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Scientific Article

Factors Associated With Early Discontinuation of Radiation Therapy: An Analysis of the National Cancer Database

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Purpose: Radiation therapy (RT) often involves multiple visits over weeks and may be discontinued before planned treatment completion. This analysis aims to identify clinical and socioeconomic factors that could serve as predictors of RT discontinuation.

Methods and Materials: Using National Cancer Database data from 2018 to 2019, we identified 749,135 cases treated with RT, chemoradiation (CRT), surgery with RT, or surgery with CRT that had information on radiation discontinuation. All patients were treated with curative intent. The variables assessed include age (18-<50, 50-<70, and ≥70), sex (male and female), race (White, Black, and Other), insurance status (private, Medicare/government, and Medicaid/uninsured), income level (<$46,277, $46,277-$57,856, $57,856-$74,062, and ≥$74,062), facility type (community, comprehensive community, academic/research, and integrated cancer network), Charlson-Deyo Comorbidity Score (0, 1, and ≥2), treatment type (RT, CRT, surgery with RT, and surgery with CRT), and primary tumor site. Reasons for RT discontinuation were evaluated. Univariable and multivariable logistic regression modeling was used to calculate the adjusted odds of RT discontinuation by clinical and socioeconomic factors.

Results: Of the 749,135 patients, RT was discontinued in 25,072 (3.3%) patients. The primary tumor sites include breast (36.6%), thorax (18.1%), genitourinary tract (13.2%), head and neck (11.4%), gastrointestinal system (10.9%), gynecologic system (6.0%), central nervous system (3.9%), musculoskeletal system (1.3%), and skin (0.7%). On multivariable analysis, older age, female sex, nonprivate insurance, lower income, treatment at community program facilities, multiple comorbidities, and CRT were independently associated with RT discontinuation. The reasons for RT discontinuation were patient decision (35.5%), contraindication because of patient risk factors (20.0%), toxicity (19.7%), patient expiration (13.8%), and family decision (3.0%).

Conclusions: This National Cancer Database analysis showed RT discontinuation rates correlated with clinical factors, including older age, multiple comorbidities, and CRT, and socioeconomic factors, including nonprivate insurance and lower household income.

Introduction

Radiation courses generally involve multiple visits over weeks depending on the disease site and treatment technique, creating the possibility of radiation therapy (RT) discontinuation before planned treatment completion. Adherence to RT is of paramount importance, because it has been shown to impact oncological outcomes.[1-4]

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Research data are available at https://www.facs.org/quality-programs/cancer-programs/national-cancer-database/.

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Prior studies have shown that patients who do not complete a full course of RT have higher risks of cancer recurrence and mortality.[4-6] Additionally, RT discontinuation is negatively correlated with overall survival in patients with triple-negative breast cancer, non-small cell lung cancer, prostate cancer, cervical cancer, and nasopharyngeal cancer.[7-13] Collectively, these studies underscore the importance of RT adherence and the need to understand clinical and socioeconomic factors contributing to RT discontinuation.

The National Cancer Database (NCDB) started to collect RT discontinuation rates on January 1, 2018.[14] Previous NCDB studies in prostate cancer highlight the racial and ethnic disparities in RT noncompletion.[15-17] A prior study using the NCDB from 2018 to 2021 by Hogan et al. observed the impact of geographic and sociodemographic factors on RT discontinuation in patients with common solid cancers.[18] During the COVID-19 pandemic, multiple studies reported increases in RT delay and interruptions because of fear of getting infected and financial strain specific to the pandemic.[19-23] Although the impact of the COVID-19 pandemic on RT discontinuation is certainly important, we aimed to explore clinical and socioeconomic factors affecting RT discontinuation across multiple cancer types, specifically from 2018 to 2019, to exclude the effects of the COVID-19 pandemic.

Additionally, we aim to understand the common reasons for RT discontinuation in various cancer types. To our knowledge, the literature has surveyed the reasons for RT discontinuation in head and neck, bladder, and cervical cancer,[24-27] but not across multiple cancer types. By identifying the patients most at risk for RT discontinuation and the most common reasons for RT discontinuation, our results may assist in developing screening tools and social services that improve RT adherence.

Methods and Materials

Data source

To identify the clinical and socioeconomic factors for RT discontinuation, we used the NCDB to examine patient characteristics and reasons pertaining to RT discontinuation. The NCDB is a joint program of the American College of Surgeons Commission on Cancer (CoC) and the American Cancer Society.[14] This clinical oncology database is sourced from hospital registry data from more than 1500 CoC-accredited facilities, including diagnostic, staging, treatment, and outcome data for patients who received a new diagnosis of cancer in the United States.[14] These data are collected using standardized coding definitions from participating institutions.[14] RT discontinuation was only documented among cases in CoC-accredited facilities diagnosed on January 1, 2018 and later.[14]

Study population

A total of 2,531,448 cancer cases were documented in the NCDB from 2018 to 2019. Of these cases, 379,667 patients were excluded for missing treatment information, treatment not given, treatment other than surgery, radiation, or chemotherapy, and active surveillance only. An additional 1,345,558 patients were excluded because of receiving chemotherapy only, surgery alone, and surgery with chemotherapy. Another 48,529 patients were excluded because of palliative treatment. Furthermore, 8559 patients were excluded for missing information on RT discontinuation, leaving 749,135 patients for the analysis (Fig. 1). Finally, patients with missing information on covariates were excluded, leaving 591,922 patients for the complete case analysis.

Data collection

Of the 749,135 patients, clinical and socioeconomic factors collected include age at diagnosis in years (18-<50, 50-<70, and ≥70), sex (male and female), race (White, Black, and Other), insurance status (private, Medicare/government, and Medicaid/uninsured), household income (<$46,277, $46,277-$57,856, $57,856-$74,062, and ≥$74,062), treatment facility type (community program, comprehensive community program, academic/research program, and integrated network cancer program), Charlson-Deyo Comorbidity Score (0, 1, and ≥2), treatment type [RT, chemoradiation (CRT), surgery with radiation (Sx+RT), and surgery with chemoradiation (Sx+CRT)], primary tumor site, distance to treatment facility in miles, radiation elapsed time in days and number of treatment fractions. The NCDB uses zip codes to determine median household income and distance to treatment facilities. For the main analysis, we chose to group uninsured and Medicaid patients, because both groups are often grouped as "vulnerable populations" in studies of safety-net hospitals, according to the Institute of Medicine.[28] Additionally, racial subgroups other than Black and White were combined into Other category for the main analysis. Because of variability across different cancer types, we do not report information on staging.

RT discontinuation

RT discontinuation is defined as the termination of RT earlier than initially intended by the treating physician, leading to receiving fewer treatment fractions than planned. This data entry, typically found in the radiation oncologist's completion summary, is required across CoC-accredited facilities for cases diagnosed on January 1, 2018 and later. The reasons behind RT discontinuation include toxicity, contraindication because of patient risk

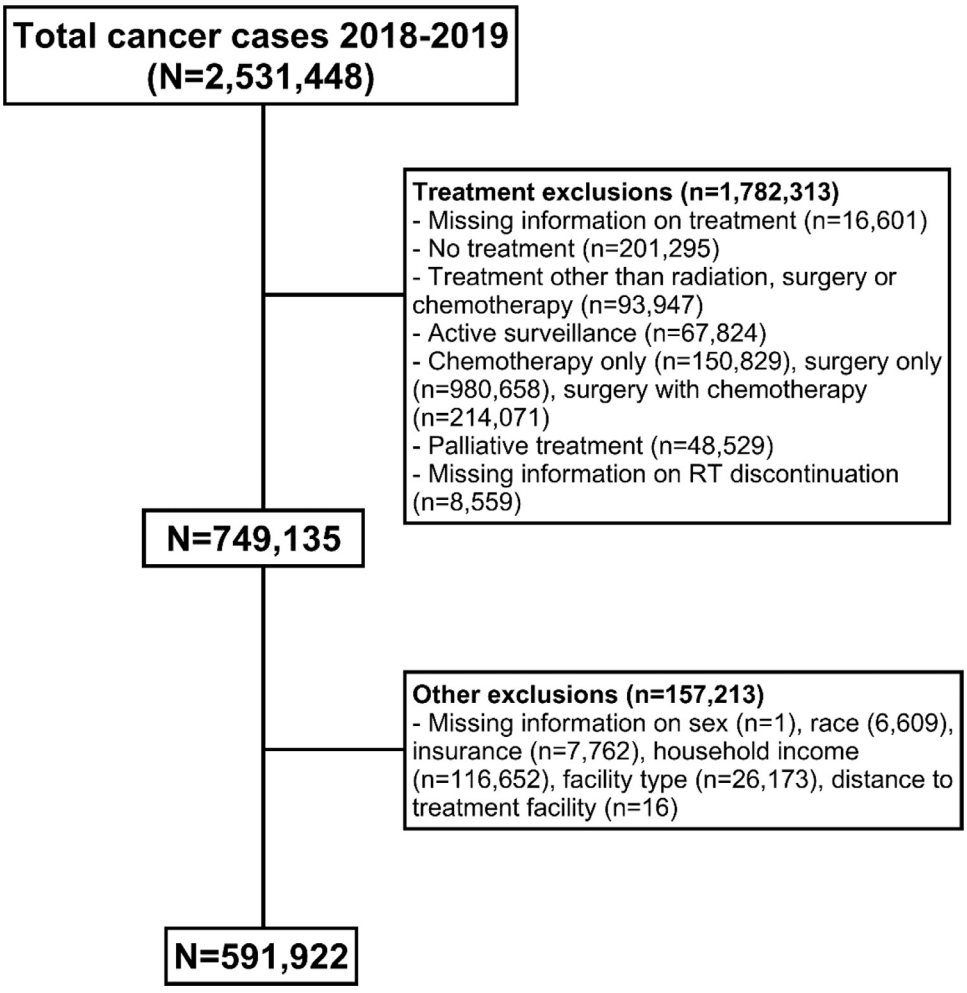

Figure 1 Patient inclusion criteria.
Abbreviation: RT=radiation therapy.

factors, patient decision, family decision, and patient death.

Statistical analysis

Descriptive statistics were computed to report overall clinical and socioeconomic factors stratified by RT discontinuation status. Frequencies are presented as the number of patients (row percent). The $\chi 2$ test was used to examine differences in categorical variables by RT discontinuation. For continuous variables, results are presented as median (IQR), and the Wilcoxon-Mann-Whitney test was used to assess differences in distribution. Univariable and multivariable logistic regression modeling was used to compute crude and adjusted odds of positive RT discontinuation by clinical and socioeconomic factors. We used a generalized estimating equation approach for within-site clustering. The generalized estimating equation approach is robust to the specification of the working correlation structure and allows for the proper estimation of SEs through robust sandwich estimators. The odds ratios (OR) with 95% CIs were computed.

Sensitivity analysis

We repeated the univariable and complete case analyses to examine the impact of various racial subgroups [American Indian, East Asian, South Asian, Southeast Asian, Native Hawaiian and Pacific Islander, and Other (Not Otherwise specified)] within the Other racial category. We computed separate ORs for Medicaid and uninsured patients to evaluate their individual effects.

Missing data analysis

In addition to performing a complete case analysis (patients with complete information on all covariates), we conducted multiple imputation analyses and imputed data values for variables with missing information.

Information on race, insurance status, household income, treatment facility type, distance to treatment facility, and radiation elapsed days was missing for 6609 (0.88%), 7954 (1.06%), 118,594 (15.8%), 31,345 (4.18%), 111,536 (14.9%), and 80,566 (10.8%) patients, respectively. We compared clinical and socioeconomic factors in patients with and without missing data to explore the plausibility of the missing data mechanism. Because the missing data correlated with several covariates, a missing at random mechanism was assumed (data not presented in the tables). The complete case analysis is the primary analysis, whereas the imputed data set was used for the confirmatory analysis.

Multiple imputations were performed in SAS 9.4 using PROC MI, and 5 imputed data sets were generated. A fully conditional specification method was applied. The imputation model included age, sex, race, insurance, household income, treatment facility type, Charlson-Deyo score, treatment type, primary tumor site, and distance to treatment facility. PROC MIANALYZE was used to pool results from the logistic regression analysis performed on the 5 imputed data sets and generate pooled ORs along with 95% CIs.

Statistical computations were performed on the SAS 9.3 system (SAS Institute). All tests were 2-sided, and $P < .05$ was considered statistically significant.

Results

Of the cancer cases documented in the NCDB from 2018 to 2019, 749,135 patients were included in our study. The majority of patients were 50 to <70 years old (n = 402,058; 53.7%), female (n = 460,422; 61.5%), and White (n = 615,751; 82.9%). They most commonly had Medicare (n = 369,907; 49.9%), household income of ≥$74,062 (n = 242,385; 38.4%), treatment at comprehensive community programs (n = 268,543; 37.4%), a Charlson-Deyo Comorbidity Score of 0 (n = 565,728; 75.5%), Sx+RT (n = 259,302; 34.6%), and primary tumor site of breast (n = 273,850; 36.6%). The median distance to treatment facility was 10.8 miles (IQR, 4.9-24.0). The median radiation elapsed time was 36 days (IQR, 22-46). The median number of treatment fractions was 20 (IQR, 11-28) (Table 1).

Of 749,135 patients, 25,072 (3.3%) stopped RT before planned treatment completion, and 724,063 (96.7%) completed the full treatment course. RT discontinuation rates were highest among patients aged ≥70 years old (4.2%, $P < .0001$), male sex (4.0%, $P < .0001$), Black race (3.6%, $P < .0001$), Medicaid/uninsured status (5.0%, $P < .0001$), income <$46,277 (4.3%, $P < .0001$), and a Charlson-Deyo Comorbidity Score ≥2 (5.4%, $P < .0001$). Patients treated at community programs had the highest RT discontinuation rates (4.2%, $P < .0001$). By treatment modality, the highest RT discontinuation rates were observed in the CRT group (6.5%), followed by RT (3.8%), Sx+CRT (2.9%), and Sx+RT (1.8%), $P < .0001$. By primary tumor site, thorax had the highest RT discontinuation rates (5.8%), followed by gastrointestinal system (5.2%), central nervous system (4.9%), skin (4.9%), head and neck (4.6%), musculoskeletal system (4.3%), gynecologic system (3.9%), genitourinary tract (1.7%), and breast (1.6%), $P < .0001$ (Table 1). The reasons for RT discontinuation were patient decision (35.5%), contraindication because of patient risk factors (20.0%), toxicity (19.7%), patient death (13.8%), and family decision (3.0%) (Fig. 2, Table 2).

Univariable and multivariable analyses

After excluding patients with missing data, the univariable analysis showed patients who were 50 to <70 years old (OR, 1.27, $P < .0001$) and ≥70 years old (OR, 1.76, $P < .0001$) had higher odds of discontinuing RT prematurely than patients between 18 and 50 years old. Compared to patients with private insurance, patients who had Medicare (OR, 1.86, $P < .0001$) or Medicaid/uninsured (OR, 2.40, $P < .0001$) had higher odds of RT discontinuation. Compared with RT, CRT (OR, 1.81, $P < .0001$) had higher odds of RT discontinuation, whereas Sx+RT (OR, 0.46, $P < .0001$) and Sx+CRT (OR, 0.79, $P < .0001$) had lower odds of discontinuing RT. Breast and genitourinary tract were the least likely primary tumor sites for RT discontinuation compared to the other systems. Complete results of the univariable analysis are presented in Table 3.

On multivariable analysis, patients over 70 had higher odds of discontinuing RT prematurely than patients between 18 and 50 (adjusted OR, 1.26, $P < .0001$). There was no statistically significant difference between Black and White patients on RT discontinuation rates (adjusted OR, 1.04, $P = .170$). Compared to patients with private insurance, patients who had Medicare (adjusted OR, 1.40, $P < .0001$) or Medicaid/uninsured (adjusted OR, 1.81, $P < .0001$) had higher odds of RT discontinuation. Increasing household income was associated with lower odds of RT discontinuation ($P < .0001$). By facility type, academic/research programs had lower odds of RT discontinuation than community programs (adjusted OR, 0.72, $P < .0001$). Patients with a Charlson-Deyo score of 1 (adjusted OR, 1.14, $P < .0001$) or 2 or more (adjusted OR, 1.33, $P < .0001$) had higher odds of RT discontinuation than patients with a Charlson-Deyo score of 0. Compared with RT, CRT (adjusted OR, 1.30, $P < .0001$) had higher odds of RT discontinuation, whereas Sx+RT (adjusted OR, 0.55, $P < .0001$) and Sx+CRT (adjusted OR, 0.81, $P < .0001$) had lower odds of RT discontinuation. Compared to the breast, the genitourinary tract (adjusted OR, 0.69, $P < .0001$) had lower odds of RT discontinuation, whereas the other systems had higher odds. Complete results from multivariable analysis are presented in Table 3.

Table 1 Clinical or socioeconomic factors and discontinuation of radiation treatment

		Radiation		*P*
	Overall (N = 749,135)	**Completed (N = 724,063)**	**Discontinued (N = 25,072)**	
	Median (IQR)			
Age (y)	65 (56-72)	65 (56-72)	67 (59-75)	<.0001
Distance to treatment facility, miles	10.8 (4.9-24.0)	10.8 (4.9-24.0)	10.6 (4.6-24.1)	<.0001
Radiation elapsed time, days	36 (22-46)	36 (22-46)	28 (11-44)	<.0001
Treatment fractions (range, 1-70)	20 (11-28)	22 (14-28)	15 (6-24)	<.0001
	n (column %)	n (row %)		
Age (y)				<.0001
18-<50	98,414 (13.1)	96,066 (97.6)	2348 (2.4)	
50-<70	402,058 (53.7)	389,753 (96.9)	12,305 (3.1)	
≥70	248,663 (33.2)	238,244 (95.8)	10,419 (4.2)	
Sex				<.0001
Male	288,712 (38.5)	277,041 (96.0)	11,671 (4.0)	
Female	460,422 (61.5)	447,021 (97.1)	13,401 (2.9)	
Missing	1			
Race				<.0001
White	615,751 (82.9)	594,905 (96.1)	20,846 (3.4)	
Black	87,350 (11.8)	84,198 (96.4)	3152 (3.6)	
Other	39,425 (5.3)	38,541 (97.8)	884 (2.2)	
Missing	6609			
Insurance				<.0001
Private	299,334 (40.4)	292,950 (97.9)	6384 (2.1)	
Medicare/government	369,907 (49.9)	355,151 (96.0)	14,756 (4.0)	
Medicaid/uninsured	71,940 (9.7)	68,357 (95.0)	3583 (5.0)	
Missing	7954			
Household income				<.0001
<$46,277	101,476 (16.1)	97,140 (95.7)	4336 (4.3)	
$46,277- $57,856	135,382 (21.5)	130,198 (96.2)	5184 (3.8)	
$57,856- $74,062	151,298 (24.0)	146,376 (96.8)	4922 (3.3)	
$74,062+	242,385 (38.4)	235,892 (97.3)	6493 (2.7)	
Missing	118,594			
Facility type				<.0001
Community program (CP)	49,795 (6.9)	47,706 (95.8)	2089 (4.2)	
Comprehensive CP	268,543 (37.4)	259,128 (96.5)	9415 (3.5)	
Academic/research program	258,201 (36.0)	250,244 (96.9)	7957 (3.1)	
Integrated Network Cancer Program	141,251 (19.7)	136,374 (96.6)	4877 (3.5)	
Missing	31,345			
Charlson-Deyo score				<.0001
0	565,728 (75.5)	549,150 (97.1)	16,578 (2.9)	
1	113,536 (15.2)	108,832 (95.9)	4704 (4.1)	
2 or more	69,871 (9.3)	66,081 (94.6)	3790 (5.4)	

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Table 1 (*Continued*)

	Overall (N = 749,135)	Radiation		*P*
		Completed (N = 724,063)	Discontinued (N = 25,072)	
Treatment				<.0001
Radiation	166,463 (22.2)	160,216 (96.3)	6247 (3.8)	
Chemoradiation	134,567 (18.0)	125,775 (93.5)	8792 (6.5)	
Surgery with radiation	259,302 (34.6)	254,758 (98.3)	4544 (1.8)	
Surgery with chemoradiation	188,803 (25.2)	183,314 (97.1)	5489 (2.9)	
Primary tumor site				<.0001
Breast	273,850 (36.6)	269,497 (98.4)	4353 (1.6)	
Central nervous system	28,992 (3.9)	27,566 (95.1)	1426 (4.9)	
Gastrointestinal	81,550 (10.9)	77,274 (94.8)	4276 (5.2)	
Genitourinary	98,597 (13.2)	96,916 (98.3)	1681 (1.7)	
Gynecologic	44,727 (6.0)	42,991 (96.1)	1736 (3.9)	
Head and neck	85,720 (11.4)	81,789 (95.4)	3931 (4.6)	
Musculoskeletal	9590 (1.3)	9178 (95.7)	412 (4.3)	
Skin	5263 (0.70)	5006 (95.1)	257 (4.9)	
Thoracic	120,846 (18.1)	113,846 (94.2)	7000 (5.8)	
Distance to treatment facility, miles				.021
≤Median (≤10.8 miles)	319,732 (50.2)	308,928 (96.6)	10,804 (3.4)	
>Median (>10.8 miles)	317,867 (40.8)	307,456 (96.7)	10,411 (3.3)	
Missing	111,536			
Year of diagnosis				.170
2018	371,374 (49.6)	358,838 (96.6)	12,536 (3.4)	
2019	377,761 (50.4)	365,225 (96.7)	12,536 (3.3)	

Distance to treatment facility and radiation elapsed days were missing for 111,536 and 80,566, respectively. Treatment fractions were missing or >70 fractions for 33,090 patients.

The analysis performed on the imputed data set of 749,135 patients mirrored the complete case multivariable analysis. Table 3 provides the complete results from the analysis of the imputed data.

Sensitivity analysis

In the multivariable analysis examining expanded racial subgroups, lower odds of RT discontinuation were found among the East Asian, South Asian, Southeast Asian, and Other subgroups compared to White patients, but not for the American Indian and Native Hawaiian and Pacific Islander subgroups, as noted in Table E1. The adjusted ORs for Medicaid (1.82) and uninsured individuals (1.77) were comparable to those for the Medicaid/uninsured group (1.81) in the main analysis.

Discussion

In this NCDB study that examines factors affecting RT discontinuation rates, we found a relatively low percentage of patients stopped RT before planned treatment completion. On multivariable analysis, we showed that older age, female sex, Medicaid/uninsured status, lower income, community program, multiple comorbidities, and CRT were independently associated with RT discontinuation.

The overall percentage of patients completing RT was consistent with a previous study by Freedman et al. examining factors associated with adjuvant RT incompletion for women with breast cancer within the NCDB.[29] Our study found that patients aged ≥70 had higher odds of discontinuing RT, similar to Freedman's study. Lazarev et al. also identified ≥60 years old as one of the factors

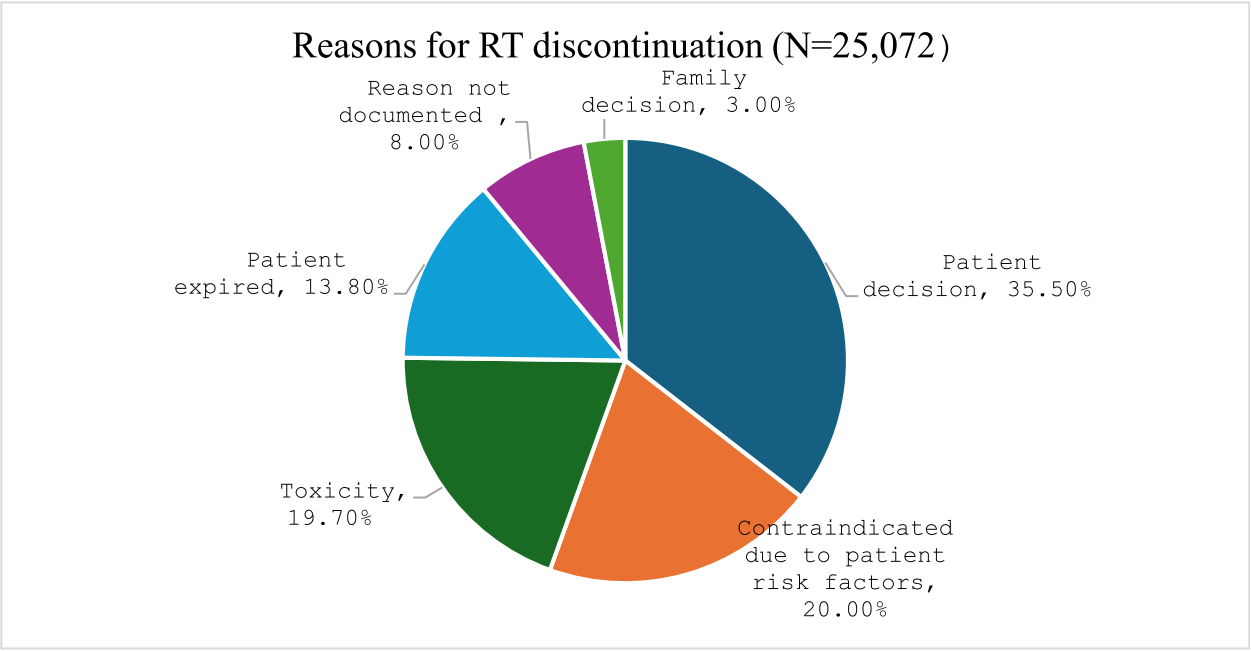

Figure 2 Reasons for RT discontinuation (N = 25,072).
Abbreviation: RT=radiation therapy.

associated with premature discontinuation of curative RT in patients with head and neck cancer.[25]

A possible explanation for the relatively high proportion of RT discontinuation in older patients is the high prevalence of medical comorbidities in this population. We found patients with a Charlson-Deyo Comorbidity Score of 2 or more had higher odds of discontinuing RT. Multiple studies, including Hogan et al. and Freedman et al., mentioned the correlation between a higher Charlson-Deyo score and RT discontinuation.[5,18,25,27,29] Depending on the severity of comorbidities, patients on treatment may be hospitalized. Hospitalization is associated with an increased risk of RT discontinuation in patients with cancer.[4,5]

We also examined RT discontinuation rates among different treatment modalities. We observed that the highest RT discontinuation rates were in the CRT cohort. At baseline, patients who require the addition of chemotherapy to RT likely have more locoregionally advanced disease. Furthermore, the additive toxicities from chemotherapy may contribute to premature discontinuation of therapy or treatment interruptions. Similar to our study, side effects and treatment toxicities were found to be the most common reasons for RT discontinuation in patients with cancer treated with curative intent.[30]

Our multivariable analysis showed that female patients had higher odds of discontinuing RT than male patients. Hogan et al. and Lebwohl et al. found that female patients were more likely to have a treatment interruption, whereas Lazarev et al. found that the male sex was associated with RT discontinuation in patients with head and neck cancer.[3,18,25] Because of the inclusion of various

Table 2 Reasons for RT discontinuation

	Overall (N = 25,072)	2018 (N = 12,536)	2019 (N = 12,536)
	n (column percent)		
Toxicity	4947 (19.7)	2646 (21.1)	2301 (18.4)
Contraindicated because of patient risk factors	5011 (20.0)	2249 (17.9)	2762 (22.0)
Patient decision	8901 (35.5)	4444 (35.5)	4457 (35.6)
Family decision	742 (3.0)	388 (3.1)	354 (2.8)
Patient expired	3467 (13.8)	1741 (13.9)	1726 (13.8)
Reason not documented	2004 (8.0)	1068 (8.5)	936 (7.5)

Abbreviation: RT=radiation therapy.

Table 3 Univariable and multivariable odds of radiation discontinuation by clinical or socioeconomic factors

	Complete case analysis (N = 591,922)				Analysis of the imputed data set (n = 749,135)	
	Univariable model		Multivariable model		Multivariable model	
	Unadjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
Age (y)						
18-<50			Reference group			
50-<70	1.27 (1.19-1.36)	<.0001	1.06 (0.99-1.13)	.086	1.13 (1.08-1.19)	<.0001
≥70	1.76 (1.64-1.89)	<.0001	1.26 (1.17-1.36)	<.0001	1.35 (1.28-1.42)	<.0001
Sex						
Male			Reference group			
Female	0.72 (0.69-0.74)	<.0001	1.07 (1.03-1.11)	.001	1.05 (1.01-1.08)	.006
Race						
White			Reference group			
Black	1.04 (0.99-1.10)	.119	1.04 (0.98-1.09)	.170	1.05 (1.01-1.10)	.014
Other	0.67 (0.61-0.73)	<.0001	0.77 (0.70-0.85)	<.0001	0.76 (0.71-0.82)	<.0001
Insurance						
Private			Reference group			
Medicare/government	1.86 (1.79-1.93)	<.0001	1.40 (1.34-1.46)	<.0001	1.41 (1.36-1.46)	<.0001
Medicaid/uninsured	2.40 (2.26-2.54)	<.0001	1.81 (1.71-1.92)	<.0001	1.83 (1.75-1.91)	<.0001
Household income						
<$46,277			Reference group			
$46,277-$57,856	0.90 (0.85-0.94)	<.0001	0.94 (0.90-0.99)	.020	0.94 (0.90-0.98)	.002
$57,856-$74,062	0.76 (0.72-0.80)	<.0001	0.85 (0.81-0.90)	<.0001	0.85 (0.81-0.90)	<.0001
$74,062+	0.63 (0.59-0.66)	<.0001	0.80 (0.76-0.84)	<.0001	0.79 (0.76-0.83)	<.0001
Facility type						
Community program (CP)			Reference group			
Comprehensive CP	0.85 (0.78-0.93)	.0003	0.89 (0.82-0.96)	.003	0.87 (0.83-0.91)	<.0001
Academic/research program	0.72 (0.66-0.80)	<.0001	0.72 (0.66-0.79)	<.0001	0.73 (0.69-0.76)	<.0001
Integrated Network Cancer Program	0.84 (0.77-0.93)	.0004	0.88 (0.80-0.95)	.003	0.85 (0.81-0.90)	<.0001
Charlson-Deyo score						
0			Reference group			
1	1.41 (1.35-1.47)	<.0001	1.14 (1.10-1.19)	<.0001	1.16 (1.12-1.20)	<.0001
2 or more	1.89 (1.79-1.99)	<.0001	1.33 (1.27-1.41)	<.0001	1.33 (1.28-1.39)	<.0001
Treatment						
Radiation			Reference group			
Chemoradiation	1.81 (1.72-1.90)	<.0001	1.30 (1.23-1.37)	<.0001	1.31 (1.26-1.36)	<.0001
Surgery with radiation	0.46 (0.43-0.49)	<.0001	0.55 (0.51-0.59)	<.0001	0.54 (0.51-0.56)	<.0001
Surgery with chemoradiation	0.79 (0.74-0.84)	<.0001	0.81 (0.76-0.87)	<.0001	0.81 (0.77-0.85)	<.0001

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Table 3 (*Continued*)

	Complete case analysis (N = 591,922)				Analysis of the imputed data set (n = 749,135)	
	Univariable model		Multivariable model		Multivariable model	
	Unadjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*	Adjusted OR (95% CI)	*P*
Primary tumor site			Reference group			
Breast						
Central nervous system	3.59 (3.29-3.93)	<.0001	2.74 (2.49-3.01)	<.0001	2.45 (2.30-2.62)	<.0001
Gastrointestinal	3.52 (3.31-3.75)	<.0001	2.07 (1.91-2.23)	<.0001	1.95 (1.85-2.06)	<.0001
Genitourinary	1.08 (0.99-1.17)	.083	0.69 (0.62-0.77)	<.0001	0.66 (0.61-0.71)	<.0001
Gynecologic	2.45 (2.27-2.64)	<.0001	1.79 (1.66-1.94)	<.0001	1.79 (1.68-1.89)	<.0001
Head and Neck	3.28 (3.07-3.49)	<.0001	2.34 (2.17-2.52)	<.0001	2.17 (2.05-2.28)	<.0001
Musculoskeletal	2.89 (2.53-3.29)	<.0001	2.74 (2.41-3.11)	<.0001	2.63 (2.37-2.92)	<.0001
Skin	3.11 (2.67-3.61)	<.0001	2.55 (2.20-2.96)	<.0001	2.54 (2.23-2.91)	<.0001
Thoracic	3.87 (3.62-4.13)	<.0001	1.81 (1.68-1.95)	<.0001	1.72 (1.63-1.81)	<.0001
Distance to treatment facility, miles						
≤Median (≤10.8 miles)	Reference group					
>Median (>10.8 miles)	0.97 (0.93-1.01)	.167	-		-	

Abbreviation: OR = odds ratio.

cancer types in our study, it is difficult to conclude the correlation of sex with RT discontinuation.

Our multivariable analysis showed no difference in RT discontinuation rates between Black and White patients. Hogan et al. also reported that Black race was not associated with lower odds of completing RT.[18] Notably, racial disparities, especially in breast and prostate cancer, are well documented, and studies showed that Black race was associated with an increased risk of RT discontinuation or noncompletion.[4,6-9,15-17,29] The lack of association between Black race and RT discontinuation may be because of the interplay between race and other variables that are not included in the analysis, such as perceptions of physician-patient communication and diagnostic certainty that were reported to affect cancer treatment decisions in both White and Black patients.[31] Unfortunately, we could not obtain such information from the NCDB. Additionally, a prior study underscored the ethnic disparities in prostate cancer presentation by disaggregation of Asian Americans, Native Hawaiians, and Pacific Islanders.[17] We also examined expanded racial subgroups in the sensitivity analysis which showed lower odds of RT discontinuation in East Asians, South Asians, and Southeast Asians, similar to Hogan's study.[18]

Besides clinical factors, we also explored the socioeconomic factors associated with RT discontinuation. We observed that patients on Medicaid/uninsured and those with an annual household income of <$46,277 had higher odds of discontinuing RT. Similarly, multiple studies highlighted insurance status and household income as the most important sociodemographic factors for RT completion.[18,32] These results indicate that patients with less financial means were more likely to discontinue RT, potentially because of the significant financial impact of missing days at work.

Hypofractionation emerged as a radiation treatment approach to shorten the total RT course without compromising efficacy. Recent trials in breast cancer and prostate cancer showed hypofractionated RT was noninferior to conventionally fractionated RT in terms of oncological outcomes and toxicity profiles.[33-37] Similar findings were also noted in soft-tissue sarcomas and glottic cancer.[38,39] Additionally, recent studies in breast and prostate cancer highlighted the cost-effectiveness of short-course RT and demonstrated that shorter regimens are associated with improved treatment completion and less frequent treatment interruptions.[15,40] By shortening RT regimens, hypofractionation could be a potential means to increase RT adherence.

Additionally, the socioeconomic factors possibly contributing to RT discontinuation suggest the benefit of patient screening, for example, by administering surveys that assess patients' insurance status, income level, and understanding of treatment logistics before starting RT. The survey could guide personalized patient navigators to ensure proper insurance enrollment, financial and logistical support. The accountability for cancer care through undoing racism and equity (ACCURE) trial illustrated a real-time registry combined with feedback and navigation

to improve treatment completion rates for patients with breast and lung cancer.[41] At the systemic level, policies that address financial challenges, such as financial assistance programs, paid sick leave, and transportation support, may mitigate barriers to RT adherence.[42,43]

The clinical factors potentially contributing to RT discontinuation, such as the adverse side effects of CRT, suggest the utility of early involvement in nutritional care and mental health counseling. Maebayashi et al. observed certain patients with head and neck cancers discontinued RT because of pain induced by stomatitis and fear of more severe adverse reactions.[26] Multiple studies have demonstrated that early nutritional intervention could reduce the incidence of mucositis, potentially improving RT adherence.[12,44,45] One study found that pretreatment depression was correlated with decreased RT compliance and worse overall survival in head and neck cancer, highlighting the importance of psychological screening and counseling during RT.[46] The National Comprehensive Cancer Network Distress Thermometer serves as an example of such intervention.[47]

The 3 most common reasons for RT discontinuation in our study, including patient decision, contraindication because of patient risk factors, and toxicities, intersect with the common reasons in the literature, such as comorbidities, radiation toxicities, and discontinuation against medical advice.[24-27] Although we did not encounter an article that details the specific reasons pertaining to the refusal of RT, we noted perceptions of worse communication as one of the factors associated with decisions against surgical care in newly diagnosed early-stage lung cancer.[31] Patient-physician communication needs emerged as an important area for treatment adherence intervention.[48] An intervention that provides real-time communication feedback, such as the tool included in the ACCURE trial, may improve RT adherence.[41]

Our study has several limitations. First, this is a retrospective study using the NCDB, which captures roughly 70% of cancer cases in the United States from participating institutions.[49] Information on treatment modality and discontinuation was missing for over half of the recorded cases, thus limiting the generalizability of our results. Second, the NCDB did not report the planned treatment fractions, timing of discontinuation, perceptions of communication, and diagnostic certainty. Third, because of the lack of a uniform staging system across different cancer types, although we do not report cancer staging, we excluded patients with palliative treatment intent, which may remove patients with advanced/metastatic disease. Fourth, although uninsured and Medicaid patients are often grouped as "vulnerable populations" in studies of safety-net hospitals,[28] further research is needed to study each population individually, because Medicaid patients have increased access to insurance coverage. Fifth, although we categorize race as Black, White, and Other because of the limitation on sample size, we appreciate the ethnic disparities pertaining to Asian Americans, Native Hawaiians, and Pacific Islanders in recent studies that warrant future research.[17]

Conclusions

This NCDB analysis showed that RT discontinuation rates correlated with clinical factors, including older age, multiple comorbidities, and CRT, and socioeconomic factors, including Medicaid/uninsured status and lower household income. Further studies investigating the effect of mitigating clinical and socioeconomic stressors on RT discontinuation are necessary to generate potential means for improving RT adherence.

Disclosures

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.adro.2025.101784.

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