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Racial differences in time to treatment for melanoma

Raghav Tripathi, MPH,a,b Laura K. Archibald, MD,c Rishabh S. Mazmudar, BS,a,b Rosalynn R. Z. Conic, MD, PhD,d Luke D. Rothermel, MD, MPH,a,e Jeffrey F. Scott, MD,a,f and Jeremy S. Bordeaux, MD, MPHa,b

Cleveland, Ohio; Minneapolis, Minnesota; and Baltimore, Maryland

Background: Longer time from diagnosis to definitive surgery (TTDS) is associated with increased melanoma-specific mortality. Although black patients present with later-stage melanoma and have worse survival than non-Hispanic white patients, the association between race and TTDS is unknown.

Objective: To investigate racial differences in time to melanoma treatment.

Methods: Retrospective review of the National Cancer Database (2004-2015). Multivariable logistic regression was used to evaluate the association of race with TTDS, controlling for sociodemographic/disease characteristics.

Results: Of the 233,982 patients with melanoma identified, 1221 (0.52%) were black. Black patients had longer TTDS for stage I to III melanoma (P < .001) and time to immunotherapy (P = .01), but not for TTDS for stage IV melanoma or time to chemotherapy (P > .05 for both). When sociodemographic characteristics were controlled for, black patients had over twice the odds of having a TTDS between 41 and 60 days, over 3 times the odds of having a TTDS between 61 and 90 days, and over 5 times the odds of having a TTDS over 90 days. Racial differences in TTDS persisted within each insurance type. Patients with Medicaid had the longest TTDS (mean, 60.4 days), and those with private insurance had the shortest TTDS (mean, 44.6 days; P < .001 for both).

Conclusions: Targeted approaches to improve TTDS for black patients are integral in reducing racial disparities in melanoma outcomes. (J Am Acad Dermatol 2020;83:854-9.)

Key words: black; chemotherapy; disparities; immunotherapy; insurance; melanoma; mortality; National Cancer Database; non-Hispanic white; racial; stage; survival; time to definitive surgery; time to treatment.
associated with increased melanoma-specific mortality.\textsuperscript{6,8-10} Despite this, the association between race and time from diagnosis to definitive surgery (TTDS) is unknown.

As such, our primary goal was to investigate differences in TTDS between black and non-Hispanic white (NHW) patients with melanoma. Our secondary goals were to determine differences in TTDS between black and NHW patients by melanoma stage and insurance type and to examine racial differences in stage at presentation, distance from the hospital, and time to medical treatment (immunotherapy and chemotherapy).

\section*{METHODS}

Patients with cutaneous melanoma were identified using the National Cancer Database (NCDB) from 2004 to 2015. The NCDB, produced by the American Cancer Society and the American College of Surgeons, contains data from more than 1500 accredited hospitals and more than 70\% of all newly diagnosed cancer cases in the United States. Patients with American Joint Committee on Cancer pathologic stage I to IV cutaneous melanoma were included in this study. TTDS was calculated as the number of days between initial diagnosis and definitive surgical resection of the primary tumor. Patients with missing data for covariates, unknown stage, or excisional biopsy as definitive treatment (TTDS of 0 days) were excluded.

Descriptive analyses were performed for initial univariate comparison of sociodemographic characteristics between racial groups using the Pearson chi-square and analysis of variance (ANOVA). The Student t test (pooled) was initially used for univariate comparison of time to immunotherapy and chemotherapy, as well as for TTDS stratified by stage and insurance type between racial groups. Multivariable logistic regression was used to evaluate the association of race with TTDS, controlling for sex, age, median household income, and insurance type. In the multivariable model, adjusted odds ratios were calculated for black patients (reference group: NHW patients). Institutional review board approval was not required for the use of this publicly available, deidentified database. All analyses were performed in the statistical software R (R Foundation, Vienna, Austria), and \( P \) less than .05 was considered significant.\textsuperscript{11}

\section*{RESULTS}

Our sample included 233,982 patients with cutaneous melanoma, of which 1221 (0.52\%) were black and 232,761 were NHW (99.5\%) (Table I). Black and NHW patients did not differ by age (\( P = .07 \)). Compared with NHW patients, black patients were more often female (\( P < .001 \)) and presented with later-stage melanoma (\( P < .001 \)). Median household income differed significantly by race (\( P < .001 \)). Most NHW patients had a median household income of $63,000 or greater (41.9\%), whereas most black patients had a median household income of less than $38,000 (32.9\%). Insurance status also differed by race, with a greater proportion of black patients having Medicaid or no insurance than NHW patients (7.0\% vs 2.1\% and 5.7\% vs 2.3\%, respectively; \( P < .001 \)). On average, black patients lived closer to the hospital than NHW patients (70.0\% vs 61.6\% living less than 20 miles from the hospital; \( P < .001 \)).

Most black (70.2\%) and NHW (85.1\%) patients had a TTDS between 0 and 30 days. Compared to NHW patients, black patients had an increased average TTDS (23.4 days vs 11.7 days; \( P < .001 \)) and increased average time to immunotherapy (129.8 days vs 108.3 days) (\( P = .01 \)). There was no significant difference in time to chemotherapy between black and NHW patients (123.4 days vs 100.4 days, \( P = .10 \)).

Stratified by stage, black patients had an increased average TTDS for stage I, II, and III melanoma (\( P < .001 \)) but not stage IV melanoma (\( P = .55 \)) (Table II). Black patients also had an increased average TTDS when stratified by insurance type (Table III). After sex, age, income, and insurance status were controlled for, black patients were significantly more likely than NHW patients to have a TTDS between 31 and 60 days (adjusted odds ratio \( [\text{aOR}] \), 2.10; 95\% confidence interval \( [\text{CI}] \), 1.74-2.54), 61 to 90 days (\( \text{aOR}, 3.15; 95\% \text{CI}, 2.42-4.02 \)), or more than 90 days (\( \text{aOR}, 5.16; 95\% \text{CI}, 3.84-6.80 \)) (\( P < .001 \) for all) (Table IV).

\section*{DISCUSSION}

In this study, black patients had a longer TTDS for stages I to III melanoma and greater time to
immunotherapy compared with NHW patients, and the racial differences in TTDS persisted within each insurance type. There were no racial differences in TTDS for stage IV melanoma or time to chemotherapy. Additionally, compared with NHW patients, black patients had over twice the odds of having a TTDS between 41 and 60 days, over 3 times the odds of having a TTDS between 61 and 90 days, and over 5 times the odds of having a TTDS over 90 days.

Table I. Sample demographics*

| Characteristics                              | NHW, n (%) | Black, n (%) | P value |
|----------------------------------------------|------------|--------------|---------|
| Total number of patients                     | 232,761    | 1221         |         |
| Age, y, n (%)                                |            |              |         |
| <30                                          | 9609 (4.1) | 37 (3.0)     | .072    |
| 30-39                                        | 17,358 (7.5) | 94 (7.7) |         |
| 40-49                                        | 31,729 (13.6) | 141 (11.5) |         |
| 50-59                                        | 48,272 (20.7) | 273 (22.4) |         |
| 60-69                                        | 52,387 (22.5) | 291 (23.8) |         |
| 70-79                                        | 44,031 (18.9) | 243 (19.9) |         |
| 80+                                          | 29,375 (12.6) | 142 (11.6) |         |
| Sex, n (%)                                   |            |              |         |
| Male                                         | 134,164 (57.6) | 530 (43.4) | <.001   |
| Female                                       | 98,597 (42.4) | 691 (56.6) | <.001   |
| Stage of melanoma, n (%)                     |            |              |         |
| Stage I                                      | 154,781 (66.5) | 438 (35.9) | <.001   |
| Stage II                                     | 43,644 (18.8) | 385 (31.5) |         |
| Stage III                                    | 27,255 (11.7) | 294 (24.1) |         |
| Stage IV                                     | 7081 (3.0) | 104 (8.5) |         |
| Time to treatment, days, mean (SD)           |            |              |         |
| Time to definitive surgery                    | 11.72 (24.61) | 23.42 (37.43) | <.001   |
| Time to chemotherapy                          | 100.41 (100.57) | 123.36 (135.55) | .100   |
| Time to immunotherapy                         | 108.31 (83.82) | 129.79 (79.31) | .012   |
| Time to definitive surgery, days, n (%)       |            |              |         |
| 0-30                                         | 198,054 (85.1) | 857 (70.2) | <.001   |
| 31-60                                        | 27,782 (11.9) | 241 (19.7) |         |
| 61-90                                        | 4775 (2.1) | 70 (5.7) |         |
| >90                                          | 2150 (0.9) | 53 (4.3) |         |
| Insurance status, n (%)                      |            |              |         |
| Not insured                                  | 5275 (2.3) | 69 (5.7) | <.001   |
| Private insurance                            | 126,858 (54.5) | 533 (43.7) | <.001   |
| Medicaid                                     | 4973 (2.1) | 85 (7.0) | <.001   |
| Medicare                                     | 88,760 (38.1) | 484 (39.6) | .280    |
| Other government                             | 2410 (1.0) | 14 (1.1) | .702    |
| Unknown                                      | 4485 (1.9) | 36 (2.9) | .010    |
| Median household income, n (%)                |            |              |         |
| <$38,000                                     | 24,273 (10.5) | 399 (32.9) | <.001   |
| $38,000-$47,999                              | 47,061 (20.4) | 272 (22.4) |         |
| $48,000-$62,999                              | 62,747 (27.2) | 287 (23.7) |         |
| $63,000+                                     | 96,540 (41.9) | 255 (21.0) |         |
| Distance to hospital, miles, n (%)            |            |              |         |
| <20                                          | 142,166 (61.6) | 847 (70.0) | <.001   |
| 20-39                                        | 43,934 (19.0) | 170 (14.0) |         |
| 40-59                                        | 17,205 (7.5) | 79 (6.5) |         |
| >60                                          | 27,408 (11.9) | 114 (9.4) |         |

NHW, Non-Hispanic white; SD, standard deviation.
*Pearson chi-square for categorical variables and t test for continuous variables.
These findings add to the literature by showing increased TTDSs for black patients with melanoma after sex, age, income, and insurance type were controlled for. Our data suggest that increased TTDSs in black patients with melanoma may be an independent explanatory factor for racial differences in melanoma survival, alongside factors such as later stage at presentation, biological differences in melanoma characteristics, and differences in health care use.\textsuperscript{6,9,12} Multiple unfavorable socioeconomic factors may exacerbate overall health status more than the additive effects of each of the individual factors.\textsuperscript{13} Racial differences in TTDS persisted within each insurance group, implying that insurance status does not fully account for racial TTDS disparities. We found that black patients also had increased TTDSs despite living closer to hospitals, suggesting that physical distance from the hospital is not as much of a contributor to TTDS for melanoma as for other cancers (eg, colorectal).\textsuperscript{14} A recent study of 3 high-risk surgical procedures showed that black patients lived closer to high-quality hospitals but were 25% to 58% more likely to receive surgery at low-quality hospitals than NHW patients; it is possible that a similar phenomenon exists in TTDS for melanoma.\textsuperscript{15} Efforts to geographically centralize care for melanoma should consider that disparities may be driven by other extrinsic and intrinsic patient-level factors. Creation of a model delineating interactions between the myriad components underlying worse outcomes for black patients with melanoma, including race and insurance status, is critical in identifying targeted avenues for intervention.

### Table II. Comparison of time to definitive surgical treatment of melanoma between racial groups by stage

| Melanoma stage | Race   | Mean TTDS, days | SD   | P value |
|----------------|--------|-----------------|------|---------|
| Stage I        | NHW    | 34.59           | 33.69| <.001   |
|                | Black  | 45.84           | 42.88|         |
| Stage II       | NHW    | 37.71           | 37.52| <.001   |
|                | Black  | 46.25           | 39.87|         |
| Stage III      | NHW    | 38.80           | 34.38| <.001   |
|                | Black  | 50.78           | 52.34|         |
| Stage IV       | NHW    | 41.74           | 42.48| .548    |
|                | Black  | 45.76           | 39.92|         |

NHW, Non-Hispanic white; SD, standard deviation; TTDS, time to definitive surgical treatment.

### Table III. Comparison of time to definitive surgical treatment of melanoma between racial groups by insurance type

| Insurance      | Race   | Mean TTDS (days) | SD   | P value |
|----------------|--------|-----------------|------|---------|
| None           | NHW    | 39.33           | 37.917| .027    |
|                | Black  | 54.8            | 45.835|         |
| Private        | NHW    | 34.29           | 32.002| <.001   |
|                | Black  | 44.63           | 46.132|         |
| Medicaid       | NHW    | 42.55           | 35.968| .046    |
|                | Black  | 60.41           | 72.707|         |
| Medicare       | NHW    | 35.77           | 23.269| <.001   |
|                | Black  | 44.53           | 29.239|         |

NHW, Non-Hispanic white; SD, standard deviation; TTDS, time to definitive surgical treatment.

### Table IV. Multivariable logistic regression for time to definitive surgery of melanoma

| Patient demographics | Adjusted odds ratio* | P value |
|----------------------|---------------------|---------|
| Sex                  | Reference           | —       |
| Male                 | 1.85 (1.65-2.08)    | <.001   |
| Female               |                     | —       |
| Age, years <30       | Reference           | —       |
| 30-49                | 1.39 (0.99-2)       | .066    |
| 50-69                | 1.81 (1.31-2.58)    | .001    |
| >70                  | 1.51 (1.06-2.22)    | .029    |
| Median household income <$38,000 | Reference | — |
| $38,000-$47,999      | 0.34 (0.29-0.4)     | <.001   |
| $48,000-$56,999      | 0.26 (0.22-0.3)     | <.001   |
| $63,000+             | 0.15 (0.12-0.17)    | <.001   |
| Insurance Not insured | Reference | —       |
| Private insurance    | 0.43 (0.33-0.56)    | <.001   |
| Medicaid             | 1.14 (0.83-1.58)    | .433    |
| Medicare             | 0.5 (0.38-0.67)     | .002    |
| Other government     | 0.58 (0.31-1)       | .927    |
| Unknown              | 0.8 (0.53-1.2)      | .1338   |
| Time to definitive surgical treatment, days 0-30 | Reference | — |
| 31-60                | 2.01 (1.74-2.34)    | <.001   |
| 61-90                | 3.15 (2.42-4.02)    | <.001   |
| More than 90         | 5.16 (3.84-6.8)     | <.001   |

CI, Confidence interval.

*Adjusted odds ratios are for black patients (reference: non-Hispanic white race).
CONCLUSION

This study investigated racial differences in time to treatment for melanoma using a large hospital-based administrative health care database. Black patients had longer TTDS for melanoma than NHW patients after other sociodemographic factors were controlled for, and racial differences in TTDS persisted after stratification by insurance type and melanoma stage. Ultimately, it is important to better understand the various components underlying worse outcomes for black patients with melanoma. Targeted approaches to improve TTDSs for black patients with melanoma are integral in reducing racial disparities in melanoma outcomes.

Raghav Tripathi had full access to all data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

REFERENCES

1. Noone AM, Howlader N, Krapcho M, et al. SEER Cancer Statistics Review, 1975-2015. Bethesda, MD: National Cancer Institute; 2017.
2. Arakaki RY, Strazzula L, Woo E, Kroshinsky D. The impact of dermatology consultation on diagnostic accuracy and antibiotic use among patients with suspected cellulitis seen at outpatient internal medicine offices. JAMA Dermatol. 2014;150(10):1056.
3. Roetzheim RG, Lee J-H, Ferrante JM, et al. The influence of dermatologist and primary care physician visits on melanoma outcomes among Medicare beneficiaries. J Am Board Fam Med. 2013;26(6):637-647.
4. Stitzenberg KB, Thomas NE, Dalton K, et al. Distance to diagnosing provider as a measure of access for patients with melanoma. Arch Dermatol. 2007;143(8):991-998.
5. Buster KJ, Stevens EL, Elmets CA. Dermatologic health disparities. Dermatol Clin. 2012;30(1):53-59.
6. Dawes SM, Tsai S, Gittleman H, Barnholtz-Sloan JS, Bordeaux JS. Racial disparities in melanoma survival. J Am Acad Dermatol. 2016;75(5):983-991.
7. Adamson AS, Zhou L, Baggett CD, Thomas NE, Meyer A-M. Association of delays in surgery for melanoma with insurance type. JAMA Dermatol. 2017;153(11):1106-1113.
8. Kooistra L, Chiang K, Dawes S, Gittleman H, Barnholtz-Sloan JS, Bordeaux J. Racial disparities and insurance status: an epidemiologic analysis of Ohio melanoma patients. J Am Acad Dermatol. 2018;78:998-1000.
9. Conic RZ, Cabrera CI, Khorana AA, Gastman BR. Determination of the impact of melanoma surgical timing on survival using the National Cancer Database. J Am Acad Dermatol. 2018;78(1):40-46.
10. Baranowski MLH, Yeung H, Chen SC, Gillespie TW, Goodman M. Factors associated with time to surgery in melanoma: an analysis of the National Cancer Database. J Am Acad Dermatol. 2019;81(4):908-916.
11. R Core Team. R: a language and environment for statistical computing. Available at: https://www.r-project.org/. Accessed January 1, 2020.
12. Tripathi R, Knusel KD, Ezaldein HH, Scott JF, Bordeaux JS. Association of demographic and socioeconomic characteristics with differences in use of outpatient dermatology services in the United States. JAMA Dermatol. 2018;154(11):1286-1291.
13. Shen JI, Cochran CR, Mazurenko O, et al. Racial and insurance status disparities in patient safety indicators among hospitalized patients. Ethn Dis. 2016;26(3):443-452.
14. Massarweh NN, Chiang YJ, Xing Y, et al. Association between travel distance and metastatic disease at diagnosis among patients with colon cancer. J Clin Oncol. 2014;32(9):942-948.
15. Dimick J, Ruhter J, Sarrazin MV, Birkmeyer JD. Black patients more likely than whites to undergo surgery at low-quality hospitals in segregated regions. *Health Aff.* 2013;32(6):1046-1053.

16. Mahendraraj K, Sidhu K, Lau CSM, Mcroy GJ, Chamberlain RS, Smith FO. Malignant melanoma in African-Americans a population-based clinical outcomes study involving 1106 African-American patients from the Surveillance, Epidemiology, and End Result (SEER) database (1988-2011). *Medicine (Baltimore)*. 2017;96(15):e6258.

17. Nakamura Y, Teramoto Y, Sato S, Yamamoto A. Current surgical management of acral lentiginous melanoma. In: *Melanoma—Current Clinical Management and Future Therapeutics*. London: Intech; 2015.

18. Nakamura Y, Fujiwara Y. Diagnosis and management of acral lentiginous melanoma. *Curr Treat Options Oncol.* 2018;19(8):42.

19. Jung JY, Roh HJ, Lee SH, Nam K, Chung KY. Comparison of secondary intention healing and full-thickness skin graft after excision of acral lentigious melanoma on foot. *Dermatologic Surg.* 2011;37(9):1245-1251.

20. Bello DM, Chou JF, Panageas KS, et al. Prognosis of acral melanoma: a series of 281 patients. *Ann Surg Oncol.* 2013;20(11):3618-3625.

21. Deshpande AD, Jeffe DB, Gnerlich J, Iqbal AZ, Thummalakunta A, Margenthaler JA. Racial disparities in breast cancer survival: an analysis by age and stage. *J Surg Res.* 2009;153(1):105-113.

22. Lai Y, Wang C, Civin JM, et al. Effects of cancer stage and treatment differences on racial disparities in survival from colon cancer: a United States population-based study. *Gastroenterology.* 2016;150:1135-1146.

23. Haque W, Verma V, Butler EB, Teh BS. Racial and socioeconomic disparities in the delivery of immunotherapy for metastatic melanoma in the United States. *J Immunother.* 2019;42(6):228-235.

24. Oliver T, Pezzi TA, Pezzi AE, et al. Immunotherapy disparities in metastatic melanoma. *J Clin Oncol.* 2019;37(15 suppl):9525.

25. Bilimoria KY, Stewart AK, Winchester DP, Ko CY. The National Cancer Database: a powerful initiative to improve cancer care in the United States. *Ann Surg Oncol.* 2008;15(3):683-690.