

Research Letter

Worsening Racial Disparities in Utilization of Intensity Modulated Radiation Therapy

Ryan J. Hutten, MD,^a Chris R. Weil, MD,^a David K. Gaffney, MD, PhD,^{a,c}
Kristine Kokeny, MD,^{a,c} Shane Lloyd, MD,^{a,c}
Charles R. Rogers, PhD, MPH, MS, MCHES,^{b,c} and Gita Suneja, MD^{a,c,*}

^aDepartment of Radiation Oncology, University of Utah School of Medicine, Salt Lake City, Utah; ^bDepartment of Family and Preventive Medicine, University of Utah School of Medicine, Salt Lake City, Utah; ^cHuntsman Cancer Institute at the University of Utah, Salt Lake City, Utah

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Abstract

Purpose: The benefits of intensity modulated radiation therapy (IMRT) compared with standard 3-dimensional conformal radiation therapy have been demonstrated in many cancer sites and include decreased acute and late toxicity, improved quality of life, and opportunities for dose escalation. Limited literature suggests non-white patients may have lower utilization of IMRT. We hypothesized that as the use of IMRT has increased in recent years, racial inequities have persisted and disproportionately affect non-Hispanic Black (NHB) patients. We aim to evaluate temporal trends in IMRT utilization focusing on disparities among minoritized populations.

Methods and Materials: The National Cancer Database was queried to identify the 10 disease sites with the highest total number of cancer patients treated with definitive intent IMRT in 2017, the most recent year for which data are available. Exclusions included stage IV, age <18 years, unknown insurance status, unknown race, and palliative intent radiation. Race and ethnicity variables were combined and classified as non-Hispanic White, Hispanic, NHB, Asian, Native American/Eskimo, and Hawaiian/Pacific Islander. Multivariable logistic regression for IMRT utilization was performed for each disease site for both early (2004-2010) and contemporary (2011-2017) cohorts, adjusting for clinical and demographic covariates.

Results: Among the 10 selected disease sites, 1,010,292 patients received radiation therapy as part of definitive treatment between 2004 and 2017. Overall IMRT utilization rates increased from 22.0% in 2004 to 57.8% in 2017. After adjustment and compared with non-Hispanic White patients, NHB patients were significantly less likely to receive IMRT in 1 of 10 disease sites in the 2004 to 2010 cohort, and 5 of 10 disease sites in the 2011 to 2017 cohort.

Conclusions: Despite greater awareness of racial disparities in cancer care and outcomes, this study demonstrates worsening disparities in the use of IMRT, particularly for NHB patients. These differences may exacerbate racial disparities in cancer outcomes; therefore, identification of underlying drivers of differential IMRT utilization is warranted.

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*Corresponding author: Gita Suneja, MD, MSHP; E-mail: gita.suneja@icloud.com

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Introduction

Although non-Hispanic Black (NHB) patients have had the highest cancer incidence and mortality of any racial and ethnic group in the United States for more than 4 decades, lower use of curative intent medical interventions including radiation therapy (RT) has been reported across multiple disease sites compared with non-Hispanic White (NHW) patients.^{1,2} The developments of image guided radiation therapy and intensity modulated radiation therapy (IMRT) have significantly improved the ability to shape radiation dose to deliver high doses to target volumes while minimizing dose to adjacent organs. Although the first commercially available IMRT platform was released in 1992, this technology was not widely adopted until recently with access to, and utilization rates of, IMRT varying widely throughout the United States.³ The benefits of IMRT compared with standard 3-dimensional conformal radiation therapy have been demonstrated in many cancer sites and include decreased acute and late toxicity, improved quality of life, and opportunities for dose escalation.⁴⁻⁸

A paucity of literature suggests that non-white patients have lower utilization rates of IMRT.⁹⁻¹³ Underlying reasons for this disparity have not been clearly established. The relationship between increasing IMRT utilization rates and worsening disparities has not been previously reported. Given persistently poor oncologic outcomes in non-white patients and inequitable distribution of advanced radiation technologies,^{2,14} we hypothesized that as use of IMRT has increased in recent years, racial inequities have persisted and disproportionately affect Black patients, who also have worse cancer

outcomes. We aimed to evaluate temporal trends in IMRT utilization while focusing on racial and ethnic disparities.

Methods and Materials

The National Cancer Database was queried to identify the 10 disease sites with the highest total number of patients with cancer treated with definitive intent IMRT in 2017, the most recent year for which data are available. The 10 disease sites included were prostate, head and neck, lung, brain, rectum, esophagus, uterus, anus, cervix, and stomach. We excluded other primary disease sites, unknown race, stage IV disease, age <18 years, unknown insurance status, palliative intent radiation. Race and ethnicity were classified as NHW, NHB, Hispanic, Asian, Native American/Eskimo, and Hawaiian/Pacific Islander. Annual rates of IMRT utilization are reported as percentages of total cases by disease site. A conceptual model incorporating individual, societal, and systems-level factors contributing to IMRT utilization, as well as corresponding variables available through NCDB is depicted in [Figure 1](#). Multivariable logistic regression for IMRT utilization was performed for each disease site for both early (2004-2010) and contemporary (2011-2017) cohorts. Models were adjusted for stage group (I, II, III), age group (<45 years, 45-65 years, >65 years), sex (male, female), race or ethnicity (NHW, NHB, Hispanic, Asian, Native American/Eskimo, Native Hawaiian/Pacific Islander), income quartiles (first, second, third, fourth), education quartiles (first, second, third, fourth), insurance status (uninsured, private, Medicaid, Medicare, other government), great circle distance (<50

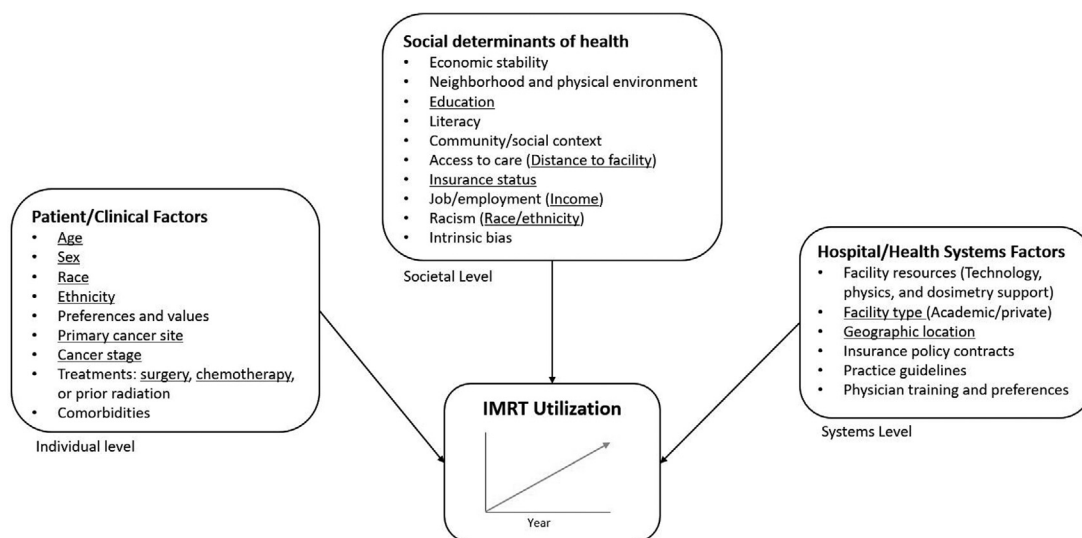


Fig. 1 Conceptual model for factors contributing to IMRT utilization. Variables available from the National Cancer Database and included in our analysis are underlined. *Abbreviation:* IMRT = intensity modulated radiation therapy.

miles, 50-200 miles, >200 miles), treatment facility type (community, comprehensive community, academic/research, integrated), geographic region (Northeast, South, Midwest, West), use of chemotherapy (yes or no), and use of surgery (yes or no). An exploratory analysis was performed to examine the association between insurance status and use of IMRT by race or ethnicity. This study is exempt from institutional review board approval.

Results

Patient clinical and sociodemographic information are summarized in Table 1. In total, 1,010,292 patients received radiation therapy to the included disease sites as part of definitive treatment between 2004 and 2017, with 485,340 of patients (48.0%) receiving IMRT. Overall IMRT utilization rates increased from 21.98% in 2004 to 57.8% in 2017. Rates of IMRT utilization during the study period for each

Table 1 Patient sociodemographic and clinical characteristics

Primary site group	3D CRT		IMRT		P value
	Number	%	Number	%	
H&N	50,802	44.1	64,403	55.9	<.001
Esophagus	21,466	58.1	15,509	41.9	
Stomach	11,975	60.0	7975	40.0	
Rectum/sigmoid	53,553	72.8	20,020	27.2	
Anus	12,902	42.6	17,417	57.4	
Lung	210,222	76.1	66,192	23.9	
Cervix	17,973	64.0	10,088	36	
Uterus	12,921	59.0	8962	41	
Prostate	90,400	28.9	222,263	71.1	
Brain	42,738	44.9	52,511	55.1	
Year of diagnosis					
2004-2008	184,264	63.2	107,387	36.8	<.001
2009-2013	182,924	49.8	184,511	50.2	
2014-2017	157,764	44.9	193,442	55.1	
Clinical stage					
I	151,336	69.3	67,071	30.7	<.001
II	159,937	39.7	243,415	60.3	
III	171,742	58.4	122,419	41.6	
Age (y)					
<45	25,910	53.5	22,485	46.5	<.001
45-65	210,050	50.9	202,812	49.1	
>65	288,992	52.6	260,043	47.4	
Sex					
Male	321,109	46.7	367,152	53.3	<.001
Female	203,843	63.3	118,188	36.7	
Race/ethnicity group					
Non-Hispanic White	426,665	52.5	385,310	47.5	<.001
Hispanic	18,667	48.4	19,905	51.6	
Non-Hispanic Black	58,948	49.3	60,653	50.7	
Asian	11,582	52.3	10,574	47.7	
Native American/Eskimo	1583	55.4	1272	44.6	
Native Hawaiian/Pacific Islander	393	54.7	325	45.3	
Other	7114	49.4	7301	50.6	

(continued on next page)

Table 1 (Continued)

Primary site group	3D CRT		IMRT		P value
	Number	%	Number	%	
Median income quartiles					
<\$40,227	101,142	55.2	82,233	44.8	<.001
\$40,227-\$50,353	112,174	53.0	99,389	47	
\$50,354-\$63,332	111,576	51.6	104,676	48.4	
≥\$63,333	160,542	51.8	149,232	48.2	
Percentage of residents without a high school degree					
≥17.6%	106,665	55.3	86,116	44.7	<.001
10.9%-17.5%	135,318	54.2	114,288	45.8	
6.3%-10.8%	136,445	51.7	127,294	48.3	
<6.3%	108,067	49.8	108,773	50.2	
Primary insurance					
Not insured	15,571	56.7	11,901	43.3	<.001
Private insurance	179,373	50.6	175,116	49.4	
Medicaid	33,944	53.1	29,991	46.9	
Medicare	284,082	52.8	254,387	47.2	
Other government	11,982	46.2	13,945	53.8	
Distance from treatment facility (miles)					
<50	449,068	52.6	404,098	47.4	<.001
50-200	36,834	54.3	31,038	45.7	
>200	5420	48.9	5667	51.1	
Facility type					
Community cancer program	51,784	56.2	40,297	43.8	<.001
Comprehensive community cancer program	218,607	51.5	206,259	48.5	
academic/research program	175,382	52.3	159,946	47.7	
Integrated	65,449	49.9	65,674	50.1	
Geographic region					
Northeast	113,737	50.9	109,797	49.1	<.001
South	189,422	53.7	163,456	46.3	
Midwest	136,889	50.9	132,110	49.1	
West	71,174	51.6	66,813	48.4	
Chemotherapy usage					
No chemo	255,309	47.0	288,040	53	<.001
Chemo	269,643	57.7	197,300	42.3	
Surgery					
No surgery	372,175	51.9	344,610	48.1	<.001
Neoadjuvant RT	54,171	68.1	25,354	31.9	
Adjuvant RT	98,606	46.1	115,376	53.9	

Abbreviations: 3D CRT = 3-dimensional conformal radiation therapy; H&N = head and neck; IMRT = intensity modulated radiation therapy; RT = radiation therapy.

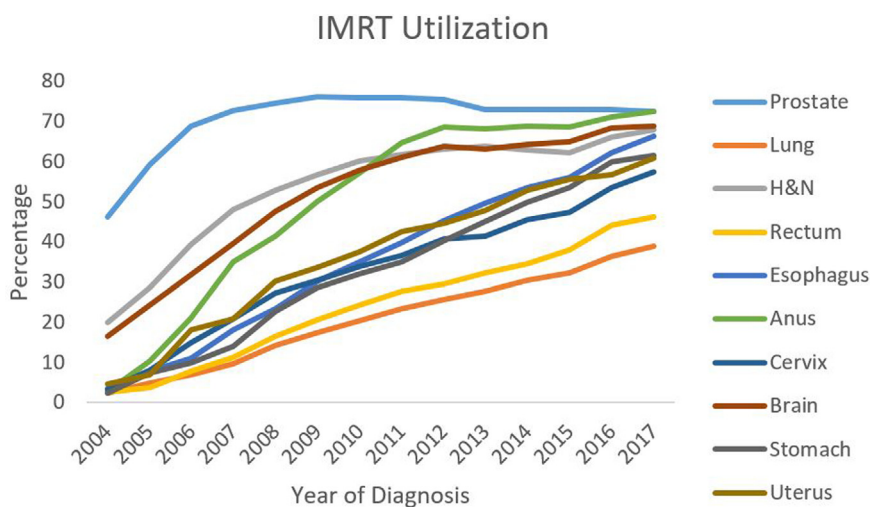


Fig. 2 Rates of IMRT utilization between 2004 and 2017. *Abbreviations:* H&N = head and neck; IMRT = intensity modulated radiation therapy.

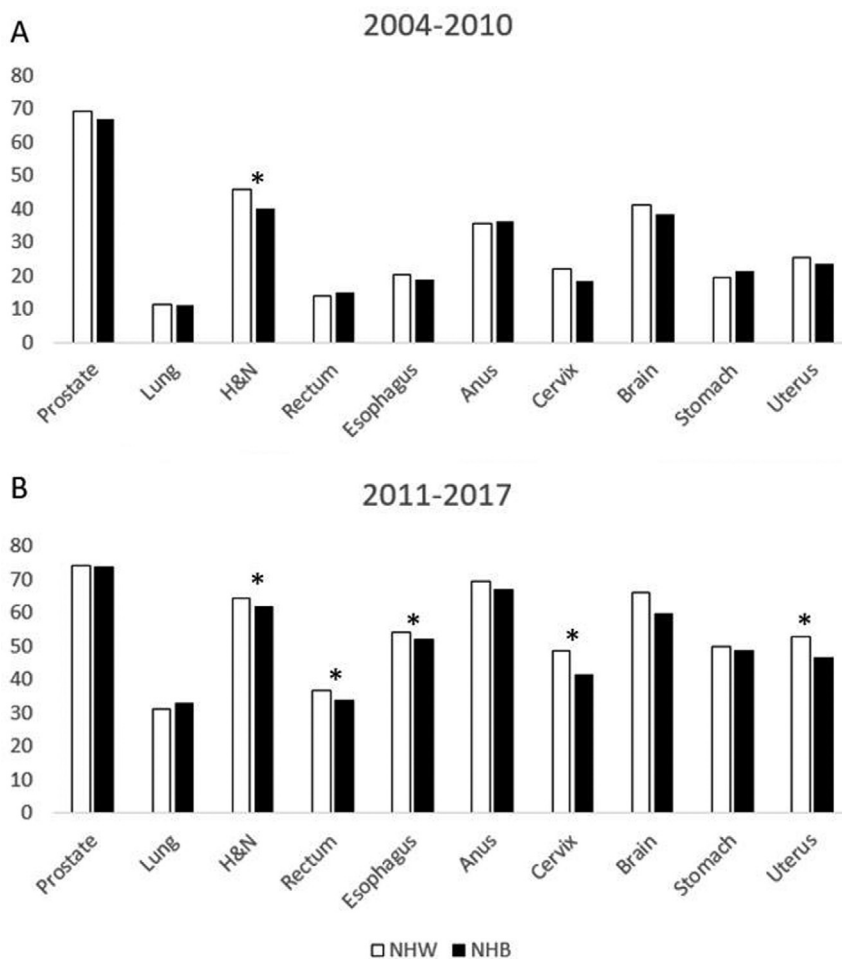


Fig. 3 Rates of intensity modulated radiation therapy utilization in NHW and NHB cohorts in (A) early and (B) contemporary cohorts. Asterisks indicate significant differences from multivariable logistic regression. *Abbreviations:* H&N = head and neck; NHB = non-Hispanic Black; NHW = non-Hispanic White.

Table 2 IMRT utilization in non-Hispanic White versus non-Hispanic Black patients over time.

Cancer type	2004 - 2010				2011 - 2017					
	Non-Hispanic White		Non-Hispanic Black		Non-Hispanic White		Non-Hispanic Black			
	Number	%	Number	%	Number	%	Number	%		
H&N	19,249	45.9%	1938	40.1%	34,001	64.3%	3953	61.82%		
Esophagus	2269	20.1%	255	18.9%	10,861	54.2%	1038	51.82%		
Stomach	985	19.3%	138	21.5%	5336	50.0%	576	48.40%		
Rectum	3417	14.0%	363	14.9%	12,790	36.8%	1271	33.76%		
Anus	3106	35.4%	364	36.1%	11,520	69.5%	1296	66.56%		
Brain	13,404	40.9%	1004	38.4%	30,640	65.9%	2396	59.74%		
Lung	10,287	11.5%	1151	11.1%	45,335	31.0%	5833	32.81%		
Cervix	1669	22.0%	354	18.3%	5041	48.7%	1058	41.23%		
Uterus	1805	25.5%	226	23.5%	5,219	52.6%	811	46.64%		
Prostate	84,172	69.3%	16,457	67.0%	84,204	74.0%	20,171	73.45%		
									AOR* 95% CI	AOR* 95% CI

Abbreviations: AOR = adjusted odds ratio; CI = confidence interval; H&N = head and neck; IMRT = intensity modulated radiation therapy.

* Adjusted for stage, age, sex, race/ethnicity, income, education, insurance status, great circle distance, treatment facility, geographic region, use of chemotherapy, and use of surgery

† p<0.001

‡ p<0.05

disease site are depicted in Figure 2. Primary sites with the largest absolute change (Δ) in IMRT utilization during the study period were cancers of the anus ($\Delta = 69.6\%$), esophagus ($\Delta = 62.9\%$), stomach ($\Delta = 59.0\%$), uterus ($\Delta = 56.2\%$), cervix ($\Delta = 54.1$), and primary brain cancer ($\Delta = 52.3\%$).

When accounting for clinical and sociodemographic covariates, compared with NHW patients, NHB patients were less likely to receive IMRT in 1 of 10 disease sites (head and neck) in the 2004 to 2010 cohort, and 5 of 10 disease sites (head and neck, esophageal, rectal, cervical, and uterine) in the 2011 to 2017 cohort (Fig 3 and Table 2). Contemporary differences in IMRT utilization for Hispanic, Asian, Native American/Eskimo, and Native Hawaiian/Pacific Islander individuals were also examined and are reported in Table E1.

In the entire cohort, the distribution of primary insurance was Medicare (53.3%), private (35.1%), Medicaid (6.3%), other government (4.9%), and uninsured (4.0%). Among patients treated with IMRT, NHB patients were more often insured with Medicare (45.7% vs 54.6%) and Medicaid (11.4% vs 4.6%) compared with NHW patients. Between the early (2004-2010) and contemporary (2011-2017) cohorts, there was an increase in the percentage of NHB patients treated with IMRT insured by Medicaid (9.0%-12.7%) and a decrease in the percentage treated with IMRT who had private insurance (37.6%-32.5%). In the contemporary cohort (2011-2017) where disparities in utilization were greater, multivariable models revealed that, compared with private insurance, patients with Medicare or Medicaid were more likely to receive IMRT in 6 of 10 disease sites (head and neck, esophagus, stomach, rectum, lung, prostate) and 3 of 10 (rectum, lung, prostate), respectively (Table 3).

An analysis focused on patients with private insurance only showed that after accounting for clinical and socio-demographic factors, compared with NHW patients, NHB patients were less likely to receive IMRT in 1 of 10 disease sites (head and neck) in the early cohort and 3 of 10 disease sites (head and neck, rectal, cervical) in the contemporary cohort.

Discussion

Inequities in access to and use of RT for Black patients with cancer have been described across a variety of disease sites including prostate, gynecologic, lung, head and neck, and breast.¹⁵ Although the general RT utilization patterns and disparities are well described, the utilization of advanced radiation therapy techniques including IMRT has not been thoroughly investigated. In this retrospective database study of patients receiving definitive radiation therapy to disease sites commonly treated with IMRT, we found evidence of racial disparities in IMRT utilization, particularly affecting NHB patients, with widening gaps as IMRT utilization increased over time and despite increased awareness of the magnitude and effect of racial disparities

Table 3 Contemporary (2011-2017) IMRT utilization by insurance relative to private insurance

Cancer type	Medicare		Medicaid		Uninsured	
	AOR	95% CI	AOR	95% CI	AOR	95% CI
H&N	1.20	1.140-1.26*	1.06	0.98-1.13	0.94	0.85-1.04
Esophagus	1.09	1.010-1.18†	1.06	0.95-1.18	0.95	0.79-1.15
Stomach	1.15	1.040-1.28‡	1.11	0.94-1.30	1.07	0.83-1.36
Rectum	1.13	1.055-1.20*	1.23	1.13-1.37*	1.00	0.89-1.13
Anus	1.06	0.965-1.16	1.04	0.92-1.17	0.87	0.73-1.03
Brain	0.74	0.339-1.61	1.30	0.51-3.31	0.83	0.19-3.52
Lung	1.11	1.069-1.14*	1.17	1.11-1.23*	0.89	0.82-0.97‡
Cervix	1.13	0.996-1.28	1.08	0.97-1.19	0.87	0.75-1.01
Uterus	1.08	0.967-1.20	1.08	0.92-1.26	0.88	0.71-1.09
Prostate	1.17	1.128-1.20*	1.15	1.08-1.23*	1.00	0.91-1.11

Abbreviations: AOR = adjusted odds ratio; CI = confidence interval; H&N = head and neck; IMRT = intensity modulated radiation therapy.
* $P < .001$.
† $P < .05$.
‡ $P < .01$.

in oncology. Our conceptual model was constructed based on the existing literature to include clinical and demographic factors that are known to affect the use of IMRT. For example, later stage tumors often require larger or more complicated target volumes requiring IMRT to maintain low dose to organs at risk. Treatment factors including the use of surgery and chemotherapy can further alter target shape and increase toxicity profile. As different practice patterns between institutions and across geographic regions exist, these variables were also included. In an ideal world, sociodemographic factors would not drive treatment decisions while controlling for the aforementioned covariates; however, race is included in the model as a surrogate for racism given the large volume of literature suggesting that racism drives treatment inequities.

As definitive intent IMRT has been demonstrated to provide significant improvements in RT-induced toxic effects, posttreatment quality of life, and RT dose escalation, equitable utilization is critical for improving cancer outcomes in minoritized populations.⁴⁻⁸ Of note, the aim of this study was to evaluate differences in utilization of IMRT rather than appropriateness of IMRT. Regardless of appropriateness, disparate utilization rates warrant a close examination to ensure equitable delivery of cancer treatment. Although the IMRT can be used for palliative intent treatment in specific contexts such as reirradiation or when targets are proximal to critical radiosensitive normal structures, we elected to limit the patient population for this study to include only definitive intent treatments with the goal of focusing on patients with the most likelihood of deriving long-term toxic effects and quality of life benefits from treatment with IMRT. Although NHB patients were more likely to be uninsured or underinsured, our analysis suggests that racial disparities exist even after controlling for insurance type. Nonetheless, the

question of whether insurance coverage of advanced radiation therapy modalities is equitably distributed remains unanswered. In many instances, treating patients who have private insurance using IMRT requires prior authorization, which can increase patient stress, delay treatment start, limit available physician time for direct patient care, and increase workload on departmental support staff.^{16,17} Our analysis demonstrated that patients with Medicare and Medicaid insurance were more likely to receive IMRT for certain cancers than those with private insurance, perhaps due to challenges with prior authorization. Potentially modifiable factors warranting further investigation (eg, inequitable denial of IMRT by insurance companies) were not ascertained in our data set yet could drive differences in IMRT.¹⁸ However, in our analysis limited to patients with private insurance only, the disparity in utilization persisted, suggesting insurance coverage alone does account for differential care. These findings warrant a closer examination of our health care system to better understand how this disparity has worsened over time and what solutions can address these disparities. For example, more information regarding the insurance prior authorization process and how it affects the use of IMRT are needed. The nation's history of structural racism at all points in the cancer care continuum, including insurance inclusions and prior authorization, must be acknowledged and its effects further examined to ensure equitable treatment and improved outcomes for NHB patients.^{19,20}

Findings from this study are novel due to the focus on IMRT utilization trends instead of static evaluation and this is the first study to relate increased rates of IMRT utilization to worsening racial disparities. As IMRT rapidly becomes the most common technique for delivering radiation therapy among many disease sites, these disparities will continue to proportionally worsen if not addressed.

Removing systemic barriers to equitable access to IMRT is a critical next step in addressing these disparities and will be the focus of future projects. Future studies collecting more granular information regarding the need for the insurance prior authorization process including the frequency of approvals, denials, and appeals and how these affect the use of IMRT are needed. However, the study's limitations should be considered. First, the retrospective database design is susceptible to inherent risk of bias due to limited available data. However, our study was strengthened as the large sample size we assessed included the 10 disease sites most commonly treated with IMRT in the modern era. Second, data regarding specifics of insurance plans did not provide information regarding insurance denials, premiums, or copays that may be barriers to treatment with IMRT. Lastly, the NCDB does not contain data regarding treatment-related toxic effects or local recurrence; therefore, the direct clinical effect of lower IMRT utilization could not be assessed.

Conclusion

Differences in utilization of IMRT may contribute to the observed racial disparities in cancer outcomes. This analysis demonstrates a concerning temporal trend of worsening disparities in utilization of IMRT in NHB patients as the overall utilization of IMRT increased in the study period. The study also found that for some cancer sites, patients with Medicare and Medicaid insurance were more likely to receive IMRT than those with private insurance, suggesting that further investigation into the equity of prior authorization and insurance denial is warranted.

Supplementary materials

Supplementary material associated with this article can be found in the online version at [doi:10.1016/j.adro.2021.100887](https://doi.org/10.1016/j.adro.2021.100887).

References

- American Cancer Society. Cancer facts & figures for African Americans 2019-2021. Available at: <https://www.cancer.org/content/dam/cancer-org/research/cancer-facts-and-statistics/cancer-facts-and-figures-for-african-americans/cancer-facts-and-figures-for-african-americans-2019-2021.pdf#:~:text=Cancer%20Facts%20%26%20Figures%20for%20African%20Americans%202019-2021,have%20converged%20for%20young%20blacks%20and%20whites.15%2C%2016>. Accessed March 30, 2021.
- McClelland S, Deville C, Thomas CR, Jaboin JJ. An overview of disparities research in access to radiation oncology care. *J Radiat Oncol*. 2016;5:437–444.
- Grant SR, Smith BD, Likhacheva AO, et al. Provider variability in intensity modulated radiation therapy utilization among Medicare beneficiaries in the United States. *Pract Radiat Oncol*. 2018;8:e329–e336.
- Kachnic LA, Winter K, Myerson RJ, et al. RTOG 0529: A phase 2 evaluation of dose-painted intensity modulated radiation therapy in combination with 5-fluorouracil and mitomycin-C for the reduction of acute morbidity in carcinoma of the anal canal. *Int J Radiat Oncol Biol Phys*. 2013;86:27–33.
- Chun SG, Hu C, Choy H, et al. Impact of intensity-modulated radiation therapy technique for locally advanced non-small-cell lung cancer: A secondary analysis of the NRG oncology RTOG 0617 randomized clinical trial. *J Clin Oncol*. 2017;35:56–62.
- Nwachukwu C, Chino J, Albuquerque K. To fracture not-sustained benefits of intensity modulated radiation therapy (IMRT) in pelvic malignancies. *Int J Radiat Oncol Biol Phys*. 2020;106:493–495.
- Yeung AR, Pugh SL, Klopp AH, et al. Improvement in patient-reported outcomes with intensity-modulated radiotherapy (RT) compared with standard RT: A report from the NRG oncology RTOG 1203 study. *J Clin Oncol*. 2020;38:1685.
- Mell LK, Sirak I, Wei LC, et al. Bone marrow-sparing intensity modulated radiation therapy with concurrent cisplatin for stage IB-IVA cervical cancer: An international multicenter phase II clinical trial (INTERTECC-2). *Int J Radiat Oncol*. 2017;97:536–545.
- Shumway DA, Griffith KA, Pierce LJ, et al. Wide variation in the diffusion of a new technology: Practice-based trends in intensity-modulated radiation therapy (IMRT) use in the state of Michigan, with implications for IMRT use nationally. *J Oncol Pract*. 2015;11:e373–e379.
- Samuel CA, Landrum MB, McNeil BJ, Bozeman SR, Williams CD, Keating NL. Racial disparities in cancer care in the Veterans Affairs health care system and the role of site of care. *Am J Public Health*. 2014;104(Suppl 4):S562–S571.
- Reyngold M, Niland J, Ter Veer A, et al. Trends in intensity modulated radiation therapy use for locally advanced rectal cancer at National Comprehensive Cancer Network centers. *Adv Radiat Oncol*. 2018;3:34–41.
- Cobran EK, Chen RC, Overman R, et al. Racial differences in diffusion of intensity-modulated radiation therapy for localized prostate cancer. *Am J Mens Health*. 2016;10:399–407.
- Osborn V, Schwartz D, Lee YC, et al. Patterns of care of IMRT usage in postoperative management of uterine cancer. *Gynecol Oncol*. 2017;144:130–135.
- Bitterman DS, Bona K, Laurie F, et al. Race disparities in proton radiotherapy use for cancer treatment in patients enrolled in children's oncology group trials. *JAMA Oncol*. 2020;6:1465–1468.
- McClelland 3rd S, Page BR, Jaboin JJ, Chapman CH, Deville Jr. C, Thomas Jr. CR. The pervasive crisis of diminishing radiation therapy access for vulnerable populations in the United States, part 1: African-American patients. *Adv Radiat Oncol*. 2017;2:523–531.
- Novak J, Germino EA, Ivanov Y, et al. Prior authorization for three-dimensional versus intensity-modulated radiotherapy comparison plans may delay treatment. *Int J Radiat Oncol*. 2020;108:E420–E421.
- Srivastava A, Gabani P, Kim E, Lee H, Pedersen K, Kim H. Radiation and medical oncology trainee perceptions of the prior authorization process: A national survey. *Int J Radiat Oncol*. 2019;105:E461.
- Dickman SL, Himmelstein DU, Woolhandler S. Inequality and the health-care system in the USA. *Lancet*. 2017;389:1431–1441.
- Gee GC, Ford CL. Structural racism and health inequities: Old issues, new directions. *Du Bois Rev*. 2011;8:115–132.
- Williams DR, Rucker TD. Understanding and addressing racial disparities in health care. *Health Care Financ Rev*. 2000;21:75–90.