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ORIGINAL ARTICLE

Trends and outcomes of sphincter-preserving surgery for rectal cancer: a national cancer database study

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Abstract

Purpose Previous studies have shown that sphincter-preserving surgery is associated with better quality of life in postsurgical rectal cancer patients. However, the factors predicting the likelihood of undergoing sphincter-preserving surgery have not been well-described. The aim of this study was to report the factors that determined the likelihood of undergoing sphincter-preserving surgery.

Methods Characteristics of 24,018 rectal cancer patients undergoing sphincter-preserving surgery and abdominoperineal resection diagnosed from 2008 to 2012 from the National Cancer Database were investigated retrospectively for rate, pattern, and differences in mortality. Cox proportional hazards models were used to calculate hazard ratios for assessing mortality. Odds ratios were calculated using logistic regressions models for outcome sphincter-preserving surgery.

Results Eighteen thousand four hundred fifty-two (77%) patients had sphincter-preserving surgery. Majority of sphincter-preserving surgery patients were aged < 70 (74%), had private insurance (52%), and got treatment at a comprehensive community cancer program (54%). Multivariable analysis showed that patients with age ≥ 70 (OR 0.87, 95% CI 0.80–0.95), male gender (OR 0.90, 95% CI 0.84–0.96), having Medicare (OR 0.83, 95% CI 0.76–0.90), Medicaid (OR 0.72, 95% CI 0.63–0.81), and poorly differentiated grade (OR 0.78, 95% CI 0.71–0.85) were less likely to undergo sphincter-preserving surgery. Multivariable analysis showed that patients having abdominoperineal resection have higher likelihood of mortality than sphincter-preserving surgery (HR 1.26, 95% CI 1.16–1.36).

Conclusions We were able to identify several patient and tumor-related factors impacting the likelihood of undergoing sphincter-preserving surgery. Patients undergoing non-sphincter sparing surgery had a higher mortality that sphincter preservation.

Keywords Sphincter-preserving surgery · SPS · Rectal cancer · NCDB · Abdominoperineal resection

Introduction

Surgery remains the mainstay of treatment of rectal cancer. Advancement in surgical technique, such as total mesorectal excision (TME) and minimally invasive surgery (MIS), along with multimodal therapies have led to improved surgical and oncologic outcomes [1–3]. Rates of sphincter-preserving surgery (SPS) have been proposed to be a quality metric in rectal cancer surgery [4]. Although previous reports have described an increase in the rate of SPS, significant variability and inconsistency exists in its implementation [5–7]. Previous reports from US centers have indicated rates of SPS ranging from approximately 50 to 75% [8–10]. However, European and Australian centers have reported generally higher and less variable SPS rates [11–13]. No study to date has utilized the National Cancer Database (NCDB) to evaluate rates and

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Table 1 Basic demographics, clinical characteristics of the study population

	Total ($N = 24,018$)
Age group	
< 70	17,693 (73.7%)
≥ 70	6325 (26.3%)
Sex	
Male	14,623 (60.9%)
Female	9395 (39.1%)
Race	
Missing	172
White	20,861 (87.5%)
Black	1856 (7.8%)
Other	1129 (4.7%)
Spanish Hispanic origin	
Missing	1246
Non-Spanish non-Hispanic	21,378 (93.9%)
Spanish Hispanic	1394 (6.1%)
Urban/rural	
Missing	662
Metro	18,807 (80.5%)
Urban	4000 (17.1%)
Rural	549 (2.4%)
Percent no high school degree	
Missing	242
21% or more	4061 (17.1%)
13–20.9%	6205 (26.1%)
7–12.9%	7939 (33.4%)
Less than 7%	5571 (23.4%)
Median income quartiles	
Missing	256
Less than 38,000	4055 (17.1%)
38,000–47,999	5950 (25.0%)
48,000–62,999	6397 (26.9%)
63,000+	7360 (31.0%)
Primary payor	
Missing	257
Not insured	1093 (4.6%)
Private insurance	11,940 (50.3%)
Medicaid	1479 (6.2%)
Medicare	8948 (37.7%)
Other government	301 (1.3%)
Charlson-Deyo Score	
0	18,538 (77.2%)
1	4337 (18.1%)
2+	1143 (4.8%)
Behavior	
In situ and/or carcinoma in situ	267 (1.1%)
Invasive	23,751 (98.9%)
Grade	
Missing	2309
Well/moderately differentiated	18,734 (86.3%)
Poorly differentiated/undifferentiated	2975 (13.7%)
TNM clinical stage group	
Stage 0	595 (2.5%)
Stage 1	6284 (26.2%)
Stage 2	8364 (34.8%)
Stage 3	8775 (36.5%)
TNM pathologic stage group	
Stage 0	966 (4.0%)
Stage 1	8512 (35.4%)
Stage 2	6323 (26.3%)
Stage 3	8217 (34.2%)
Facility type	
Community cancer program	2542 (10.6%)
Comprehensive community cancer program	13,020 (54.2%)
Academic/research program	8430 (35.1%)
Other specified types of cancer programs	26 (0.1%)
Neoadjuvant treatment	
Missing	1229
Neoadjuvant chemo + neoadjuvant RT	13,342 (58.5%)
Neoadjuvant chemo	192 (0.8%)
Neoadjuvant RT	712 (3.1%)
No neoadjuvant therapy	8543 (37.5%)

trends of SPS in the USA. Furthermore, studying the rates and trends of SPS has further value given with the recent development of the National Accreditation Program for Rectal Cancer (NAPRC), and this may serve as a baseline for which future studies can be compared post-implementation of the NAPRC.

We aimed to report on trends and outcomes of SPS from participating hospitals of the NCDB. We hypothesize that rates of abdominoperineal resection (APR), which serve as a proxy for rates of overall non-SPS, should be decreasing over time compared to other resection extents. Furthermore, we hypothesize that rates of SPS may be impacted by patient or facility characteristics as opposed to tumor-related factors.

Materials and methods

This study was deemed institutional review board exempt. The 2014 Participant User File of the National Cancer Database was queried for all patients with a rectal adenocarcinoma from 2008 to 2012. Patients with tumors located in the recto-sigmoid or anus were excluded. Patients undergoing SPS (surgery site codes describing low anterior resection (LAR) or coloanal) were compared to non-SPS (surgery site codes describing abdominoperineal resection). Those patients undergoing local excision, total proctocolectomy, and multivisceral resection (including T4b tumors) were excluded. Any patient with stage IV disease and incomplete staging information were also excluded.

Where appropriate, chi-square or Fisher's exact tests were used to examine categorical variables. The Cochrane-Armitage trend test was used to evaluate trends of SPS over time. Univariate and multivariable logistic regression models were used to assess factors such as age, sex, race, education level, income level, insurance status, urban/rural location, year of diagnosis, Charlson-Deyo Score, and facility type associated with the likelihood of undergoing SPS.

Univariate and multivariable Cox proportional hazards models were used to assess the differences in mortality. Statistical significance was defined as $p < 0.05$ for all

Table 2 Univariate and multivariable logistic models assessing factors associated with undergoing SPS

Variable	Level	APR ($N = 5566$)	SPS ($N = 18,452$)	Univariate OR OR (95% CI)	p value	Multivariable OR (OR 95% CI)	p value
Age group	< 70	4005 (72.0%)	13,688 (74.2%)	1.0 reference		1.0 reference	
	≥ 70	1561 (28%)	4764 (25.8%)	0.89 (0.83, 0.95)	< 0.001	0.87 (0.80, 0.95)	0.002
Sex	Male	3540 (63.6%)	11,083 (60.1%)	0.86 (0.81, 0.92)	< 0.001	0.90 (0.84, 0.96)	< 0.001
	Female	2026 (36.4%)	7369 (39.9%)	1.0 reference		1.0 reference	
Race	White	4883 (87.7%)	15,978 (86.6%)	1.0 reference		1.0 reference	
	Black	434 (7.8%)	1422 (7.7%)	1.0 (0.90, 1.12)	0.982	1.02 (0.91, 1.15)	0.720
	Other	210 (3.8%)	919 (5.0%)	1.34 (1.15, 1.56)	< 0.001	1.35 (1.15, 1.58)	< 0.001
	Unknown	39 (0.7%)	133 (0.7%)	1.04 (0.73, 1.49)	0.821	1.16 (0.80, 1.69)	0.431
Spanish Hispanic origin	Non-Spanish non-Hispanic	4921 (88.4%)	16,457 (89.2%)	1.0 reference		1.0 reference	
	Spanish Hispanic	316 (5.7%)	1078 (5.8%)	1.02 (0.90, 1.16)	0.763	1.04 (0.91, 1.20)	0.549
	Unknown	329 (5.9%)	917 (5.0%)	0.83 (0.73, 0.95)	0.006	0.82 (0.71, 0.94)	0.004
Urban/rural	Metro	4183 (75.2%)	14,624 (79.3%)	1.0 reference		1.0 reference	
	Urban	1074 (19.3%)	2926 (15.9%)	0.78 (0.72, 0.84)	< 0.001	0.82 (0.75, 0.89)	< 0.001
	Rural	155 (2.8%)	394 (2.1%)	0.73 (0.60, 0.88)	< 0.001	0.78 (0.64, 0.95)	0.013
	Unknown	154 (2.8%)	508 (2.9%)	0.94 (0.79, 1.13)	0.535	0.87 (0.70, 1.09)	0.219
Percent no high school degree	21% or more	967 (17.4%)	3094 (17.9%)	1.0 reference		1.0 reference	
	13–20.9%	1445 (26.0%)	4760 (25.8%)	1.03 (0.94, 1.13)	0.540	1.01 (0.91, 1.11)	0.913
	7–12.9%	1883 (33.8%)	6056 (32.8%)	1.01 (0.92, 1.10)	0.909	0.94 (0.84, 1.04)	0.232
	Less than 7%	1219 (21.9%)	4352 (23.6%)	1.12 (1.01, 1.23)	0.026	0.96 (0.84, 1.10)	0.543
	Unknown	52 (0.9%)	190 (1.0%)	1.14 (0.83, 1.57)	0.409	0.88 (0.23, 3.39)	0.850
Median income quartiles	Less than 38,000	1000 (18.0%)	3055 (16.6%)	1.0 reference		1.0 reference	
	38,000–47,999	1414 (25.4%)	4536 (25.6%)	1.05 (0.96, 1.15)	0.304	1.05 (0.94, 1.16)	0.394
	48,000–62,999	1516 (27.2%)	4881 (26.5%)	1.05 (0.96, 1.16)	0.262	1.0 (0.89, 1.12)	0.974
	63,000+	1581 (28.4%)	5779 (31.3%)	1.20 (1.09, 1.31)	< 0.001	1.07 (0.94, 1.22)	0.288
	Unknown	55 (1.0%)	201 (1.1%)	1.20 (0.88, 1.63)	0.252	1.39 (0.38, 5.11)	0.620
Primary payor	Not insured	339 (6.0%)	754 (4.1%)	0.58 (0.50, 0.66)	< 0.001	0.61 (0.53, 0.70)	< 0.001
	Private insurance	2460 (44.2%)	9480 (51.4%)	1.0 reference		1.0 reference	
	Medicaid	406 (7.3%)	1073 (5.8%)	0.69 (0.61, 0.78)	< 0.001	0.72 (0.63, 0.81)	< 0.001
	Medicare	2191 (44.8%)	6757 (36.6%)	0.80 (0.75, 0.85)	< 0.001	0.83 (0.76, 0.90)	< 0.001
	Other government	81 (1.5%)	220 (1.2%)	0.70 (0.54, 0.91)	0.008	0.72 (0.56, 0.94)	0.016
	Unknown	89 (1.6%)	168 (0.9%)	0.49 (0.38, 0.64)	< 0.001	0.47 (0.36, 0.62)	< 0.001
Year of diagnosis	2008	1020 (18.3%)	3230 (17.5%)	1.0 reference		1.0 reference	
	2009	982 (17.6%)	3473 (18.8%)	1.12 (1.01, 1.23)	0.030	1.12 (1.01, 1.24)	0.033
	2010	1236 (22.2%)	3854 (20.9%)	0.98 (0.90, 1.08)	0.750	1.01 (0.91, 1.11)	0.910
	2011	1160 (20.8%)	3944 (21.4%)	1.07 (0.98, 1.18)	0.147	1.10 (1.0, 1.22)	0.052
	2012	1168 (21.0%)	3951 (21.4%)	1.07 (0.97, 1.18)	0.178	1.11 (1.01, 1.22)	0.038
Charlson-Deyo Score	0	4229 (76.0%)	14,309 (77.5%)	1.0 reference		1.0 reference	
	1	1072 (19.3%)	3265 (17.7%)	0.90 (0.83, 0.97)	0.007	0.90 (0.83, 0.97)	0.007
	2+	265 (4.8%)	878 (4.8%)	0.98 (0.85, 1.13)	0.771	0.96 (0.83, 1.11)	0.565
Behavior	In situ and/or carcinoma in situ	18 (0.3%)	249 (1.3%)	1.0 reference		1.0 reference	
	Invasive	5548 (99.7%)	18,203 (98.8%)	0.24 (0.15, 0.38)	< 0.001	0.70 (0.40, 1.23)	0.214
Grade	Well/moderately differentiated	4249 (76.3%)	14,485 (78.5%)	1.0 reference		1.0 reference	
	Poorly differentiated/undifferentiated	820 (14.7%)	2155 (11.7%)	0.77 (0.71, 0.84)	< 0.001	0.78 (0.71, 0.85)	< 0.001
	Unknown	497 (8.9%)	1812 (9.8%)	1.07 (0.96, 1.19)	0.210	1.08 (0.97, 1.21)	0.154
Clinical stage group	Stage 0	49 (0.8%)	546 (3.0%)	1.0 reference		1.0 reference	
	Stage 1	1042 (18.7%)	5242 (33.2%)	0.45 (0.33, 0.61)	< 0.001	0.56 (0.39, 0.79)	0.001

Table 2 (continued)

Variable	Level	APR ($N = 5566$)	SPS ($N = 18,452$)	Univariate OR OR (95% CI)	p value	Multivariable OR (OR 95% CI)	p value
	Stage 2	2237 (40.2%)	6127 (33.3%)	0.25 (0.18, 0.33)	< 0.001	0.44 (0.31, 0.62)	< 0.001
	Stage 3	2238 (40.2%)	6537 (35.5%)	0.26 (0.19, 0.35)	< 0.001	0.47 (0.33, 0.66)	< 0.001
Facility type	Community cancer program	608 (10.9%)	1934 (10.5%)	1.0 reference		Not included in multivariable model	
	Comprehensive community cancer program	3028 (54.4%)	9992 (54.2%)	1.04 (0.94, 1.15)	0.471		
	Academic/research program	1925 (34.6%)	6505 (35.3%)	1.06 (0.96, 1.18)	0.256		
	Other specified types of cancer programs	5 (0.1%)	21 (0.1%)	1.32 (0.50, 3.52)	0.578		
Neoadjuvant treatment	Neoadjuvant chemo + neoadjuvant RT	3707 (66.6%)	9635 (52.2%)	1.0 reference		1.0 reference	
	Neoadjuvant chemo	42 (0.8%)	150 (0.8%)	1.37 (0.97, 1.94)	0.070	1.32 (0.93, 1.87)	0.117
	Neoadjuvant RT	207 (3.7%)	505 (2.7%)	0.94 (0.79, 1.11)	0.455	0.94 (0.80, 1.12)	0.498
	No neoadjuvant therapy	1306 (23.5%)	7237 (39.2%)	2.13 (1.99, 2.29)	< 0.001	1.90 (1.75, 2.07)	< 0.001
	Unknown	304 (5.5%)	925 (5.0%)	1.17 (1.02, 1.34)	0.022	1.11 (0.96, 1.27)	0.150

comparisons. All statistical analyses were completed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

The National Cancer Database is a joint project of the Commission on Cancer (CoC) of the American College of Surgeons (ACS) and the American Cancer Society. The CoC's NCDB and the hospitals participating in the CoC NCDB are the source of the de-identified data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

Results

Twenty-four thousand eighteen patients were identified, of which 18,452 (76.8%) underwent SPS. The majority of these patients ($n = 13,688$, 74.2%) were aged < 70. A greater proportion of female patients underwent SPS compared to male patients (78.4% vs. 75.8%, $p < 0.001$). Demographic and clinical characteristics are outlined in Table 1. Of note, 51.8% of the SPS patients had private insurance and 42.8% had Medicare or Medicaid. This compared to 44.9% in the non-SPS cohort with private insurance and 47.4% with Medicare or Medicaid ($p < 0.001$). Regarding clinical TNM stage, a greater proportion of Stage II and III patients underwent non-SPS compared to SPS (40.2 vs. 33.2% and 40.2 vs. 34.4%, respectively, both $p < 0.001$). The majority of patients (54.2%) underwent treatment at a comprehensive community cancer program. More than half of the patients (58.5%, $n = 13,342$) received neoadjuvant chemoradiotherapy. Of this cohort, 9635 (72.2%) underwent SPS.

Univariate and multivariable logistic regression models for assessing factors associated with SPS are reported in Table 2. Univariate analysis shows that patients with age ≥ 70 years, male sex, living in a rural or urban region, and having Medicare, Medicaid, or no insurance were less likely to undergo SPS. Multivariable analysis shows that patients with age ≥ 70 (OR 0.87, 95% CI 0.80–0.95), male sex (OR 0.90, 95% CI 0.84–0.96), having Medicare (OR 0.83, 95% CI 0.76–0.90), Medicaid (OR 0.72, 95% CI 0.63–0.81), and poorly differentiated histology (OR 0.78, 95% CI 0.71–0.85) were less likely to undergo SPS.

Univariate and multivariable Cox proportional hazards models calculated for mortality are demonstrated in Table 3. Notably, on univariate analysis, patients undergoing non-SPS had a higher likelihood of mortality compared to those with SPS (HR 1.38, 95% CI 1.28–1.49). Patients aged ≥ 70 were more likely to die with estimated hazard ratio of 2.53 (95% CI 2.36–2.71) compared to patients aged < 70. Males (HR 1.17, 95% CI 1.09–1.26) were at increased risk of death. There was lower risk of death in patients belonging to metropolitan areas vs. those from urban (HR 1.12, 95% CI 1.03–1.23) areas. Patients having private insurance were less likely to die

Table 3 Univariate and multivariable Cox proportional hazards models (please note—year of diagnosis 2012 was removed due to missing follow-up)

Variable	Level	Univariate CPH models HR (95% CI)	*p* value	Multivariable CPH models (95% CI)	*p* value
Procedure type	SPS	1.0 reference		1.0 reference	
	Non-SPS	1.38 (1.28, 1.49)	< 0.001	1.26 (1.16, 1.36)	< 0.001
Age group	< 70	1.0 reference		1.0 reference	
	≥ 70	2.53 (2.36, 2.71)	< 0.001	2.02 (1.84, 2.22)	< 0.001
Sex	Male	1.17 (1.09, 1.26)	< 0.001	1.21 (1.13, 1.30)	< 0.001
	Female	1.0 reference		1.0 reference	
Race	White	1.0 reference		1.0 reference	
	Black	1.11 (0.98, 1.26)	0.102	1.07 (0.94, 1.22)	0.341
	Other	0.71 (0.59, 0.87)	< 0.001	0.72 (0.59, 0.88)	0.001
	Unknown	0.79 (0.51, 1.23)	0.294	0.84 (0.54, 1.32)	0.457
Spanish Hispanic origin	Non-Spanish non-Hispanic	1.0 reference		1.0 reference	
	Spanish Hispanic	0.77 (0.65, 0.92)	0.003	0.74 (0.62, 0.88)	< 0.001
	Unknown	1.02 (0.89, 1.18)	0.744	1.09 (0.94, 1.26)	0.254
Urban/rural	Metro	1.0 reference		1.0 reference	
	Urban	1.12 (1.03, 1.23)	0.012	0.95 (0.86, 1.05)	0.316
	Rural	1.23 (0.99, 1.52)	0.064	0.98 (0.78, 1.22)	0.842
	Unknown	1.41 (1.16, 1.70)	< 0.001	0.93 (0.72, 1.20)	0.553
Percent no high school degree	21% or more	1.0 reference		1.0 reference	
	13–20.9%	0.97 (0.88, 1.08)	0.616	1.04 (0.93, 1.16)	0.507
	7–12.9%	0.88 (0.80, 0.98)	0.016	1.0 (0.89, 1.13)	0.989
	Less than 7%	0.74 (0.66, 0.82)	< 0.001	0.88 (0.76, 1.02)	0.093
	Unknown	2.37 (1.85, 3.04)	< 0.001	4.58 (0.63, 33.40)	0.134
Median income quartiles	Less than 38,000	1.0 reference		1.0 reference	
	38,000–47,999	0.90 (0.81, 1.0)	0.050	0.93 (0.83, 1.03)	0.167
	48,000–62,999	0.83 (0.75, 0.93)	< 0.001	0.92 (0.81, 1.04)	0.162
	63,000+	0.70 (0.63, 0.78)	< 0.001	0.85 (0.74, 0.98)	0.025
	Unknown	2.10 (1.65, 2.69)	< 0.001	0.55 (0.08, 3.89)	0.546
Primary payor	Not insured	1.71 (1.44, 2.04)	< 0.001	1.59 (1.33, 1.91)	< 0.001
	Private insurance	1.0 reference		1.0 reference	
	Medicaid	1.95 (1.68, 2.26)	< 0.001	1.74 (1.50, 2.02)	< 0.001
	Medicare	2.49 (2.31, 2.69)	< 0.001	1.55 (1.41, 1.71)	< 0.001
	Other government	1.43 (1.01, 2.01)	0.042	1.37 (0.98, 1.94)	0.070
	Unknown	1.63 (1.15, 2.31)	0.007	1.38 (0.97, 1.96)	0.075
Year of diagnosis	2008	1.0 reference		1.0 reference	
	2009	1.11 (1.02, 1.22)	0.023	1.15 (1.05, 1.26)	0.003
	2010	1.17 (1.06, 1.29)	0.002	1.22 (1.10, 1.35)	< 0.001
	2011	1.13 (1.00, 1.28)	0.043	1.20 (1.06, 1.35)	0.003
Charlson-Deyo Score	0	1.0 reference		1.0 reference	
	1	1.58 (1.46, 1.72)	< 0.001	1.37 (1.26, 1.49)	< 0.001
	2+	2.82 (2.50, 3.19)	< 0.001	2.37 (2.10, 2.68)	< 0.001
Behavior	In situ and/or carcinoma in situ	1.0 reference		1.0 reference	
	Invasive	2.14 (1.38, 3.32)	< 0.001	1.46 (0.86, 2.50)	0.164
Grade	Well/moderately differentiated	1.0 reference		1.0 reference	
	Poorly differentiated/undifferentiated	1.77 (1.63, 1.94)	< 0.001	1.54 (1.41, 1.69)	< 0.001
	Unknown	0.92 (0.81, 1.05)	0.219	1.06 (0.93, 1.21)	0.409
Clinical stage group	Stage 0	1.0 reference		Not included in multivariable model	
	Stage 1	1.17 (0.89, 1.54)	0.259		
	Stage 2	1.60 (1.23, 2.10)	< 0.001		
	Stage 3	1.70 (1.30, 2.23)	< 0.001		
Pathologic stage group	Stage 0	1.0 reference		1.0 reference	
	Stage 1	1.16 (0.90, 1.51)	0.252	1.04 (0.76, 1.42)	0.805
	Stage 2	2.11 (1.63, 2.73)	< 0.001	1.86 (1.37, 2.54)	< 0.001
	Stage 3	2.86 (2.22, 3.68)	< 0.001	2.66 (1.96, 3.61)	< 0.001
Facility type	Community cancer program	1.0 reference		Not included in multivariable model	
	Comprehensive community cancer program	0.89 (0.80, 0.99)	0.039		
	Academic/research program	0.66 (0.59, 0.74)	< 0.001		
	Other specified types of cancer programs	1.05 (0.43, 2.53)	0.919		
Neoadjuvant treatment	Neoadjuvant chemo + neoadjuvant RT	1.0 reference		1.0 reference	
	Neoadjuvant chemo	1.05 (0.71, 1.56)	0.800	0.95 (0.64, 1.41)	0.785
	Neoadjuvant RT	1.26 (1.04, 1.53)	0.021	1.13 (0.93, 1.38)	0.217
	No neoadjuvant therapy	1.11 (1.03, 1.20)	0.005	1.09 (1.01, 1.18)	0.026
	Unknown	1.15 (0.99, 1.34)	0.064	1.14 (0.98, 1.32)	0.090

compared to those having Medicare (HR 2.49, 95% CI 2.31–2.69) or Medicaid (HR 1.95, 95% CI 1.68–2.26), and no insurance (HR 1.71, 95% CI 1.44–2.04). Compared to community cancer programs, academic/research programs (HR 0.66, 95% CI 0.59–0.74) and comprehensive community cancer programs (HR 0.89, 95% CI 0.80–0.99) had a lower likelihood of mortality. Multivariable analysis shows that non-SPS, age ≥ 70 years, male gender, insurance other than private and poorly differentiated grade had higher likelihood of mortality.

There was no statistical difference in the proportion of patients undergoing SPS over the study period (76.0% in 2008 to 77.2% in 2012, $p = 0.386$). The trends of SPS over time are shown in Table 4.

Discussion

This study described the rate, pattern, and associated factors of sphincter-preserving surgery in rectal cancer patients diagnosed from 2008 to 2012 from the National Cancer Database. The study not only identified tumor and patient-related factors but also highlighted some of the disparities in care. Our study identified that older age (≥ 70 years), male sex, having a government insurance, and poorly differentiated grade were factors leading to a lower likelihood of undergoing SPS.

The rate of SPS in the USA has been variable and historically less than that reported in European centers, but has reportedly increased in recent years [11, 13]. A study conducted on 41,631 rectal cancer patients in 2007 reported an increase in the proportion of SPS from 1988 (26.9%) to 2003 (48.3%) [14]. Our study of the NCDB database showed a greater percentage of patients undergoing SPS (76.8%) as treatment for rectal cancer than non-SPS (23.2%). In an Australian study conducted by Marwan and colleagues, similar results were reported, with 76.6% patients having SPS for rectal cancer among whom the majority were aged < 70 years (60%) and were of male sex (64.7%) [12]. Abdelsattar and colleagues studied 329 rectal cancer patients who were treated at ten different hospitals in Michigan and reported the overall rate of SPS to be 72% [6]. Given this report of the NCDB and similar results compared to other reports may indicate that the rates of SPS and non-SPS in the USA have plateaued.

Table 4 Trends of SPS over time

Year of diagnosis	Procedure type		
Frequency row pct	SPS	APR	Total
2008	3230	1020	4250
	76.0	24.0	
2009	3473	982	4455
	78.0	22.0	
2010	3854	1236	5090
	75.7	24.3	
2011	3944	1160	5104
	77.3	22.7	
2012	3951	1168	5119
	77.2	22.8	
Total	18,452	5566	24,018

$p = 0.386$

Variability in care in the USA has previously been attributed to colorectal specialization and hospital/surgeon volume [15–18]. Secondary to these deficiencies and variances in care, the American College of Surgeons in conjunction with the Commission on Cancer have recently developed a National Accreditation Program for Rectal Cancer [19]. It remains to be seen if implementation and adherence to such standards improves overall disparities of care, either by forcing improved training, greater specialization, or regionalization of care by creation of centers of excellence. It is notable, however, that in our study, there was no statistically significant difference in rates of SPS between facility types. While differences may in reality exist, there are limitations in the available data through NCDB with regard to facility type that may make a true determination of difference based on surgery location difficult.

Several previous studies have revealed that rectal cancer patients having private insurance and of greater socioeconomic status are more likely to undergo SPS [8, 14]. These reports are congruent with findings in our study which demonstrated that having private insurance was correlated with an increased probability of undergoing SPS. This may be due to the reason that each of these variables offers greater options in choosing hospital and surgeon compared to government insurances.

The strengths of this study are the large patient cohort (n = 24,018) with comprehensive cancer-related data. The NCDB has been reported to capture approximately 70% of new cancer diagnoses in the USA [20]. Limitations include the retrospective nature and lack of detailed patient/tumor specific factors. Furthermore, NCDB lacks granular data describing exact facility type that the operative intervention took place, thus making it difficult to evaluate trends in SPS by facility type.

In summary, we found that SPS rate is higher than non-SPS among rectal cancer patients. Regional and institutional disparities persist, and the positive impact of the implementation of the NAPRC on this and general outcomes in rectal cancer care is eagerly anticipated.

Contribution of each author/coauthor Authors AM, FS, and PMK conceptualized the study and discussed with other authors DC, KLM, and DWL. Authors AM, FS, PMK, DC, KLM, and DWL designed and planned the study and developed methodology. Data was analyzed by statistician CND. This was in close discussions and revisions with authors AM and EH. All the authors approved of the final analysis and results. AM and FS wrote the initial draft which was extensively reviewed and edited by all the authors. Final version of the manuscript was approved by all the authors prior to submission of the paper.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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