STS AQO 2019: GTSD Risk Model Updates & Star Ratings

Benjamin D. Kozower, MD, MPH
Chair, STS GTSD
Professor of Surgery
Vice-Chair, Quality Improvement and Patient Safety
Washington University School of Medicine
St. Louis, MO
Disclosures

• No conflicts
• Chair, STS GTSD

• This is where most of your surgeons will focus their attention!
GTSD Risk Models

- Lung cancer resection
- Esophageal cancer resection

- 3 Composite Quality Measures
  - Lobectomy for lung cancer
  - Lung cancer resection
  - Esophagectomy for esophageal cancer
Methodology for Risk Adjustment

• Comparison of hospital/surgeon performance needs to account for patient level risk factors (comorbidities)
  – Age
  – Pulmonary function
  – Performance status (ECOG)
  – Smoking status
  – Etc.

• Critical for STS data to be accurate and complete
Methodology for Risk Adjustment

• Develop a predictive model that:
  1. Predicts the outcome of interest
  2. Adjusts for important patient and procedure specific factors
  3. Provides the impact (odds ratios) for the variables used in the model
Importance of Risk Adjustment

- To fairly compare programs, the quality outcomes of interest need to be adjusted for patient and procedure specific risk.
- A program with very young, healthy patients, may appear to have outstanding outcomes compared to a program with older, very sick patients.
- Risk-adjustment helps to level the playing field and create fair comparisons.
Thoracic Surgery Outcomes: Measuring Hospital Performance

The Society of Thoracic Surgeons Lung Cancer Resection Risk Model: Higher Quality Data and Superior Outcomes

Felix G. Fernandez, MD, MS, Andrzej S. Kosinski, PhD, William Burfeind, MD, Bernard Park, MD, Malcolm M. DeCamp, MD, Christopher Seder, MD, Blair Marshall, MD, Mitchell J. Magee, MD, Cameron D. Wright, MD, and Benjamin D. Kozower, MD, MPH

## General Thoracic Surgery Database (GTSD) Evolution

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung Cancer resections</td>
<td>18,800</td>
<td>27,844</td>
</tr>
<tr>
<td>Centers reporting</td>
<td>111</td>
<td>231</td>
</tr>
<tr>
<td>Thoracoscopy (VATS)</td>
<td>37%</td>
<td>62%</td>
</tr>
<tr>
<td>Database audited</td>
<td>No</td>
<td>Yes*</td>
</tr>
</tbody>
</table>

Methods: Outcome Measures

- Operative mortality: 30 day or in-hospital

- Major morbidity
  - Tracheostomy
  - Reintubation
  - Initial ventilatory support greater than 48 hours
  - ARDS
  - Bronchopleural fistula
  - Pulmonary embolus
  - Pneumonia
  - Unexpected return to the operating room
  - Myocardial infarction

- Composite mortality or major morbidity
# Patient and Disease Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>No. (% of all patients)</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>27,844 (100%)</td>
<td></td>
</tr>
<tr>
<td>Age, years</td>
<td></td>
<td>67.2 ± 10.1</td>
</tr>
<tr>
<td>Male gender (%)</td>
<td>12,647 (45.4%)</td>
<td></td>
</tr>
<tr>
<td>Race - White</td>
<td>24,099 (87.0%)</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)*</td>
<td></td>
<td>27.6 ± 6.2</td>
</tr>
<tr>
<td>Zubrod 0 or 1</td>
<td>26,678 (95.8%)</td>
<td></td>
</tr>
<tr>
<td>ASA = 3</td>
<td>20,953 (75.3%)</td>
<td></td>
</tr>
<tr>
<td>FEV1 predicted (%)</td>
<td></td>
<td>81.3 ± 21.0</td>
</tr>
</tbody>
</table>

*Missing values imputed to median by gender for BMI*
Adverse Events

- Operative mortality: 1.4% (401/27,844)
- Major morbidity: 9.1% (2,545/27,844)
- Composite mortality or major morbidity: 9.5% (2,654/27,844)
# Mortality Risk Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure: Pneumonectomy</td>
<td>4.80 (2.87, 8.02)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Bilobectomy</td>
<td>3.57 (2.09, 6.12)</td>
<td></td>
</tr>
<tr>
<td>Lobectomy*</td>
<td>1.69 (1.14, 2.53)</td>
<td></td>
</tr>
<tr>
<td>Approach – Thoracotomy*</td>
<td>1.87 (1.49, 2.36)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Reoperation*</td>
<td>1.38 (1.00, 1.94)</td>
<td>0.05</td>
</tr>
<tr>
<td>Induction therapy</td>
<td>1.51 (1.09, 2.10)</td>
<td>0.014</td>
</tr>
</tbody>
</table>

C statistic = 0.78

* - not significant in prior model
## Major Morbidity Risk Model

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odds Ratio (95% CI)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure: Lobectomy</td>
<td>1.96 (1.67, 2.30)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Sleeve*</td>
<td>1.93 (1.36, 2.75)</td>
<td></td>
</tr>
<tr>
<td>Bilobectomy</td>
<td>2.98 (2.34, 3.80)</td>
<td></td>
</tr>
<tr>
<td>Pneumonectomy</td>
<td>2.74 (2.15, 3.48)</td>
<td></td>
</tr>
<tr>
<td>Approach - Thoracotomy</td>
<td>1.49 (1.35, 1.64)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Reoperation*</td>
<td>1.35 (1.16, 1.58)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Induction therapy</td>
<td>1.20 (1.02, 1.40)</td>
<td>0.024</td>
</tr>
</tbody>
</table>

C statistic = 0.68

* - not significant in prior model
Predictors of Major Morbidity or Mortality After Resection for Esophageal Cancer: A Society of Thoracic Surgeons General Thoracic Surgery Database Risk Adjustment Model

Daniel P. Raymond, MD, Christopher W. Seder, MD, Cameron D. Wright, MD, Mitchell J. Magee, MD, Andrzej S. Kosinski, PhD, MS, Stephen D. Cassivi, MD, Eric L. Grogan, MD, Shanda H. Blackmon, MD, Mark S. Allen, MD, Bernard J. Park, MD, William R. Burfeind, MD, Andrew C. Chang, MD, Malcolm M. DeCamp, MD, David W. Wormuth, MD, Felix G. Fernandez, MD, and Benjamin D. Kozower, MD
• 2315 esophagectomies
• 73 participating centers
Time to update the model . . .

- Increase in number of contributing centers
  – 164 vs 73

- Growth of minimally invasive esophageal procedures

  - Transhiatal-Total esophagectomy, without thoracotomy, with cervical esophagogastrostomy (43107)
  - Three hole-Total esophagectomy with thoracotomy; with cervical esophagogastrostomy (43112)
  - Ivor Lewis-Partial esophagectomy, distal two-thirds, with thoracotomy and separate abdominal incision (43117)
  - Thoracoabdominal-Partial esophagectomy, thoracoabdominal approach (43122)
  - Minimally invasive three hole esophagectomy
  - Minimally invasive esophagectomy, Ivor Lewis approach
  - Minimally invasive esophagectomy, Abdominal and neck approach
Methods

• Limited time interval to three years
  – January 1, 2012 to December 31, 2014

• Expanded definitions:
  – Mortality: in hospital or 30 day
  – Major morbidity: unexpected return to the operating room, anastomotic leak, reintubation, initial vent support > 48 hours, pneumonia, renal failure, recurrent nerve paresis
Covariates For Analysis

- Age
- Sex
- Race
- BMI
- Smoking
- Zubrod Score
- ASA
- Clinical Stage
- Induction Therapy
- Primary Procedure

Comorbidities

- Hypertension
- Diabetes Mellitus
- Congestive Heart Failure
- Coronary Disease
- Renal dysfunction
- PVD
- Steroid Use
Results

• 4321 procedures
  – 4124 for multivariable analysis due to missing data
• Perioperative mortality: 3.1%
• Perioperative morbidity (≥1): 33.1%
• 2/3 overweight, 3% underweight
• 60% former smokers; 15% active smokers
Tumor Site at Presentation

- Upper: 1%
- Middle: 7%
- GE Jxn: 31%
- Lower: 61%
Procedure Type

- MIE- THE: 3%
- MIE- McK: 10%
- MIE- IL: 21%
- McKeown: 10%
- Transhiatal: 22%
- Ivor Lewis: 32%
- Thoracoabdominal: 2%
Independent Predictors of Perioperative Mortality

- Age > 65
- ECOG > 1
- Steroid Use
- MIE - IL
Independent Predictors of Perioperative Morbidity or Mortality

- CHF
- Zubrod >1
- McKeown Esoph.
- Current Smoker
- BMI ≥35
- Age >65
- Past Smoker
Conclusions

- Thoracic surgeons contributing to the STS GTSD perform esophagectomy with low perioperative morbidity and mortality

- Updated model enhances participating surgeon’s ability to reduce perioperative morbidity and mortality
Star Ratings: Composite Quality Measures

• To develop an easy way to measure & report program performance

• Composite quality measures
  – Major morbidity (20%) and mortality (80%)

• Star Ratings
  – 3 star – higher than expected
  – 2 star – as expected
  – 1 star – lower than expected
Star Ratings: Composite Quality Measures

• Lobectomy for lung cancer
  – First public reporting initiative for the GTSD

• Lung cancer resection
  – In press, star ratings coming soon

• Esophageal cancer resection
  – Second composite measure, available on GTSD feedback reports, and for public reporting
Public Reporting of Surgical Outcomes
Objectives

• Develop composite quality measures for lobectomy for lung cancer and esophagectomy for esophageal cancer

• Participant comparisons:
  1. Risk-adjusted outcomes with STS peers
  2. Comparison of STS participants with national outcomes
Methods:
Using the Lobectomy Model for Demonstration

• 3 years of GTSD data 7/11-6/14
• Elective lobectomy for lung cancer
• Two domain composite
  – Operative mortality
  – Major complications
    • Pneumonia, ARDS, BPF, PE, vent support > 48 hrs, reintubation / respiratory failure, MI, or unexpected return to OR for any cause

Methods: Estimation of Composite Scores & Star Ratings

• Composite score = (1-risk adjusted mortality rate) + (1-risk adjusted complication rate)

• Outcomes were weighted inversely by their respective standard deviations

• Star ratings (3 categories)
  – High (3-star) and low (1-star) performers if 95% credible intervals outside average scores

Results: Patient Population

22,362 lobectomies at 234 programs

Non-elective status (1,211)
Missing data (n=281)
Benign disease (n=122)

20,657 at 231 centers (92.4%)
## Composite Outcomes

<table>
<thead>
<tr>
<th>Event</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative mortality</td>
<td>1.5%</td>
</tr>
<tr>
<td>Major complications</td>
<td>9.6%</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>4.3%</td>
</tr>
<tr>
<td>Unexpected return to OR</td>
<td>3.9%</td>
</tr>
<tr>
<td>Reintubation</td>
<td>3.4%</td>
</tr>
<tr>
<td>Pulmonary embolus</td>
<td>0.5%</td>
</tr>
<tr>
<td>Initial Vent Support &gt;48 Hours</td>
<td>0.5%</td>
</tr>
<tr>
<td>Bronchopleural fistula</td>
<td>0.4%</td>
</tr>
<tr>
<td>Tracheostomy</td>
<td>1.0%</td>
</tr>
<tr>
<td>ARDS</td>
<td>0.7%</td>
</tr>
<tr>
<td>Myocardial infarction</td>
<td>0.4%</td>
</tr>
</tbody>
</table>

**Length of stay (median)**: 4 days, IQR (3,7)
Distribution of Composite Scores

Participants Sorted in Order of Increasing Composite Score
Limitations

• Generalizability
  – STS outcomes are better than national benchmarks
  – Fewer than 50% of lobectomies in the US

• Short term outcome measure
  – STS will be linking with other data sources to automate long term survival

• Missing data
  – Improving but continued issue
Conclusions

• Developed a two-domain quality measure for lobectomy for lung cancer
• Identifies 9% of participating programs as outliers
• Compares STS participants with national benchmarks
• Encourage participation in voluntary public reporting
Acknowledgements

• STS Quality Measurement Task Force
• STS GTSD Task Force
• DCRI
• STS National Database
  – Jane Han, MSW
  – Donna McDonald MPH, RN
  – Susan Becker, RN
Star Ratings: Lobectomy

Table 2: Lobectomy for Lung Cancer Composite Quality Rating

<table>
<thead>
<tr>
<th>Quality Domain</th>
<th>Participant Score (95% CI)</th>
<th>STS Mean Participant Score</th>
<th>Participant Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2016 - Dec 2018 Overall</td>
<td>98.1% (97.20, 98.74)</td>
<td>96.0%</td>
<td>★ ★</td>
</tr>
<tr>
<td>Jan 2016 - Dec 2018 Absence of Mortality</td>
<td>98.9% (97.92, 99.32)</td>
<td>99.0%</td>
<td>★ ★</td>
</tr>
<tr>
<td>Jan 2016 - Dec 2018 Absence of Major Complication</td>
<td>93.0% (89.97, 95.34)</td>
<td>92.0%</td>
<td>★ ★</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality Domain</th>
<th>Eligible Procedures</th>
<th>Detail</th>
<th>Count</th>
<th>Percent²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2016 - Dec 2018 Absence of Mortality</td>
<td>340</td>
<td>Operative Mortality</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Jan 2016 - Dec 2018 Absence of Major Complication</td>
<td>340</td>
<td>Major Complication</td>
<td>19</td>
<td>10.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pneumonia</td>
<td>2</td>
<td>10.5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ARDS</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bronchopleural Fistula</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pulmonary Embolus</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Initial Vent Support &gt;48 hrs</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reintubation/Resp. Failure</td>
<td>5</td>
<td>26.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tracheostomy</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Myocardial Infarction</td>
<td>1</td>
<td>5.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Unexpected Return to OR</td>
<td>4</td>
<td>21.1%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Multiple Complications (more than 1 of the above)</td>
<td>7</td>
<td>36.8%</td>
</tr>
</tbody>
</table>

* Percentages represent the proportion that the specific complication contributed to the total number of patients with a major complication. This information is intended to facilitate and focus process and quality improvement initiatives by providers.
### Table 1: Participant Performance for Lobectomy Compared to STS and NIS Databases

<table>
<thead>
<tr>
<th></th>
<th>Participant Last 3 Years Jan 2016 - Dec 2018</th>
<th>STS Last 3 Years Jan 2016 - Dec 2018</th>
<th>Nationwide Inpatient Sample (NIS) Most Recently Available Year Jan 2015 - Dec 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discharge Mortality</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=349</td>
<td></td>
<td>n=30,567</td>
<td>n=25,990</td>
</tr>
<tr>
<td>Percent (95% CI)</td>
<td></td>
<td>Percent</td>
<td>Percent</td>
</tr>
<tr>
<td>3/349=0.9% (0.2, 2.5)</td>
<td>184/30567=0.6%</td>
<td>333/25990=1.3%</td>
<td></td>
</tr>
<tr>
<td><strong>Postoperative Length of Stay (Days)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=349</td>
<td></td>
<td>n=30,559</td>
<td>n=25,990</td>
</tr>
<tr>
<td>Median (Q1, Q3)</td>
<td></td>
<td>Median</td>
<td>Median</td>
</tr>
<tr>
<td>4.0 (3.0, 5.0)</td>
<td>4.0</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td><strong>Minimally Invasive Lobectomy for Clinical Stage I Lung Cancer</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=220</td>
<td></td>
<td>n=22,099</td>
<td></td>
</tr>
<tr>
<td>Percent (95% CI)</td>
<td></td>
<td>Percent</td>
<td>Percent</td>
</tr>
<tr>
<td>152/220=69.1% (52.5, 75.1)</td>
<td>17419/22099=78.8%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Refer to the Report Overview for the Lobectomy Population inclusion details
2 Computed time between the surgery date and discharge date
Esophagectomy Composite

• Very similar process for esophageal cancer.
• Only 50% of programs will receive a star rating!
  – All programs receive their results
  – Low program volumes (<5 per year) result in low composite measure reliability.
### Table 3: Esophagectomy Composite Quality Rating

<table>
<thead>
<tr>
<th>Quality Domain</th>
<th>Participant Score (95% CI)</th>
<th>STS Mean Participant Score</th>
<th>Participant Rating</th>
<th>Eligible Procedures</th>
<th>Detail</th>
<th>Count</th>
<th>Percent²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 2016 - Dec 2018 Overall</td>
<td>92.7% (90.01, 94.74)</td>
<td>89.5%</td>
<td>★★★</td>
<td>144</td>
<td>Operative Mortality</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>77.81</td>
<td>67.89</td>
<td>Median 61.18</td>
<td>Max 67.77</td>
<td>Favorable</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- STS Mean Participant Score
- Participant

| Jan 2016 - Dec 2018 Absence of Mortality | 97.7% (96.14, 99.27) | 96.5% | ★★ | 144 | Major Complication Unexpected Return to OR Anastomotic Leak Req Med Rx only Reintub./Resp. Failure Initial Vent Support >48hrs Pneumonia New Renal Failure per RIFLE criteria Recurrent laryngeal nerve paresis Multiple Complications (more than 1 of the above) | 35 | 9 | 25.7%  |
| | 68.74 | 68.74 | Median 66.78 | Max 68.71 | Favorable |  |

| Jan 2016 - Dec 2018 Absence of Major Complication | 76.4% (69.40, 82.74) | 69.6% | ★★ | 144 | Operative Mortality | 2 |  |
| | 48.86 | 65.67 | Median 66.64 | Max 73.51 | Favorable |  |

² Percentages represent the proportion that the specific complication contributed to the total number of patients with a major complication. This information is intended to facilitate and focus process and quality improvement initiatives by providers.
Star Ratings

• 85% of programs have a 2-star rating
  – This represents excellent care provided by STS participants (expected)
  – Very difficult to be statistically different than the STS mean
    • Low volumes
    • Natural variation in outcomes
Thank You

I DON'T ALWAYS GET SUCKED INTO A JET ENGINE

BUT, WHEN I DO, I USE ICD-10 V97.33XD