The Society of Thoracic Surgeons Composite Score for Evaluating Esophagectomy for Esophageal Cancer

The Society of Thoracic Surgeons General Thoracic Surgery Database Task Force*

Background. The Society of Thoracic Surgeons (STS) has developed composite quality measures for cardiac surgical procedures and lobectomy for lung cancer. This study sought to develop a composite measure for esophagectomy for esophageal cancer.

Methods. The STS esophagectomy composite score is derived from two risk-adjusted outcomes: mortality and major complications. General Thoracic Surgery Database data were included from 2012 to 2014, and 95% Bayesian credible intervals were established to determine "star" ratings. STS participants were compared with the National Inpatient Sample as a national benchmark (including non-STS participants).

Results. The study population included 4,321 patients who underwent esophagectomy from 167 participating centers. The operative mortality rate was 3.1% (N = 135), and the major complication rate was 33.1% (N = 1,429). Of the 167 participants, 70 reported an average yearly volume of five or more esophagectomies during the study period. With this threshold, reliability for the composite score was 0.58 (95% credible interval, 0.41 to 0.72). Of these 70 participants, 5 (7.1%) were three star, 63 (90.0%) were two star, and 2 (2.9%) were one star. A majority of STS participants, 58.1% (N = 97), did not have sufficient volume to receive a reliable composite score. Benchmarked to the 2012 National Inpatient Sample cohort, STS General Thoracic Surgery Database participants have comparable discharge mortality rates and shorter postoperative lengths of stay.

Conclusions. STS has developed a quality measure for esophageal cancer surgical procedures based on a composite score of risk-adjusted operative mortality rates and major complications. The composite rating for esophagectomy has good reliability for programs performing an average of five procedures annually, although almost 60% of participants are not eligible for a star rating because of lower procedure volumes.

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Esophagectomy for esophageal cancer is a high-risk operation, and numerous studies have focused on the quality of surgical care. Although early studies implicated a relationship between operative volume and mortality rates after esophagectomy [1–3], this proxy measure for the quality of surgical care depends on how esophagectomy volume is defined and measured [4–7].

The Society of Thoracic Surgeons (STS) General Thoracic Surgery Database (GTSD) Task Force recently updated the risk model for major complications and operative death after esophagectomy [8]. The purpose of this study was to develop a composite outcome measure for esophagectomy for esophageal cancer. The measure includes the two domains of risk-adjusted mortality and major complications by using methodology applied previously for developing composite measures for lobectomy for lung cancer [9], aortic valve replacement [10], and mitral valve operations [11]. The association between participant procedure volume and the composite measure outcome also was investigated. As an additional measure of performance, we compared STS GTSD participants with national esophagectomy outcomes data from the National Inpatient Sample (NIS).

Patients and Methods

The Society of Thoracic Surgeons Database

The third component of the STS National Database, the STS GTSD, was established in 2002 as a voluntary, externally audited [12] registry to support quality improvement efforts of thoracic surgeons and hospitals [13]. Participating institutions receive biannual reports containing center-specific results as well as risk-adjusted

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national benchmarks for lung and esophageal cancer resection. Analyses of deidentified data, such as this study, are exempt from institutional review board approval and do not require individual patients' consent.

Patient Population

The GTSD (version 2.2) was queried for all patients undergoing esophagectomy for primary esophageal cancer between January 1, 2012 and December 31, 2014. Patients with benign disease, emergency operations, and discordance between declared diagnosis and staging information, as well as patients whose records were missing any essential data elements such as age, sex, and discharge mortality, were excluded, leaving 4,321 subjects for analysis. One percent of patients with missing body mass index (BMI) had values imputed by the sex-specific median. For the multivariable analyses, 179 records with clinical stage missing were excluded, leaving 4,142 patient records from 164 participants.

The 2012 NIS was queried, using methods previously reported [14], to provide comparable outcomes derived from a broader and more generalizable cohort of patients undergoing esophagectomy for cancer in the United States. Within the NIS, discharge records were identified by the following diagnosis and procedure categories using the International Classification of Diseases-Ninth Revision-Clinical Modification (ICD-9-CM) diagnosis codes: 1500, 1501, 1502, 1503, 1504, 1505, 1508, 1509, or 1510 for primary esophageal or esophagogastric junction cancer and procedure codes 4240, 4241, 4242, or 4399 for esophagectomy.

Outcome Measures

The outcomes used to derive the composite score included operative mortality, defined as death occurring at discharge or within 30 days of operation, and major postoperative events or complications. These complications were defined as follows: unexpected return to the operating room, anastomosis requiring medical or surgical treatment, reintubation, initial ventilator support for >48 hours, pneumonia, renal failure, and recurrent laryngeal nerve paresis, and they were included in the esophagectomy risk model [5, 8]. STS and NIS outcomes for discharge mortality and hospital length of stay were compared. Comparison between STS and NIS outcomes focused on discharge mortality because the NIS does not report 30-day mortality. Comparisons were not adjusted for comorbidities because of the differences in how such risk factors are reported in the STS GTSD clinical dataset and the NIS administrative dataset.

Covariate Selection

Covariates included in the analyses (Table 1) were the same as those used in the recent models for esophagectomy for esophageal cancer [8]. Age was treated as a continuous variable but was allowed to have different slopes for those patients older than 65 years of age and younger than 65 years of age. The Zubrod score was divided into three groups: 0, 1, and 2 to 5 (because of the small sample sizes for patients with scores of 2 through 5). BMI was divided into five groups based on the commonly accepted World Health Organization classification: underweight (BMI <18.5 kg/m^2), normal weight (BMI ≥18.5 and <25.0 kg/m^2), overweight (BMI ≥25.0 and <30.0 kg/m^2), obesity class I (BMI ≥30 and <35 kg/m^2), and obesity class II or III (BMI ≥35 kg/m^2) [15].

Table 1. Patient Characteristics

Characteristic	Summary Value (N = 4,321)[a]
Age (years)	63.6 ± 9.5
Male	3,588 (83.0)
Black	155 (3.6)
Body mass index (kg/m^2)	
<18.5	118 (2.7)
≥18.5 and <25.0	1,340 (31.0)
≥25.0 and <30.0	1,587 (36.7)
≥30.0 and <35.0	829 (19.2)
≥35.0	447 (10.3)
ASA class	
I	15 (0.3)
II	667 (15.4)
III	3,287 (76.1)
IV	350 (8.1)
V	2 (<0.1)
Zubrod score	
0	936 (21.7)
1	3,172 (73.4)
2	185 (4.3)
3	20 (0.5)
4	7 (0.2)
5	1 (<0.1)
Past smoker	2,594 (60.0)
Current smoker	631 (14.6)
Hypertension	2,500 (57.9)
Congestive heart failure	103 (2.4)
Coronary artery disease	848 (19.6)
Peripheral vascular disease	202 (4.7)
Steroid use	67 (1.6)
Diabetes mellitus	952 (22.0)
Renal dysfunction	55 (1.3)
Induction therapy	2,930 (67.8)
Clinical stage (N = 4,142)	
I	651 (15.7)
II	1,873 (45.2)
III	1,547 (37.3)
IV	71 (1.7)

[a] N (%) or mean ± SD.

ASA = American Society of Anesthesiologists.

Procedure Definitions

The operative approach was determined at the discretion of the participating surgeon. As reviewed [16], several esophagectomy techniques have been described and currently are used in practice: