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Clinical Research

# Emergent Esophagectomy in Patients with Esophageal Malignancy Is Associated with Higher Rates of Perioperative Complications but No Independent Impact on Short-Term Mortality

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**Background:** Data on perioperative outcomes of emergent versus elective resection in esophageal cancer patients requiring esophagectomy are lacking. We investigated whether emergent resection was associated with increased risks of morbidity and mortality.
**Methods:** Data on patients with esophageal malignancy who underwent esophagectomy from 2005 to 2020 were retrospectively analyzed from the American College of Surgeons National Surgical Quality Improvement Program database. Thirty-day complication and mortality rates were compared between emergent esophagectomy (EE) and non-emergent esophagectomy. Logistic regression assessed factors associated with complications and mortality.
**Results:** Of 10,067 patients with malignancy who underwent esophagectomy, 181 (1.8%) had EE, 64% had preoperative systemic inflammatory response syndrome, sepsis, or septic shock, and 44% had bleeding requiring transfusion. The EE group had higher American Society of Anesthesiologists (ASA) class and functional dependency. More transhiatal esophagectomies and diversions were performed in the EE group. After EE, the rates of 30-day mortality (6.1% vs. 2.8%), overall complications (65.2% vs. 44.2%), bleeding, pneumonia, prolonged intubation, and positive margin (17.7% vs. 7.4%) were higher, while that of anastomotic leak was similar. On adjusted logistic regression, older age, lower albumin, higher ASA class, and fragility were associated with increased complications and mortality. McKeown esophagectomy and esophageal diversion were associated with a higher risk of postoperative complications. EE was associated with 30-day postoperative complications (odds ratio, 2.39; 95% confidence interval, 1.66–3.43; p<0.0001).
**Conclusion:** EE was associated with a more than 2-fold increase in complications compared to elective procedures, but no independent increase in short-term mortality. These findings may help guide data-driven critical decision-making for surgery in select cases of complicated esophageal malignancy.

**Keywords:** Emergent, Esophagectomy, Perioperative outcomes, National Surgical Quality Improvement Program

## Introduction

Esophageal cancer is the seventh most common malignancy worldwide and the sixth leading cause of cancer-related mortality [1]. In the United States, 17,650 new cases of esophageal cancer are estimated each year, with 16,080 deaths annually [2]. Esophagectomy is the standard of care in the management of patients with non-metastatic, resectable esophageal cancer. Esophagectomy is associated with high morbidity, such as anastomotic leak, prolonged intubation, pneumonia, and reoperation [3,4]. Esophagectomy for malignancy is typically performed in the elective set-

ting, with careful selection, nutritional optimization of patients, and possible neoadjuvant therapy. Occasionally, however, esophageal cancer may require emergent surgery. Perforation due to iatrogenic injury from endoscopic procedures or rupture of the tumor after chemoradiation can occur, as well as uncontrollable bleeding and sepsis, all of which confer high mortality rates if not treated promptly [5-8]. In the setting of esophageal malignancy requiring emergent surgery, the risks and benefits of emergent surgery must be considered thoroughly and holistically for each patient.

Prior studies have addressed the impact of emergent versus elective esophagectomy on perioperative outcomes. In a single-institution 36-year retrospective review of 3,015 patients who underwent esophagectomy for both benign and malignant causes, emergent esophagectomy was associated with higher complication rates than elective esophagectomy. There was, however, no difference in survival between these 2 groups up to 5 years [9]. Two additional studies investigating emergent surgery for esophageal perforations both found that while there was high morbidity associated with emergent esophagectomy, emergent surgery was necessary and effective in patients with perforation [9,10]. Interestingly, postoperative quality of life, another consideration in the setting of emergent surgery, was comparable in patients who underwent elective versus emergent esophagectomy with cervical anastomosis [11].

While these data demonstrate increased morbidity for emergent esophagectomy, they are limited by smaller sample sizes, the number of emergent operations, and single-institutional data. Importantly, these studies combine both benign and malignant diseases, further limiting the interpretation of perioperative outcomes and mortality in esophageal malignancies requiring emergent surgery. Therefore, this study aimed to utilize a national multi-institutional database to investigate the differences in perioperative outcomes, morbidity, and mortality for emergent and elective esophagectomies in patients with esophageal cancer and to identify independent risk factors of morbidity and mortality.

## Methods

### Database and patient population

The American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database was queried for patients with esophageal cancer who underwent esophagectomy between January 2005 and December 2020 including reported Procedure Targeted Participant User Files (PUF) from 2016 to 2020. ACS-NSQIP contains over 150 variables captured from de-identified surgical cases performed in over 600 participating hospitals. These variables include preoperative characteristics, intraoperative events, and postoperative outcomes within 30 days of the operation. Additionally, the Procedure Targeted PUF for esophagectomy was used, which provides an additional 20 relevant variables with data regarding preoperative cancer staging, neoadjuvant chemotherapy and radiation, and procedural-specific complications including anastomotic leak.

Current Procedural Terminology codes were used to identify patients who underwent a transhiatal esophagectomy (43107), Ivor Lewis esophagectomy (43117), McKeown esophagectomy (43112), and esophagectomy without reconstruction and cervical esophagostomy for diversion (43124). Only patients with the International Classification of Diseases and Clinical Modification (ICD) diagnosis codes for malignant esophageal diseases were included. The ICD-9 codes included were: 150, malignant neoplasm of esophagus; 150.0, malignant neoplasm of cervical esophagus; 150.1, malignant neoplasm of thoracic esophagus; 150.2, malignant neoplasm of abdominal esophagus; 150.3, malignant neoplasm of upper third of esophagus; 150.4, malignant neoplasm of middle third of esophagus; 150.5, malignant neoplasm of lower third of esophagus; 150.8, malignant neoplasm of other specified part of esophagus; 150.9, malignant neoplasm of esophagus, unspecified site; and 151.0, malignant neoplasm of cardia. ICD-10 diagnostic codes included C15, malignant neoplasm of esophagus; C15.3, malignant neoplasm of upper third of esophagus; C15.4, malignant neoplasm of middle third of esophagus; C15.5, malignant neoplasm of lower third of esophagus; C15.8, malignant neoplasm of overlapping sites of esophagus; C15.9, malignant neoplasm of esophagus, unspecified; C16.0, malignant neoplasm of cardia. Patients who underwent esophagectomy for benign esophageal pathologies including trauma were excluded. Given the de-identified nature of the data, this study did not require approval by an institutional review board.

### Preoperative patient demographics, clinical characteristics, and study outcomes

The following preoperative variables were studied: demographic and anthropomorphic information (age, sex, race, body mass index [BMI]), American Society of Anesthesiologists (ASA) class, comorbid conditions (diabetes,

hypertension [on medications], severe chronic obstructive pulmonary disease, congestive heart failure within 30 days before surgery, and end-stage renal disease requiring dialysis), weight loss greater than 10% within 6 months, smoking within 1 year before surgery, and laboratory results for preoperative serum creatinine and albumin. The NSQIP 5-factor modified frailty index was calculated for each patient based on diabetes mellitus, hypertension, congestive heart failure, chronic obstructive pulmonary disease, and functional dependence and classified into mild, moderate, and severe [12]. The tumor clinical staging was calculated from the reported tumor-node-metastasis (TNM) staging, as well as esophageal malignancy type (adenocarcinoma versus squamous cell carcinoma) based on the 8th edition of the American Joint Committee on Cancer (AJCC) staging of epithelial cancers of the esophagus and esophagogastric junction. Receipt of neoadjuvant chemotherapy and radiation within 90 days of surgery was evaluated. Operative data studied were the surgical technique (Ivor Lewis, transhiatal, McKeown, and whether patients had reconstruction or not), the surgical specialty of the operating surgeon, and operative time.

The primary outcomes of the study were 30-day postoperative complications, including bleeding requiring transfusion, surgical site infection, anastomotic leak, pneumonia, pulmonary embolism, prolonged intubation (>48 hours), unplanned re-intubation, urinary tract infection, acute renal failure, myocardial infarction, cardiac arrest requiring cardiopulmonary resuscitation, deep venous thrombosis (DVT), stroke and sepsis. Secondary outcomes included the rates of reoperation, readmission, and extended length of hospital stay (LOS >7 days and LOS >30 days), the rate of any complications, the rate of major complications (excluding urinary tract infections and superficial surgical site infections), discharge destination, and death.

Esophagectomy cases were defined as emergent if the surgery was coded as emergent per ACS-NSQIP or for any of the following: ASA Class 5, preoperative systemic inflammatory response syndrome (SIRS), sepsis, or septic shock, requirement of >4 units of red blood cells in 72 hours before resection, and/or preoperative ventilator dependency. These parameters were utilized as a surrogate indicator of acute patient illness and contraindication for elective oncologic resection [13].

### Statistical analyses

Patients were stratified by the acuity of the surgical procedure into emergent esophagectomy versus elective resection groups. Given the patient sample size difference in the emergent group relative to the total patient population, we did not report a non-adjusted statistical analysis for comparisons between the 2 groups. Given the large overall study size and multicenter registry database use, regression analysis was performed [14]. To evaluate factors independently associated with mortality and morbidity after esophagectomy, binary logistic regression and multiple linear regression analyses with a backward selection procedure were constructed with the following covariates: patient age, sex, BMI, NSQIP frailty index, ASA classification, surrogates of nutritional status (history of weight loss >10% and prepropeptide status), tumor characteristics (AJCC clinical staging and neoadjuvant chemoradiation), and surgical factors including operative technique (with and without reconstruction) and operative timing (emergent versus elective). SAS ver. 9.4 (SAS Institute Inc., Cary, NC, US) was used for analyses, and statistical significance was defined as a p-value <0.05.

## Results

### Preoperative patient characteristics and surgical techniques

During the study period, 10,067 patients with an esophageal malignancy were identified, of whom 9,886 patients (98.2%) underwent elective resection, while 181 patients (1.8%) underwent emergent esophagectomy. Of the patients who underwent emergent surgery, 64% had a preoperative SIRS response with sepsis or septic shock, while 44% had bleeding requiring transfusion, and 6.6% were ventilator-dependent. Patients' sociodemographics, preoperative characteristics, and comorbidities are presented in Table 1, while oncological data, neoadjuvant therapy, performing surgeon specialty, and surgical techniques are shown in Table 2.

### Perioperative outcomes

From an oncologic perspective, patients who underwent emergent esophagectomy had higher rates of positive resection margins than those in the elective esophagectomy group (17.65% versus 7.42%). Perioperative complications over 30 days in the emergent esophagectomy and elective esophagectomy groups are shown in Table 3. There were higher rates of bleeding requiring transfusion in the emergent group than in the elective group (29.28% versus 13.05%). Higher rates were also observed for other compli-

**Table 1.** Preoperative demographics, comorbidities, serum creatinine and albumin, functional status, and frailty index in patients who underwent esophagectomy for malignancy in the American College of Surgeons National Surgical Quality Improvement Program database from January 2005 through December 2020

| Characteristic | Total | Non-emergent esophagectomy | Emergent esophagectomy |
|---|---|---|---|
| No. of patients | 10,067 | 9,886 | 181 |
| Age (yr) | 64.0 (58.0–71.0) | 64.0 (58.0–71.0) | 64.0 (57.0–71.0) |
| Male sex | 8,344 (82.92) | 8,187 (82.83) | 157 (87.71) |
| Race | | | |
| Black | 278 (2.76) | 269 (2.72) | 9 (4.97) |
| White | 8,329 (82.74) | 8,201 (82.96) | 128 (70.72) |
| Other | 1,460 (14.50) | 1,416 (14.32) | 44 (24.31) |
| Body mass index (kg/m$^2$) | 26.95 (23.67–30.80) | 26.97 (23.71–30.82) | 28.71 (22.31–56.42) |
| Preoperative serum creatinine | 0.84 (0.70–1.00) | 0.84 (0.71–1.00) | 0.79 (0.65–0.93) |
| Preoperative serum albumin | 3.90 (3.60–4.10) | 3.90 (3.60–4.20) | 3.55 (2.90–3.90) |
| Diabetes | 1,840 (18.28) | 1,806 (18.27) | 24 (18.78) |
| Smoking (within 1 year) | 2,630 (26.12) | 2,580 (26.10) | 50 (27.62) |
| Chronic obstructive pulmonary disease | 810 (8.05) | 792 (8.01) | 18 (9.94) |
| CHF (30 days before surgery) | 33 (0.33) | 31 (0.31) | 2 (1.10) |
| Hypertension (on medications) | 5,049 (50.15) | 4,968 (50.25) | 81 (44.75) |
| ESRD (currently on dialysis) | 14 (0.14) | 12 (0.12) | 2 (1.10) |
| Weight loss (>10% last 6 months) | 2,109 (20.95) | 2,056 (20.80) | 53 (29.28) |
| ASA class | | | |
| 1 | 31 (0.31) | 30 (0.30) | 1 (0.56) |
| 2 | 1,640 (16.32) | 1,624 (16.45) | 16 (8.89) |
| 3 | 7,575 (75.36) | 7,463 (75.60) | 112 (62.22) |
| 4 | 802 (7.98) | 755 (7.65) | 47 (26.11) |
| 5 | 4 (0.04) | 0 | 4 (2.22) |
| Functional status (dependent) | 96 (0.95) | 82 (0.83) | 14 (7.73) |
| Frailty index | | | |
| Mild | 8,185 (81.31) | 8,043 (81.36) | 142 (78.45) |
| Moderate | 1,880 (18.67) | 1,841 (18.62) | 39 (21.55) |
| Severe | 2 (0.02) | 2 (0.02) | 0 |

Values are presented as number, number (%) for categorical variables, or median (25th–75th) for continuous variables.
CHF, congestive heart failure; ESRD, end-stage renal disease; ASA Class, American Society of Anesthesiologists Classification.

cations in emergent esophagectomies compared to non-emergent esophagectomies, including sepsis, septic shock, pneumonia, unplanned intubation, prolonged intubation, DVT/thrombophlebitis, and progressive renal insufficiency. The rates of wound disruption, anastomotic leak, and surgical site infections were similar.

Patients who underwent emergent esophagectomies had a higher 30-day mortality rate (6.08% versus 2.82%), any complication rate (65.19% versus 44.23%), and major complication rate (64.09% versus 40.91%) (Table 4). Overall, the patients in the emergent group had longer hospital stays (15 days versus 10 days) and were more likely to be discharged to another facility besides their home than those in the elective group (17.97% versus 12.18%).

## Factors independently associated with mortality and major complications

Regression analysis was completed to assess mortality, using 8,000 patients' data with 228 events excluding incomplete records (Table 5), and major complications, based on 8,000 patients' data with 3,340 events excluding incomplete records (Table 5). Older age, female sex, lower albumin, higher ASA class (4/5), moderate/severe frailty, and esophagectomy without reconstruction were associated with higher rates of mortality and complications. Additionally, a lower BMI was associated with a higher risk of mortality. ASA class 3 and McKeown esophagectomy were associated with a higher rate of postoperative complica-

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**Table 2.** Pathological stage, neoadjuvant therapy receipt, surgical technique in patients who underwent esophagectomy for malignancy in the American College of Surgeons National Surgical Quality Improvement Program database from January 2005 through December 2020

| Variable | Total | Non-emergent esophagectomy | Emergent esophagectomy |
|---|---|---|---|
| No. of patients | 10,067 | 9,886 | 181 |
| Clinical stage[a] | | | |
| Stage 0 | 29 (1.22) | 29 (1.23) | 0 |
| Stage I | 288 (12.11) | 286 (12.14) | 2 (8.33) |
| Stage II | 375 (15.76) | 373 (15.84) | 2 (8.33) |
| Stage III | 1,344 (56.49) | 1,327 (56.35) | 17 (70.83) |
| Stage IV | 343 (14.42) | 340 (14.44) | 3 (12.50) |
| Neoadjuvant therapy[a),b)] | | | |
| Neoadjuvant chemotherapy | 319 (17.84) | 310 (17.84) | 9 (16.67) |
| Neoadjuvant radiation | 606 (33.97) | 587 (33.93) | 19 (35.19) |
| Hospital admission to operation (day) | 0±5.37 | 0.237±5.36 | 2.43±5.77 |
| Surgical specialty | | | |
| Thoracic surgery | 4,353 (43.24) | 4,284 (43.33) | 69 (38.12) |
| General surgery | 5,607 (55.70) | 5,499 (55.62) | 108 (59.67) |
| Others | 107 (1.06) | 103 (1.04) | 4 (2.21) |
| Surgical technique | | | |
| Ivor Lewis | 5,394 (53.58) | 5,319 (53.80) | 75 (41.44) |
| McKeown | 1,730 (17.18) | 1,697 (17.17) | 33 (18.23) |
| Transhiatal | 2,755 (27.37) | 2,689 (27.20) | 66 (36.46) |
| No reconstruction | 163 (1.62) | 158 (1.60) | 5 (2.76) |
| Total operative time (min) | 349 (265–445) | 349 (266–445) | 334 (250–454) |

Values are presented as number, number (%) for categorical variables, mean±standard deviation, or median (25th–75th) for continuous variables.
[a]Data reported for patients who underwent esophagectomy between 2016 and 2020 (2,866 patients). [b]Neoadjuvant therapy within 90 days before surgery.

tions. Emergency esophagectomy was associated with more complications (odds ratio, 2.39; 95 confidence interval, 1.66–3.43; p<0.001), but there was no independent association with short-term 30-day mortality.

## Discussion

To our knowledge, this is the largest contemporary retrospective study of outcomes for elective versus emergent esophageal resection in patients with esophageal malignancy. We showed that, unsurprisingly, emergent esophageal resection compared to elective resection in this patient population was associated with higher morbidity and mortality rates. However, on adjusted analysis, the risk of suffering a major complication was 2-fold increased in patients that require emergent esophagectomy, but short-term mortality was not independently associated with the emergent nature of the procedure.

A study from 2015 published similar findings to ours [9]. In this study, the authors investigated the incidence of mortality and safety outcomes after emergent esophagectomy for esophageal perforation in the setting of both benign and malignant diseases. They reported that there were higher rates of complications in the emergent group than in the elective group, but noted no significant differences in 30-day or 6-month survival. When further analyzing survival for just patients with malignant disease (2,328 patients, of whom 38 [1.6%] underwent emergent esophagectomy). Seo et al. [9] found that the survival was again similar at 30 days and 6 months. These data, along with our data, make it reasonable to question if emergent esophagectomy, when necessary, independently increases the risk of preoperative mortality. These findings provide useful clinical insights for when a surgeon must weigh the risks and benefits of pursuing emergent surgery in a patient with esophageal malignancy. All decisions to pursue surgery are patient-centered and individualized to that patient's indications, comorbidities, and assessment of likely postoperative outcomes. Nonetheless, prior studies have shown an association between emergent procedures and higher morbidity [15-17]. This is an important consideration that must be factored into decisions and informed discussions about emergent esophagectomy in the setting of cancer.

The factors that increased the risk of morbidity and mor-

**Table 3.** Thirty-day perioperative complications in patients who underwent esophagectomy for malignancy in the American College of Surgeons National Surgical Quality Improvement Program database from January 2005 through December 2020

| Thirty-day perioperative complications | Total | Non-emergent esophagectomy | Emergent esophagectomy |
|---|---|---|---|
| No. of patients | 10,067 | 9,886 | 181 |
| Bleeding requiring transfusion | 1,343 (13.34) | 1,290 (13.05) | 53 (29.28) |
| Anastomotic leak[a] | 428 (14.13) | 423 (14.13) | 5 (14.29) |
| Wound disruption | 122 (1.21) | 117 (1.18) | 5 (2.76) |
| Positive resection margins[a] | 216 (7.54) | 210 (7.42) | 6 (17.65) |
| Proximal esophagus | 62 (2.16) | 62 (2.19) | 0 |
| Radial | 68 (2.37) | 67 (2.37) | 1 (2.94) |
| Distal/gastric | 41 (1.43) | 40 (1.41) | 1 (2.94) |
| Other description/combination | 45 (1.57) | 41(1.45) | 4 (11.76) |
| Infectious complications | | | |
| Surgical site infection | | | |
| Superficial | 598 (5.94) | 584 (5.91) | 14 (7.73) |
| Deep | 170 (1.69) | 165 (1.67) | 5 (2.76) |
| Organ space | 888 (8.82) | 870 (8.80) | 18 (9.94) |
| Sepsis | 678 (6.73) | 655 (6.63) | 23 (12.71) |
| Septic shock | 616 (6.12) | 591 (5.98) | 25 (13.81) |
| Respiratory complications | | | |
| Pneumonia | 1,620 (16.09) | 1,579 (15.97) | 41 (22.65) |
| Pulmonary embolism | 204 (2.03) | 198 (2.00) | 6 (3.31) |
| Unplanned intubation | 1,238 (12.30) | 1,201 (12.15) | 37 (20.44) |
| Prolonged intubation >48 hours | 1,146 (11.38) | 1,111 (11.24) | 35 (19.34) |
| Cardiovascular and thromboembolic complications | | | |
| DVT/thrombophlebitis | 319 (3.17) | 308 (3.12) | 11 (6.08) |
| Cardiac arrest | 179 (1.78) | 173 (1.75) | 6 (3.31) |
| Myocardial infarction | 111 (1.10) | 107 (1.08) | 4 (2.21) |
| CVA with neurological deficit | 35 (0.35) | 33 (0.33) | 2 (1.10) |
| Genitourinary complications | | | |
| Urinary tract infection | 245 (2.43) | 239 (2.42) | 6 (3.31) |
| Acute renal failure | 130 (1.29) | 127 (1.28) | 3 (1.66) |
| Progressive renal insufficiency | 67 (0.67) | 63 (0.64) | 4 (2.21) |

Values are presented as number or number (%) for categorical variables.
DVT, deep venous thrombosis; CVA, cerebrovascular accident.
[a]Data reported for patients who underwent esophagectomy between 2016 and 2020 (2,866 patients).

tality, including increasing age, higher ASA score, higher frailty index, and lower preoperative albumin levels, are not unique to this particular surgery and patient population. Multiple studies have found similar associations for a variety of procedures and clinical scenarios [18-24]. However, specific to esophageal cancer and surgery, we found that esophagectomy without reconstruction was an independent positive predictor of major morbidity and mortality, and the operative approach via McKeown esophagectomy was a positive predictor of major morbidity. The finding that an increased risk of morbidity and mortality was associated without esophagectomy without reconstruction is not excessively surprising. The decision to perform a staged procedure with initial resection and later reconstruction in an emergency is likely a function of the patient's current clinical profile and whether they could withstand further operative time in the setting of possible sepsis and hemodynamic instability [25]. These underlying drivers of sepsis, hemodynamic instability, and so forth, may explain the increase in morbidity and mortality in this particular subset of patients. McKeown esophagectomy has been shown previously in NSQIP studies of esophageal cancer patients to be associated with increased morbidity [26,27].

Lastly, it is interesting to note that there was a higher rate of positive surgical margins in the cohort that underwent emergent esophagectomy compared to elective esophagectomy despite similar TMN stages. This is an important consideration in long-term oncologic prognosis and sur-

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**Table 4.** Thirty-day perioperative mortality, reoperation, length of stay, discharge destination, and readmission in patients who underwent esophagectomy for malignancy in the American College of Surgeons National Surgical Quality Improvement Program database from January 2005 through December 2020

| 30-Day outcomes | Total | Non-emergent esophagectomy | Emergent esophagectomy |
|---|---|---|---|
| No. of patients | 10,067 | 9,886 | 181 |
| Mortality | 290 (2.88) | 279 (2.82) | 11 (6.08) |
| Any complications | 4,491 (44.61) | 4,373 (44.23) | 118 (65.19) |
| Major complications | 4,160 (41.32) | 4,044 (40.91) | 116 (64.09) |
| Reoperation | 145 (14.43) | 1,422 (14.38) | 31 (17.13) |
| Length of stay (day) | 10 (8–14) | 10 (8–14) | 15 (9–23) |
| >7 | 7,836 (79.26) | 7,679 (79.07) | 157 (89.71) |
| >30 | 551 (5.57) | 524 (5.40) | 27 (15.43) |
| Discharge destination | | | |
| Home | 7,251 (84.74) | 7,157 (84.91) | 94 (73.44) |
| Other facility | 1,050 (12.27) | 1,027 (12.18) | 23 (17.97) |
| Readmission | 961 (11.09) | 946 (11.09) | 15 (11.28) |

Values are presented as number, number (%) for categorical variables, or median (25th–75th) for continuous variables.

**Table 5.** Independent predictors of mortality and major complications in patients who underwent esophagectomy for malignancy in the American College of Surgeons National Surgical Quality Improvement Program database from January 2005 through December 2020

| Preoperative factor | OR/estimate (95% CI) | p-value |
|---|---|---|
| Mortality | | |
| Age (yr) | 1.046 (1.030–1.062) | **<0.001** |
| Body mass index | 0.968 (0.944–0.993) | **0.011** |
| Preoperative albumin | 0.694 (0.536–0.899) | **0.005** |
| Frailty index, moderate/severe vs. mild | 1.600 (1.183–2.162) | **0.002** |
| ASA Class 3 vs. 1/2 | 1.607 (0.980–2.638) | 0.149 |
| ASA Class 4/5 vs. 1/2 | 3.915 (2.226–6.889) | **<0.001** |
| Esophagectomy without reconstruction (yes vs. no) | 2.114 (1.048–4.265) | **0.036** |
| Major complications | | |
| Age (yr) | 1.011 (1.006–1.016) | **<0.001** |
| Sex (female vs. male) | 1.304 (1.157–1.469) | **<0.001** |
| Preoperative albumin | 0.713 (0.648–0.786) | **<0.001** |
| Frailty index, moderate/severe vs. mild | 1.515 (1.347–1.704) | **<0.001** |
| ASA Class 3 vs. 1/2 | 1.400 (1.229–1.594) | **<0.001** |
| ASA Class 4/5 vs. 1/2 | 2.311 (1.886–2.831) | **<0.001** |
| McKeown esophagectomy vs. Ivor Lewis and transhiatal | 1.294 (1.151–1.454) | **0.006** |
| Esophagectomy without reconstruction (yes vs. no) | 1.614 (1.148–2.270) | **<0.001** |
| Emergency | 2.390 (1.664–3.431) | **<0.001** |

Statistically significant results are marked in bold.
OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists.

vival. It is likely that this finding is related to the patient's surgical indication (e.g., perforation, bleeding, etc.), the emergent nature of the procedure, and the stability of the patient at the time of surgery, which may hamper a surgeon's ability to obtain adequate margins. Eighty-five percent of surveyed thoracic surgeons obtained pathologic margin evaluation with frozen samples at the time of surgery [28]. This is likely not a luxury many surgeons or patients can afford, nor require, during an emergent esophagectomy.

This study is not without limitations. As the data were extracted from the ACS-NSQIP database, a large hospital-based database, the results are not generalizable to the population of the United States [29]. NSQIP case data also do not include all the potential cases of interest; instead, cases are included via random sampling. This likely under-

estimates the true incidence of patients with esophageal malignancy requiring emergent resection, limiting the sample size. Limited and missing data were also a concern during our statistical analyses for determining independent predictors of mortality and major complications, which required the removal of cases with missing data to complete the analyses. This may misrepresent the true impact of these independent predictors, but we were still able to maintain large sample sizes despite the removal of some cases. Lastly, an important limitation of our study is the lack of long-term survival data and analysis, which is of great significance when studying outcomes in oncologic patient subsets. Despite the lack of an independent association between emergent esophagectomy and short-term 30-day mortality, the higher rates of noted positive margins may translate into higher rates of recurrence and poor long-term survival, which is not reported in the NSQIP [30].

In conclusion, emergent esophagectomy in patients with esophageal malignancies is associated with an independent increased risk of major morbidity, but is not associated with an independent increased risk of short-term perioperative mortality. These data may help guide surgeons, patients, and families in making a data-driven critical decision for surgery in select cases of complicated esophageal malignancy.

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### Author contributions

YA, DCF, JK, WAJ, RDS, CAP, LB, and RP were responsible for the study design, data acquisition, and statistical analysis. All authors contributed to drafting the manuscript, revising it critically, and providing approval of the final manuscript version.

### Conflict of interest

No potential conflict of interest relevant to this article was reported.

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