Disparity on Unplanned Readmission in Melanoma Patients: A National Cancer Database Analysis

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Abstract. *Background/Aim: This study aimed to analyze associated factors of 30-day hospital readmission after surgery for melanoma. Patients and Methods: We conducted a retrospective analysis of postoperative 30-day unplanned readmission in patients with melanoma in the National Cancer Database (NCDB). Results: Higher odds of unplanned readmission were found in non-white patients compared to white, uninsured patients compared to those with private insurance, tumors with invasive behavior compared to in situ, presence of ulceration, American Joint Committee on Cancer stages greater than II, and location in the extremities. Lower odds of unplanned readmission were found in women living in areas where the percentage of adults who did not graduate from high school was below 13.0% with an annual income of $38,000 or more, who were treated in Academic/Research Programs or Integrated Network Cancer Programs. Conclusion: Non-white patients and low-income zip-codes were associated with unplanned readmission.*

The incidence of melanoma is rising, representing an important epidemiologic and health issue worldwide (1). Readmission is an important marker of care quality in the United States (2). Rehospitalization is a frequent and expensive event often due to flaws in post-discharge care.

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The rate of readmission can be reduced with improvement of the health care system (3). To achieve that outcome, it is important to understand the factors associated with disparities in readmissions in the United States. Disparities in melanoma treatment across the country are a proven reality (4). In 2017, Ascha et al. (5) analyzed the factors associated with 30-day readmission following sentinel lymph node biopsy and lymphadenectomy after malignant melanoma.

This study sought to analyze all patients diagnosed with melanoma recorded in the National Cancer Database (NCDB), searching for factors associated with unplanned readmission after surgical discharge and eventual disparities in the population sample. We hypothesized that patient disparities impact 30-day unplanned surgical readmission in this study population.

Patients and Methods

For our study, we used the NCDB, an initiative driven by the American Cancer Society and the American College of Surgeons' Commission on Cancer that registers 70% of all cancer diagnoses in the United States (6). Our study was considered exempt from review by the institutional review board.

Eligible cases were identified using the NCDB Participant User File of melanoma patients. Data were extracted for all patients diagnosed with melanoma with recorded information regarding 30-day hospital readmission following surgical discharge from January 1, 2004, to December 31, 2015. The cohort was then split into two groups based on hospital readmission (*i.e.*, unplanned readmission or no unplanned readmission) (Table I). Patients who did not undergo a surgical procedure or for whom information about readmission was missing were excluded from this analysis.

Data were extracted on patient demographics, facility type, and tumor characteristics. Patient demographics included age, sex, race, income (*i.e.*, median household income for area of

Table I. *Patient demographic and clinical data by presence or absence of unplanned readmission.*

Variable	No unplanned readmission		Unplanned readmission		p-Value
	No.	%	No.	%	
Total	485,528	98.9%	5,216	1.1%	
Age, mean (SD)	61.38	16.146	62.29	16.273	<0.001
Age					<0.001
0-49	110,609	22.8%	1,173	22.5%	
50-59	96,429	19.9%	963	18.5%	
60-69	113,044	23.3%	1,130	21.7%	
70-79	98,616	20.3%	1,129	21.6%	
80+	66,830	13.8%	821	15.7%	
Gender					<0.001
Male	276,383	56.9%	3,104	59.5%	
Female	209,145	43.1%	2,112	40.5%	
Income					<0.001
<$38,000	48,388	10.0%	765	14.7%	
$38,000-$47,999	95,413	19.7%	1,157	22.2%	
$48,000-$62,999	131,373	27.1%	1,418	27.2%	
>$63,000	206,227	42.5%	1,824	35.0%	
Unknown	4,127	0.9%	52	1.0%	
Education					<0.001
>21.0%	44,275	9.1%	669	12.8%	
13.0%-20.9%	99,280	20.4%	1,265	24.3%	
7.0%-12.9%	168,535	34.7%	1,773	34.0%	
<7.0%	169,591	34.9%	1,464	28.1%	
Unknown	3,847	0.8%	45	0.9%	
Population density					<0.001
Metro counties	399,051	82.2%	4,207	80.7%	
Urban counties	62,515	12.9%	776	14.9%	
Rural counties	7,932	1.6%	93	1.8%	
Unknown	16,030	3.3%	140	2.7%	
Race					<0.001
Caucasian	472,640	97.3%	5,041	96.6%	
Non-Caucasian	5,860	1.2%	117	2.2%	
Unknown	7,028	1.4%	58	1.1%	
Insurance					<0.001
Private	254,612	52.4%	2,345	45.0%	
Not insured	9,813	2.0%	163	3.1%	
Government	210,160	43.3%	2,338	44.8%	
Unknown	10,943	2.3%	370	7.1%	
Facility type					<0.001
Community Cancer Program	27,316	5.6%	420	8.1%	
Comprehensive Community Cancer Program	157,026	32.3%	2,179	41.8%	
Academic/Research Program	210,582	43.4%	1,591	30.5%	
Integrated Network Cancer Program	39,599	8.2%	508	9.7%	
Unknown	51,005	10.5%	518	9.9%	

Chi square or Mann-Whitney test was used for the analyses.

residency), level of education (based on area of residency), insurance (*i.e.*, private, uninsured, and government), and population density (*i.e.*, metro counties, urban counties, rural counties). Facility characteristics included facility type. Tumor characteristics included invasive behavior, Breslow depth, American Joint Committee on Cancer (AJCC) stage, and presence of ulceration.

Patient demographics, facility type, and tumor characteristics were described and analyzed using χ^2 or Mann-Whitney tests as appropriate. Multivariate analysis was performed using a logistic regression model to assess independent associations, adjusting for confounders. Separate analyses were conducted with the outcome variable being unplanned readmission and predicted variables being patient demographic and tumor characteristics (*i.e.*, age, sex, race, income, education, insurance, AJCC stage, ulceration, behavior, and body location). The significance level was set at $p<0.05$. Statistical analysis was done using SPSS, version 25.0, statistical software (SPSS Inc.).

Results

A total of 490,744 patients met the inclusion criteria of the study. The analyzed cohort included 485,528 (98.9%) patients without unplanned readmission and 5,216 (1.1%) with unplanned readmission. Unplanned readmission was more prevalent among non-white men older than 70 years, living in urban or rural counties and areas with an income lower than $47,999 per year, where the percentage of adults who did not graduate from high school was above 12.9% ($p<0.001$). On the other hand, unplanned readmission was less prevalent among patients with private insurance treated in Academic/Research Programs ($p<0.001$) (Table I).

Higher odds of unplanned readmission were found in non-white patients compared to white, uninsured patients compared to those with private insurance, tumors with invasive behavior compared to *in situ*, presence of ulceration, AJCC stages greater than II compared to stage 0, and location in the extremities compared to head and neck. Lower odds of unplanned readmission were found in women, living in areas where the percentage of adults who did not graduate from high school was below 13.0% compared to 21.0% or more, with an annual income of $38,000 or more compared to less than $38,000, and treated in Academic/Research Programs or Integrated Network Cancer Programs compared to Community Cancer Program (Table II).

Discussion

To our knowledge, this study is the largest series to date to delineate factors associated with unplanned readmission among melanoma patients. Patients diagnosed with melanoma in the United States over a 12-year span were more likely to have 30-day unplanned readmission if they had low socioeconomic status and were non-white. Therefore, our data illustrates the need for efforts to improve sociodemographic disparities in melanoma treatment.

This topic has been largely unexplored in the literature; however, a few smaller studies have analyzed factors such as insurance status. A study in 2017 that examined surgical treatment delays in patients with melanoma according to insurance type pointed out that people insured by Medicaid experienced delays in treatment in comparison to people insured by private companies and Medicare (7). A similar analysis identified melanoma patients insured by Medicaid to be more likely to manifest with advanced tumor and less likely to undergo curative treatment (8). In our analysis, uninsured patients were more likely to have a 30-day unplanned readmission compared to privately insured patients.

Timeline of swift diagnosis and expedited therapy is of utmost importance in cancer treatment as disparities in cancer care have been heavily studied based on type of

Table II. *Odds of presenting unplanned readmission among melanoma patients.*

Variables	OR	95%CI Lower	95%CI Upper	*p*-Value
Age	1.003	1	1.006	0.051
Gender				
Male	1	Reference		-
Female	0.92	0.868	0.975	0.005
Income				
<$38,000	1	Reference		-
$38,000-$47,999	0.829	0.751	0.915	<0.001
$48,000-$62,999	0.801	0.722	0.889	<0.001
>$63,000	0.764	0.681	0.858	<0.001
Unknown	1.855	0.868	3.965	0.111
Education				
>21%	1	Reference		-
13%-20.9%	0.969	0.877	1.07	0.53
7%-12.9%	0.891	0.803	0.99	0.031
<7%	0.822	0.73	0.925	0.001
Unknown	0.441	0.193	1.008	0.052
Population density				
Metro counties	1	Reference		-
Urban counties	0.95	0.875	1.033	0.231
Rural counties	0.822	0.666	1.015	0.068
Unknown	0.798	0.659	0.965	0.02
Race				
Caucasian	1	Reference		-
Non-Caucasian	1.514	1.255	1.827	<0.001
Unknown	0.796	0.613	1.034	0.087
Insurance				
Private	1	Reference		-
Not insured	1.362	1.158	1.602	<0.001
Government	1.054	0.977	1.136	0.173
Unknown	3.893	3.471	4.367	<0.001
Behavior				
In situ	1	Reference		-
Invasive	1.448	1.188	1.765	<0.001
Body location				
Head and neck	1	Reference		-
Trunk	0.975	0.901	1.055	0.525
Extremities	1.14	1.061	1.226	<0.001
Others	1.751	1.419	2.161	<0.001
Ulceration				
No	1	Reference		-
Yes	1.288	1.189	1.395	<0.001
Unknown	0.828	0.746	0.919	<0.001
AJCC - tumor stage				
0	1	Reference		-
I	1.013	0.824	1.245	0.902
II	1.255	1.012	1.557	0.039
III	2.258	1.822	2.8	<0.001
IV	2.922	2.274	3.755	<0.001
Unknown	1.43	1.174	1.741	<0.001
Facility type				
Community Cancer Program	1	Reference		-
Comprehensive Community Cancer Program	0.93	0.836	1.034	0.179
Academic/ Research Program	0.512	0.458	0.571	<0.001
Integrated Network Cancer Program	0.852	0.746	0.972	0.017
Unknown	0.738	0.631	0.862	<0.001

Multivariate logistic regression for unplanned readmission.

insurance, including greater wait times, treatment delays, and higher mortality (8-11). Furthermore, surgical delays have been consistently shown to result in increased morbidity and mortality (12, 13). In our analysis, unplanned readmission was more prevalent in invasive tumors, with AJCC stages higher than II and Breslow depth greater than 1.01 mm. We speculate that these patients potentially had delayed diagnosis and treatment.

Our study used a large sample taken from the NCDB, which records approximately 70% of the newly diagnosed cancer patients in the United States. However, studies on national patient databases have limitations that merit consideration, such as the potential for coding errors and a retrospective nature. Moreover, melanoma is a disease that affects primarily white people, making the cohort of other races substantially smaller. Still, the advantage of the multi-institutional national database allotted in this analysis allows for increased geographic diversity compared to single-institution cohort studies. Our large sample size provided enough statistical power for our multivariate analysis adjusted for confounders. We encourage the continued investigation of predictive factors of unplanned readmission to track temporal trends of these patient disparities.

In conclusion, our analysis of predictive factors contributing to unplanned readmission of patients who underwent surgical treatment for melanoma identified higher odds among non-white patients and those living in a zip code with lower average income. The implications of these differences on care delivery are unclear, but should be taken into consideration.

Conflicts of Interest

The Authors have no conflicts of interest to declare regarding this study.

Authors' Contributions

DB, MTH, and AJF had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: DB, AJF, ACS, EG. Acquisition, analysis, or interpretation of data: DB, ASP, AJF. Drafting of the manuscript: DB, DJR, MTH, AS. Critical revision of the manuscript for important intellectual content: AAL, SB, MTH, ACS, EG, and AJF. Study supervision: AJF.

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