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Association of Care Processes With Timely, Equitable Postoperative Radiotherapy in Patients With Surgically Treated Head and Neck Squamous Cell Carcinoma

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Abstract

IMPORTANCE—Delays in initiation of postoperative radiotherapy (PORT) after surgery for head and neck squamous cell carcinoma (HNSCC) are common, predominantly affect racial minorities, and are associated with decreased survival. Details regarding the care processes that contribute to timely, equitable PORT remain unknown.

OBJECTIVE—To determine care processes associated with timely, equitable PORT.

DESIGN, SETTING, AND PARTICIPANTS—This retrospective cohort study included patients 18 years or older undergoing surgery for HNSCC at the Medical University of South Carolina (MUSC), Charleston, followed by PORT (at MUSC or elsewhere) with or without chemotherapy from January 1, 2014, through December 31, 2016. Data were analyzed from September 15, 2017, through June 28, 2018.

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Author Contributions: Drs Graboyes and Janz had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

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MAIN OUTCOMES AND MEASURES—The main outcome measure was the proportion of timely, guideline-adherent initiation of PORT (≤6 weeks postoperatively). Secondary outcome measures included care processes associated with timely PORT. The association between process variables with timely PORT was explored using multivariable logistic regression analysis. Effect modification of the association between receipt of care processes and timely PORT by race was explored using interaction effects.

RESULTS—A total of 197 patients were included in the analysis; they were predominantly white (157 [79.7%]) and male (136 [69.0%]) with a mean age of 59 years (range, 28-89 years). Overall, 89 patients (45.2%) experienced a delay initiating PORT. African American patients had a 13.5% absolute increase in the rate of delayed PORT relative to white patients (21 of 37 [56.8%] vs 68 of 157 [43.3%]). The adjusted multivariable regression showed that the following care processes were associated with timely PORT: preoperative radiotherapy consultation (odds ratio [OR], 8.94; 95% CI, 1.64-65.53), PORT at MUSC (OR, 6.21; 95% CI, 1.85-24.75), pathology report within 7 postoperative days (OR, 4.14; 95% CI, 1.21-15.86), time from surgery to PORT referral of no longer than 10 days (OR, 12.14; 95% CI, 3.14-63.00), time from PORT referral to consultation of no longer than 10 days (OR, 10.76; 95% CI, 3.01-49.70), and time from PORT consultation to its start of no longer than 21 days (OR, 4.80; 95% CI 1.41-18.44). Analysis of interactions revealed no statistically significant differences between African American and white patients in receipt of key processes associated with timely PORT.

CONCLUSIONS AND RELEVANCE—Specific care processes are associated with guideline-adherent initiation of PORT. Novel strategies appear to be needed to ensure that these processes are performed for all patients with HNSCC, thereby facilitating timely, equitable PORT.

Timeliness of care is a primary indicator of health care quality that is also important for health care equity.[1,2] Treatment delays in head and neck squamous cell carcinoma (HNSCC) are common and occur across the cancer care continuum from symptom onset through consultation,[3] specialist referral,[4] treatment initiation,[5–10] treatment package time,[11–15] and surgery to postoperative radiotherapy (PORT).[16–18] Time to PORT has been proposed as a key indicator of quality care for HNSCC.[19] Time to PORT is the only measure of timely care in the National Comprehensive Cancer Network (NCCN) Guidelines,[20] and consensus exists about optimal time to PORT (unlike optimal time to treatment initiation[5–10] or treatment package time[11–15]). Unfortunately, delays in initiation of PORT are common[14,16] and associated with decreased survival.[19,21] These delays, which disproportionately affect racial minorities,[16] contribute to racial disparities in HNSCC outcomes.[22]

Although patient- and hospital-level risk factors for delayed initiation of PORT have been described,[16] there is a gap in our understanding of the care processes that facilitate timely, guideline-adherent PORT. Whether differential receipt of care processes explains observed racial differences in the rate of delayed PORT is also unclear. As a result, effective strategies to provide timely, equitable PORT after surgery for HNSCC remain unknown.

The primary objective of this study was to identify care processes associated with timely initiation of PORT after surgery for HNSCC. A secondary objective was to assess whether racial differences in the receipt of key processes explain observed racial disparities in timely PORT.

Methods

Study Design

We performed a retrospective cohort study at the Medical University of South Carolina (MUSC) in Charleston. The institutional review board at MUSC reviewed and approved the study. A waiver of informed consent for this retrospective review was obtained from the institutional review board.

Study Population

Patients included in the study were 18 years or older with HNSCC who underwent surgery at MUSC followed by PORT (at MUSC or elsewhere) with or without chemotherapy from January 1, 2014, through December 31, 2016. Patients were identified using *International Classification of Diseases for Oncology* codes within the MUSC Hollings Cancer Center Cancer Registry as well as hospital billing records. A total of 390 patients were identified. Of these, 193 patients were excluded for non-squamous cell histologic findings or missing treatment date information, producing a final cohort of 197 patients. Because of the known importance of multidisciplinary evaluation and management,[23,24] all cases are presented at the tumor board before definitive treatment. In situations in which optimal adjuvant therapy is unclear (eg, T1N1 oral tongue cancer without adverse features), cases are again presented at tumor board at the discretion of the surgical, radiation, or medical oncologist.

Outcome Measures

The primary outcome measure was adherence to the NCCN recommendation to initiate PORT within 6 weeks of surgery. Time to initiation of PORT was calculated as the interval from the definitive surgical procedure and the beginning of radiotherapy and dichotomized as adherent (initiation of PORT ≤6 weeks postoperatively) or nonadherent (initiation of PORT >6 weeks postoperatively) to NCCN guidelines.

Study Variables

Patient demographics, comorbidities, oncologic and treatment details, hospital course, and postdischarge care were extracted from the electronic medical record (EMR). Race was defined by the participant, obtained from the EMR, and categorized as white, African American, and other. Health insurance was dichotomized into Medicaid or self-pay and private or Medicare. Travel distance was calculated from the patient's home address to the hospital using Google Maps[25] and then categorized as less than 50.0 miles, 50.0 to 99.9 miles, and 100.0 miles (to convert to kilometers multiply by 1.6). Severity of comorbidity was calculated using the Adult Comorbidity Score.[26] Hospital length of stay was calculated from the date of admission for definitive surgical management to the date of discharge and categorized as 7 or less, 8 to 14, and 15 or more days. Margin status was determined based on margins analyzed separately from the main specimen. Positive margins generally underwent a second resection if possible and if the patient did not otherwise have an indication for adding chemotherapy (eg, extracapsular spread). Postoperative wound complications included surgical site infections, dehiscences, and fistulas. They were classified according to inpatient or out-patient wound complication based on the timing of

the first detection of the complication. Thirty-day unplanned readmissions did not include readmission for conversion of a naso-enteric feeding tube to a gastrostomy tube. Postdischarge unplanned reoperation before PORT included unplanned surgery under general anesthesia related to the index HNSCC (eg, second resection of positive margins, control of bleeding, etc).

For care processes, radiotherapy evaluation before surgery consisted of a separate consultation with radiation oncology, at MUSC or elsewhere, for discussion of definitive nonsurgical management or PORT. Time to pathology report availability was calculated based on the number of days from surgery to the time when the pathology report was signed and available in the EMR. Addenda issued at the request of the surgeon (eg, for p16 immunohistochemistry) were not counted when determining time to pathology report availability. Time from the date of surgery to referral for PORT was assessed based on the date the referral was placed in the EMR for the patient's postoperative evaluation by radiation oncology. For dental evaluation before surgery, patients were categorized as yes, no, or not applicable (eg, edentulous).

Statistical Analysis

Data were analyzed from September 15, 2017, through June 28, 2018, using R (version 3.3.3; CRAN) and SPSS (version 24; IBM Corp) statistical software. We evaluated associations between demographic and clinical variables and the outcome variables for delayed PORT and care processes using the Fisher exact test for categorical variables and the 2-sample *t* tests for continuous variables. We further evaluated associations using logistic regression analyses and constructed odds ratios (ORs) and corresponding 95% CIs. All CIs were constructed using a profile likelihood approach to improve interval coverage.[27] For care process variables, we additionally conducted a multiple logistic regression analysis adjusting for key demographic variables.

We investigated effect modification by race of the association between care processes and receipt of timely PORT by evaluating appropriate interaction effects in multiple logistic regression models. Accordingly, ORs and 95% CIs summarizing the associations between care processes and PORT timeliness were constructed and reported separately for African American and white patients.

Results

Patient Characteristics and Association With Initiation of PORT

The study included 197 patients who had surgery for HNSCC at MUSC followed by PORT with or without chemotherapy (136 men [69.0%] and 61 women [31.0%]; mean age, 59 years [range, 28-89 years]). Overall, 89 patients (45.2%) experienced a delay initiating PORT (ie, >6 weeks after surgery). The median time to PORT was 42 days (range, 13-123 days); 50 patients (25.4%) were delayed starting PORT by at least 1 week (ie, >7 weeks after surgery). The most common subsite was the oral cavity (120 [60.9%]). Most patients had pT3 to pT4a tumors (130 [66.0%]), and 121 (61.4%) underwent microvascular reconstruction.

The demographic, oncologic, and treatment characteristics of the patients and their association with delayed initiation of PORT are shown in Table 1. African American patients had a 13.5% absolute increase in the rate of delayed PORT (21 of37 [56.8%]) compared with white patients (68 of 157 [43.3%]). The median time to PORT for African American patients was 44 days (range, 20-81 days) after surgery. Fifteen of 37 (40.5%) were delayed starting PORT by at least 1 week. Delayed initiation of PORT was more common in those who traveled more than 100 miles for surgery (OR, 2.39; 95% CI, 1.16-5.11). Patients who had a postdischarge wound complication were more likely to experience delayed PORT (OR, 2.79; 95% CI, 1.32-6.16), as were those who underwent unplanned reoperation (OR, 5.23; 95% CI, 1.27-35.31). No other oncologic or treatment characteristics were associated with delays in PORT.

Care Processes Associated With Timely Initiation of PORT

The association between different care processes and guideline-adherent initiation of PORT is shown in Table 2. We performed a multivariable analysis to identify care processes associated with timely, guideline-adherent initiation of PORT (Table 3). Patients who had a consultation with radiation oncology before surgery had a 8.9-fold increase in the odds of starting PORT in a timely fashion compared with those who did not (OR, 8.94; 95% CI, 1.64-65.53). Those who received their PORT at MUSC had an approximate 6-fold increase in the odds of starting PORT in a timely fashion relative to those who received PORT outside of MUSC (OR, 6.21; 95% CI, 1.85-24.75). Those with a pathology report issued within7 days of surgery (OR, 4.14; 95% CI, 1.21-15.86) likewise experienced a significant increase in the odds of starting PORT in a timely, guideline-adherent fashion. Numerous variables related to the timing of appointments were also related to timely initiation of PORT, including time from surgery to PORT referral of no longer than 10 days (OR, 12.14; 95% CI, 3.14-63.00), time from PORT referral to consultation of no longer than 10 days (OR, 10.76; 95% CI, 3.01-49.70), and time from PORT consultation to start of PORT of no longer than 21 days (OR, 4.80; 95% CI, 1.41-18.44).

Racial Disparities in Care Processes and Timely PORT

Because African American race has previously been identified as an independent risk factor for delayed PORT[16] and African American patients had a 13.5% absolute increase in the rate of delayed PORT in this study, we investigated whether differential receipt of care processes contributed to the observed racial disparities in timely PORT. Our analysis of effect modification by race of the association between care processes and timely initiation of PORT is shown in Table 4. In this preliminary analysis, the effect size between races for consultation with radiation oncology before surgery (ORs, 3.01 [95% CI, 1.47-6.47] for white patients and 7.39 [95% CI, 1.27-42.96] for African American patients) and for adjuvant therapy location (ORs, 3.86 [95% CI, 1.98-7.71] for white patients and 20.00 [95% CI, 2.21-180.00] for African American patients) was large and in a direction that suggests that differential receipt of these specific processes may contribute to racial differences in timely PORT.

Discussion

Time to PORT, the only measure of timely care in NCCN guidelines for HNSCC,[20] is a critical indicator of quality care for HNSCC.[19] Unfortunately, delays in initiation of guideline-adherent PORT are common and disproportionately affect racial minorities.[16] To our knowledge, the care processes that contribute to timely PORT for some patients have not been described, and whether differential receipt of these processes is responsible for observed racial disparities in timely PORT is not known. In this study, we identified care processes associated with timely, guideline-adherent initiation of PORT. We also found that differential receipt in these processes did not explain observed racial disparities in the initiation of timely PORT.

Racial Disparities in Timely Initiation of PORT

Prior research has shown that delays starting PORT disproportionately affect African American individuals.[16] Our findings agree with this work, because our African American patients had a 13.5% absolute increase in the rate of delayed PORT relative to our white patients. Prior studies have described racial disparities in health care delivery, particularly timely adjuvant therapy, or treatment package time for patients with HNSCC.[15,16] The effect size (OR, 1.71) and associated 95% CI (0.84-3.58) for the difference in timely initiation of PORT between the races are consistent with those of prior research[16] and likely reflect a clinically meaningful difference. In addition to experiencing delayed initiation of PORT, significant racial differences in timely HNSCC care exist along with other aspects of the cancer care continuum, including time from symptom onset to consultation,[3] diagnosis to treatment,[5,28] and overall treatment time.[15] Delays in timely care are a source of preventable mortality and a contributor to racial disparities in outcomes.[15,21,22,29]

To date, the reasons underlying the observed racial disparities in timely, guideline-adherent initiation of PORT have not been described. The association between delays in initiation of PORT and the patient's racial background, clinical factors, and social determinants of health is complex.[10,30,31] Unfortunately, our data do not allow us to identify the patient- and health care professional-level barriers to care. Barriers accessing health care for cancer screening and treatment initiation are well documented and frequently relate to social determinants of health, including insurance status, cost, lack of insurance, fear, distrust of the medical system, lack of knowledge, and lack of perceived importance, among others. Whether these barriers are also the drivers in multimodal sequential cancer care (eg, surgery followed by PORT) is unknown, but other factors, such as toxic effects from treatment, wound healing, and coordination across hospital systems, likely contribute. One possible explanation for these observed racial disparities is that key process measures are differentially performed. Our exploratory analysis of interactions did not reveal statistically significant effect modification by race. These results should be interpreted with caution given the limited sample size. Future research will be necessary to identify the nature, severity, and distribution of barriers to care in this patient population and to understand how these barriers to care cause breakdowns in key care processes, thereby producing delays starting PORT.

Care Processes Associated With Timely Initiation of PORT

Those who received PORT at MUSC experienced a 6-fold increase in the odds of starting PORT in a timely fashion relative to those who received PORT outside MUSC. Fragmentation of care has been associated with delays in other aspects of HNSCC care, including time to treatment initiation[5,6] and time to PORT.[16] The reasons for the increased likelihood of timely PORT in patients who do not experience care fragmentation are likely associated with increased familiarity between surgical and radiation oncology professionals within a single health care system, improved communication, and ease of appointment scheduling. In our experience, when patients experience unexpected postoperative events, the system has more internal resiliency to accommodate the altered time schedule. For example, strategies to compensate for unplanned readmission or excessive length of stay that would otherwise delay PORT include having the radiation oncology consultation during the inpatient admission.

Preradiotherapy management of teeth is also a critical aspect of the multidisciplinary management of HNSCC.[20] In general, 10 to 14 days are required for healing from dental extractions before the initiation of radiotherapy.[32,33] Our finding that the timely extraction of carious and nonrestorable teeth was not associated with timely PORT on multivariable regression analysis likely reflects the low baseline proportion of patients (10%) who did not have appropriate dental extractions before hospital discharge. The standard protocol at our Head and Neck Tumor Center is to have all patients receive a consultation with dental oncology and an orthopantomogram before treatment; 10% of the dentulous patients in our study did not receive protocol-directed care. In addition, breakdowns in care occurred even after dental consultation because some patients who received a presurgical dental consultation did not have appropriate extractions before hospital discharge. Further research is necessary to understand how this system breaks down and strategies to improve dental care delivery.

The time from surgery to issue of the pathology report in the EMR was also associated with timely PORT. Patients for whom the pathology report was issued within 7 days of surgery experienced a 4-fold increase in the odds of starting PORT in a guideline-adherent fashion. According to the College of American Pathologists,[34] at least 90% of surgical pathology reports should have a turnaround within 2 weeks. The mechanism between a prompt pathology report and timely PORT likely reflects patients for whom unexpected pathologic upstaging occurs (eg, cN0 becoming pN positive) or discovery of other adverse features (eg, perineural invasion in a patient with pathologic stages I to II cancer) that indicate an unanticipated need for PORT. Especially because patients with early-stage disease are likely to be discharged within 7 days, delayed issue of the pathology report could preclude referrals and appointment scheduling with radiation oncology.

Radiotherapy planning includes appointments for consultation and treatment planning and thus requires multiple appointments postoperatively.[35] The interval between the timing of PORT referrals, consultation, and initiation of radiotherapy were described. These data can be used as benchmarks to ensure that patients are maintaining a timely schedule postoperatively and that the 6-week recommended timeframe is broken into smaller, goal-directed intervals. They can also be used to recognize when patients fall behind

benchmarked intervals (eg, time from PORT referral to consultation >10 days), triggering alternative mechanisms to accelerate care delivery so that patients do not experience treatment delays.

Limitations

This study possesses numerous limitations. First, it is a single-institution study set at a high-volume, academic, tertiary care referral center; therefore, our results concerning population mix, case complexity, health care professional practices, care processes, and institutional protocols may preclude generalizability to other institutions that treat HNSCC. Second, the study is retrospective and therefore limited to the content and accuracy of the EMR. Reliance on the EMR also precludes us from knowing relevant variables related to aggressive tumor behavior, tumor board discussions, patient-physician discussion about the risks and benefits of adjuvant therapy that may affect the time to PORT, patient preferences, and patient and physician indecisiveness. Third, our sample size is small, which limits our power to detect small but clinically meaningful differences between the groups with and without timely PORT. In addition, our sample size was not determined a priori to measure any prespecified differences between those who did and did not receive guideline-adherent, timely PORT. Fourth, we did not examine type of radiotherapy modality, because records from outside institutions were not universally available. Receipt of intensity-modulated radiotherapy, although the standard of care for HNSCC and provided to all patients treated at MUSC during the study period, is known to increase the likelihood of delayed PORT.[16] Fifth, although we collected data on marital status and insurance, numerous other variables related to social determinants of health and support that might affect ability to travel for cancer care, to recover from toxic effects of surgical treatment before starting PORT, and to attend appointments were not collected. These variables might affect key care processes and thereby likelihood of timely PORT. This study examined timely initiation of PORT instead of other measures of timely care such as time to treatment initiation or treatment package time because (1) these other measures are not currently incorporated into NCCN guidelines for HNSCC[20] and (2) no consensus on optimal time to treatment initiation[5–10] or treatment package time[11–15] exists, at this time, as it does for time to PORT.[19,21] In addition, the barriers to timely care are likely different in each of these situations, particularly for treatment package time, which includes processes associated with access to care and differences in radiotherapy techniques related to altered fractionation schedules.[11,14]

Conclusions

Delays starting PORT are common, affecting nearly half of the patients in our study and an even higher percentage of African American patients. Specific care processes are associated with guideline-adherent, timely initiation of PORT. Further research is required to understand the patient- and health care professional-level barriers to timely PORT and to elucidate how these barriers contribute to breakdowns in care that cause delayed PORT. Novel strategies to address these care processes are needed to improve timely, equitable care for patients with HNSCC.

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Key Points

Question

Do key care processes facilitate timely, equitable postoperative radiotherapy after surgery for head and neck squamous cell carcinoma?

Findings

In this cohort study of 197 patients with head and neck squamous cell carcinoma, care processes including preoperative radiotherapy consultation, location of postoperative radiotherapy, timing of pathology report, and timing of referrals and consultation for postoperative radiotherapy were associated with timely, guideline-adherent initiation of therapy within 6 weeks of surgery.

Meaning

Novel strategies appear to be needed to ensure that these processes are performed for all patients with head and neck squamous cell carcinoma, thereby facilitating timely, equitable guideline-adherent initiation of postoperative radiotherapy

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Table 1.

Demographic, Oncologic, and Treatment Characteristics and Their Association With Delayed PORT[a]

	Treatment Group			
Variable	**All (N = 197)**	**Delayed PORT (n = 89)**	**Timely PORT (n = 108)**	**OR (95% CI)**
Age, mean (range), y	59 (28-89)	59 (33-89)	59 (28-88)	1.01 (0.98-1.03)
Sex, No. (%)				
Female	61 (31.0)	28 (31.5)	33 (30.6)	1 [Reference]
Male	136 (69.0)	61 (68.5)	75 (69.4)	0.96 (0.52-1.76)
Race, No. (%)				
White	157 (79.7)	68 (76.4)	89 (82.4)	1 [Reference]
African American	37 (18.8)	21 (23.6)	16 (14.8)	1.71 (0.84-3.58)
Other	3 (1.5)	0	3 (2.8)	NA
Insurance, No. (%)[b]				
Private or Medicare	158 (81.0)	68 (77.3)	90 (84.1)	1 [Reference]
Medicaid or self-pay	37 (19.0)	20 (22.7)	17 (15.9)	1.56 (0.76-3.23)
Relationship status, No. (%)				
Married	125 (63.4)	50 (56.2)	75 (69.4)	1 [Reference]
Not married	72 (36.5)	39 (43.8)	33 (30.6)	1.77 (0.99-3.20)
Travel distance, miles, No. (%)				
<50.0	45 (22.8)	14 (15.7)	31 (28.7)	1 [Reference]
50.0-99.9	46 (23.4)	20 (22.5)	26 (24.1)	1.70 (0.73-4.08)
>100.0	106 (53.8)	55 (61.8)	51 (47.2)	2.39 (1.16-5.11)
ACE-27 score, No. (%)[c]				
0-1	149 (75.6)	66 (74.2)	83 (76.8)	1 [Reference]
2-3	48 (24.5)	23 (25.8)	25 (23.1)	1.16 (0.60-2.23)
Prior treatment, No. (%)				
None	143 (72.6)	61 (68.5)	82 (75.9)	1 [Reference]
Surgery (only)	29 (14.7)	15 (16.9)	14 (13.0)	1.44 (0.65-3.24)
Surgery plus adjuvant therapy	9 (4.6)	5 (5.6)	4 (3.7)	1.69 (0.43-7.04)

Variable	Treatment Group			OR (95% CI)
	All (N = 197)	Delayed PORT (n = 89)	Timely PORT (n = 108)	
Primary RT or CRT	16 (8.1)	8 (9.0)	8 (7.4)	1.34 (0.47-3.85)
Prior HNSCC, No. (%)				
No	143 (72.6)	61 (68.5)	82 (75.9)	1 [Reference]
Yes	54 (27.4)	28 (31.5)	26 (24.1)	1.45 (0.77-2.72)
Length of stay, d, No. (%)				
≤7	80 (40.6)	31 (34.8)	49 (45.4)	1 [Reference]
8-14	74 (37.6)	34 (38.3)	40 (37.0)	1.34 (0.71-2.56)
≥15	43 (21.8)	24 (27.0)	19 (17.6)	2.00 (0.95-4.28)
Discharge destination, No. (%)				
Home without home health referral	67 (34.0)	26 (29.2)	41 (38.0)	1 [Reference]
Home with home health referral	108 (54.8)	53 (59.6)	55 (50.9)	1.52 (0.82-2.84)
Skilled nursing facility	20 (10.2)	10 (11.2)	10 (9.3)	1.58 (0.57-4.36)
Other	2 (1.0)	0	2 (1.8)	NA
HNSCC subsite, No. (%)				
Oral cavity	120 (60.9)	58 (65.2)	62 (57.4)	1 [Reference]
Oropharynx	42 (21.3)	16 (18.0)	26 (24.1)	0.66 (0.32-1.34)
Hypopharynx	10 (5.1)	6 (6.7)	4 (3.7)	1.60 (0.44-6.54)
Larynx	25 (12.7)	9 (10.1)	16 (14.8)	0.60 (0.24-1.44)
Pathologic T classification, No. (%)				
0-2	67 (34)	27 (30.3)	40 (37.0)	1 [Reference]
3-4	130 (66.0)	62 (69.7)	68 (63.0)	1.35 (0.75-2.47)
Pathologic N classification, No. (%)				
0-1	109 (55.3)	47 (52.8)	62 (57.4)	1 [Reference]
2-3	88 (44.7)	42 (47.2)	46 (42.6)	1.20 (0.68-2.12)
Extracapsular spread, No. (%)				
No	124 (62.9)	56 (62.9)	68 (63.0)	1 [Reference]
Yes	73 (37.1)	33 (37.1)	40 (37.0)	1.00 (0.56-1.79)
Surgical margins, No. (%)				

Variable	Treatment Group			OR (95% CI)
	All (N = 197)	Delayed PORT (n = 89)	Timely PORT (n = 108)	
Negative	176 (89.3)	81 (91.0)	95 (88.0)	1 [Reference]
Positive	21 (10.7)	8 (9.0)	13 (12.0)	0.72 (0.27-1.80)
Reconstruction, No. (%)				
None	54 (27.4)	20 (22.5)	34 (31.5)	1 [Reference]
Allograft/skin graft	13 (6.6)	8 (9.0)	5 (4.6)	2.72 (0.79-10.10)
Regional flap	9 (4.6)	4 (4.5)	5 (4.6)	1.36 (0.31-5.73)
Free flap	121 (61.4)	57 (64.0)	64 (59.3)	1.51 (0.79-2.96)
Adjuvant therapy, No. (%)				
RT	94 (47.7)	36 (40.4)	58 (53.7)	1 [Reference]
CRT	103 (52.3)	53 (59.6)	50 (46.3)	1.71 (0.97-3.03)
Postoperative wound complication, No. (%)				
No	162 (82.2)	66 (74.2)	96 (88.9)	1 [Reference]
Yes	35 (17.8)	23 (25.8)	12 (11.1)	2.79 (1.32-6.16)
Postoperative wound complication, No. (%)				
None	162 (82.2)	66 (74.2)	96 (88.9)	1 [Reference]
Inpatient	19 (9.6)	12 (13.5)	7 (6.5)	2.49 (0.95-7.01)
Outpatient	16 (8.1)	11 (12.4)	5 (4.6)	3.20 (1.11-10.55)
30-Day readmission, No. (%)				
No	180 (91.4)	81 (91.0)	99 (91.7)	1 [Reference]
Yes	17 (8.6)	8 (9.0)	9 (8.3)	1.08 (0.39-2.94)
Postdischarge unplanned reoperation before RT, No. (%)				
No	187 (94.9)	81 (91.0)	106 (98.1)	1 [Reference]
Yes	10 (5.1)	8 (9.0)	2 (1.8)	5.23 (1.27-35.31)

Abbreviations: ACE-27, Adult Comorbidity Evaluation-27; CRT, chemoradiotherapy; HNSCC, head and neck squamous cell carcinoma; NA, not applicable; OR, odds ratio; PORT, postoperative radiotherapy; RT, radiotherapy.

SI conversion factor: To convert miles to kilometers, multiply by 1.6.

[a] Percentages have been rounded and may not total 100. Delayed PORT indicates more than 42 days after surgery.

[b] Two patients had other insurance.

[c] Higher scores indicate greater severity.

Table 2.

Care Processes Associated With Timely Initiation of PORT[a]

	Treatment Group, No. (%)[b]			
Variable	**All (N = 197)**	**Timely PORT (n = 108)**	**Delayed PORT (n = 89)**	**OR (95% CI)**
RT consultation before surgery				
No	137 (69.5)	63 (58.3)	74 (83.1)	1 [Reference]
Yes	60 (30.4)	45 (41.7)	15 (16.8)	3.52 (1.83-7.09)
Adjuvant therapy location				
Other	73 (37.1)	23 (21.3)	50 (56.2)	1 [Reference]
MUSC	124 (62.9)	85 (78.7)	39 (43.,8)	4.74 (2.57-8.96)
Dental consultation before surgery				
No	24 (12.2)	9 (8.3)	15 (16.8)	1 [Reference]
Yes	77 (39.1)	46 (42.6)	31 (34.8)	2.47 (0.98-6.56)
Edentulous	96 (48.7)	53 (49.1)	43 (48.3)	2.05 (0.83-5.32)
Dental extractions before hospital discharge				
No	20 (10.2)	5 (4.6)	15 (16.8)	1 [Reference]
Yes	81 (41.1)	50 (46.3)	31 (34.8)	4.84 (1.69-16.10)
Edentulous	96 (48.7)	53 (49.1)	43 (48.3)	3.70 (1.32-12.11)
Time from surgery to pathology report issue, d				
>7	74 (37.6)	31 (28.7)	43 (48.3)	1 [Reference]
≤7	123 (62.4)	77 (71.3)	46 (51.7)	2.32 (1.29-4.21)
Time from surgery to PORT referral, d				
>10	61 (45.5)	18 (26.9)	43 (64.1)	1 [Reference]
≤10	73 (54.5)	49 (73.1)	24 (35.8)	4.88 (2.37-10.38)
Time from PORT referral to consultation, d				
>10	63 (50.8)	25 (39.1)	38 (63.3)	1 [Reference]
≤10	61 (49.2)	39 (60.9)	22 (36.7)	2.69 (1.31-5.64)
Time from surgery to PORT consultation, d				
>21	68 (42.5)	23 (25.8)	45 (63.4)	1 [Reference]

Variable	Treatment Group, No. (%)[b] All (N = 197)	Timely PORT (n = 108)	Delayed PORT (n = 89)	OR (95% CI)
≤21	92 (57.5)	66 (74.2)	26 (36.6)	4.97 (2.56-9.93)
Time from PORT consultation to start, d				
>21	61 (37.9)	23 (25.6)	38 (52.8)	1 [Reference]
≤21	100 (62.1)	67 (74.4)	34 (47.2)	3.21 (1.67-6.30)

Abbreviations: MUSC, Medical University of South Carolina; OR, odds ratio; PORT, postoperative radiotherapy; RT, radiotherapy.

[a]Timely PORT indicates no later than 42 days after surgery.

[b]Frequency may not total numbers in column heads owing to missing or unknown values. Percentages have been rounded and may not total 100.

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Table 3.

Multivariable Analysis of Care Processes Associated With Timely Postoperative Radiation Therapy[a]

	OR (95% CI)	
Variable	**Unadjusted**	**Adjusted[b]**
RT consultation before surgery		
No	1 [Reference]	1 [Reference]
Yes	5.81 (1.31-33.85)	8.94 (1.64-65.53)
Adjuvant therapy location		
Other	1 [Reference]	1 [Reference]
MUSC	4.98 (1.63-16.95)	6.21 (1.85-24.75)
Dental extractions before hospital discharge		
No	1 [Reference]	1 [Reference]
Yes	2.05 (0.33-15.16)	2.98 (0.43-24.68)
Edentulous	1.52 (0.24-11.25)	2.15 (0.31-17.56)
Time from surgery to pathology report issue, d		
>7	1 [Reference]	1 [Reference]
≤7	4.28 (1.34-15.05)	4.14 (1.21-15.86)
Time from surgery to PORT referral, d		
>10	1 [Reference]	1 [Reference]
≤10	8.36 (2.52-33.92)	12.14 (3.14-63.00)
Time from PORT referral to consultation, d		
>10	1 [Reference]	1 [Reference]
≤10	8.60 (2.64-35.01)	10.76 (3.01-49.70)
Time from PORT consultation to start, d		
>21	1 [Reference]	1 [Reference]
≤21	4.84 (1.55-16.71)	4.80 (1.41-18.44)

Abbreviations: MUSC, Medical University of South Carolina; OR, odds ratio; PORT, postoperative radiotherapy; RT, radiotherapy.

[a]Timely PORT indicates no later than 42 days after surgery.

[b]Regression model is adjusted with sociodemographic variables of age, sex, race, and insurance status.

Table 4.

Care Processes Associated With Timely Initiation of PORT Stratified by Race[a]

Characteristic	Treatment Group[b] All (N = 194)	Timely PORT (n = 105)	Delayed PORT (n = 89)	OR (95% CI)
Adjuvant therapy location				
White				
Other	60 (38.2)	22 (24.7)	38 (55.9)	1 [Reference]
MUSC	97 (61.8)	67 (75.3)	30 (44.1)	3.86 (1.98-7.71)
African American				
Other	13 (35.1)	1 (6.2)	12 (57.1)	1 [Reference]
MUSC	24 (64.9)	15 (93.8)	9 (42.8)	20.00 (2.21-180)
Time from surgery to pathology report issue, d				
White				
>7	59 (37.6)	27 (30.3)	32 (47.1)	1 [Reference]
≤7	98 (62.4)	62 (69.7)	36 (52.9)	2.04 (1.06-3.96)
African American				
>7	14 (37.8)	3 (18.8)	11 (52.4)	1 [Reference]
≤7	23 (62.1)	13 (81.2)	10 (47.6)	4.77 (1.04-21.79)
RT consultation before surgery				
White				
No	107 (68.2)	52 (58.4)	55 (80.9)	1 [Reference]
Yes	50 (31.8)	37 (41.6)	13 (19.1)	3.01 (1.47-6.47)
African American				
No	28 (75.7)	9 (56.2)	19 (90.5)	1 [Reference]
Yes	9 (24.3)	7 (43.8)	2 (9.5)	7.39 (1.27-42.96)
Time from surgery to PORT referral, d				
White				
>10	48 (46.6)	15 (27.3)	33 (68.8)	1 [Reference]
≤10	55 (53.4)	40 (72.7)	15 (31.2)	5.87 (2.56-14.14)

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Characteristic	Treatment Group[b]			OR (95% CI)
	All (N = 194)	Timely PORT (n = 105)	Delayed PORT (n = 89)	
African American				
>10	13 (43.3)	3 (27.3)	10 (52.6)	1 [Reference]
≤10	17 (56.7)	8 (72.7)	9 (47.4)	2.96 (0.60-14.73)
Time from PORT referral to consultation, d				
White				
≤10	48 (49.5)	20 (37.7)	28 (63.6)	1 [Reference]
≤10	49 (50.5)	33 (62.3)	16 (36.4)	2.89 (1.28-6.73)
African American				
>10	14 (53.8)	4 (40.0)	10 (62.5)	1 [Reference]
≤10	12 (46.2)	6 (60.0)	6 (37.5)	2.50 (0.49-12.64)
Time from surgery to PORT consultation, d				
White				
>21	54 (42.8)	19 (26.4)	35 (64.8)	1 [Reference]
≤ 21	72 (57.1)	53 (73.6)	19 (35.2)	5.14 (2.43-11.29)
African American				
>21	14 (45.2)	4 (28.6)	10 (58.8)	1 [Reference]
≤21	17 (54.8)	10 (71.4)	7 (41.2)	3.57 (0.79-16.15)
Time from PORT consultation to start, d				
White				
>21	45 (35.7)	18 (25.0)	27 (50.0)	1 [Reference]
≤21	81 (64.3)	54 (75.0)	27 (50.0)	3.00 (1.42-6.47)
African American				
>21	15 (46.9)	4 (28.6)	11 (61.1)	1 [Reference]
≤21	17 (53.1)	10 (71.4)	7 (38.9)	3.93 (0.88-17.56)
Dental extractions before hospital discharge				
White				
No	18 (11.5)	5 (5.6)	13 (19.1)	1 [Reference]
Yes	63 (40.1)	38 (42.7)	25 (36.8)	3.95 (1.32-13.60)

Characteristic	Treatment Group[b]			OR (95% CI)
	All (N = 194)	Timely PORT (n = 105)	Delayed PORT (n = 89)	
Edentulous	76 (48.4)	46 (51.7)	30 (44.1)	3.99 (1.35-13.49)
African American				
No	2 (5.4)	0	2 (9.5)	1 [Reference]
Yes	15 (40.5)	9 (56.2)	6 (28.6)	NA[c]
Edentulous	20 (54.1)	7 (43.8)	13 (61.9)	NA[c]

Abbreviations: MUSC, Medical University of South Carolina; NA, not applicable; OR, odds ratio; PORT, postoperative radiotherapy; RT, radiotherapy.

[a]Timely PORT indicates no later than 42 days after surgery.

[b]Frequency may not total numbers in column headings owing to missing or unknown values. Percentages have been rounded and may not total 100. Three patients were other races.

[c]Because the reference group contains a cell with 0 count, the OR and 95% CI cannot be accurately estimated.