Impact of Surgeon Specialty on Perioperative Outcomes of Surgery for Benign Esophageal Diseases: A NSQIP Analysis

Zeyad Khoshhal, MBBS, MPH,¹⁻³ Joseph Canner, MHS,³ Eric Schneider, PhD,³
Miloslawa Stem, MS,⁴ Elliott Haut, MD, PhD,^{3,4} Francisco Schlottmann, MD,⁵ Arianna Barbetta, MD,⁵
Benedetto Mungo, MD,⁴ Anne Lidor, MD, MPH,⁶ and Daniela Molena, MD⁵

Abstract

Background: Surgery for benign esophageal disease is mostly performed either by general surgeons (GS) or cardiothoracic surgeons (CTS) in the United States. The purpose of this study was to evaluate the effect of surgeon specialty on perioperative outcomes of surgery for benign esophageal diseases.

Materials and Methods: We have conducted a retrospective analysis using the ACS-NSQIP during the period of 2006–2013. Patients who underwent paraesophageal hernia (PEH) repair, gastric fundoplication, or Heller esophagomyotomy were divided into two groups according to the specialty of the surgeon (GS or CTS). Outcomes compared between the two groups using multivariable logistic regression included 30-day mortality, overall morbidity, discharge destination, hospital length of stay (LOS), and readmission rates.

Results: Most of the surgeries were performed by general surgeons (PEH: 97.1%; fundoplication: 97.6%; Heller: 91.6%). Patients had lower comorbidities, better physical condition, and underwent a laparoscopic approach more frequently in the GS group. Regression analysis showed that GS group had a lower mortality rate (operating room, 0.44; 95% confidence interval [CI]: 0.23–0.86; $P = .017$), shorter LOS, and more home discharge for patients undergoing PEH repair. Mortality, morbidity, readmission, LOS, and home discharge were comparable between GS and CTS in fundoplication and Heller esophagomyotomy.

Conclusion: GS perform most of esophageal surgeries for benign diseases. GS group has better outcomes in PEH repair compared with CTS, whereas there is no difference in the overall outcomes between GS and CTS in fundoplication and Heller esophagomyotomy. These results show that specialization is not always the answer to better outcomes. Difference in outcomes, however, might be related to disease severity, approach needed, or case volume.

Keywords: esophageal surgery, benign disease, outcomes

Introduction

PREVIOUS STUDIES HAVE TRIED to address the relationship between specialty training and patient outcomes^{1,2} or assess whether the result of an operation is influenced by it being performed by a general or specialty-trained surgeons.³⁻⁷ Esophageal surgery, in fact, encompasses a large group of

operations for either benign or malignant diseases and in the United States, these are performed, for the most part, either by general surgeons (GS) or cardiothoracic surgeons (CTS). Multiple studies analyzed the relationship between specialty training and patient outcomes in esophagectomy.⁸⁻¹¹ Most of them have shown that specialty matters and better outcomes are achieved when esophagectomy is performed by specialty-

¹Epidemiology and Biostatistics Concentration, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland.

²Department of Surgery, Taibah University School of Medicine, Madinah, Saudi Arabia.

³Department of Surgery, Johns Hopkins Surgery Center for Outcomes Research, Johns Hopkins University School of Medicine, Baltimore, Maryland.

⁴Department of Surgery, Johns Hopkins University School of Medicine, Baltimore, Maryland.

⁵Department of Surgery, Thoracic Surgery Service, Memorial Sloan Kettering Cancer Center, New York, New York.

⁶Department of Surgery, University of Wisconsin, Madison, Wisconsin.

Meeting Presentation: Oral presentation at the 11th Annual Academic Surgical Congress, Jacksonville, Florida.

trained surgeons. It is unknown, however, if specialty is always better, or just only for complex procedures. To our knowledge, no previous reports have studied the relationship between surgical training and other common esophageal operations. Gastroesophageal reflux disease (GERD) is the most common gastrointestinal outpatient diagnosis in the U.S. and the prevalence of hiatal hernias in the population range from 10% to 50%.¹² Achalasia also shows a rising prevalence due to the improvement in diagnostic tools.¹³ Therefore, the purpose of this study was to compare the perioperative outcomes of esophageal surgery for the most common benign esophageal diseases (paraesophageal hernia (PEH), gastroesophageal reflux disease, and achalasia) between GS and CTS in the United States.

Material and Methods

Data source

We have obtained data from the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database¹⁴ and used a retrospective cohort design to explore the relation between specialty training and perioperative outcomes. NSQIP is a nationwide, risk-adjusted, outcome-based program with an emphasis on quality enhancement and high successful rates on many disciplines. The program collects data on over 150 variables, including preoperative risk factors, intraoperative variables, and 30-day postoperative mortality and morbidity outcomes for patients undergoing major surgical procedures in both the inpatient and outpatient setting. Data are gathered and managed by a Surgical Clinical Reviewer who is obligated to complete the ACS-NSQIP training program and participate in ongoing training and conferences. Surgical specialty is a variable defined as the surgical specialty area that best characterizes the principal operative procedure. This is either based on the surgeon's self-declared specialty or the service line/specialty most closely related to the principal operative procedure if the surgeon is privileged to perform cases within multiple specialties or is board certified in multiple specialties. We combined cardiac surgery and thoracic surgery specialties in our analysis. The Institutional Review Board of the Johns Hopkins University School of Medicine approved the study.

Inclusion criteria

Adult patients (18 years and older) who underwent esophageal operations for benign diseases (PEH repair, gastric fundoplication, and Heller's esophagomyotomy) between 2006 and 2013 were included in this study. We used the following current procedural terminology codes for PEH: 39502, 39520, 39530, 39531, 43281, 43282, 43332, 43333, 43334, 43335, 43336, and 43337; for gastric fundoplication: 43280, 43324, 43325, 43326, 43327, and 43328; and for Heller esophagomyotomy: 32665, 43279, 43330, and 43331. Each procedure was analyzed separately to maintain homogeneity between the groups.

Baseline characteristics of the patients

We divided the patients into two groups according to the specialty of the surgeon who performed the operation (GS versus CTS). Baseline characteristics included age, sex, race, the American Society of Anesthesiology (ASA) classification

of the patient's physical condition, body mass index, preoperative comorbidities such as diabetes mellitus (with oral agents or insulin), current history of smoking (within 1 year before the operation), dyspnea, hypertension requiring medication, weight loss (<10% of body weight in last 6 months), steroid use for chronic condition, history of chronic obstructive pulmonary disease, congestive heart failure (CHF), and myocardial infarction within 6 months; the type of the operation, the approach, and emergent versus elective status were also evaluated.

Outcomes

The primary outcome was 30-day mortality. Secondary outcomes included overall morbidity, hospital length of stay (LOS), discharge destination, and readmission rates. Overall morbidity was defined by presence of at least one of the following complications: wound infection, pneumonia, urinary tract infection, return to operating room (OR), venous thromboembolic events, cardiac complication, shock/sepsis, unplanned intubation, bleeding requiring transfusion, renal complication, ventilator dependency >48 hours, and organ/space surgical site infection (SSI).

Statistical analysis

Comparison of baseline characteristics between general surgeons and CTS was done using Pearson's Chi-squared test for categorical variables and two-sample *t*-tests for continuous variables. Matching analysis was performed using either clinically relevant variables and/or those that were statistically significant ($P < .05$) in a logistic regression of specialty as the outcome. After matching for these variables, a multivariable logistic regression analysis was conducted for prediction of the 30-day mortality, overall morbidity, and readmission. Negative binomial regression model was used for estimation of the hospital LOS. Statistical analyses were performed using Stata/MP version 12 (StataCorp LP, College Station, TX). Statistical significance was indicated by P -value $< .05$.

Results

Patient characteristics (Table 1)

Paraesophageal hernia. During the study period, 18,878 PEH repairs were performed. Most of these operations were done by GS (97.1%). GS used a laparoscopic approach more often ($P < .001$), whereas CTS used a transthoracic approach in a significantly higher number of cases ($P < .001$). CTS operated on older patients and with significantly higher preoperative comorbidity (Table 1).

Gastric fundoplication. A total of 20,412 cases were observed and GS performed 19,919 of them (97.6%). Laparoscopic approach was again used more often by GS than CTS ($P < .001$). A transthoracic approach, although more commonly used by CTS ($P < .001$), was very uncommon in this group. Patients of CTS were older and had higher comorbidities than patients of GS (Table 2).

Heller esophagomyotomy. The total number of cases was 2948. GS performed 91.6% of the cases. There was no

TABLE 1. BASELINE DEMOGRAPHIC AND CLINICAL CHARACTERISTICS (PARAESOPHAGEAL HERNIA)

<i>Characteristic</i>	<i>Total 18,878</i>	<i>General surgery 18,337 (97.13%)</i>	<i>Cardiothoracic surgery 523 (2.77%)</i>	<i>P</i>
Age, mean $\pm$ SD	57.15 $\pm$ 15.36	56.91 $\pm$ 15.35	65.45 $\pm$ 13.58	<.001
Male (%)	4593 (24.39)	4424 (24.18)	169 (31.30)	<.001
Race (%)				
White	14,409 (78.65)	13,971 (78.54)	438 (82.33)	<.001
Black	1907 (10.41)	1897 (10.66)	10 (1.88)	<.001
Hispanic	1849 (10.09)	1767 (9.93)	82 (15.41)	<.001
Other	156 (0.85)	154 (0.87)	2 (0.38)	<.001
ASA classification (%)				
No disturb/mild disturb	8184 (43.39)	7935 (43.31)	249 (46.20)	.005
Serious disturb	10,104 (53.57)	9841 (53.71)	263 (48.79)	.005
Life threat/moribund	573 (3.04)	546 (2.98)	27 (5.01)	.005
Approach (%)				
Laparoscopic	13,732 (72.74)	13,416 (73.16)	316 (58.41)	<.001
Open	5146 (27.26)	4921 (26.84)	225 (41.59)	<.001
Transthoracic	1129 (6)	1023 (5.6)	106 (19.6)	<.001
Body mass index	35.36 $\pm$ 9.51	35.52 $\pm$ 9.55	30.14 $\pm$ 5.70	<.001
Diabetes (%)	2539 (13.45)	2494 (13.60)	45 (8.32)	<.001
Current smoker (with in 1 year) (%)	1683 (8.92)	1639 (8.94)	44 (8.13)	.517
Dyspnea (%)	2906 (15.39)	2787 (15.2)	119 (22)	<.001
History of COPD (%)	765 (4.05)	728 (3.97)	37 (6.84)	.001
History of CHF (%)	72 (0.38)	68 (0.37)	4 (0.74)	.171
Hypertension (%)	10,069 (53.35)	9775 (53.31)	294 (53.34)	.635
Weight loss (%)	303 (1.61)	280 (1.53)	23 (4.25)	<.001
Steroid use (%)	534 (2.83)	516 (2.81)	18 (3.33)	.478
Emergency case (%)	633 (3.35)	615 (3.35)	18 (3.33)	.973

ASA, American Society of Anesthesiology; COPD, chronic obstructive pulmonary disease; SD, standard deviation; CHF, congestive heart failure.

TABLE 2. BASELINE DEMOGRAPHIC AND CLINICAL CHARACTERISTICS (GASTRIC FUNDOPLICATION)

<i>Characteristic</i>	<i>Total 20,412</i>	<i>General surgery 19,919 (97.58%)</i>	<i>Cardiothoracic surgery 493 (2.42%)</i>	<i>P</i>
Age, mean $\pm$ SD	54.89 $\pm$ 14.99	54.80 $\pm$ 14.99	58.22 $\pm$ 14.79	<.001
Male (%)	7145 (35.06)	6955 (34.98)	190 (38.54)	.102
Race (%)				
White	16,319 (84.71)	15,931 (84.79)	388 (81.51)	<.001
Black	1205 (6.26)	1190 (6.33)	15 (3.15)	<.001
Hispanic	1476 (7.66)	1411 (7.51)	65 (13.66)	<.001
Other	264 (1.37)	256 (1.36)	8 (1.68)	<.001
ASA classification (%)				
No disturb/mild disturb	12,616 (61.88)	12,356 (62.11)	260 (52.74)	<.001
Serious disturb	7389 (36.24)	7178 (36.08)	211 (42.80)	<.001
Life threat/moribund	382 (1.87)	360 (1.81)	22 (4.46)	<.001
Approach (%)				
Laparoscopic	18,559 (90.92)	18,254 (91.64)	305 (61.87)	<.001
Open	1853 (9.08)	1665 (8.36)	188 (38.13)	<.001
Transthoracic	26 (0.12)	6 (0.03)	20 (4.05)	<.001
Body mass index	30.45 $\pm$ 6.96	30.49 $\pm$ 7.00	29.09 $\pm$ 5.26	<.001
Diabetes (%)	1745 (8.55)	1709 (8.58)	36 (7.30)	.316
Current smoker (with in 1 year) (%)	2688 (13.17)	2630 (13.20)	58 (11.76)	.350
Dyspnea (%)	2542 (12.45)	2449 (15.2)	93 (18.87)	<.001
History of COPD (%)	894 (4.38)	864 (4.34)	30 (6.09)	.061
History of CHF (%)	53 (0.26)	51 (0.26)	2 (0.41)	.519
Hypertension (%)	8572 (42.00)	8355 (41.95)	217 (44.02)	.358
Weight loss (%)	500 (2.45)	479 (2.40)	21 (4.26)	.008
Steroid use (%)	823 (4.03)	799 (4.01)	24 (4.87)	.339
Emergency case (%)	278 (1.36)	264 (1.33)	14 (2.84)	.004

ASA, American Society of Anesthesiology; COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure; SD, standard deviation.

TABLE 3. BASELINE DEMOGRAPHIC AND CLINICAL CHARACTERISTICS (HELLER ESOPHAGOMYOTOMY)

Characteristic	Total 2948	General surgery 2701 (91.62%)	Cardiothoracic surgery 247 (8.38%)	P
Age, mean $\pm$ SD	52.78 $\pm$ 16.53	52.81 $\pm$ 16.41	52.53 $\pm$ 17.85	.802
Male (%)	1492 (50.75)	1362 (50.58)	130 (52.63)	.536
Race (%)				
White	2095 (74.71)	1908 (74.39)	187 (78.24)	.123
Black	309 (11.02)	292 (11.38)	17 (7.11)	.123
Hispanic	335 (11.95)	303 (11.81)	32 (13.39)	.123
Other	65 (2.32)	62 (2.42)	3 (1.26)	.123
ASA classification (%)				
No disturb/mild disturb	1861 (63.15)	1707 (63.22)	154 (62.35)	.017
Serious Disturb	1034 (35.09)	951 (35.22)	83 (33.60)	.017
Life Threat/Moribund	52 (1.76)	42 (1.56)	10 (4.05)	.017
Approach (%)				
Laparoscopic	2183 (74.05)	2001 (74.08)	182 (73.68)	.891
Open	765 (25.95)	700 (25.92)	65 (26.32)	.891
Transthoracic	223 (7.56)	184 (6.81)	39 (15.78)	<.001
Body mass index	27.45 $\pm$ 6.66	27.55 $\pm$ 6.78	26.32 $\pm$ 5.11	.006
Diabetes (%)	271 (9.19)	252 (9.33)	19 (7.69)	.394
Current smoker (with in 1 year) (%)	459 (15.57)	413 (15.29)	46 (18.62)	.167
Dyspnea (%)	212 (7.19)	190 (7.03)	22 (8.91)	.475
History of COPD (%)	101 (3.43)	88 (3.26)	13 (5.26)	.097
History of CHF (%)	7 (0.24)	6 (0.22)	1 (0.40)	.572
Hypertension (%)	1042 (35.35)	967 (35.80)	75 (30.36)	.087
Weight loss (%)	402 (13.64)	362 (13.40)	40 (16.19)	.221
Steroid use (%)	59 (2.00)	56 (2.07)	3 (1.21)	.356
Emergency case (%)	34 (1.15)	29 (1.07)	5 (2.02)	.180

ASA, American Society of Anesthesiology; COPD, chronic obstructive pulmonary disease; CHF, congestive heart failure; SD, standard deviation.

statistically significant difference in the baseline characteristics between the patients of CTS and GS, except for the ASA classification, the number of obese patients, and the number of procedures done with a transthoracic approach (Table 3).

Unadjusted outcomes

Paraesophageal hernia. Unadjusted outcomes showed that GS group had lower mortality, overall morbidity (return to OR, sepsis/shock, unplanned intubation, and bleeding requiring transfusion), LOS, and facility discharge.

Gastric fundoplication. Unadjusted outcomes showed that GS group had lower overall morbidity (wound infection and bleeding requiring transfusion) and shorter LOS.

Heller esophagomyotomy. Unadjusted outcomes were comparable between the two groups and there was no significant difference in the perioperative outcomes

Adjusted outcomes after matching for baseline characteristics

Paraesophageal hernia. After matching for baseline differences, GS group had lower mortality rate (OR, 0.44; 95% confidence interval [CI]: 0.23–0.86; $P = .017$), shorter LOS, and higher home discharge rates (OR, 1.82; 95% CI: 1.31–2.53; $P < .001$). Additionally, GS group had lower odds of some morbidity such as return to OR and occurrence of shock

(Table 4). There was no significant difference between the two groups regarding overall morbidity and readmission rates.

Gastric fundoplication. After matching for baseline characteristics, GS group had lower odds of superficial SSI (Table 5). There was no significant difference in mortality, overall morbidity, home discharge, hospital LOS, and readmission between both groups.

Heller esophagomyotomy. Results were the same as the unadjusted outcome analysis, with no significant difference between the two groups in the perioperative outcomes (Table 6).

Discussion

In this study we compared the perioperative outcomes of surgeries for benign esophageal diseases between GS group and CTS group. Most of the esophageal surgeries for benign diseases were performed by GS (97.1% of paraesophageal hernias, 97.6% of gastric fundoplications, and 91.6% of Heller esophagomyotomies). For PEH surgery, GS group showed lower mortality rates, less morbidity in terms of return to the OR and shock, shorter LOS, and higher home discharge. Both groups had similar 30-day mortality, overall morbidity, LOS, and readmission rates for gastric fundoplication and Heller esophagomyotomy. These interesting results suggest that specialization *per se* might not be a determinant factor to influence outcome of esophageal surgery for benign esophageal diseases.

Previous studies have compared outcomes of esophagectomy between general and thoracic surgeons in the United

TABLE 4. ADJUSTED MULTIVARIABLE ANALYSIS OF OUTCOMES BY SURGICAL SPECIALTY, COMPARING GENERAL VERSUS CARDIOTHORACIC SURGEONS (REFERENCE GROUP) IN MATCHED COHORT, (PARAESOPHAGEAL HERNIA)

Outcome	Adjusted OR ^a	P	95% (CI)
30-day mortality	0.44	.017	0.23–0.86
Overall morbidity	0.84	.200	0.65–1.10
Wound infection (superficial)	0.85	.627	0.43–1.66
Wound infection (deep)	1.17	.830	0.26–4.77
Pneumonia	1.01	.971	0.56–1.82
Urinary tract infection	1.60	.259	0.71–3.61
Return to OR	0.60	.010	0.41–0.88
Venous thromboembolism	5.59	.087	0.78–40.24
Cardiac complications	1.22	.727	0.39–3.90
Sepsis	0.82	.557	0.41–1.60
Shock	0.46	.011	0.25–0.84
Unplanned intubation	0.87	.389	0.44–1.37
Bleeding transfusion (surgical start time up to and including 72 hours)	0.66	.087	0.41–1.06
Renal complications (progressive +acute renal failure)	0.48	.162	0.17–1.34
On ventilator >48 hours	1.10	.755	0.59–2.05
Organ space SSI	0.93	.852	0.43–1.99
Hospital length of stay, days ^b	0.76	<.001	0.70–0.83
Discharge destination (home versus facility)	1.82	<.001	1.31–2.53
Readmission	0.79	.449	0.43–1.45

^aAdjusted for: ASA classification, hypertension smoking status, history of COPD, history of congestive heart failure, and steroid therapy.

^bNegative binomial regression model was used for this outcome and the incidence rate ratio (IRR) was calculated.

ASA, American Society of Anesthesiology; OR, operating room; CI, confidence interval; COPD, chronic obstructive pulmonary disease; SSI, surgical site infection.

States. Dimick et al.⁸ concluded that although thoracic surgeons had better mortality odds, hospital and surgeon's volume had a higher influence on mortality. Gopaldas et al.⁹ affirmed that surgeon subspecialty was associated with mortality and failure to rescue (defined as death from complication). They reported a reduction in both parameters in higher hospital and surgeon volume and in surgeons with a predominant cardiac and thoracic surgery practice. Ferraris et al.¹⁵ showed that when patients were matched for comorbidities and serious preoperative risk factors, thoracic surgeons had improved outcomes. Smith et al.¹⁰ on the other hand, using the University Health system Consortium (UHC) clinical database, concluded that while thoracic surgeons favored Ivor Lewis approach and general surgeons the blunt transhiatal approach, specialty training did not seem to affect outcomes of esophagectomy. Using again NSQIP database and evaluating over 5000 esophagectomies, we also previously showed that some specific morbidities and LOS were higher for surgery performed by GS.¹¹ All of the aforementioned studies compared the outcomes of a very complex surgery such as esophagectomy, and data support that complicated cases are better treated by specialist surgeons. However, is this also true for less complicated surgeries?

TABLE 5. ADJUSTED MULTIVARIABLE ANALYSIS OF OUTCOMES BY SURGICAL SPECIALTY, COMPARING GENERAL VERSUS CARDIOTHORACIC SURGEONS (REFERENCE GROUP) IN MATCHED COHORT, (FUNDOPLICATIONS)

Outcome	Adjusted OR ^a	P	95% (CI)
Overall morbidity	1.27	.152	0.92–1.75
Wound infection (superficial)	0.56	.017	0.35–0.90
Wound infection (deep)	1.62	.635	0.22–11.81
Pneumonia	1.73	.154	0.81–3.70
Urinary tract infection	1.72	.285	0.64–4.64
Return to OR	1.79	.105	0.88–3.63
Venous thromboembolism	2.68	.327	0.37–19.29
Cardiac complications	0.46	.294	0.11–1.94
Sepsis	1.00	.990	0.49–2.05
Shock	4.58	.131	0.64–33.04
Unplanned intubation	1.73	.231	0.70–4.27
Bleeding transfusion (surgical start time up to and including 72 hours)	0.83	.631	0.39–1.77
Renal complications (progressive +acute renal failure)	2.88	2.99	0.39–21.23
On ventilator >48 hours	2.21	.119	0.81–6.00
Organ space SSI	1.48	.505	0.47–4.66
Hospital length of stay, days ^b	0.98	.483	0.88–1.06
Discharge destination (home versus facility)	0.86	.678	0.44–1.72
Readmission	0.81	.587	0.38–1.74

^aAdjusted for: Diabetes, hypertension smoking status, history of COPD, history of congestive heart failure, weight loss, and steroid therapy.

^bNegative binomial regression model was used for this outcome and the incidence rate ratio (IRR) was calculated.

OR, operating room; CI, confidence interval; COPD, chronic obstructive pulmonary disease; SSI, surgical site infection.

Overall surgery for benign esophageal diseases shows very low morbidity and 30-day mortality in previously reported large series of patients.^{16–18} It is possible that for surgeries that are not technically complex, specialization does not offer significant short-term benefits. However, the impact of specialization on long-term outcomes remains unknown.

It is worth to mention, however, that GS favored the minimally invasive approach and operated on healthier and younger patients compared with CTS. Moreover, case complexity as the size of the paraesophageal hernia or a previous failed repair was not accounted for and may have significantly affected the approach choice as well as the outcome. A more complex hernia in fact may have been more frequently referred to a thoracic surgeon and a transthoracic approach preferred either due to the hernia complexity or the surgeon's personal preference. A transthoracic approach, especially an open thoracotomy, is associated with higher odds of morbidity than a laparoscopic approach. Mungo et al.,¹⁹ in fact, showed that a transthoracic approach for repair of paraesophageal hernias had significantly increased odds of overall (OR 2.73 95% CI 1.88–3.96) and serious morbidity (OR 2.49 95% CI 1.54–4.00) compared with the laparoscopic approach. Although a thoracotomy might be necessary in case of multiple previous abdominal PEH repairs or other

TABLE 6. ADJUSTED MULTIVARIABLE ANALYSIS OF OUTCOMES BY SURGICAL SPECIALTY, COMPARING GENERAL VERSUS CARDIOTHORACIC SURGEONS (REFERENCE GROUP) IN MATCHED COHORT, (HELLER ESOPHAGOMYOTOMY)

Outcome	Adjusted OR ^a	P	95% (CI)
Overall morbidity	1.18	.600	0.64–2.19
Wound infection (superficial)	0.96	.959	0.22–4.25
Pneumonia	0.65	.430	0.22–1.90
Urinary tract infection	1.28	.816	0.17–9.83
Return to OR	2.74	.165	0.66–11.35
Cardiac complications	0.56	.610	0.06–5.10
Sepsis	1.51	.694	0.19–11.92
Shock	0.99	.989	0.12–7.80
Bleeding transfusion (surgical start time up to and including 72 hours)	0.35	.197	0.07–1.72
On ventilator >48 hours	3.88	.226	0.43–34.93
Hospital length of stay, days ^b	0.91	.108	0.81–1.02
Discharge destination (home versus facility)	0.15	.086	0.02–1.31
Readmission	0.32	.095	0.09–1.22

^aAdjusted for: ASA classification, diabetes, smoking status, dyspnea, history of COPD, history of congestive heart failure, weight loss, and steroid therapy.

^bNegative binomial regression model was used for this outcome and the incidence rate ratio (IRR) was calculated.

ASA, American Society of Anesthesiology; OR, operating room; CI, confidence interval; COPD, chronic obstructive pulmonary disease.

abdominal surgeries, a paraesophageal hernia, which was never treated before, might still be repaired through a thoracotomy if referred to a thoracic surgeon who is not familiar with laparoscopic techniques.

Our results might also reflect a volume–outcome relationship. The inverse association between hospital/surgeons volume and postoperative mortality has been well established for most complex surgeries.²⁰ Esophagectomy is not an exception, and there is consensus that surgeons/hospitals with higher volume of patients do have better outcomes.^{21,22} Even if this relationship has never been demonstrated for esophageal surgery done for benign disease, it is logical to think that volume has a positive influence on outcomes for this type of surgery—and most cases are done by GS in the United States. Regrettably, we were not able to distinguish the surgeon's or hospital's volume in our series and account for differences across groups.

The results of our study should be interpreted in light of some limitations. First, NSQIP does not provide data on the center or surgeon volume, which might affect the relation between specialty training and surgical outcomes. It also does not provide information about esophageal fellowship training without a corresponding Board (i.e., surgical oncology, gastrointestinal surgery), preventing us to account for specific surgical skills. Second, this administrative database does not provide long-term outcomes, it only measures short-term outcomes with 30 postoperative days follow-up and since these surgeries have a very low risk of perioperative morbidities, long-term outcomes might be a more relevant target to investigate. Finally, details about the complexity of cases

(type of PEH, reoperations after failed previous surgery, previous abdominal or thoracic surgery, etc.) are not provided by NSQIP, and possibly more difficult cases might have been referred with higher frequency to a specialized surgeon, therefore introducing confounders in our study. However, to our knowledge, our study is the first study that looked at the effect of specialty training on the outcomes of surgeries for benign esophageal diseases. Beside the limitations of the ACS-NSQIP, it is a nationally validated database specifically designed for surgical outcomes with a large sample of esophageal operations from different hospital categories in the United States, which added unique advantages to our study. For this reason, we believe our study provides additional information to the current literature.

In conclusion, general surgeons treat most of the benign esophageal diseases like GERD, achalasia, and paraesophageal hernias in the United States. Our data show that GS group have lower mortality rates, shorter hospital LOS, and higher home discharge for PEH operations and slightly better specific morbidity for PEH and funduplications. However, older sicker patients with more severe disease handled by thoracic surgeons more frequently might explain these differences. Most certainly the more frequent use of the laparoscopic approach and the higher volume of cases are positive factors in favor of GS. Case complexity, surgeon's volume, and long-term outcomes are not measurable with NSQIP and other large volume databases should be used to better understand the role of specialization in benign foregut surgery.

Disclosure Statement

None of the authors has any declarations related to this study.

Dr. Elliott Haut is the primary investigator of a grant (1R01HS024547-01) from the Agency for Healthcare Research and Quality (AHRQ) titled “Individualized Performance Feedback on Venous Thromboembolism Prevention Practice.” Dr. Haut is the primary investigator of a contract (CE-12-11-4489) with The Patient-Centered Outcomes Research Institute (PCORI) titled “Preventing Venous Thromboembolism: Empowering Patients and Enabling Patient-Centered Care through Health Information Technology.” Dr. Haut receives royalties from Lippincott, Williams, Wilkins for a book—“Avoiding Common ICU Errors.” Dr. Haut is a paid consultant and speaker for the “Preventing Avoidable Venous Thromboembolism—Every Patient, Every Time” VHA/Vizient IMPERATIV® Advantage Performance Improvement Collaborative. Dr. Haut is a paid consultant and speaker for the Illinois Surgical Quality Improvement Collaborative “ISQIC.” Dr. Haut was the paid author of an article commissioned by the National Academies of Medicine titled “Military Trauma Care's Learning Health System: The Importance of Data-Driven Decision Making” which was used to support the report titled “A National Trauma Care System: Integrating Military and Civilian Trauma Systems to Achieve Zero Preventable Deaths After Injury.”

References

1. Sharp LK, Bashook PG, Lipsky MS, et al. Specialty board certification and clinical outcomes: The missing link *Acad Med* 2002;77:534–542.
2. Grosch EN. Does specialty board certification influence clinical outcomes? *J Eval Clin Pract* 2006;12:473–481.

3. da Silva PS, de Aguiar VE, Waisberg J. Pediatric surgeon vs general surgeon: Does subspecialty training affect the outcome of appendicitis? *Pediatr Int* 2014;56:248–253.
4. Etzioni DA, Young-Fadok TM, Cima RR, et al. Patient survival after surgical treatment of rectal cancer: Impact of surgeon and hospital characteristics *Cancer* 2014;120:2472–2481.
5. Tieu B, Schipper P. Specialty matters in the treatment of lung cancer *Semin Thorac Cardiovasc Surg* 2012;24:99–105.
6. von Meyenfeldt EM, Gooiker GA, van Gijn W, et al. The relationship between volume or surgeon specialty and outcome in the surgical treatment of lung cancer: A systematic review and meta-analysis. *J Thorac Oncol* 2012;7:1170–1178.
7. Schipper PH, Diggs BS, Ungerleider RM, et al. The influence of surgeon specialty on outcomes in general thoracic surgery: A national sample 1996 to 2005. *Ann Thorac Surg* 2009;88:1566–1572; discussion 1572–1563.
8. Dimick JB, Goodney PP, Orringer MB, et al. Specialty training and mortality after esophageal cancer resection. *Ann Thorac Surg* 2005;80:282–286.
9. Gopaldas RR, Bhamidipati CM, Dao TK, et al. Impact of surgeon demographics and technique on outcomes after esophageal resections: A nationwide study. *Ann Thorac Surg* 2013;95:1064–1069.
10. Smith BR, Hinojosa MW, Reavis KM, et al. Outcomes of esophagectomy according to surgeon's training: General vs. thoracic. *J Gastrointest Surg* 2008;12:1907–1911.
11. Khoushhal Z, Canner J, Schneider E, et al. Influence of specialty training and trainee involvement on perioperative outcomes of esophagectomy. *Ann Thorac Surg* 2016;102:1829–1836.
12. Davis SS, Jr. Current controversies in paraesophageal hernia repair. *Surg Clin North Am* 2008;88:959–978, vi.
13. O'Neill OM, Johnston BT, Coleman HG. Achalasia: A review of clinical diagnosis, epidemiology, treatment and outcomes. *World J Gastroenterol* 2013;19:5806–5812.
14. User guide for the 2015 ACS-NSQIP participants use data file (PUF). American College of Surgeons, National Surgical Quality Improvement Program. Revised Version October 2016.
15. Ferraris VA, Saha SP, Davenport DL, et al. Thoracic surgery in the real world: Does surgical specialty affect outcomes in patients having general thoracic operations? *Ann Thorac Surg* 2012;93:1041–1047; discussion 1047–1048.
16. Mungo B, Molena D, Stem M, et al. Thirty-day outcomes of paraesophageal hernia repair using the NSQIP database: Should laparoscopy be the standard of care? *J Am Coll Surg* 2014;219:229–236.
17. Molena D, Mungo B, Stem M, et al. Hospitalization for esophageal achalasia in the United States. *World J Gastrointest Endosc* 2015;7:1096–1102.
18. Schuchert MJ, Luketich JD, Landreneau RJ, et al. Minimally-invasive esophagomyotomy in 200 consecutive patients: Factors influencing postoperative outcomes. *Ann Thorac Surg* 2008;85:1729–1734.
19. Molena D, Mungo B, Stem M, et al. Outcomes of operations for benign foregut disease in elderly patients: A National Surgical Quality Improvement Program database analysis. *Surgery* 2014;156:352–360.
20. Birkmeyer JD, Siewers AE, Finlayson EV, et al. Hospital volume and surgical mortality in the United States. *N Engl J Med* 2002;346:1128–1137.
21. Markar SR, Karthikesalingam A, Thrumurthy S, et al. Volume-outcome relationship in surgery for esophageal malignancy: Systematic review and meta-analysis 2000–2011. *J Gastrointest Surg* 2012;16:1055–1063.
22. Dimick JB, Wainess RM, Upchurch GR, Jr., et al. National trends in outcomes for esophageal resection. *Ann Thorac Surg* 2005;79:212–216; discussion 217–218.

Address correspondence to:
Daniela Molena, MD
Division of Thoracic Surgery
Department of Surgery
Memorial Sloan Kettering Cancer Center
1275 York Avenue
New York, NY 10065-6007

E-mail: molenad@mskcc.org