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Utilization of Surgical Treatment for Local and Locoregional Esophageal Cancer: Analysis of the National Cancer Data Base

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Abstract

Background—Previous studies suggest esophagectomy is severely underutilized for patients with resectable esophageal cancer. Recent expansion of endoscopic local therapies, advances in surgical techniques and improved postoperative outcomes have changed the therapeutic landscape. The impact of these developments and evolving treatment guidelines on national practice patterns is unknown.

Methods—Patients diagnosed with clinical stage 0-III esophageal cancer were identified from the National Cancer Data Base (2004-2013). We analyzed receipt of potentially curative surgical treatment over time and used multivariate logistic regression to identify factors associated with surgical treatment.

Results—52,122 patients were included in the analysis. From 2004 to 2013, overall rate of potentially curative surgical treatment increased from 36.5% to 47.4% ($P<0.001$). For stage 0 disease, receipt of esophagectomy decreased from 23.8% to 17.9% ($P<0.001$), while use of local therapies increased from 34.3% to 58.8% ($P<0.001$). Use of surgical treatment increased from 43.4% to 61.8% ($P<0.001$), 36.1% to 45.0% ($P<0.001$) and 30.8% to 38.6% ($P<0.001$) for patients with stage I, II and III disease, respectively. On multivariate analysis, divergent practice patterns and adherence to national guidelines were noted between academic and community facilities.

Conclusion—Use of potentially curative surgical treatment has increased for patients with stage 0-III esophageal cancer. Expansion of local therapies has driven increased rates of surgical

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treatment for early stage disease. While increased use of esophagectomy for more advanced disease is encouraging, significant variation persists at the patient and facility level.

Graphical Abstract

Precis: National use of potentially curative surgical treatment increased from 36.4% in 2004 to 47.4% in 2013 for patients with stage 0-III esophageal cancer. Adoption of endoscopic local therapies predominated for early stage disease, while an encouraging increase in use of esophagectomy for locoregional disease was observed.

Keywords

esophageal cancer; esophagectomy; epidemiology; socioeconomic factors; treatment

Introduction

National incidence of esophageal cancer has risen steadily, increasing seven-fold since the 1970s.^{1, 2} In 2016, there will be an estimated 16,900 newly diagnosed cases; roughly 50-60% of these patients will present with potentially resectable disease.^{2, 3} Although esophagectomy has traditionally been the mainstay of curative treatment, prior studies suggest it is severely underutilized.⁴⁻⁶ Possible explanations include a nihilistic attitude towards surgery due to historically high postoperative morbidity and mortality, variation in access to treatment, and a paucity of definitive evidence to guide therapy.^{5, 6} However, recent paradigm shifts in management of potentially curable disease call for reevaluation of surgical utilization.

The development of new treatment modalities and advances in operative technique have changed the therapeutic landscape. National Cancer Care Network (NCCN) guidelines first recommended endoscopic local therapy as a primary option for early-stage disease in 2008 and as preferred treatment since 2012. However, esophagectomy persists as an accepted alternative for stage 0 and I and continues to be integral to the management of stage II and III disease.⁷ Furthermore, improved outcomes with minimally invasive approaches may allow patients to benefit from surgical treatment who were previously considered too high-risk for resection.⁸⁻¹⁰

Optimal management of locoregional disease continues to evolve. National guidelines promote preoperative chemoradiation followed by esophagectomy but allow for multiple therapeutic pathways.⁷ While the necessity of surgical treatment for squamous cell tumors has been challenged,^{6, 11} NCCN recommendations support definitive chemoradiation only for patients who refuse surgery, are medically unfit for resection, or present with cervical esophageal tumors.⁷ In contrast, European Society for Medical Oncology (ESMO) guidelines endorse definitive chemoradiation for select stage II/III squamous cell carcinomas.¹²

The impact of conflicting treatment strategies, expanded therapeutic options, and improved surgical outcomes on practice patterns remains unknown. We sought to evaluate national

utilization of esophagectomy and local therapies over time and identify factors associated with surgical treatment for patients with local or locoregional esophageal cancer.

Methods

We conducted a retrospective cohort study using the National Cancer Data Base (NCDB), a joint project of the Commission on Cancer of the American College of Surgeons and the American Cancer Society. The NCDB collects data from over 1500 Commission on Cancer accredited facilities nationwide. The database captures greater than 70% of newly diagnosed cancer cases in the United States and Puerto Rico each year. As the NCDB is a de-identified readily available dataset it was not subject to Institutional Review Board approval.

Study Population

We selected patients age 18 years and older diagnosed with adenocarcinoma or squamous cell carcinoma of the esophagus or gastroesophageal junction from 2004 to 2013. The NCDB records data from a single reporting facility; we excluded patients diagnosed at the reporting facility but received all treatment elsewhere. Clinical stage was reported based on the American Joint Committee on Cancer staging edition at the time of diagnosis and we collapsed this variable (e.g. stage IA and IB were assigned as stage I). We excluded patients with documented clinical evidence of metastatic disease or tumors of the cervical esophagus, identified by the International Classification of Diseases for Oncology, 3rd edition (C15.0).¹³ (Figure 1) Median household income was based on the patient's home zip code at the time of diagnosis. We considered community and comprehensive community treatment centers together, referred to as community hospitals.

Treatment Definitions

The NCDB reports therapies administered as part of the planned initial course of treatment and we presumed patients underwent surgery with curative intent given the disease stages selected for analysis. Potentially curative surgical treatment includes esophagectomy (codes 30-80) and endoscopic local therapy (10-27, 90) based on Facility Oncology Registry Standards.¹⁴ Detailed distribution of local therapies is provided in Table 1. The NCDB defines these interventions as “surgery” and reports the reason for no surgical treatment according to the categories depicted in Figure 1. ‘Surgery not part of the first course of treatment’ includes situations in which patients were given multiple options and chose medical therapy or did not receive any treatment.

Analysis

The primary outcome was the rate of potentially curative surgical treatment from 2004 to 2013. We used logistic regression with year as a continuous predictor to evaluate treatment rates over time. Comparison of patient and facility characteristics was done using Pearson chi-squared tests for categorical variables. To evaluate predictors of surgical treatment, we performed a multivariate analysis using a binary logistic regression model with year of diagnosis as the main predictor and included age, sex, race, Charlson-Deyo comorbidity score, insurance status, median household income, AJCC clinical stage, histology, facility type and geographic region as a priori defined covariates. We performed a sensitivity

analysis excluding patients who died prior to surgery or for whom surgery was not recommended due to patient risk factors.

We performed two subgroup analyses. First, as local therapy is preferred treatment over esophagectomy for superficial lesions, we used multivariate models to identify factors associated with receipt of esophagectomy for the subset of patients with clinical stage 0 (carcinoma in situ) or I disease who underwent potentially curative surgical treatment. Second, as guidance on use of definitive chemoradiation as a potentially curative alternative to esophagectomy for locoregional disease has evolved, we compared stage II/III patients who received an esophagectomy to those who were offered multiple treatment options but opted for chemoradiation without surgery. Patients for whom surgery was contraindicated due to risk factors or who died prior to surgery were excluded. Significance level (α) was set at 0.05 for all analyses and P-values were calculated as two-tailed. Analyses were performed using SPSS, version 23 (Chicago, IL).

Results

The analytic cohort included 52,122 patients. Patients had a median age of 67 years (range 19-90) and were predominantly white males. Over 70% presented with clinical stage II or III disease and 64.5% had adenocarcinoma. Although approximately 13% of hospitals in the database are academic facilities, nearly half of the study population (46.8%) were managed at these institutions. (Table 2)

Overall, 19,050 (36.5%) patients underwent esophagectomy and 4,110 (7.9%) received endoscopic local therapy. The rate of esophagectomy steadily increased from 30.7% to 37.9% ($P<0.001$) and use of local therapies rose from 5.6% to 9.5% ($P<0.001$), such that the overall rate of potentially curative surgical treatment increased from 36.5% in 2004 to 47.4% in 2013 ($P<0.001$). Reasons why the remaining 28,962 (55.6%) patients did not undergo surgical treatment included death prior to planned surgery ($N=275$), contraindication due to patient risk factors ($N=3,173$), patient refusal ($N=1,039$), and unknown ($N=2,252$). (Figure 1) Of the 22,223 for whom surgery was not part of the planned first course of treatment, 3,761 received single modality medical therapy with either chemotherapy or radiation, 14,408 received combined chemoradiation and 3,566 opted for no treatment.

Utilization of Surgical Treatment by Clinical Stage

For stage 0, esophagectomy use decreased from 23.8% to 17.9% ($P<0.001$) with a concomitant rise in rates of endoscopic local therapy from 34.3% to 58.8% ($P<0.001$). The impact of local therapies drove growth in overall use of surgical treatment from 58.0% in 2004 to 76.7% by 2013. (Figure 2a) Receipt of esophagectomy for stage I increased modestly from 29.8% to 34.5% ($P=0.16$). Use of local therapies doubled from 13.6% to 27.4% ($P<0.001$), contributing to expansion of surgical treatment from 43.4% to 61.8% by 2013 for stage I. (Figure 2b) For locoregional disease, rates of surgical treatment increased from 36.1% to 45.0% ($P<0.001$) and 30.8% to 38.6% ($P<0.001$) in clinical stage II and III, respectively. Use of local therapy remained less than 2.6%. (Figure 2 c,d)

Predictors of Potentially Curative Surgical Treatment

Patients receiving surgical treatment tended to be younger, white, privately insured males with higher median household income ($P<0.001$). Those managed at academic centers were significantly more likely to undergo potentially curative surgical treatment as opposed to community hospitals (OR 2.72, 95% CI 2.61-2.84). More advanced clinical stage was associated with decreased odds of surgical treatment as compared to stage 0 (stage I: OR 0.51, 95% CI 0.46-0.57; stage II: OR 0.26, 95% CI 0.23-0.29; stage III: OR 0.16, 95% CI 0.15-0.19) and patients with adenocarcinoma were over two fold more likely to undergo surgical treatment compared to squamous cell carcinoma (OR 2.68, 95% CI 2.56-2.81). On adjusted analysis, year of diagnosis remained a small but significant predictor (OR per year: 1.04, 95% CI 1.03-1.04, $P<0.001$). (Table 3) Sensitivity analysis excluding patients who died prior to surgery or for whom surgery was contraindicated yielded similar findings.

Use of Esophagectomy: Clinical Stage 0 or I

Of the subset of stage 0/I patients who underwent surgical treatment ($n=7,965$), adjusted analysis revealed receipt of esophagectomy rather than endoscopic local therapy was more likely for clinical stage I disease (OR 3.52, 95% CI 3.08-4.02) and those with adenocarcinoma as opposed to squamous cell carcinoma (OR 1.28, 95% CI 1.06-1.37). Notably, patients managed at community facilities had significantly greater odds of being treated with esophagectomy (OR 1.78, 95% CI 1.59-2.00). Year was a negative predictor of esophagectomy (OR per year 0.91, 95% CI 0.89-0.92, $P<0.001$). (Table 4)

Use of Esophagectomy: Clinical Stage II or III

Of stage II/III patients treated with esophagectomy or chemoradiation without surgery ($n=29,480$), those managed surgically tended to be younger, white, privately insured and lived in regions with higher median household income ($P<0.001$ for all). Compared to stage II, stage III patients were less likely to undergo esophagectomy (OR 0.66, 95% CI 0.63-0.70). Treatment at an academic facility (OR 2.42, 95% CI 2.29-2.56) and adenocarcinoma (OR 2.83, 95% CI 2.67-3.01) were the strongest predictors of surgical treatment. On adjusted analysis, year of diagnosis remained a significant predictor of esophagectomy (OR per year 1.04, 95% CI 1.01-1.03, $P<0.001$).

Discussion

Using a large, national dataset our results demonstrate a significant increase in utilization of surgical treatments for stage 0-III esophageal cancer from 36.5% in 2004 to 47.4% in 2013. This rise was fueled by adoption of endoscopic local therapies for management of local disease (stage 0/I) and increased use of esophagectomy for locoregional cancers (stage II/III). To our knowledge, this is the first study to report national practice patterns in the surgical management of potentially resectable esophageal cancer in recent years. These findings are encouraging given the rising burden of disease and suggest growing awareness and adherence to national guidelines.

Although evidence supports improved survival after complete surgical resection for patients without distant disease,^{4, 15} previous national studies have reported severe underuse of

esophagectomy.^{4, 5} Investigations using the Surveillance, Epidemiology, and End Results cancer registry report a rate of 34.1% for stage I-III between 1997 and 2002⁴ and subsequent analysis including in situ, local and regional disease from 1988 to 2004 found 44% of patients received an esophagectomy. Notably, esophagectomy rates failed to increase during the 17-year period.⁵ While exposing critical underuse, these studies were limited by small sample sizes and were conducted prior to formal incorporation of local therapies into national guidelines.

We noted a significant overall increase in rates of esophagectomy driven by the clear majority of patients who presented with stage II/III disease. Although esophagectomy has been historically viewed as an invasive, high-risk procedure with questionable benefit given low overall disease survival,⁴ these findings suggest increasing acceptance of radical resection. Potential explanations for this shift include adoption of minimally invasive esophagectomy,^{8, 10} lower postoperative mortality at specialized, high-volume centers,¹⁶⁻¹⁸ and growing evidence from prospective studies, such as the CROSS trial,¹⁹ demonstrating improved long-term survival with preoperative chemoradiation.^{20, 21}

In concordance with preferred treatment algorithms, endoscopic modalities were the primary contributor to increasing rates of surgical treatment for superficial cancers and subgroup analysis of stage 0/I disease indicates a shift away from esophagectomy. Our findings build upon work by Berry and colleagues, who reported increasing use of endoscopic local therapies for T1N0 disease from 8.1% in 1998 to 24.1% in 2008.²² While retrospective analyses suggest local treatments provide effective therapy,^{22, 23} given the apparent widespread adoption of these modalities, prospective trials may be increasingly valuable to evaluate long-term outcomes.

We identified 61.9% of newly diagnosed cases presented with tumors considered resectable based on clinical stage (0-III), consistent with previous population-based reports.² Although our data suggest an increase in overall surgical use, more than half of these patients received exclusively non-surgical therapies or did not undergo treatment, indicating significant ongoing underutilization of potentially curative surgical options. Previous investigations have cited racial and socioeconomic disparity as drivers of surgical underuse,^{4, 5} and unfortunately we found this trend persists. Interestingly, while patient level disparities were less pronounced in predictors of esophagectomy versus local therapies for stage 0/I, we noted significant racial and socioeconomic influence in use of esophagectomy compared to definitive chemoradiation in the stage II/III subgroup. Precise etiology of this patient-level variation is uncertain but may include access to care, cost of therapy, knowledge deficits related to available and preferred treatment options or patient preference to avoid potentially onerous radical surgical resection. Further clarification of patient-related barriers to surgical treatment is needed, particularly for those with more advanced disease.

Our analysis uncovered significant variation in adherence to national guidelines, as academic and community hospitals demonstrated distinctly different practice patterns. We found patients treated at community hospitals were less likely to receive surgical treatment compared to their counterparts at academic centers. Diverging practices persisted in both subgroup analyses: those managed at community centers were more likely to receive

esophagectomy for stage 0/I disease and less likely to undergo esophagectomy for stage II/III tumors. This heightened deviation from preferred algorithms at non-academic centers may stem from limited access to skilled providers who perform local therapies or advanced minimally invasive techniques and insufficient resources to provide higher level post-esophagectomy care or specialty services necessary to facilitate multidisciplinary management of these complex patients. As academic centers are not located in many communities, longer travel times and hesitancy to refer patients to out-of-network providers may pose critical barriers to preferred surgical treatment, particularly in light of identified socioeconomic disparities. This facility variability highlights an opportunity to improve awareness of current guidelines and dissemination of local therapy options at the community level.

Ongoing controversy exists regarding optimal management of patients with squamous cell carcinomas. While a recent Cochrane review found no difference in long-term mortality or recurrence for patients treated with definitive chemoradiation versus surgery, the quality of evidence was low or very low.²⁴ Our results demonstrate that patients with squamous cell carcinoma were almost three times less likely to have surgical therapy compared to those with adenocarcinoma. This histology based deviation provides evidence to support the impact of European guidelines¹² endorsing definitive chemoradiation on practice patterns in the United States.

It is worth noting that for the majority of patients who did not undergo surgical therapy, the reason was documented as ‘surgery not part of the first course of treatment.’ This includes a heterogeneous group of patients; it is unknown how many were offered surgery and chose alternative therapy versus how many were not offered surgery. However, this category is distinct from those for whom surgery is contraindicated and thus we presume it represents patients who are potentially surgical candidates. Targeted investigation into the manner in which surgery is presented and characterization of the subset that did not undergo any curative treatment offers tremendous potential to improve utilization and intervene on potential surgeon bias and patient understanding of therapeutic options.

Our use of the NCDB offers analysis of a significantly larger nationally representative sample than previous reports. However, this study has several limitations. We included all patients with potentially resectable disease based on clinical stage in order to facilitate comparison to earlier studies. While our cohort contains patients for whom surgery was contraindicated or who died prior to treatment, these patients represented a small proportion and sensitivity analysis produced similar results. Due to changes in AJCC staging guidelines during the study period, our cohort includes 725 (1.4% of the total cohort) patients with T4b lesions for whom definitive chemoradiation is currently recommended. We believe inclusion of these patients is justified to facilitate comparison to earlier studies as prior to 2010 the distinction between T4a and T4b lesions did not exist. The NCDB does not provide information on how patients were staged, so we are unable to assess the quality and accuracy of staging information and although it offers some data on patient characteristics, this database lacks the granularity necessary to better define differences between those for whom surgical therapies were and were not recommended. Unfortunately, the database only records information for a single reporting facility and thus we acknowledge that our analyses

do not account for patients who were diagnosed at the reporting hospital but received all treatment elsewhere. However, this scenario occurred in less than 4% of patients in the database with clinical stage 0-IV disease and given the otherwise large sample size exclusion of these patients is unlikely to have substantial impact on overall trends. Finally, these data represent the planned initial treatment strategy; the NCDB does not report subsequent therapies following failed first-course treatment. Therefore, it is likely that overall utilization of surgical treatment is greater than these results indicate, as there are certainly patients who underwent esophagectomy following failed local therapy, salvage resection after definitive chemoradiation, or subsequent local therapy such as cryotherapy with palliative intent.

Conclusions

Using a large national sample, we demonstrate increased use of surgical treatment from 2004 to 2013 for stage 0-III esophageal cancer. The impact of local therapies has significantly expanded receipt of surgical treatment for superficial tumors. However, facility and patient level variation in use of esophagectomy for locoregional disease persists. Further investigation into characteristics of medically fit patients managed non-operatively is warranted to identify barriers to receiving recommended surgical therapies.

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Figure 1.
Cohort selection and management of patients with stage 0-III esophageal cancer from 2004-2013

a)

b)

Figure 2. Utilization rates of esophagectomy, local therapy, and overall potentially curative surgical treatment from 2004-2013 for patients with clinical A) stage 0, B) stage I, C) stage II, and D) stage III esophageal cancer

Table 1

Distribution of endoscopic local therapies

Local therapy	N (%)
Local tumor destruction, NOS	116 (2.8)
Photodynamic therapy	268 (6.5)
Electrocautery, fulguration	83 (2.0)
Cryosurgery	134 (3.3)
Laser	125 (3.0)
Local tumor excision, NOS	971 (23.6)
Polypectomy or excisional biopsy	1555 (37.8)
Polypectomy or excisional biopsy with photodynamic therapy	58 (1.4)
Polypectomy or excisional biopsy with electrocautery	272 (6.6)
Polypectomy or excisional biopsy with cryosurgery	75 (1.8)
Polypectomy or excisional biopsy with laser ablation	216 (5.3)
Polypectomy or excisional biopsy with laser excision	50 (1.2)
Surgery, NOS	187 (4.5)
Total	4110

Table 2

Baseline characteristics of patients with stage 0-III esophageal cancer

Characteristic	
Age, median (mean, SD)	67 (66.8, 11.4)
Male gender, N (%)	40662 (78.0)
Race, N (%)	
White	45398 (87.1)
Black	4867 (9.3)
Other	1857 (3.6)
AJCC clinical stage, N (%)	
0	2220 (4.3)
I	11085 (21.3)
II	17760 (34.1)
III	21057 (40.4)
Adenocarcinoma, N (%)	33628 (64.5)
Charlson Comorbidity Score	
0	38374 (73.6)
1	10343 (19.8)
2	3405 (6.5)
Median income, N (%)	
<38K	9457 (18.1)
38-47999	12623 (24.2)
48-62999	13775 (26.4)
>63K	15147 (29.1)
Unknown	1120 (2.1)
Insurance status, N (%)	
Uninsured	1532 (2.9)
Private	17208 (33.0)
Medicaid and other government	4157 (8.0)
Medicare	27519 (52.8)
Unknown	1706 (3.3)
Facility type, N (%)	
Community	24347 (46.7)
Academic	24402 (46.8)
Other	3373 (6.5)
Facility location, N (%)	
Northeast	11661 (22.4)

Characteristic	
South Atlantic	11465 (22.0)
Midwest	13809 (26.5)
South	6864 (13.2)
West	7867 (15.1)
Unknown	456 (0.9)

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Table 3

Multivariate analysis of factors predictive of potentially curative surgical treatment for patients with stage 0-III esophageal cancer

Variable	Surgery, N (%)	Adjusted Odds Ratio (OR)	95% CI	Adjusted P value
Age				<0.001
18-49	1964 (57.9)	1.00 (Referent)		
50-59	5672 (53.8)	0.81	0.74-0.89	
60-69	8591 (52.3)	0.69	0.63-0.76	
70-79	5549 (39.3)	0.39	0.36-0.43	
80	1384 (18.1)	0.12	0.10-0.13	
Sex				<0.001
Female	3966 (34.6)	1.00 (Referent)		
Male	19194 (47.2)	1.13	1.08-1.19	
Race				<0.001
Black	982 (20.2)	1.00 (Referent)		
White	21410 (92.4)	2.15	1.98-2.34	
Other	768 (41.4)	1.84	1.61-2.10	
Insurance status				<0.001
Uninsured	439 (28.7)	1.00 (Referent)		
Private	10179 (59.2)	2.78	2.45-3.16	
Medicaid or other government	1462 (35.2)	1.24	1.08-1.43	
Medicare	10474 (38.1)	1.99	1.75-2.27	
Unknown	606 (35.5)	0.93	0.78-1.09	
Median income				<0.001
<38K	3362 (35.6)	1.00 (Referent)		
38-47999	5566 (44.1)	1.18	1.11-1.26	
48-62999	6463 (46.9)	1.24	1.16-1.32	
>63K	7351 (48.5)	1.30	1.22-1.38	
Unknown	418 (37.3)	0.92	0.79-1.06	
Charlson score				<0.001
0	17246 (44.9)	1.00 (Referent)		
1	4673 (45.2)	1.09	1.03-1.14	
2	1241 (36.4)	0.70	0.65-0.77	
AJCC clinical stage				<0.001
0	1515 (68.2)	1.00 (Referent)		
I	6450 (58.2)	0.51	0.46-0.57	
II	7573 (42.6)	0.26	0.23-0.29	
III	7622 (36.2)	0.16	0.15-0.18	

Variable	Surgery, N (%)	Adjusted Odds Ratio (OR)	95% CI	Adjusted P value
Histology				<0.001
Squamous cell carcinoma	5082 (27.5)	1.00 (Referent)		
Adenocarcinoma	18078 (53.8)	2.68	2.56-2.81	
Facility type				<0.001
Community	7923 (32.5)	1.00 (Referent)		
Academic	13671 (56.0)	2.72	2.61-2.84	
Other	1566 (46.4)	1.69	1.54-1.84	
Facility location				<0.001
Northeast	5254 (45.1)	1.00 (Referent)		
South Atlantic	4904 (42.8)	1.10	1.03-1.17	
Midwest	6534 (47.3)	1.21	1.14-1.28	
South	2701 (39.4)	0.96	0.89-1.03	
West	3472 (44.1)	1.13	1.06-1.21	
Unknown	295 (64.7)	1.40	1.10-1.79	
Year of diagnosis		1.04	1.03-1.04	<0.001
2004	1360 (36.4)			
2005	1614 (40.5)			
2006	1683 (39.7)			
2007	1898 (42.5)			
2008	2450 (46.0)			
2009	2601 (46.4)			
2010	2750 (46.3)			
2011	2890 (47.4)			
2012	2846 (45.5)			
2013	3068 (47.4)			

Table 4

Multivariate analysis of clinical stage 0 or I comparing those who underwent esophagectomy (N=4452) to those who received endoscopic local therapy (N=3513)

Variable	Esophagectomy, N (%)	Adjusted Odds Ratio (OR)	95% CI	Adjusted P value
Age				<0.001
18-49	348 (73.9)	1.00 (Referent)		
50-59	1023 (65.9)	0.63	0.48-0.82	
60-69	1736 (63.2)	0.57	0.44-0.74	
70-79	1165 (49.8)	0.33	0.25-0.43	
80	180 (21.1)	0.09	0.06-0.12	
Sex				0.83
Female	781 (52.6)	1.00 (Referent)		
Male	3671 (56.6)	1.01	0.89-1.15	
Race				0.053
Black	171 (64.8)	1.00 (Referent)		
White	4141 (55.9)	0.77	0.58-1.04	
Other	140 (47.6)	0.62	0.42-0.91	
Insurance status				<0.001
Uninsured	61 (59.8)	1.00 (Referent)		
Private	1830 (63.9)	1.27	0.81-1.98	
Medicaid or over government	277 (61.8)	1.12	0.69-1.82	
Medicare	2113 (48.9)	1.09	0.69-1.70	
Unknown	171 (74.0)	2.34	1.35-4.04	
Median income				0.54
<38K	654 (58.7)	1.00 (Referent)		
38-47999	1074 (56.8)	0.96	0.81-1.14	
48-62999	1298 (57.0)	0.99	0.84-1.16	
>63K	1357 (53.0)	0.90	0.77-1.06	
Unknown	69 (58.0)	1.09	0.71-1.66	
Charlson score				<0.001
0	3166 (53.7)	1.00 (Referent)		
1	1015 (64.1)	1.48	1.30-1.68	
2	271 (55.2)	1.06	0.86-1.29	
AJCC clinical stage				<0.001
0	484 (31.9)	1.00 (Referent)		
I	3968 (61.5)	3.52	3.08-4.02	
Histology				0.004
Squamous cell	847 (46.6)	1.00 (Referent)		

Variable	Esophagectomy, N (%)	Adjusted Odds Ratio (OR)	95% CI	Adjusted P value
Adenocarcinoma	3605 (58.6)	1.28	1.06-1.37	
Facility type				<0.001
Academic	2734 (51.2)	1.00 (Referent)		
Community	1421 (65.1)	1.78	1.59-2.00	
Other	297 (66.6)	1.97	1.54-2.5	
Facility location				<0.001
Northeast	864 (49.7)	1.00 (Referent)		
South Atlantic	918 (50.4)	0.98	0.85-1.14	
Midwest	1237 (60.0)	1.27	1.10-1.46	
South	660 (69.8)	1.53	1.27-1.85	
West	724 (54.4)	1.08	0.92-1.27	
Unknown	49 (69.0)	0.63	0.33-1.19	
Year of diagnosis		0.91	0.89-0.92	<0.001

Table 5

Multivariate analysis of clinical stage II or III comparing those who underwent esophagectomy (N=14,597) to those who received chemoradiation without surgery (N=14,883)

Variable	Esophagectomy, N (%)	Adjusted Odds Ratio (OR)	95% CI	Adjusted P value
Age				<0.001
18-49	1450 (62.8)	1.00 (Referent)		
50-59	4000 (57.9)	0.79	0.70-0.88	
60-69	5680 (55.9)	0.68	0.60-0.76	
70-79	3042 (40.3)	0.36	0.32-0.41	
80	425 (16.6)	0.10	0.08-0.11	
Sex				0.002
Female	2351 (39.7)	1.00 (Referent)		
Male	12246 (52.0)	1.11	1.04-1.19	
Race				<0.001
Black	664 (25.6)	1.00 (Referent)		
White	13490 (52.1)	1.86	1.67-2.07	
Other	443 (45.1)	1.66	1.40-1.98	
Insurance status				<0.001
Uninsured	318 (36.2)	1.00 (Referent)		
Private	7114 (63.4)	2.44	2.01-2.86	
Medicaid or over government	964 (39.0)	1.07	0.90-1.27	
Medicare	5844 (42.3)	1.84	1.56-2.16	
Unknown	357 (32.7)	0.57	0.46-0.70	
Median income				<0.001
<38K	2120 (41.1)	1.00 (Referent)		
38-47999	3532 (49.3)	1.15	1.06-1.25	
48-62999	4028 (51.4)	1.18	1.09-1.28	
>63K	4637 (53.2)	1.25	1.15-1.35	
Unknown	280 (45.6)	0.97	0.80-1.17	
Charlson score				<0.001
0	10911 (49.1)	1.00 (Referent)		
1	2975 (52.2)	1.17	1.09-1.25	
2	711 (45.3)	0.87	0.78-0.98	
AJCC clinical stage				<0.001
II	7230 (53.0)	1.00 (Referent)		
III	7367 (46.5)	0.66	0.63-0.70	
Histology				<0.001
Squamous cell	3069 (31.0)	1.00 (Referent)		

Variable	Esophagectomy, N (%)	Adjusted Odds Ratio (OR)	95% CI	Adjusted P value
Adenocarcinoma	11528 (58.9)	2.83	2.67-3.01	
Facility type				<0.001
Community	5471 (39.5)	1.00 (Referent)		
Academic	8034 (58.9)	2.42	2.29-2.56	
Other	1092 (54.6)	1.76	1.57-1.97	
Facility location				<0.001
Northeast	3366 (51.1)	1.00 (Referent)		
South Atlantic	2959 (47.6)	1.05	0.96-1.13	
Midwest	4306 (52.8)	1.16	1.08-1.25	
South	1683 (43.8)	0.96	0.88-1.06	
West	2067 (47.2)	1.02	0.94-1.11	
Unknown	216 (67.7)	1.12	0.83-1.50	
Year of diagnosis		1.02	1.01-1.03	<0.001