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Clinical Characteristics, Response to Therapy, and Survival of African American Patients Diagnosed With Chronic Lymphocytic Leukemia:

Joint Experience of the MD Anderson Cancer Center and Duke University Medical Center

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Abstract

Background—Little is known regarding racial disparities in characteristics and outcomes among patients with chronic lymphocytic leukemia (CLL).

Methods—The characteristics and outcomes of untreated African American (AA) patients with CLL (n=84) were analyzed and compared with a reference nonblack (NB) patient population (n=1571).

Results—At the time of presentation, AA patients had lower median hemoglobin levels (12.9 g/dL vs 13.7 g/dL), higher β2 microglobulin levels (2.7 mg/dL vs 2.4 mg/dL), greater frequency of constitutional symptoms (27% vs 10%), unmutated immunoglobulin heavy-chain variable region (*IGHV*) mutation status (65% vs 47%), ζ-chain-associated protein kinase 70 (ZAP70) expression (58% vs 32%), and deletion of chromosome 17p or chromosome 11q (28% vs 17%; $P \leq 02$ for each comparison). Fifty-one percent of AA patients and 39% of NB patients required first-line therapy and 91% and 88%, respectively, received chemoimmunotherapy. Overall response rates to treatment were 85% for AA patients and 94% for NB patients (P=.06); and the complete response rates were 56% and 58%, respectively (P=.87). The median survival of AA patients was shorter compared with that of NB patients (event-free survival: 36 months vs 61 months; P=.007; overall survival: 152 months vs not reached; P=.0001). AA race was an independent predictor of shorter event-free and overall survival in multivariable regression models.

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Conclusions—The current results indicated that AA patients with CLL have more unfavorable prognostic characteristics and shorter survival compared with their NB counterparts.

Keywords

Chronic Lymphocytic Leukemia; Racial Disparities; African Americans; Prognostic Factors; Chemoimmunotherapy; Survival

Introduction

Extensive literature has demonstrated that patients with cancer who belong to minority racial groups fare less well than Caucasians.[1] Studies on racial disparities among both adults and children with a variety of solid tumors have uniformly confirmed a worse prognosis for African American (AA) patients compared with nonblack (NB) patients.[1,2] In particular, the long-term survival of AA patients diagnosed with cancer is significantly inferior to that of Caucasian patients for virtually all types of cancer.[2] The same observations have been made with respect to hematologic malignancies.[1-9] Numerous reasons have been put forth to explain this phenomenon. These putative variables include: AA patients' comparatively inferior socioeconomic status (SES) and access to high-quality care; greater reluctance to seek medical attention; lower adherence to screening procedures, compliance with therapy or follow-up visits, and acceptance of supportive measures or certain therapeutic options (such as stem cell transplantation); higher burden of comorbidities at the time of cancer diagnosis; lower enrollment rate in clinical trials; more aggressive disease phenotype; and a more adverse pharmacogenetic profile.[10-12]

Chronic lymphocytic leukemia (CLL)/small lymphocytic lymphoma (SLL) has an overall disease-specific incidence per 100,000 population per year of 5.49 (95% confidence interval [CI], 5.43-5.56; CLL: 4.17; 95% CI, 4.12-4.23; SLL: 1.32; 95% CI, 1.29-1.35) and is more frequent among males than females, with an incidence rate ratio of 1.89 (95% CI, 1.85-1.93).[13] There is considerable racial variability in the distribution and clinical course of CLL/SLL. Analyses of information from the Surveillance, Epidemiology, and End Results (SEER) database have indicated that the incidence of CLL is lower among AAs than Caucasians, with a calculated incidence rate ratio of 0.73 (95% CI, 0.69-0.77).[13,14] In addition to a lower incidence of CLL/SLL, AA patients with CLL/SLL have an inferior 5-year relative survival rate compared with whites (77.1% vs 63.9%; *P*=.01). This discrepancy persists regardless of the year of diagnosis.[14] It has also been observed that, compared with Caucasians, AAs with CLL/SLL present at a significantly younger age. Among patients with SLL, AAs have more advanced stage at diagnosis, more frequent constitutional symptoms, and a greater extent of extranodal disease.[14] Factors accounting for these differences can only be hypothesized at this time, because population-based or registry-based studies are descriptive by nature, are potentially limited by ascertainment bias, and contain a low level of detail.

To address this gap in knowledge regarding racial disparity, we analyzed the characteristics and outcomes of AA patients with CLL/SLL who were referred to our institutions. We compared this patient cohort with a reference NB CLL/SLL patient population that was

evaluated over the same time period. The results of our detailed analysis of demographic, clinical, and biologic parameters as well as assessments of response to treatment with chemoimmunotherapy and long-term outcomes are presented.

Materials and Methods

Study Population

We reviewed paper and electronic records of patients with newly diagnosed CLL/SLL who had been consecutively referred to The University of Texas MD Anderson Cancer Center (MDACC) or Duke University Medical Center (DUMC) between 1997 and 2011. We identified 160 AA patients with CLL (118 who were followed at MDACC and 42 who were followed at DUMC). Eighty-four patients were untreated at the time of referral and formed our AA study population. Similarly, we identified a total of 1571 consecutive untreated NB patients with CLL, who served as the comparison group. This sample constitutes all CLL patients who attended our institutions during the study period. Data were collected in a retrospective manner. CLL and SLL were analyzed aggregately in this study and are referred to here as CLL.

Information was organized into 4 categories. 1) Demographic characteristics included patient age at the time of CLL diagnosis, sex, and race (the latter defined per patient self-reported ancestry). 2) Clinical data included date of diagnosis of CLL, date of referral to MDACC or DUMC, white blood cell (WBC) count, absolute lymphocyte count, hemoglobin (Hgb) level, platelet level, presence and size of superficial lymphadenopathies, spleen size or liver size, stage according to the Rai prognostic classification system,[15] presence of constitutional symptoms, β2 microglobulin (β2-m) level, and immunoglobulin heavy-chain variable region (*IGHV*) gene mutational status. The presence of the following molecular cytogenetic abnormalities was determined from fluorescence in situ hybridization (FISH) results using bone marrow (BM) or peripheral blood (PB) samples: chromosome 17p deletion (del17p), chromosome 11q deletion (del11q), trisomy of chromosome 12, and chromosome 13q deletion (del13q). The clinical data also included CD38 expression (as determined by flow cytometry with BM or PB samples) and ζ-chain–associated protein kinase 70 (ZAP70) expression (as assessed by immunohistochemical analysis on BM samples or by flow cytometry on PB samples).[3] Treatment information included the start date of treatment (if applicable), the treatment regimen used, and treatment duration. Indications for treatment initiation included a lymphocyte doubling time <6 months, enlarging lymphadenopathies, symptomatic splenomegaly, evidence of BM failure, constitutional or mass-related symptoms, and symptomatic leukostasis.[4] Information on outcome included, as applicable, the type of response to therapy, date of treatment failure, date of last follow-up, survival status, and cause of death.

Study Design

The first objective of the current study was to analyze the characteristics of untreated AA patients with CLL compared with those of a reference population of untreated NB patients with CLL. The second objective was to analyze time to treatment (TTT), response to therapy, and survival outcomes in terms of event-free survival (EFS) and overall survival

(OS) in the 2 patient populations. Treatment indications and response to therapy were assessed according to the 1996 version of the National Cancer Institute-sponsored Working Group criteria.[16] TTT was defined as the interval between the date of presentation at MDACC or DUMC and the date first-line treatment started. Patients who never received treatment were censored at their last follow-up date. The overall response rate (ORR) included a partial response (PR) or better. EFS was defined as the time between the date of treatment and the date of death, disease progression, or last follow-up, whichever occurred first. Patients who were alive and without disease progression at the last follow-up date were censored at that time. OS was defined as the time between the date of diagnosis and the date of death or last follow-up, whichever occurred first. Patients who were alive at the last follow-up date were censored at that time.

Because the AA patient population was much smaller than the NB population, the spectrum of treatments that had been used for the former was narrower. To create a matched comparison between the 2 groups in our analyses of response and EFS, we created a subgroup of NB patients who had received the same therapies as the AA group. This study was approved by the institutional review boards of MDACC and DUMC and was conducted in accordance with institutional guidelines and the Declaration of Helsinki.

Statistical Analyses

Patient characteristics were summarized using means (with standard deviations) or medians (with ranges) for continuous variables and frequencies (percentages) for categorical variables. Fisher exact tests and Wilcoxon-rank sum tests were used to assess the association between race (ie, AA vs NB) and categorical and continuous variables, respectively. The probabilities of OS or EFS were estimated using the method of Kaplan and Meier,[17] and the log-rank test[18] was performed to assess differences between AA and NB patient subgroups. Univariate and multivariable logistic regression models were fit to assess the association between prognostic factors and response. Univariate and multivariable Cox[19] proportional hazards models were fit to assess the association between prognostic factors and OS or EFS. *P* values < .05 were deemed statistically significant. All statistical analyses were conducted using SAS version 9 for Windows (SAS Institute Inc., Cary, NC) and S-PLUS 8.0 for Windows (Insightful Corp., Seattle, Wash).

Results

Patient Characteristics

Characteristics of the AA and NB patients at the time of referral are summarized in Table 1. Median age and sex distributions were similar between the 2 groups, as was the proportion of patients with a diagnosis of SLL. Compared with the NB patients, AA patients had a significantly lower median Hgb level (12.9 g/dL vs 13.7 g/dL; *P*=.001), higher β2-m level (2.7 mg/dL vs 2.4 mg/dL; *P*=.004), a higher proportion of patients with bulky lymph nodes (10% vs 1%; *P* < .0001) and constitutional symptoms (27% vs 10%; *P* < .0001). The distribution of Rai stage also differed significantly between groups, with the NB group having a higher proportion of patients with stage 0 disease (32% vs 21%; *P*=.02). The prognostic profile of AA patients at the time of referral also differed from that of NB

patients (Table 1). In particular, AA patients had a significantly higher proportion of cases with unmutated *IGHV* gene status (65% vs 47%; *P*=.006) and had a different distribution of cytogenetic features (*P*=.0004), with a higher fraction of del11q among AAs (20% vs 11%). ZAP70 expression also was more frequent in AA patients than in NB patients (58% vs 32%; *P*=.004), but there was no statistically significant difference in CD38 expression (35% vs 30%; *P*=.38). To evaluate ascertainment bias as a potential contributing factor for the discrepancies in the presenting characteristics between AA and NB patients, we assessed the time from diagnosis to referral to MDACC or DUMC. The median time to first visit was shorter for AAs compared with NBs (2.3 months [range, 0-86 months] vs 4.1 months [range, 0-428 months], respectively; *P*=.001).

Time to Treatment and Response

Forty-three of the 84 AA patients (51%) required therapy, compared with only 607 of 1571 NB patients (39%). The median TTT was 14.3 months and 57.2 months for those 43 AA patients and 607 NB patients, respectively (*P*=.007; log-rank test) (Fig. 1A).

Four hundred eighty-seven NB patients received the same treatment regimens that were received by the AA patient group. The ORR to first-line therapy was 85% in AA patients and 94% in NB patients, and the complete response rate was 56% and 58%, respectively. There was no statistically significant difference in the ORR or the complete response rate between the 2 groups (*P*=.06 and *P*=.87, respectively). Because the majority of patients in both groups received chemoimmunotherapy as first-line treatment, we next focused on response to this type of therapy. Ninety-one percent of the 43 AA patients and 88% of the 487 NB patients received chemoimmunotherapy (*P*=.81). Chemoimmunotherapy consisted of fludarabine, cyclophosphamide, and rituximab (FCR); rituximab-intensified FCR (FCR3); FCR plus granulocyte-monocyte colony-stimulating factor (GM-CSF); FCR plus mithoxantrone; FCR plus alemtuzumab; or pentostatin, cyclophosphamide, and rituximab. Within this subgroup of patients, the ORR was 92% for AAs and 96% for NBs (*P*=.21), and the complete response rate values were 62% and 64%, respectively (*P*=.86).

Multiple clinical and biologic parameters were associated with the achievement of a PR or better in the univariate model. On multivariate analysis, lower Hgb, chromosome 17p deletion (*P* < .0001), and unmutated *IGHV* status (*P*=.01) were correlated independently and inversely with the likelihood of achieving a PR of better (Table 2). However, AA race was not significantly correlated (*P*=.54).

Survival

Sixty-six AA patients and 1428 NB patients are alive. Causes of death among the AA patients included CLL and CLL-related complications (progressive disease in 4 patients, other cancers in 3, and septic shock in 1), treatment-related complications (stem cell transplantation-related death in 1 patient, subarachnoid hemorrhage in 1, and pulmonary thromboembolism in 1), and other causes (advanced dementia in 1 patient and accident in 1); and the cause of death was unknown for 5 patients. Among the NB patients, the causes of death included CLL and CLL-related complications (progressive disease in 12 patients, infectious complications in 20, Richter transformation in 14, other cancers in 29, and

aplastic anemia in 1), treatment-related complications (hemorrhage in 2 patients, pulmonary embolism in 2, drug-related hepatotoxicity in 1, and stem cell transplantation-related in 6), and other causes (cardiovascular in 5 patients, cerebrovascular in 3, dementia in 1, accident in 1, and suicide in 1); and cause of death was unknown for 45 patients. The median OS was 152 months for the AA group and was not reached for the NB group (P=.0001; log-rank test) (Fig. 1B). The median EFS was 36 months (95% CI, 21-47 months) for the AA group and 61 months (95% CI, 49-75 months) for the NB group (P=.0007) (Fig. 1C).

The survival of AA patients was statistically significantly inferior to that of NB patients across different levels of β2-m (≤2 mg/dL or >2 mg/dL), *IGHV gene* mutation status (mutated or unmutated), and cytogenetic abnormalities (del17p plus del11q or other abnormalities; $P \leq .04$ for all comparisons) (Fig. 2A-C). This group inferiority was maintained with Rai stages 0 though 2 (P=.0002) but not with Rai stages 3 and 4 (P=.18) (Fig. 2D). The most significant factors associated with EFS duration in the univariate analysis were age, race, WBC count, β2-m level, cytogenetic abnormalities, *IGHV* status, ZAP70 expression, and type of first-line treatment. Of these variables, higher β2-m level, higher WBC count, presence of del17p, unmutated *IGHV* status, and AA race were each independently correlated with shorter EFS in the multivariate model (Table 3). Similarly, age, race, constitutional symptoms, Rai stage, Hgb level, β2-m level, del17p, *IGHV* status, CD38 expression, and ZAP70 expression were associated with OS in the univariate analysis. In the multivariable model, only older age, advanced Rai stage, presence of del17p, unmutated *IGHV* status, and AA race each retained an independent adverse effect on OS (Table 4). These observations indicate that AA race is associated with the presence of worse prognostic factors and, per se, is a predictor of shorter EFS and OS in patients with CLL.

Discussion

We conducted a comprehensive retrospective analysis to study the presenting features and clinical outcomes of AA patients diagnosed with CLL who were referred to 2 tertiary care centers. To our knowledge, this is the first study of AA patients with CLL to provide such a high degree of detail. We observed significant differences in baseline characteristics between AA patients and NB patients. Specifically, adverse prognostic factors for CLL occurred more frequently among AAs and included: low Hgb level, advanced Rai stage, constitutional symptoms, high β2-m level, unmutated *IGHV*, cytogenetic abnormalities, and ZAP70 positivity. These discrepancies may explain the shorter time to first treatment and worse survival in AA patients with CLL.

There are 2 possible limitations of the current study. First, the characteristics of the population referred to our centers may not be entirely representative of the overall CLL population. In particular, the median age of both AA and NB patients at the time of referral was 59 years. This age is in line with previous separate reports from both of our groups but is lower compared with 72 years, which is the median age at the time of CLL diagnosis reported in the SEER registry. In addition, we likely observed a higher proportion of patients with more aggressive CLL features and, consequently, indication for treatment, because this is frequently the reason for patient referral. Finally, the majority of our patients had adequate insurance or Medicare coverage, making the generalization of our findings to the uninsured

patient population difficult. However, the AA-to-NB cumulative incidence ratio was 5.5%, (anticipated ratio, 7.2%), suggesting that the potential selection bias of a referral population may have applied to some degree to both the AA group and the NB group. Second, because this was a retrospective study, information regarding the TTT and post-treatment patient management after completion of the initial treatment program may have been influenced by the frequency of follow-up. Although approximately 66% of patients who progressed after initial treatment received subsequent therapy at our institutions, survival still may be influenced by treatment choices after disease progression and by the management of late complications or the timeliness of detecting relapses.

There is extensive literature indicating that the prognosis for AA cancer patients, particularly for long-term survival, is worse than that for whites across various hematologic malignancies, such as acute myeloid leukemia,[8,20-22] acute lymphoblastic leukemia,[6,8,23,24] Hodgkin[4,25] and non-Hodgkin lymphoma,[3,5,7,26] and CLL.[9,14] However, data in those reports are insufficiently detailed, and only “educated hypotheses” have been made to address this phenomenon. Shenoy and colleagues have recently published an analysis of data from 13 SEER registries between 1992 and 2007. Those authors reported inferior 2-year and 5-year relative survival for AA patients with CLL compared with Caucasians as well as the independent prognostic relevance of race in patient outcome. However, because of the population-based nature and the time period covered by their analysis, information regarding relevant prognostic factors was very limited. No information on the type of treatment was reported. Although the authors did demonstrate slight improvement in outcome for patients who received treatment after the year 2000, suggesting that newer treatment modalities may be of benefit overall, they were not able to ascertain whether this improvement differed according to race.[14]

SES is frequently discussed as a potential prognostic factor in cancer medicine, because it can affect several important components of cancer patient management.[27] Delay or failure to seek medical attention is a problem that appears to correlate with SES.[11] It has been suggested that cancer patients belonging to minority racial or ethnic groups, including AAs, may have poorer access to health care facilities for medical concerns or routine blood tests, leading to potential diagnostic delay and more advanced disease at diagnosis.[11] However, we did not observe significant differences in terms of the type or extent of insurance coverage at the time of referral between AA patients and NB patients (94% and 99%), and the distribution of occupations was similar (data not shown). Moreover, the time from diagnosis (made either incidentally or because of clinical symptoms) to referral was shorter for AA patients than for NB patients in our analysis, making this difference an unlikely cause of the worse prognosis for the AA patients included in the current analysis. Finally, it has been demonstrated that timeliness of diagnosis does not affect patient outcome in CLL[28] to the extent it does in acute leukemia.[29] Arguably, reluctance to present to medical attention may explain why the AA group was enriched in cases with more aggressive, symptomatic disease. However, the inferior survival of AA patients persisted when stratifying the patients according to relevant prognostic factors. More important, multivariable analyses indicated race as an independent prognostic factor for both shorter EFS and shorter OS, even when controlling for other relevant clinical and prognostic variables. Lesser compliance with therapy and therapy-related procedures among AA patients also has been hypothesized.

According to our review, this is unlikely to be the case in our patient group, because no differences in terms of number of cycles or treatment duration were noted between AA patients and NB patients.

Bach and colleagues[30] suggested that disparities in outcome between AA and NB patients with cancer might disappear if the same treatment is received by both groups. For the analysis of response to treatment and outcome, we focused on patients receiving first-line chemoimmunotherapy, because this is the treatment received by the vast majority of our AA and NB patients, and it represents the standard of care for newly diagnosed CLL. We analyzed response to treatment and patient outcome aggregately for all chemoimmunotherapy-based combinations, because the results achieved with most of these regimens in our hands have been similar and significantly better compared with conventional chemotherapy without the addition of monoclonal antibodies. It is noteworthy that response rates to chemoimmunotherapy were similar between AAs and NBs. Race had no notable influence on the likelihood of response in the univariate and multivariable models, suggesting that potential race-specific differences in chemosensitivity are not relevant to response to chemoimmunotherapy. However, compared with the NB group, the median duration of response to chemoimmunotherapy was shorter in the AA group, resulting in inferior EFS and ultimately worse OS. Although AA patients had a higher proportion of cases with known adverse prognostic factors, the negative impact of AA race on both EFS and OS persisted as an independent variable. These findings suggest that, although they induce similarly high response rates, such treatments do not overcome racial differences in outcome among patients with CLL. Eighteen deaths have occurred to date among our AA patients without excess in any specific cause of death in this group.

In conclusion, our analysis demonstrated that AA patients with CLL present with more unfavorable clinical and biologic characteristics, have an earlier need of treatment, have shorter remission duration after FCR-based chemoimmunotherapy regimens, and have a shorter OS compared with NB patients. This race-associated discrepancy is independent of other relevant prognostic factors, such as β2-m level, *IGHV* mutation status, and cytogenetic abnormalities. Future studies should focus on revealing the biologic basis for these divergent clinical outcomes.

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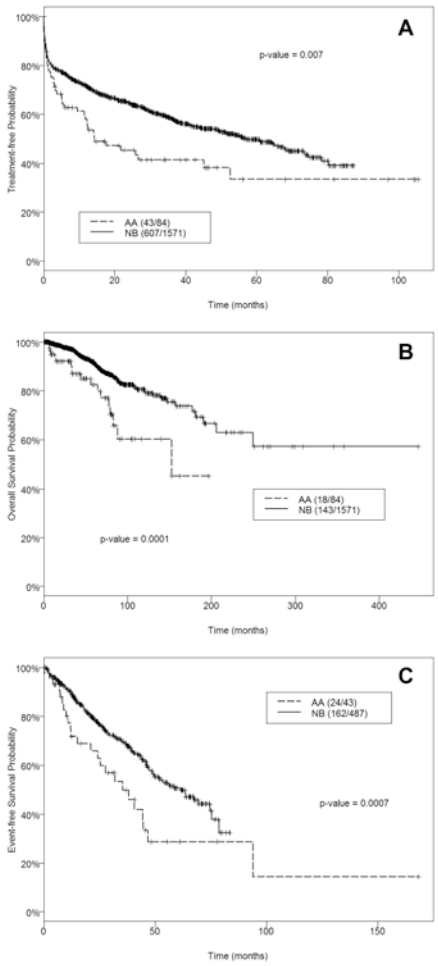
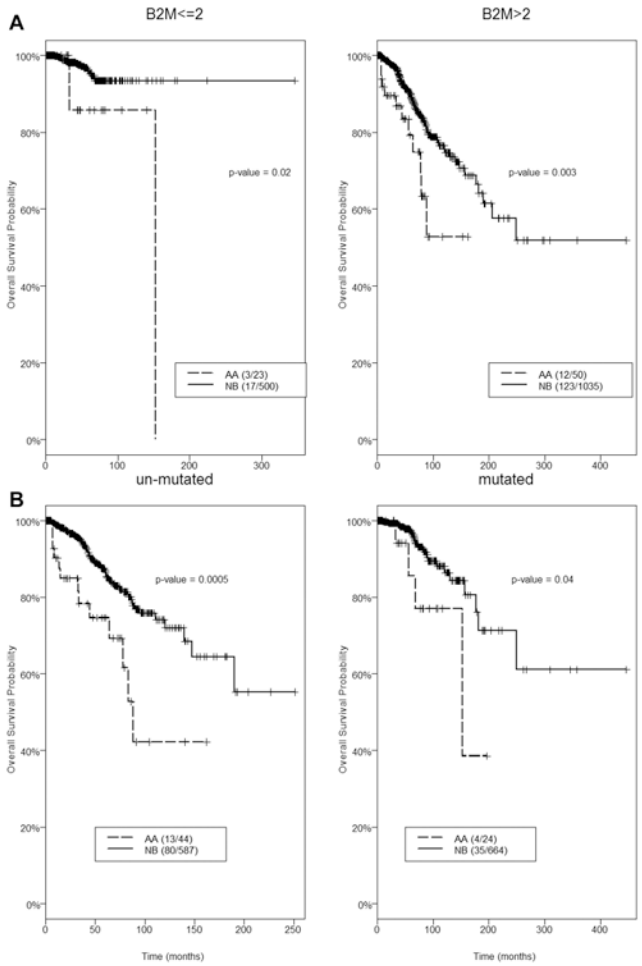


Figure 1.

(A) Time to treatment, (B) overall survival, and (C) event-free survival are illustrated in patients with chronic lymphocytic leukemia according to race. AA indicates African American; NB, nonblack.



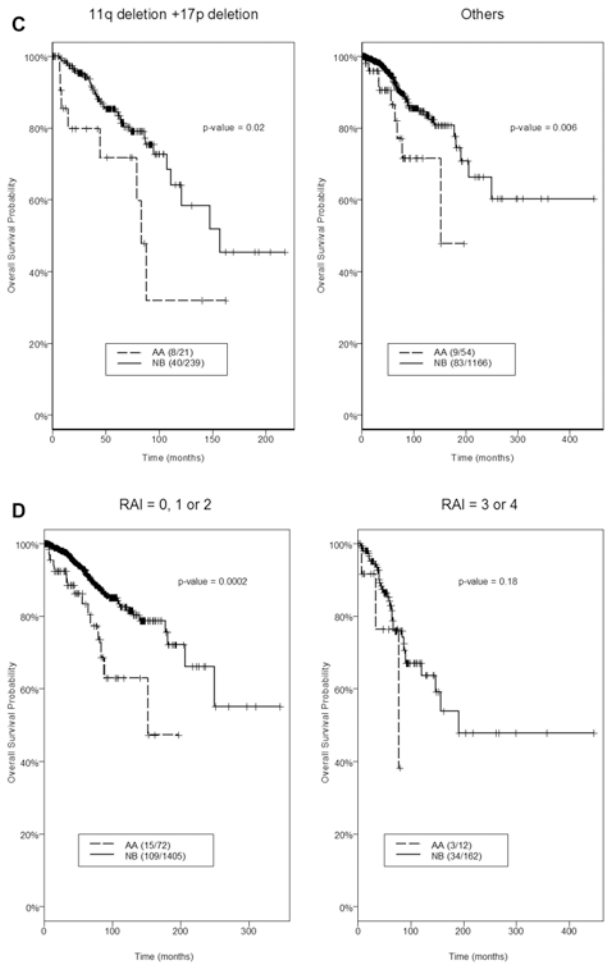


Figure 2.

Kaplan-Meier overall survival estimates are illustrated according to race. The survival of African American (AA) patients and nonblack (NB) patients is illustrated according to (A) β2 microglobulin (B2M) level (≤2 mg/dL or >2 mg/dL), (B) immunoglobulin heavy-chain variable region (*IGHV*) mutation status (unmutated or mutated), (C) cytogenetic abnormalities (del17p plus del11q or other abnormalities), and (D) Rai stage (stages 0-2 or 3-4).

Table 1

Selected Characteristics of African American and Nonblack Patients With Chronic Lymphocytic Leukemia at Initial Presentation

Characteristic	No. of Patients (%)		
	AA, n = 84	NB, n = 1571	*P*
Age: Median [range], y	59 [35-88]	59 [26-94]	.56
Sex, men:women	48:36	955:616	.57
Diagnosis, CLL:SLL	75:9	1331:240	.35
Hemoglobin: Median [range], g/dL	12.9 [7-16.5]	13.7 [5.5-17.7]	.001
WBC count: Median [range], $\times 10^3/\mu L$	21.6 [4.4-421.4]	22.1 [1-786]	.42
Absolute lymphocyte count: Median [range], $\times 10^3/\mu L$	16.27 [0.55-331.54]	16.51 [0-707.40]	.38
Platelets: Median [range], $\times 10^3/\mu L$	215 [29-631]	200 [3-961]	.53
Hepatomegaly	2 (2)	80 (5)	.27
Splenomegaly	8 (10)	215 (14)	.28
Bulky lymphadenopathy: ≥5 cm	8 (10)	22 (1)	<.0001
Rai stage			.02
0	18 (21)	508 (32)	
1	48 (57)	718 (46)	
2	6 (7)	183 (12)	
3	8 (10)	67 (4)	
4	4 (5)	95 (6)	
Constitutional symptoms	23 (27)	155 (10)	<.0001
β2-Microglobulin: Median [range], mg/L	2.7 [1.2-11.9]	2.4 [0-36.6]	.004
Unmutated *IGHV*	44/68 (65)	587/1251 (47)	.006
CD38 positive	27/78 (35)	363/1214 (30)	.38
ZAP70 positive	48/74 (65)	495/1041 (47)	.004
Cytogenetic abnormality (FISH)			.0004
del17p	6/75 (8)	84/1406 (6)	
del11q	15/75 (20)	155/1406 (11)	
del13q	13/75 (17)	527/1406 (37)	
Trisomy 12	23/75 (31)	246/1406 (17)	
Negative	18/75 (24)	393/1406 (28)	
First-line chemoimmunotherapy, no. (%)	39/43 (91)	431/487 (88)	.81

Abbreviations: AA, African American; CLL, chronic lymphocytic leukemia; IGHV, immunoglobulin heavy chain variable region; NB, nonblack; SLL, small lymphocytic lymphoma; ZAP80, ζ-chain–associated protein kinase 70.

Table 2

Multivariable Logistic Regression Model for the Achievement of a Partial Response or Better Among Patients With Chronic Lymphocytic Leukemia: 422 Evaluable Patients, 392 Responders

Variable	OR	95% CI	*P*
Intercept			<.0001
Chromosome 17p deletion	0.18	0.08-0.43	.0001
Unmutated *IGHV*	0.26	0.08-0.90	.03
AA race	0.71	0.19-2.61	.61

Abbreviations: AA, African American; CI, confidence interval; *IGHV*, immunoglobulin heavy chain variable region; OR, odds ratio.

Table 3

Multivariable Cox Proportional Hazards Model for Event-Free Survival in Patients With Chronic Lymphocytic Leukemia

Variable	HR	95% CI	*P*
Chromosome 17p deletion	2.61	1.72-3.97	<.0001
Unmutated *IGHV*	1.79	1.24-2.60	.002
AA race	1.78	1.09-2.91	.02
Age	1.03	1.01-1.05	.04

Abbreviations: AA, African American; CI, confidence interval; *IGHV*, immunoglobulin heavy chain variable region; HR, hazard ratio.

Table 4

Multivariable Cox Proportional Hazards Model for Overall Survival in Patients With Chronic Lymphocytic Leukemia

Variable	HR	95% CI	*P*
AA race	3.62	2.13-6.17	<.0001
Age	1.06	1.04-1.07	<.0001
Chromosome 17p deletion	3.47	2.22-5.41	<.0001
Unmutated *IGHV*	2.60	1.76-3.84	<.0001
Rai stage 3-4	1.81	1.21-2.71	.004

Abbreviations: AA, African American; CI, confidence interval; HR, hazard ratio; *IGHV*, immunoglobulin heavy chain variable region.