transplantation status was observed on the use of use of triplet treatment during 1L, suggesting adaptation of evidence-based guidelines in community practice, irrespective of patient race.[15-17] A relatively short duration of 1L induction therapy (<6 months) was noted irrespective of patient race. This trend has been demonstrated in other real-world analyses as well, compared with the longer duration of 1L induction therapy reported in clinical trials.[18] NSCT patients, patients from both racial groups had similar durations of 1L induction regimens. Although not statistically significant, the 6-month–longer duration of maintenance therapy observed in AA patients might have had an effect on survival outcomes. It is interesting to note that no effect for race was observed on survival outcomes (PFS or OS) among patients who underwent NSCT. However, AA patients who received SCT had a significantly longer OS compared with White patients who received SCT, even after adjusting for age.

The current data suggest that AA patients from primarily community settings, such as the Connect MM Registry, are being treated appropriately as per standard of care. Voluntary participation in a registry (in contrast to the required participation in SEER) might favor the enrollment of better insured and better-informed patients who are treated by physicians who follow similar practices (eg, evidence-based medicine), which could lead to more homogeneous treatment patterns and help to reduce the treatment disparities that have been observed in population-based studies. This reiterates the importance of resolving racial disparities in treatment access and use, especially limited access to SCT and novel therapies, which have been observed in SEER.[6,9]

Real-world data are emerging that demonstrate better or similar outcomes in AA patients (compared with White patients) within a setting of equal access to health care and novel drugs. In a large population of patients with MM (15,717 patients) at Veterans Affairs hospitals with equal access to health care, SCT, and novel therapies for all patients, OS was shown to be superior in AA patients compared with White patients, particularly in the younger population aged <65 years (median OS: 7.07 years [95% CI, 6.36-7.70 years] vs 5.83 years [95% CI, 5.44-6.09 years]; log-rank $P > .001$), but was similar in both groups for patients aged ≥65 years (log-rank $P = .63$).[19] The current data from the Connect MM Registry support the findings of the Veterans Affairs study and demonstrate that similar treatment patterns may contribute toward improved survival outcomes in AA patients compared with White patients undergoing SCT. One hypothesis for the improved survival is that AA patients have a lower incidence of high-risk cytogenetics,[20,21] although to our knowledge, a definite association has not been studied to date. Conversely, a higher incidence of t(11;14) has been reported in AA patients compared with White patients,[22,23] although t(11;14) has been associated with a shorter OS only in AA patients.[24] Given the molecular heterogeneity observed among the AA and White patients, further research is warranted to fully understand the impact of these cytogenetic abnormalities on survival.

There are well-known limitations to real-world studies such as patient registries, including a lack of patient randomization, a lack of protocol-mandated specific treatments, and variations in treatment duration and intensity. Similar to any observational study, there also is the potential for missing or erroneous data. To address this issue, the Connect MM Registry can query sites for more information regarding questionable data, and multiple imputation methods are used in the analyses to mitigate the impact of missing data. Lastly, although the survival analyses were adjusted for several potential confounding factors, there always is the potential for residual or unmeasured confounding. We acknowledge that nearly 80% of the AA patients receiving SCT in the current study were aged <65 years, but nearly 40% of White patients undergoing SCT were aged >75 years. Hence, even though the survival analyses were adjusted for age, the small percentage of elderly AA patients in this registry population limited our ability to stratify the SCT subgroups further by age to fully understand the impact of age on the survival estimates.

Despite these limitations, the Connect MM Registry allowed for the examination of treatment patterns and clinical outcomes in patients treated in a mostly community-based setting, which better reflects real-world populations and clinical practices compared with clinical trials. The findings of the current study highlight the importance of initiating efforts toward the similar and optimal treatment and management of AA and White patients with MM across US clinical practices to maintain equality in survival outcomes and maximize the benefit of therapeutic advancements for all patients.

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CONFLICT OF INTEREST DISCLOSURES

Sikander Ailawadhi has acted as a paid consultant for Bristol-Myers Squibb for work performed as part of the current study and has acted as a paid consultant for Takeda Pharmaceuticals, Novartis, Celgene, A Bristol-Myers Squibb Company, Amgen, and Sanofi; has received institutional research funding from AstraZeneca, Ascentage Pharma, Pharmacyclics LLC, and Amgen; and has received other fees from Janssen and Cellectar Biosciences Inc for work performed outside of the current study. Sundar Jagannath has acted as a paid consultant/member of the advisory board for Celgene, A Bristol-Myers Squibb Company, AbbVie, Karyopharm Therapeutics, Janssen Pharmaceuticals, Merck and Company, Bristol-Myers Squibb, and Novartis, and has participated in speakers' bureaus for MMRF and Medicom for work performed outside of the current study. Hans C. Lee has acted as a paid consultant for Adaptive Biotechnologies, Amgen, Celgene, A Bristol-Myers Squibb Company, Pimera, and Takeda Pharmaceuticals; has received research funding from Amgen, Celgene, A Bristol-Myers Squibb Company, Daiichi Sankyo, Eutropics Pharmaceuticals, Janssen Pharmaceutical, Prothena Corporation, and Takeda Pharmaceuticals; has received grants and personal fees from GlaxoSmithKline; and has received personal fees from Sanofi for work performed outside of the current study. Mohit Narang has acted as a paid consultant and participated in speakers' bureaus for Celgene, A Bristol-Myers Squibb Company and has participated in speakers' bureaus for Janssen. Robert M. Rifkin has acted as a paid consultant/member of the advisory board for Amgen, Boehringer Ingelheim, Bristol-Myers Squibb/Celgene, A Bristol-Myers Squibb Company, EMD Serono, Sandoz, and Takeda Pharmaceuticals for work performed outside of the current study and owns stock in McKesson. Howard R. Terebelo has acted as a member of the scientific advisory board for Bristol-Myers Squibb for work performed as part of the current study and has acted as a paid consultant for Celgene, A Bristol-Myers Squibb Company and participated in speakers' bureaus for Janssen, Takeda Pharmaceuticals, and Pharmacyclics LLC. Brian G.M. Durie has acted in a consulting or advisory role for Amgen, Janssen, Celgene, A Bristol-Myers Squibb Company, and Takeda Pharmaceuticals. Kathleen Toomey participated in speakers' bureaus for Myriad Genetics, and received travel reimbursement from Dava Oncology. Kathleen Toomey has acted as a member of the advisory board for Celgene, A Bristol-Myers Squibb Company/Bristol-Myers Squibb for work performed as part of the current study. James W. Hardin has received payment for services on the Connect MM scientific advisory board from Celgene, A Bristol-Myers Squibb Company/Bristol-Myers Squibb for work performed as part of and outside of the current study. Cristina J. Gasparetto has acted as paid consultant, member of the advisory board, and member of the speakers' bureau for Celgene, A Bristol-Myers Squibb Company/Bristol-Myers Squibb; has acted as a member of the advisory board and speakers' bureau for Karyopharm and Sanofi; has acted as a member of the advisory board for GlaxoSmithKline and AbbVie; has acted as a member of the advisory board and as a paid consultant for Adaptive and Janssen; has acted as a paid consultant for Takeda Pharmaceuticals; has received travel reimbursement from Janssen, Bristol-Myers Squibb, and Celgene, A Bristol-Myers Squibb Company; and has received research funding from Celgene, A Bristol-Myers Squibb Company for work performed outside of the current study. Lynne Wagner has acted as a paid member of the Connect MM Steering Committee for Celgene, A Bristol-Myers Squibb Company as part of the current study; has received honoraria for her role as a Section Editor for *Cancer* from the American Cancer Society; and has acted as a paid scientific consultant for EveryFit, Gilead, and Janssen. James L. Omel has received honoraria from and is a member of the board of directors/advisory committee for Takeda Oncology and Celgene, A Bristol-Myers Squibb Company. Mia He, Lihua Yue, Elizabeth Dawn Flick, and Amit Agarwal are employed by Bristol-Myers Squibb. Rafat Abonour is a member of steering committees for Celgene, A Bristol-Myers Squibb Company and Takeda Pharmaceuticals and has received research funding from Celgene, A Bristol-Myers Squibb Company, Takeda Pharmaceuticals, and Prothena.

AUTHOR CONTRIBUTIONS

All authors contributed to the acquisition, analysis, or interpretation of the data for this article and drafts of the article; revised the article critically for important intellectual content; approved the final version of the article to be published; and agreed to be accountable for all aspects of the article.

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