original contributions

Racial and Ethnic Health Disparities in Delay to Initiation of Intensity-Modulated Radiotherapy

Ryan J. Hutten, MD[1]; Christopher R. Weil, MD[1]; David K. Gaffney, MD, PhD[1]; Kristine Kokeny, MD[1]; Shane Lloyd, MD[1]; Charles R. Rogers, PhD, MPH, MS, MCHES[2]; and Gita Suneja, MD, MSHP[1]

QUESTION ASKED: While controlling for clinical, sociodemographic, and health systems factors, are there significant differences in timeliness of initiating curative-intent treatment with intensity-modulated radiation therapy (IMRT) among racial and ethnic minorities?

SUMMARY ANSWER: Non-Hispanic Black (NHB), Hispanic, and Asian patients were significantly more likely to have delays in initiation of treatment with IMRT for nearly all included disease sites compared with non-Hispanic White (NHW) patients. NHW, Hispanic, and Asian patients with private insurance had shorter intervals to initiation of treatment than those with Medicare; however, NHB patients with private insurance had longer intervals to initiation of treatment than those with Medicare.

WHAT WE DID: From the National Cancer Database, we identified 716,082 patients with 10 different primary malignancies commonly treated with IMRT and quantified the interval of time between diagnosis and initiation of radiotherapy. We produced multivariable logistic regression models for each disease site to identify predictors of delay in treatment while controlling for clinical, sociodemographic, and health systems factors.

WHAT WE FOUND: We found evidence of racial disparities in timeliness of treatment with IMRT among NHB, Hispanic, and Asian patients compared with NHW patients. In our analysis, the median interval to initiation of treatment with IMRT was 20 days longer for NHB patients, 10 days longer for Hispanic patients, and 7 days longer for Asian patients, compared with NHW patients. Unlike NHW, Hispanic, and Asian patients, NHB patients with private insurance experienced longer delays in treatment than those with Medicare.

BIAS, CONFOUNDING FACTORS, REAL-LIFE IMPLICATIONS: Because of the retrospective nature of this large database study, there are measured cofounders, for example specific insurance policies and oncologic outcomes such as local control. This limits direct conclusions regarding the clinical impact of delayed IIT.

To our knowledge, this is the largest-scale report of disparities in the timeliness of radiation across multiple disease sites. Further investigation into the causes of these delays is urgently needed to improve timely initiation of IMRT and reduce related health care inequities.

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ASSOCIATED CONTENT

Appendix

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EQUITY IN CANCER CARE

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abstract

PURPOSE Delays in initiation of radiotherapy may contribute to inferior oncologic outcomes that are more commonly observed in minoritized populations in the United States. We aimed to examine inequities associated with delayed initiation of intensity-modulated radiotherapy (IMRT).

MATERIALS AND METHODS The National Cancer Database was queried to identify the 10 cancer sites most commonly treated with IMRT. Interval to initiation of treatment (IIT) was broken into quartiles for each disease site, with the 4th quartile classified as delayed. Multivariable logistic regression for delayed IIT was performed for each disease site using clinical and demographic covariates. Differences in magnitude of delay between subsets of patients stratified by race and insurance status were evaluated using two-sample *t*-tests.

RESULTS Among patients (n = 350,425) treated with IMRT between 2004 and 2017, non-Hispanic Black (NHB), Hispanic, and Asian patients were significantly more likely to have delayed IIT with IMRT for nearly all disease sites compared with non-Hispanic White (NHW) patients. NHB, Hispanic, and Asian patients had significantly longer median IIT than NHW patients (NHB 87 days, $P < .01$; Hispanic 76 days, $P < .01$; Asian 74 days, $P < .01$; and NHW 67 days). NHW, Hispanic, and Asian patients with private insurance had shorter median IIT than those with Medicare ($P < .01$); however, NHB patients with private insurance had longer IIT than those with Medicare ($P < .01$).

CONCLUSION Delays in initiation of IMRT in NHB, Hispanic, and Asian patients may contribute to the known differences in cancer outcomes and warrant further investigation, particularly to further clarify the role of different insurance policies in delays in advanced modality radiotherapy.

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INTRODUCTION

The benefits of intensity-modulated radiotherapy (IMRT) over standard radiotherapy (RT), including decreased acute and late toxicities, improved quality of life, and opportunities for dose escalation, have been demonstrated in many disease sites.[1-14] As a result, IMRT is often the preferred modality for radiotherapy delivery. The implementation of IMRT can be more resource-intensive than standard three-dimensional conformal RT (3DCRT), requiring insurance prior authorization, complex treatment planning, and specialized medical physics and dosimetry support. Timely initiation of RT is critical, yet many factors can affect the interval to initiation of treatment (IIT).

Limited published data suggest that sociodemographic factors including race, ethnicity, and insurance coverage may contribute to delays in IIT of RT.[15-20] As IMRT utilization has significantly increased over the past decade, a contemporary examination of the burden of treatment delays and disparities in timely initiation of definitive IMRT is needed.[21] We hypothesize that delays in initiation of therapy associated with the use of advanced radiotherapy modalities disproportionately affect minoritized patients. Herein, we aimed to examine

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racial health care inequities associated with delayed initiation of IMRT.

MATERIALS AND METHODS

To identify disease sites to include, the most recent year of available data from the National Cancer Database was queried to identify the 10 sites with the highest total number of patients with cancer treated with definitive-intent IMRT in 2017 Patients receiving definitive-intent RT (either 3DCRT or IMRT) to any of these 10 primary disease sites between 2004 and 2017 were included for analysis. Exclusions included stage IV, age $<$ 18 years, unknown insurance status, unknown race, adjuvant RT, palliative-intent RT, and missing RT start date. Race and ethnicity were classified as Asian, non-Hispanic Black (NHB), Hawaiian/Pacific Islander, Hispanic, American Indian/Alaska Native, and non-Hispanic White (NHW). Descriptive statistics were used to report patient characteristics by race and ethnicity with differences between groups evaluated using the chi-squared test.

Annual rates of IMRT utilization were reported as percentages of total cases, separated by disease site. IIT was defined as the time difference in days between the diagnosis of malignancy and the start of RT. For each disease site and modality, IIT was broken into quartiles, with the first two quartiles classified as no delay and the fourth quartile classified as delayed. The third quartile was not included in subsequent analysis. Patients initiating RT at or sooner than the median IIT comprise the no-delay cohort, and those in the fourth quartile comprise the delayed cohort. We chose to use relative delay instead of choosing an absolute number of days given the multiple cancer sites included, recognizing that clinically relevant delay would differ by cancer site. The population was divided into an IMRT and a 3D cohort before classifying quartiles for IIT, thereby eliminating the confounding difference between standard turnaround time for IMRT and 3D. Duration of IIT was compared between subgroups using two-sample *t*-tests.

Multivariable logistic regression for delayed IIT was adjusted for stage (I, II, and III), age ($<$ 45 years, 45-65 years, and $>$ 65 years), sex (male, female), race/ethnicity (Asian, NHB, Hawaiian/Pacific Islander, Hispanic, American Indian/Alaska Native, and NHW), income quartiles (first, second, third, and fourth), education quartiles (first, second, third, and fourth), insurance status (uninsured, private, Medicaid, Medicare, and other government), great circle distance (the distance in miles [mi] between the patient's home and the treating facility, $<$ 50 mi, 50-200 mi, and $>$ 200 mi), treatment facility type (community, comprehensive community, academic/research, and integrated), geographic region (Northeast, South, Midwest, and West), use of chemotherapy (yes/no), and use of surgery (no, neoadjuvant RT). This study was exempt from institutional review board approval. All analyses were performed using STATA/IC-14.[22]

RESULTS

In 2017, the 10 disease sites with the highest number of cases treated with IMRT, in descending order, were prostate, lung, head and neck (H&N), rectum, esophagus, anus, pancreatic, stomach, cervix, and uterus. In total, from 2004 to 2017, 716,082 patients were included in this study, with 350,425 receiving IMRT and 365,657 treated with 3DCRT. Patient clinical and sociodemographic information by race and ethnicity is given in Table 1. American Indian/Alaska Native, Hawaiian/Pacific Islander, and other races made up a small proportion of the overall population (0.29%, 0.07%, and 1.39%, respectively) and are therefore not reported in the subsequent analyses.

Overall IMRT utilization rates increased from 20.3% in 2014 to 64.9% in 2017. Primary sites with the largest absolute change (Δ) in IMRT utilization over the study period were cancers of the anus (Δ = 67.1%), esophagus (Δ = 62.2%), stomach (Δ = 58.3%), lung (Δ = 56.1%), and pancreas (Δ = 55.4%).

Among the 10 disease sites, the percent of NHW patients with delayed IIT ranged from 27.4% to 40.4%, compared with 38.4% to 58.9% in Hispanic patients, 38.1% to 57.9% in NHB patients, and 27.3% to 49.1% in Asian patients, as shown in Table 2. When accounting for clinical and sociodemographic covariates, compared with NHW patients, Hispanic patients were more likely to have delayed IIT for 9 of 10 disease sites (H&N, esophagus, stomach, rectum, anus, pancreas, lung, cervix, and prostate), NHB patients were significantly more likely to have delayed IIT for 7 of 10 disease sites (H&N, esophagus, stomach, rectum, anus, lung, cervix, and prostate), and Asian patients were significantly more likely to have delayed IIT for 8 of 10 disease sites (H&N, stomach, rectum, anus, pancreas, lung, cervix, and prostate), as depicted in Table 2. In a sensitivity analysis including only patients with either private insurance or Medicare, similar patterns of disparities among Hispanic, NHB, and Asian patients persisted in both groups.

IIT was significantly longer for NHB (median 87 days, interquartile range [IQR] 52-135 days, $P < .01$), Hispanic (median 76 days, IQR 46-124 days, $P < .01$), and Asian patients (median 74 days, IQR 43-120 days, $P < .01$) compared with NHW patients (median 67 days, IQR 40-110 days). As shown in Figure 1, a larger percentage of NHB (32.3%), Hispanic (32.8%), and Asian (31.5%) patients are in the fourth quartile of IIT compared with NHW patients (23.7%). Site-specific IIT stratified by race is shown in Appendix Table A1 (online only). A separate analysis revealed that NHB, Hispanic, and Asian patients were also more likely to have delays in standard 3DCRT; however, the difference in median IIT compared with NHW was smaller than in those receiving IMRT (NHB median

TABLE 1. Clinical and Sociodemographic Features of the Study Cohort

Variable	NHW, No. (%)	Hispanic, No. (%)	NHB, No. (%)	Asian, No. (%)	*P*[a]
Primary site					
H&N	58,009 (10.2)	2,481 (9.3)	7,751 (8.3)	1,930 (12.4)	< .01
Esophagus	29,928 (5.3)	999 (3.8)	3,276 (3.5)	736 (4.7)	
Stomach	13,238 (2.3)	606 (2.3)	1,098 (1.2)	404 (2.6)	
Rectum/sigmoid	50,693 (8.9)	3,435 (12.9)	5,327 (5.7)	2,369 (15.2)	
Anus	19,991 (3.5)	939 (3.5)	2,243 (2.4)	232 (1.5)	
Pancreatic	14,698 (2.6)	664 (2.5)	2,362 (2.5)	436 (2.8)	
Lung	166,574 (29.3)	3,629 (13.7)	21,554 (23)	3,064 (19.7)	
Cervix	12,328 (2.2)	2,502 (9.4)	3,439 (3.7)	902 (5.8)	
Uterus	2,988 (0.5)	195 (0.7)	602 (0.6)	84 (0.5)	
Prostate	199,413 (35.1)	11,101 (41.8)	45,907 (49.1)	5,418 (34.8)	
Total	567,860 (100)	26,551 (100)	93,559 (100)	15,575 (100)	
Year of diagnosis					
2004-2008	183,984 (32.4)	8,052 (30.3)	28,590 (30.6)	4,564 (29.3)	< .01
2009-2013	201,435 (35.5)	9,601 (36.2)	34,648 (37)	5,521 (35.4)	
2014-2017	182,441 (32.1)	8,898 (33.5)	30,321 (32.4)	5,490 (35.2)	
Total	567,860 (100)	26,551 (100)	93,559 (100)	15,575 (100)	
Stage					
I	90,296 (15.9)	4,015 (15.1)	13,332 (14.3)	1,941 (12.5)	< .01
II	264,177 (46.5)	13,667 (51.5)	50,618 (54.1)	7,458 (47.9)	
III	213,270 (37.6)	8,864 (33.4)	29,590 (31.6)	6,160 (39.6)	
Total	567,743 (100)	26,546 (100)	93,540 (100)	15,559 (100)	
Age, years					
< 45	14,350 (2.5)	2,064 (7.8)	3,150 (3.4)	983 (6.3)	< .01
45-65	213,575 (37.6)	11,126 (41.9)	47,486 (50.8)	5,837 (37.5)	
> 65	339,935 (59.9)	13,361 (50.3)	42,923 (45.9)	8,755 (56.2)	
Total	567,860 (100)	26,551 (100)	93,559 (100)	15,575 (100)	
Sex					
Male	409,104 (72)	19,219 (72.4)	71,092 (76)	11,265 (72.3)	< .01
Female	158,756 (28)	7,332 (27.6)	22,467 (24)	4,310 (27.7)	
Total	567,860 (100)	26,551 (100)	93,559 (100)	15,575 (100)	
Income quartiles					
< $40,227	85,632 (16.4)	7,276 (29.8)	40,593 (47.8)	1,217 (8.4)	< .01
$40,227-$50,353	126,159 (24.2)	5,547 (22.7)	17,662 (20.8)	1,877 (13)	
$50,354-$63,332	129,557 (24.9)	5,462 (22.4)	12,578 (14.8)	2,899 (20.1)	
≥ $63,333	179,394 (34.4)	6,118 (25.1)	14,041 (16.5)	8,437 (58.5)	
Total	520,742 (100)	24,403 (100)	84,874 (100)	14,430 (100)	
Percent of residents without a high school degree					
≥ 17.6%	85,969 (16.5)	13,619 (55.7)	35,965 (42.3)	3,822 (26.5)	< .01
10.9%-17.5%	142,198 (27.2)	4,879 (20)	27,725 (32.6)	2,905 (20.1)	
6.3%-10.8%	160,706 (30.8)	3,612 (14.8)	14,915 (17.5)	3,962 (27.5)	
< 6.3%	133,107 (25.5)	2,325 (9.5)	6,407 (7.5)	3,743 (25.9)	
Total	521,980 (100)	24,435 (100)	85,012 (100)	14,432 (100)	

(continued on following page)

TABLE 1. Clinical and Sociodemographic Features of the Study Cohort (continued)

Variable	NHW, No. (%)	Hispanic, No. (%)	NHB, No. (%)	Asian, No. (%)	*P*[a]
Insurance status					
Not insured	12,104 (2.1)	2,192 (8.3)	4,335 (4.6)	530 (3.4)	< .01
Private insurance	183,526 (32.3)	8,166 (30.8)	29,831 (31.9)	6,222 (39.9)	
Medicaid	26,601 (4.7)	4,255 (16)	11,135 (11.9)	1,826 (11.7)	
Medicare	331,093 (58.3)	11,513 (43.4)	44,583 (47.7)	6,825 (43.8)	
Other government	14,536 (2.6)	425 (1.6)	3,675 (3.9)	172 (1.1)	
Total	567,860 (100)	26,551 (100)	93,559 (100)	15,575 (100)	
Distance from treatment facility, miles					
< 50	484,114 (91.9)	23,569 (95.4)	83,045 (96.4)	13,985 (96.5)	< .01
50-200	36,533 (6.9)	985 (4)	2,769 (3.2)	371 (2.6)	
> 200	6,376 (1.2)	143 (0.6)	359 (0.4)	141 (1)	
Total	527,023 (100)	24,697 (100)	86,173 (100)	14,497 (100)	
Facility type					
Community	62,095 (11.1)	2,213 (8.7)	7,348 (8)	1,560 (10.4)	< .01
Comprehensive community	264,178 (47)	9,054 (35.6)	33,456 (36.3)	5,079 (33.8)	
Academic/research program	164,400 (29.3)	10,347 (40.7)	38,521 (41.8)	6,923 (46)	
Integrated	71,041 (12.6)	3,793 (14.9)	12,733 (13.8)	1,477 (9.8)	
Total	561,714 (100)	25,407 (100)	92,058 (100)	15,039 (100)	
Geographic region					
Northeast	130,115 (23.2)	6,146 (24.2)	17,536 (19)	3,232 (21.5)	< .01
South	191,991 (34.2)	8,474 (33.4)	50,238 (54.6)	2,381 (15.8)	
Midwest	166,481 (29.6)	2,374 (9.3)	19,597 (21.3)	1,520 (10.1)	
West	73,127 (13)	8,413 (33.1)	4,687 (5.1)	7,906 (52.6)	
Total	561,714 (100)	25,407 (100)	92,058 (100)	15,039 (100)	
Chemotherapy use					
No	283,647 (50)	13,901 (52.4)	57,255 (61.2)	7,145 (45.9)	< .01
Yes	284,213 (50)	12,650 (47.6)	36,304 (38.8)	8,430 (54.1)	
Total	567,860 (100)	26,551 (100)	93,559 (100)	15,575 (100)	
Surgery					
No	499,430 (87.9)	23,076 (86.9)	87,552 (93.6)	13,109 (84.2)	< .01
Yes (neoadjuvant RT)	68,430 (12.1)	3,475 (13.1)	6,007 (6.4)	2,466 (15.8)	
Total	567,860 (100)	26,551 (100)	93,559 (100)	15,575 (100)	
Delayed interval to initiation of treatment					
No	295,835 (68.8)	11,453 (56.3)	40,633 (57.5)	6,731 (58)	< .01
Yes	134,190 (31.2)	8,886 (43.7)	29,985 (42.5)	4,866 (42)	
Total	430,025 (100)	20,339 (100)	70,618 (100)	11,597 (100)	
Treatment modality					
IMRT	275,327 (48.5)	13,175 (49.6)	48,304 (51.6)	7,302 (46.9)	< .01
3D	292,533 (51.5)	13,376 (50.4)	45,255 (48.4)	8,273 (53.1)	
Total	567,860 (100)	26,551 (100)	93,559 (100)	15,575 (100)	

Abbreviations: 3D, 3-dimensional; H&N, head and neck; IMRT, intensity-modulated radiation therapy; NHB, non-Hispanic Black; NHW, non-Hispanic White; RT, radiotherapy.

[a]*P* values from the chi-squared test.

TABLE 2. Association Between Race/Ethnicity and Delayed Interval to Initiation of Treatment With Intensity-Modulated Radiation Therapy by Cancer Type

	NHW	Hispanic		NHB		Asian	
Primary Site	No. (%)	No. (%)	AOR[a] (95% CI)	No. (%)	AOR[a] (95% CI)	No. (%)	AOR[a] (95% CI)
H&N	8,267 (36.8)	531 (53.1)	1.57 (1.36 to 1.81)[b]	1,328 (48.0)	1.43 (1.30 to 1.57)[b]	860 (41.2)	1.27 (1.08 to 1.49)[c]
Esophagus	2,936 (33.1)	180 (51.7)	1.80 (1.42 to 2.28)[b]	380 (42.9)	1.13 (0.96 to 1.33)	232 (35.3)	1.10 (0.82 to 1.49)
Stomach	1,082 (27.4)	116 (58.3)	2.56 (1.79 to 3.66)[b]	158 (49.4)	1.37 (1.03 to 1.82)[d]	112 (49.1)	1.57 (1.00 to 2.46)[d]
Rectum	3,701 (38.5)	389 (56.6)	1.70 (1.41 to 2.04)[b]	519 (52.1)	1.48 (1.26 to 1.73)[b]	391 (48.9)	2.12 (1.68 to 2.68)[b]
Anus	2,500 (31.5)	192 (55.7)	2.08 (1.63 to 2.66)[b]	504 (57.9)	2.18 (1.84 to 2.58)[b]	88 (44.3)	2.04 (1.31 to 3.17)[c]
Pancreas	1,856 (38.0)	120 (51.7)	1.65 (1.22 to 2.25)[c]	304 (38.1)	0.98 (0.81 to 1.19)	117 (47.0)	1.64 (1.08 to 2.50)[d]
Lung	11,145 (30.7)	372 (40.5)	1.50 (1.30 to 1.73)[b]	1,788 (39.3)	1.38 (1.29 to 1.48)[b]	715 (42.0)	1.50 (1.28 to 1.76)[b]
Cervix	1,009 (34.9)	338 (58.9)	2.25 (1.76 to 2.88)[b]	351 (51.1)	1.87 (1.50 to 2.33)[b]	193 (37.8)	1.50 (1.05 to 2.14)[d]
Uterus	302 (40.4)	26 (54.2)	1.32 (0.65 to 2.69)	58 (45.7)	1.18 (0.73 to 1.90)	22 (27.3)	0.93 (0.33 to 2.62)
Prostate	33,208 (30.7)	2,174 (38.4)	1.26 (1.18 to 1.34)[b]	10,240 (42.4)	1.56 (1.51 to 1.61)[b]	2,713 (42.1)	1.39 (1.28 to 1.51)[b]

Abbreviations: AOR, adjusted odds ratio; H&N, head and neck; NHB, non-Hispanic Black; NHW, non-Hispanic White; RT, radiotherapy.

[a]AOR, adjusted for year of diagnosis (2004-2010 and 2011-2017), stage group (I, II, and III), age group (< 45, 45-65, and > 65), sex (M/F), race (NHW, NHB, Hispanic, Asian, American Indian/Alaska Native, and Native Hawaiian/Pacific Islander), income quartiles (first, second, third, and fourth), education quartiles (first, second, third, and fourth), great circle distance (< 50 mi, 50-200 mi, and > 200 mi), facility type (community, comprehensive community, academic/research, and integrated), geographic region (Northeast, South, Midwest, and West), receipt of chemotherapy (yes/no), and use of surgery (no, neoadjuvant RT).

[b]$P < .001$.

[c]$P < .01$.

[d]$P < .05$.

58 days, Hispanic median 55 days, Asian median 51 days, and NHW median 45 days, $P < .01$). When stratifying by primary insurance, NHW, Hispanic, and Asian patients with private insurance had shorter IIT (NHW median 62 days, 37-106 days; Hispanic median 73 days, 44-124 days; and Asian median 65 days, 40-113 days) than NHW, Hispanic, and Asian patients with Medicare (NHW median 70 days, 42-112 days, $P = < .01$; Hispanic median 77 days, 47-125 days, $P = .01$; and Asian median 82 days, 48-126 days). However, NHB patients with private insurance had longer IIT (median 91 days, 54-139 days) than NHB patients with Medicare (median 85 days, 52-131 days, $P < .01$).

DISCUSSION

In this retrospective database study of 716,082 patients treated with curative-intent RT across the 10 disease sites for which IMRT was most commonly used, we found evidence of racial disparities in IIT with IMRT among NHB, Hispanic, and Asian patients. The disease sites with nonsignificant findings on multivariable logistic regression are those with the smallest sample sizes, likely reflecting a lack of power to detect a difference between subgroups. When stratifying by insurance status, NHB patients, but not NHW, Hispanic, or Asian patients, with private insurance had longer delays in treatment than those with Medicare.

In this study, we excluded patients treated with adjuvant RT to eliminate delays because of postoperative complications. Delays observed in this study population are therefore more specific to the clinical processes required for RT including referral patterns, clinic scheduling, insurance authorization/approval, and treatment planning time. Of note, the appropriateness of IMRT utilization is not being investigated in this work. Certain disease sites, such as uterine cancer, are typically treated with upfront surgery. We excluded patients undergoing adjuvant radiotherapy to minimize delays attributable to surgery. Differences in utilization and timeliness of treatment with IMRT between racial and ethnic groups, regardless of appropriateness of treatment, are noteworthy and an area warranting further investigation.

Using a method previously reported by Fujiwara et al,[23] we defined a delay as the fourth quartile of IIT for each disease site, thus excluding the third quartile, which might have clinically insignificant differences in time to treatment from the median population. Furthermore, as the treatment planning processes differ between patients treated with IMRT and 3DCRT, we defined delay (ie, fourth quartile of IIT) separately in the two treatment groups. A quartile-based definition of delay among all included patients (3DCRT and IMRT) would bias the results and possibly obscure differences in IIT because of baseline differences in utilization rates between different racial and ethnic subgroups.

Utilization rates of IMRT have steadily increased throughout the study period, largely because of high-quality evidence that IMRT results in favorable treatment-related toxicity, post-treatment quality of life, and opportunities for dose escalation.[4,5,7,12,14] The available literature regarding racial disparities in IIT with advanced RT modalities such as IMRT is limited. There are, however, some published data

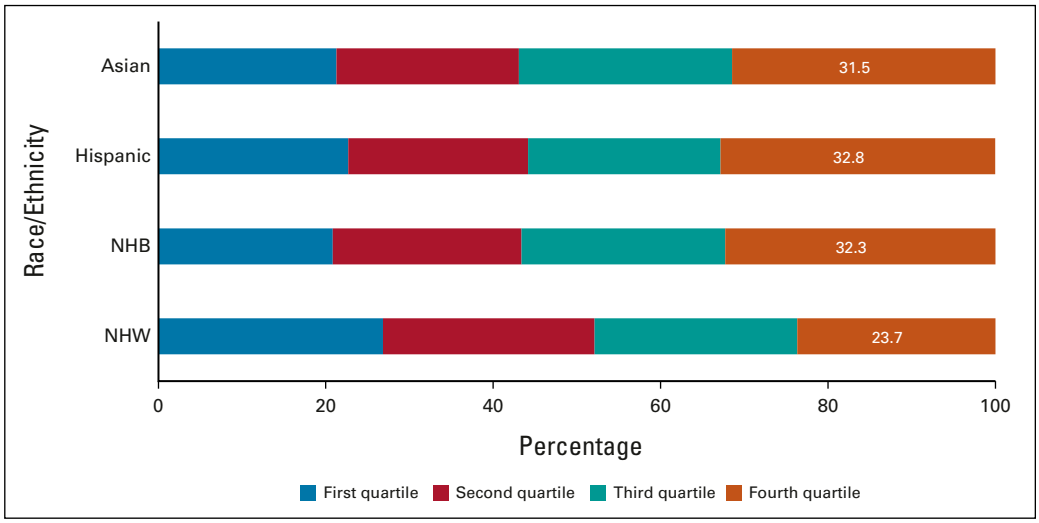

FIG 1. Delays in IMRT by race and ethnicity. A higher percentage of NHB, Hispanic, and Asian patients experience delays in initiation of treatment with IMRT, as evidenced by the higher percentage of patients in the fourth quartile. IMRT, intensity-modulated radiation therapy; NHB, non-Hispanic Black; NHW, non-Hispanic White.

regarding radiotherapy treatment delays and the resulting disparities in treatment outcomes affecting minoritized populations. Two published analyses of patients with anal cancer suggest that Black patients have longer delays to initiation of chemoradiation and also have inferior survival.[15,16] Similarly, Hispanic patients with anal squamous cell carcinoma have been found to have longer delays in start of chemoradiation than NHW patients.[18] NHB and Hispanic women with cervical cancer have longer treatment delays than NHW patients, with IMRT utilization correlated with longer delays.[17] Delays in prostate cancer treatment have also been reported to be more common in Black men.[19]

Cancer is the leading cause of death among Asian Americans, setting them apart from all other racial/ethnic minority groups in the United States.[24] Studies have demonstrated that Asian Americans are more likely to present with advanced-stage prostate, cervical, and lung cancers, suggesting a lack of access to screening.[25-27] To our knowledge, our work is the first to illustrate that Asian Americans are more likely to experience delays in advanced radiation treatment compared with NHW patients.

Etiologies of treatment-related delays in cancer are complex and multifactorial. Social determinants of health including economic stability, housing, transportation, education, support systems, insurance coverage, as well as systemic racism can lead to inferior health outcomes and delays in initiation of cancer treatments.[28] In our analysis, the median IIT with IMRT was 20 days longer for NHB patients, 10 days longer for Hispanic patients, and 7 days longer for Asian patients, compared with NHW patients. For patients treated with standard 3DCRT, this difference was less pronounced with 13-day, 10-day, and 6-day differences in median delay for NHB, Hispanic, and Asian patients, respectively. This raises the concern that prompt delivery of advanced radiotherapy techniques may not be equitably distributed among different racial groups. Although we did not examine outcomes in this work, the observed IIT is well within the boundaries of clinically significant delays and detriments to overall survival for patients with cervical cancer, anal squamous cell carcinoma, head and neck cancers, and non–small-cell lung cancers.[17,18,29-31] We identify a clear area for improving the process of RT delivery and eliminating bias in timeliness of delivery, which disproportionately affects non-White patients. To improve oncologic outcomes for minoritized patients, equitable IIT with advanced RT techniques is urgently needed.

In patients with private insurance, the use of advanced RT techniques, such as IMRT, often requires prior authorization, which can introduce delays in treatment start. Unanswered questions remain regarding bias in the prior authorization process, including whether denials are more common in minoritized populations. A recently published study reported disproportionately low rates of IMRT utilization in NHB patients compared with NHW patients, with the disparity worsening in recent years.[21] Interestingly, patients insured by Medicare or Medicaid were more likely to receive IMRT than those with private insurance, perhaps because of the burdensome prior authorization process required by many private insurance companies.[32] In our analysis, NHB patients with private insurance had longer delays than NHB with Medicare. This difference was not observed in NHW, Hispanic, or Asian patients, who actually had shorter intervals to initiation of treatment if privately insured. We hypothesize that this difference reflects a

systemic bias present within the private insurance prior authorization process.

To our knowledge, this study provides the largest-scale report of disparities in treatment timeliness across multiple disease sites commonly treated with IMRT. However, the study's limitations should be considered. First, the retrospective database design was susceptible to bias; however, the large sample size from multiple disease sites across the United States helps overcome this issue. Second, many pertinent details of insurance policies (premiums and co-pays) and authorization (denials and time to denials) could be barriers to timely initiation of IMRT but are not available in the National Cancer Database. Finally, data regarding treatment-related toxicity, patient quality of life, and oncologic outcomes including local recurrence are not available from this data set, therefore limiting the examination of the clinical impact of delayed IIT.

In conclusion, significant racial and ethnic disparities in the likelihood and duration of treatment delay were observed. Delays in initiation of IMRT among Black, Hispanic, and Asian patients may contribute to the previously documented differences in cancer outcomes. Further investigation of the causes of these delays is urgently needed to improve timely initiation of IMRT and reduce related health care inequities.

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DISCLAIMER

The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH, 5 For the Fight, V Foundation for Cancer Research, Exact Sciences, Huntsman Cancer Institute, or the University of Utah.

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Racial and Ethnic Health Disparities in Delay to Initiation of Intensity-Modulated Radiotherapy

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APPENDIX

TABLE A1. Site specific breakdown of proportion of delayed interval to initiation of treatment by race/ethnicity.

			Percent Classified as Delayed			
Primary Site	**Median IIT (days)**	**Delayed IIT (days)**	**NHW**	**NHB**	**Hispanic**	**Asian**
Prostate	98	≥ 138	23.8	32.6	30.4	31.3
Lung	48	≥ 75	24.1	30.2	30.6	31.3
H&N	44	≥ 64	23.7	31.1	35.5	30.7
Rectum	40	≥ 56	23.0	34.1	36.1	37.5
Esophagus	41	≥ 57	24.2	31.8	38.5	25.4
Anus	38	≥ 52	21.4	40.2	38.3	33.3
Cervix	42	≥ 62	20.8	32.7	38.0	27.7
Pancreas	82	≥ 139	24.4	26.2	35.6	37.4
Stomach	46	≥ 70	22.6	39.5	49.2	36.2
Uterus	58	≥ 93	24.7	29.9	31.0	21.4

Abbreviations: H&N, head & neck; IIT, interval to initiation of treatment; NHB, non-Hispanic Black; NHW, non-Hispanic White.