Esophagectomy – How I (We Must) Achieve Excellence in Outcome

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Director, DDI Center for Esophageal Excellence
Virginia Mason Medical Center
Seattle, WA
Esophagectomy – We Must Achieve Excellence in Outcome

Is this Subject an Important Clinical and Educational Issue to Thoracic Surgeons?

or

Is it a Critical Issue to the Continued Involvement of Surgery in the Treatment of Esophageal Cancer
# Hospital Volume and Surgical Mortality in the United States

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Low Volume</th>
<th>High Volume</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colectomy</td>
<td>6.9%</td>
<td>5.4%</td>
<td>1.5</td>
</tr>
<tr>
<td>Gastrectomy</td>
<td>12.7%</td>
<td>8.7%</td>
<td>4.0</td>
</tr>
<tr>
<td>Esophagectomy</td>
<td>18.9%</td>
<td>8.1%</td>
<td>10.8</td>
</tr>
<tr>
<td>Pancreatectomy</td>
<td>15.4%</td>
<td>3.8%</td>
<td>12.6</td>
</tr>
<tr>
<td>Nephrectomy</td>
<td>3.2%</td>
<td>2.6%</td>
<td>.6</td>
</tr>
<tr>
<td>Cystectomy</td>
<td>6.3%</td>
<td>2.9%</td>
<td>3.4</td>
</tr>
<tr>
<td>Pulmonary lobectomy</td>
<td>5.9%</td>
<td>4.2%</td>
<td>1.7</td>
</tr>
<tr>
<td>Pneumonectomy</td>
<td>15.4%</td>
<td>10.6%</td>
<td>4.8</td>
</tr>
</tbody>
</table>

Birkmeyer et al. NEJM 2002;346:1128-1137
# Modern Results of Esophagectomy

<table>
<thead>
<tr>
<th>Operation</th>
<th>Year</th>
<th>Type</th>
<th>N</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portale</td>
<td>2006</td>
<td>Open</td>
<td>263</td>
<td>4.5%</td>
</tr>
<tr>
<td>Orringer</td>
<td>2007</td>
<td>Open</td>
<td>2007</td>
<td>3.0%</td>
</tr>
<tr>
<td>Low</td>
<td>2007</td>
<td>Open</td>
<td>340</td>
<td>0.3%</td>
</tr>
<tr>
<td>Smithers</td>
<td>2007</td>
<td>Open</td>
<td>114</td>
<td>2.6%</td>
</tr>
<tr>
<td>van Heijl</td>
<td>2010</td>
<td>Open</td>
<td>940</td>
<td>3.3%</td>
</tr>
<tr>
<td>Luketich</td>
<td>2003</td>
<td>MIE</td>
<td>222</td>
<td>1.4%</td>
</tr>
<tr>
<td>Palanivelu</td>
<td>2006</td>
<td>MIE</td>
<td>130</td>
<td>1.5%</td>
</tr>
</tbody>
</table>
National Trend in Esophageal Surgery: Are Outcomes as Good as We Believe?

Nationwide Inpatient Sample
1998-2006
57,676 Esophagectomies

<table>
<thead>
<tr>
<th>Year</th>
<th>Mortality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>12.1%</td>
</tr>
<tr>
<td>2002</td>
<td>9.0%</td>
</tr>
<tr>
<td>2006</td>
<td>7.0%</td>
</tr>
</tbody>
</table>
The Rising Incidence of Esophageal Cancer

Figure 1.3: Age-standardised (European) incidence rates, oesophageal cancer, by sex, GB, 1975-2002

Source: Cancer Mortality Maps & Graphs Web Site, a service of the National Cancer Institute
http://cancer.gov/atlasplus/
National Trend in Esophageal Surgery: Are Outcomes as Good as We Believe?

- Increase of esophageal adenocarcinoma in the United States demonstrated annual increase of 2% per year between 1998-2003

<table>
<thead>
<tr>
<th>Year</th>
<th>Nationwide Esophagectomies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>6,425</td>
</tr>
<tr>
<td>2006</td>
<td>6,032</td>
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</table>
# Changing Perceptions Regarding the Role of Esophagectomy in the Treatment of HGD/Barrett’s and Esophageal Cancer

<table>
<thead>
<tr>
<th>HGD</th>
<th>Endoscopic Therapy/Esophagectomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMC</td>
<td>T1a T1b</td>
</tr>
<tr>
<td></td>
<td>Low Risk Short Segment EMR (EII)/</td>
</tr>
<tr>
<td></td>
<td>Esophagectomy</td>
</tr>
<tr>
<td>cT2-3N0-3Mo</td>
<td>Squamous cell</td>
</tr>
<tr>
<td></td>
<td>Definitive Chemorad/Neoadjuvant</td>
</tr>
<tr>
<td></td>
<td>Chemorad and Esophagectomy</td>
</tr>
<tr>
<td>Adenocarcinoma</td>
<td>Neoadjuvant Therapy and Esophagectomy</td>
</tr>
</tbody>
</table>
# Evolution in Esophagectomy Volumes

<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Barrett’s Esophagus HGD</td>
<td>21</td>
<td>4</td>
</tr>
<tr>
<td>Salvage Esophagectomy</td>
<td>2</td>
<td>18</td>
</tr>
<tr>
<td>Total Volumes</td>
<td>136</td>
<td>201</td>
</tr>
</tbody>
</table>
## Comparisons of Outcomes Between Transhiatal and Transthoracic Esophageal Resection

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Reference</th>
</tr>
</thead>
</table>
| Transhiatal vs. transthoracic esophagectomy for adenocarcinoma of the distal esophagus and cardia. | Stark et al.  
| A prospective randomized comparison of transhiatal and transthoracic resection for lower third esophageal carcinoma. | Chu et al.  
| Relationships between operative approaches and outcomes in esophageal cancer. | Pommier et al.  
Am J Surg 1998;175:422                                                  |
| Transthoracic vs. transhiatal resection for carcinoma of the esophagus: A meta-analysis. | Hulscher et al.  
Ann Thor Surg 2001;72:306                                             |
| A decade of experience with transthoracic and transhiatal esophagectomy. | Bousamra et al.  
| Extended transthoracic resection compared with limited transhiatal resection for adenocarcinoma of the esophagus. | Hulscher et al.  
NEJM 2002;347:1662                                                 |
| Transthoracic vs. transhiatal esophagectomy: A prospective study of 945 patients. | Rentz et al.  
JTCVS 2003;125:1114                                               |
J Am Con Surg 2007;205:735                              |
Approaches to Esophageal Resection

- **Open**
  - Transhiatal
  - Ivor Lewis
  - Left Thoracoabdominal
  - 3-hole esophagectomy
  - Retrosternal
  - Vagal-saving esophagectomy
  - Inversion esophagectomy

- **Hybrid**
  - Laparoscopically assisted
  - Thoracoscopically assisted

- **MIE**
  - Laparoscopic transhiatal
  - MI Ivor Lewis
  - MI Thoracoscopic/laparoscopic
  - MI prone esophagectomy
Transhiatal esophagectomy for benign and malignant disease

Mark B. Orringer, MD, Becky Marshall (by invitation), and
Mack C. Stirling, MD (by invitation), Ann Arbor, Mich.

Ivor Lewis Esophagogastrectomy for Esophageal Cancer

Antonio L. Visbal, MD, Mark S. Allen, MD, Daniel L. Miller, MD,
Claude Deschamps, MD, Victor F. Trastek, MD, and Peter C. Pairolero, MD

Division of General Thoracic Surgery, Mayo Clinic, Rochester, Minnesota, and Department of Surgery, Mayo Clinic,
Scottsdale, Arizona

Should En Bloc Esophagectomy Be the Standard of Care for Esophageal Carcinoma?

Nasser Altorki, MD, and David Skinner, MD

From the Weill Medical College of Cornell University, Department of Cardiothoracic Surgery, New York, New York

Minimally Invasive Esophagectomy

Outcomes in 222 Patients

James D. Luketich, MD, Miguel Alvelo-Rivera, MD, Percival O. Buenaventura, MD,
Neil A. Christie, MD, James S. McCaughan, MD, Virginia R. Little, MD, Philip R. Schauer, MD,
John M. Close, MA, and Hiran C. Fernando, MD

486 Annals of Surgery • Volume 238, Number 4, October 2003
THE SURGICAL TREATMENT OF CARCINOMA OF THE ÖSOPHAGUS*

WITH SPECIAL REFERENCE TO A NEW OPERATION FOR GROWTHS OF THE MIDDLE THIRD

BY IVOR LEWIS

NORTH MIDDLESEX COUNTY HOSPITAL, LONDON

The ösophagus is a difficult surgical field for three reasons: its inaccessibility; its lack of a serous coat; and its enclosure in structures where infection is especially dangerous and rapid. In the case of carcinoma of this viscus surgery is still more difficult, for several reasons. It involves an extensive resection in a part of the alimentary canal which not only has no serous covering but also no slack. This in itself renders the ordinary procedures of abdominal surgery well-nigh impossible to apply. Moreover, regarded as a thoracic operation its resection is a formidable undertaking in a usually old and starved patient, and more than any other thoracic operation it threatens the surgeon with having both pleuræ opened during its course. The arteries of the gullet are largely longitudinal and in its upper thoracic course anastomose precariously with branches of the inferior thyroid. It is the direction of blood flow rather than its longitudinal course which besets the surgeon—mainly in the upper third. The contents are commonly septic in these cases. Because of the loosely-knit muscle, anastomosis of its walls has with some reason been described as “suturing the unsuturable.” The pioneers realized early that, except for a few growths of the cardia, resection with anastomosis seemed out of the question. Attempts at suture of the

Ivor Lewis Esophagectomy

- Initial description of a case: Aug 1944
  - Proceedings Royal Society of Medicine
- Initial published case series: 7 patients, 2 mortalities
  - British Journal of Surgery: 1946
- Initially done as a two-stage operation
  - Initial laparotomy with gastric mobilization
  - Secondary staged right thoracotomy with resection and re-anastomosis
First Publication

NOTE: Ivor Lewis is one person

- Only two of the first seven resections resembled the current Ivor Lewis esophagectomy
- The anastomosis – “Suturing the Unsuturable”
- "Only with the great advances of the 1930s in chest surgery and anesthetics had the thorax at last been made a place fit for the abdominal surgeon to work in."
Ivor Lewis Esophagectomy

Advantages:

- Two standardized incisions *easiest to teach*
- Thoracic and abdominal dissections done under direct vision
- Allows extensive (complete) thoracic or abdominal lymphadenectomy
- Easily adaptable to minimally invasive techniques
- Flexibility in location of anastomosis
- Direct visualization for dissection of mid-thoracic tumors

** Minimal intra-operative cardiac manipulation/retraction  **
?? Feasible to perform as two surgical/subspecialty teams??
Ivor Lewis Esophagectomy

Disadvantages:

- Repositioning – two separate stages
- Longer operation than transhiatal approach
- Increased post-operative pain and pulmonary complications
- Higher morbidity with chest anastomotic leak?
- Potential for delayed discovery of thoracic intra-operative advanced disease
The National Oesophago–Gastric Cancer Audit

British Oesophageal Group Meeting

28th February 2009
## Surgical procedures – open oesophagectomy

<table>
<thead>
<tr>
<th>Method</th>
<th>Oesophagectomy total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left thoracoabdominal</td>
<td>249 (19.6)</td>
</tr>
<tr>
<td>Ivor – Lewis</td>
<td>935 (73.4)</td>
</tr>
<tr>
<td>McKeown</td>
<td>35 (2.7)</td>
</tr>
<tr>
<td>Transhiatal</td>
<td>54 (4.2)</td>
</tr>
</tbody>
</table>
## Current VMMC Diversified Approach to Esophageal Resection

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Clinical Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transhiatal/Inversion Esophagectomy</td>
<td>HGD/IMC laryngopharyngoesophagectomy</td>
</tr>
<tr>
<td>Ivor Lewis</td>
<td>Significant cardiac Dis CAD (dysrhythmia CAD etc)</td>
</tr>
<tr>
<td></td>
<td>Sign. cardial component to EG Jcn Cancer</td>
</tr>
<tr>
<td>Left Thoracoabdominal</td>
<td>• Bulky (T4) distal esophageal cancer</td>
</tr>
<tr>
<td></td>
<td>• Extensive involvement of upper stomach</td>
</tr>
<tr>
<td></td>
<td>• Colon interposition</td>
</tr>
<tr>
<td>Three-Hole Esophagectomy</td>
<td>• Bulky proximal esophageal tumor</td>
</tr>
<tr>
<td></td>
<td>• Late salvage esophagectomy</td>
</tr>
<tr>
<td>Robotic Thoracic Mobilization and Transhiatal</td>
<td>• Extensive mediastinal adenopathy</td>
</tr>
</tbody>
</table>
Overall Goals for the Surgical Treatment of Esophageal Cancer

- Directed staging and physiological patient assessment
- Provide a supportive and informative patient experience
- Apply multidisciplinary evidenced based treatment (Tumor Board)
- Modify operative approach according to patient specific tumor and physiologic issues
Excellence in Outcome Associated with Esophageal Resection

- Maintenance of high quality surgical technique and clinical judgment is essential in producing excellent outcomes following esophagectomy.
- Surgeons have typically advocated that a single surgical approach has significant outcome advantages.
- We have also concentrated on technical or surgical issues when looking to impact esophagectomy outcomes.

**In the majority of dedicated high volume Centers of Excellence**

1. Technical expertise is a given.
2. Esophageal resection approach should be individualized according to presenting patient and tumor characteristics.
3. With #1 as a given, the greatest impact on esophagectomy outcomes will be associated with Standardized Multidisciplinary Pathways.
Standardized Clinical Care Pathways for Major Thoracic Cases Reduce Hospital Costs

Kenton J. Zehr MD, Patty B. Dawson RN, Stephen C. Yang MD, and Richard F. Heitmiller MD

Division of Thoracic Surgery, The Johns Hopkins Hospital, Baltimore, Maryland, USA

Background. Standardized clinical care pathways have been developed for postoperative management in an attempt to contain costs in an era of rising health care costs and limited resources. The purpose of this study was to assess the effect of these pathways on length of stay, hospital charges, and outcome for major thoracic surgical procedures.

Methods. All anatomic lung (segmentectomy, lobectomy, and pneumonectomy) and partial and complete esophageal resections performed from July 1991 to July 1997 were retrospectively analyzed for length of stay, hospital charges, and outcome. A prospectively developed database was used. Clinical care pathways were introduced in March 1994. Comparisons were made between the procedures performed before (group I) and after (group II) pathway implementation. Common to both pathways are early mobilization and prudent x-ray and laboratory analysis. In addition, the pathway for esophagectomies emphasizes overnight intubation with 24-hour intensive care unit care, and staged diet advancement. The discharge goal was postoperative day 10. For lung resection the emphasis is early postoperative extubation with overnight intensive care unit management. The discharge goal was postoperative day 7.

Results. Group I esophagectomies (n = 56) had significantly greater hospital charges compared with group II (n = 96) ($21,977 ± $13,555 versus $17,919 ± $5,321; p < 0.04, in actual dollars) and ($29,097 ± $18,586 versus $19,260 ± $6,000; p < 0.001, in dollars adjusted for inflation) and greater length of stay (13.6 ± 6.9 versus 9.5 ± 2.8 days; p < 0.001). Group I lung resections (n = 185) had a significantly greater length of stay compared with group II (n = 241) (8.0 ± 6.2 versus 6.4 ± 3.8 days; p < 0.002); although charges trended downward ($13,113 ± $10,711 versus $12,404 ± $7,189; not significant) in actual dollars, charges were significantly less in dollars adjusted for inflation ($17,103 ± $13,211 versus $13,432 ± $8,056; p < 0.01). The most significant decreases in charges for esophagectomies were in miscellaneous charges (61% in dollars adjusted for inflation), pharmaceuticals (60%), laboratory (42%) and radiologic (39%) tests, physical therapy charges (35%), and routine charges (34%). For lung resections the greatest savings occurred for pharmaceuticals (38%), supplies (34%), miscellaneous charges (25%), and routine charges (22%). Mortality was similar (esophagectomies: I, 3.6%; II, 0%; lung resections: I, 0.5%; II, 0.8%; not significant).

Conclusions. Introduction of standardized clinical pathways has resulted in a marked reduction of length of stay for all major thoracic surgical procedures. Total charges were reduced for both esophagectomies (34%) and lung resections (21%) with continued quality of outcome.

Standardized Clinical Care Pathways for Major Thoracic Cases Reduce Hospital Costs

<table>
<thead>
<tr>
<th></th>
<th>07/91 – 03/94</th>
<th>04/94 – 07/97</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Esophageal Resections</td>
<td>56</td>
<td>96</td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td>$21,977</td>
<td>$17,919</td>
<td>&lt; .04</td>
</tr>
<tr>
<td>LOS (Days)</td>
<td>13.6</td>
<td>9.5</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Mortality</td>
<td>3.6%</td>
<td>0%</td>
<td></td>
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</table>
# Thoracic Team Esophagectomy Management Protocol

<table>
<thead>
<tr>
<th>POD &amp; Loc</th>
<th>POD 0. PPOCU overnight</th>
<th>POD 1. L 16</th>
<th>POD 2 or 3. L 16</th>
<th>POD 4-5. L 16</th>
<th>POD 6-7 or DC. L 16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medication</td>
<td>Antiemetic protocol</td>
<td>Antiemetic protocol</td>
<td>Antiemetic protocol</td>
<td>Antiemetic protocol</td>
<td>Oral crushed PPI</td>
</tr>
<tr>
<td></td>
<td>IV esomeprazole (monitor gastric pH)</td>
<td>IV esomeprazole (monitor gastric pH)</td>
<td>Consider Reglan or Erythromycin</td>
<td>IV esomeprazole (monitor gastric pH)</td>
<td>All other meds given as liquid or crushed through J-tube</td>
</tr>
<tr>
<td></td>
<td>Consider rectal ASA</td>
<td>Lasix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pain control</td>
<td>PCEA &amp; ± PCA (for breakthrough px)</td>
<td>PCEA &amp; ± PCA (for breakthrough px)</td>
<td>PCEA &amp; ± PCA (for breakthrough px)</td>
<td>Transition from PCEA. Stop infusion 6 hr before PCEA removal</td>
<td>Rx given 24-48 hrs prior to DC</td>
</tr>
<tr>
<td></td>
<td>Avoid bolus/pressors for low urine output or MAP &lt;70 mmHg</td>
<td>Consider Ketorolac if Cr is normal</td>
<td>Consider Ketorolac if Cr is normal</td>
<td>J-tube narc. to be scheduled, NOT PRN</td>
<td>Liquid narcotics &amp; meds not available in all pharmacies.</td>
</tr>
<tr>
<td>Positioning &amp; Activity</td>
<td>Keep HOB &gt;45° at all times</td>
<td>Keep HOB &gt;45° at all times</td>
<td>Keep HOB &gt;45° at all times</td>
<td>Keep HOB &gt;45° at all times</td>
<td>Keep HOB &gt;45° at all times</td>
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<tr>
<td></td>
<td>Compression stocking &amp; SCD</td>
<td>Compression stocking &amp; SCD</td>
<td>Compression stocking &amp; SCD</td>
<td>Compression stocking &amp; SCD</td>
<td>Compression stocking &amp; SCD</td>
</tr>
<tr>
<td></td>
<td>Up in chair 4-6 hrs post-op if hemodynamically stable</td>
<td>Up in chair 2-3 hr/day</td>
<td>Up in chair 80% of day</td>
<td>Up in chair 80% of day</td>
<td>Up in chair 80% of day</td>
</tr>
<tr>
<td></td>
<td>Initial walk 12-14 hr post-op</td>
<td>Schedule walks 6-8/day</td>
<td>Schedule walks 5-8/day</td>
<td>Schedule walks 5-8/day</td>
<td>Schedule walks 5-8/day</td>
</tr>
<tr>
<td></td>
<td>Avoid CPAP</td>
<td>Maintain MAP ≥70 mmHg</td>
<td>Consider liquid NSAID as supp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imaging</td>
<td>Recovery room post-op CXR (portable – 1 view)</td>
<td>CXR (2 view) @ 5 am</td>
<td>CXR (2 view) @ 5 am</td>
<td>CXR (2 view) @ 5 am</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D/C Apical CT if no air leak &amp; low CT output (&lt;150 cc/24 hrs)</td>
<td>No CXR req to r/o pnx CT #2</td>
<td>For transhiatal &amp; LTA, CT #2 may be removed</td>
<td>DC NG if contrast study is normal &amp; emptying is good.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20 cm Suction NG - Low cont wall suction</td>
<td>CT #2</td>
<td>If CT output &lt;300 cc/24 hrs</td>
<td>If emptying is delayed, NG tube removal held</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Foley Cath</td>
<td>NO CONT MANIPULATE</td>
<td>FU CXR in 4 hrs</td>
<td>DC CT #2 in Ivor Lewis when oral intake initiated</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>For Ivor Lewis, CT #2 remains until oral intake initiated</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Drainage tubes</td>
<td>NPO</td>
<td>NPO</td>
<td>NPO</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>J-tube: selective meds</td>
<td>J-tube: initiate feed up to 30cc/hr</td>
<td>J-tube: advance to goal (dietary target)</td>
<td>Advance oral protocol to 30cc/hr pending on pt tolerance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Initiate J-tube feeds 10ml/hr</td>
<td></td>
<td>Transition to all meds (except PPI)</td>
<td>Advance oral clear fluid diet ½ cup/hr then to 250cc/hr</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>J-Tube: patient &amp; family teaching</td>
<td></td>
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<tr>
<td>Diet</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Dietitian consultation w/pt &amp; family 1-2 days before DC</td>
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<td>Home Health for Tube Feed</td>
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<td></td>
<td>Social Work – PRN DC issues/placement</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>± Rehab</td>
</tr>
<tr>
<td>Consult</td>
<td></td>
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Esophageal Resection
Standardized Clinic Pathway

Initial Contact: (Referral):
- Interview patient within 48 hours of referral
- Verbal Review (telephone interview)
  - PMH
  - Current Symptoms → Swallowing/Wt Loss
  - Current Investigations
  - Travel Arrangements – Seattle accommodations
  - Initial description of surgery/VM
- Patient Appointment made with respect to patient/referring physician wishes, patient symptoms/status, patient availability

Prior to VM Appointment
- Arrangements for previous notes, investigations, films, path sent or brought to VM
- Arrange patient tailored schedule – which is forwarded to patient

Initial Encounter (completes within 2-3 working days)
- Consultations
  - Thoracic surgery
  - Medical oncology
  - Radiation Oncology
  - Cardiology (>50 y.o. (risk factors))
- Path Review
- Investigations
  - Contrast CT
  - PET/CT
- EGD/EGD US – attended by surgeon

Presentation at thoracic tumor board (next conference following initial appointment)
- Patient contacted with recommendations day following tumor board – reports sent to referring MD

Pre-Op Arrangements
- Initiate chemotherapy or chemoradiotherapy
- Referral for neoadjuvant therapy
- Reassessment following completion of neoadjuvant therapy
  - CT scan
  - EGD US
- Reassessment done 2-4 weeks prior to operative date

Individualized operative approach according to
  - Tumor/Barrett’s characteristics
  - Patient Physiology
  - Previous Surgery

Surgery
- Thoracic epidural placed pre-operatively
- Minimize blood loss/transfusions
- Conservative intra-operative fluid administration
- Immediate extubation
- Post-op anesthesia – PCEA
- Admit to ICU

Post-Op
- Patient sits up and dangles evening of surgery
- Patient walks in hall morning POD #1

Discharge from ICU 12-18 hours post-op
- Walks the ward 3-4 x each day
- Physical therapy consult
- Chest tube 1 removed Day 2
- Chest tube 2 removed Day 3, 4 or 5
- Jejunostomy tube nutrition initiated Day 3
- Gastrografin/Barium swallow Day 4 or 5
- NG tube removed Day 5 or 6
- Switch to oral/J-tube analgesics Day 5 or 6
- Dietary/Home Health Consult Day 5 or 6
- Discharge Day 7 or 8
- Represent at next available tumor board following completion of path results
- Review recommendations with patient within 24 hours
- Forward recommendations to referring (outside MDs)
VMMC

Esophagectomy Standardized Pathway:

Participants:
- Thoracic Oncology Nurse Coordinator
- Anesthesiology
- Recovery Room Staff
- Pain Service
- ICU Nursing
- Thoracic Unit Nursing
- Physical Therapy
- Dieticians
- Social Service Team
- Residents

Initiated: 1998
Virginia Mason Standardized Pathways for Esophagectomy

- Currently 30 regimented parameters in place

- Today
  - Anesthesia management
  - Peri-operative fluid and transfusion protocols
  - Post-operative mobilization
  - Peri-operative nutrition
  - Complications assessment
Virginia Mason Standardized Pathways for Esophagectomy

- Currently 30 regimented parameters in place

- Today
  - Anesthesia management
  - Peri-operative fluid and transfusion protocols
  - Post-operative mobilization
  - Peri-operative nutrition
  - Complications assessment
**Anesthesia for Esophagectomy – Supplement**

Esophageal resection is a technically complex operation with a historically high rate of perioperative morbidity & mortality. The main morbidities of the operation are pulmonary (pneumonia, respiratory failure, pneumothorax & pleural effusion), atrial dysrhythmias, delirium, & anastomotic leaks. Thoracic epidural analgesia is a critical factor in achieving good postoperative analgesia, early patient mobilization & reducing the incidence of pulmonary complications. Intraoperative fluid restriction appears to be very important as well in minimizing fluid shifts into pulmonary & gastrointestinal tissues, & seems critical in preventing respiratory failure & surgical anastomotic leak. While mortality due to esophageal resection quoted in the literature often ranges from 5-10%, at Virginia Mason the 30-day mortality is <1% due to a robust multi-disciplinary perioperative clinical pathway & surgical & anesthetic excellence.

There are a variety of surgical approaches to resection that depend on the nature & the location of the esophageal lesion, the experience of the surgeon, & the overall health & previous surgical history of the patient.

<table>
<thead>
<tr>
<th>Surgical Approach</th>
<th>Incisions</th>
<th>Indications</th>
<th>Special anesthetic concerns</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Transthoracic esophagectomy through a right thoracotomy (Ivor-Lewis)</strong></td>
<td>Midline upper abdominal, then right thoracotomy (Fig 3)</td>
<td>Carcinoma involving upper 2/3 of esophagus, complications of reflux esophagitis/Barrett’s esophagus</td>
<td>DLT. Less likely to cause sudden hypotension or dysrhythmias or due to manipulation of aortic arch, heart or other major vascular structures.</td>
</tr>
<tr>
<td><strong>Transthoracic esophagectomy through a left thoraco-abdominal approach</strong></td>
<td>Left thoracoabdominal, then anterior neck. Most common approach at VM. (Fig 4)</td>
<td>Lesions of the distal esophagus, gastroesophageal junction, &amp; gastric cardia</td>
<td>DLT. Collapse of left upper lobe is critical for surgical access. Sudden hypotension or dysrhythmias more likely than right-sided approach.</td>
</tr>
<tr>
<td><strong>Transhiatal esophagectomy without thoracotomy</strong></td>
<td>Midline upper abdominal, anterior neck (Fig 5)</td>
<td>Thoracic-cervical esophageal carcinoma, removal of esophagus after pharyngolaryngectomy, etc. Proximal esophageal tumor in which resectability will be dictated by mediastinal dissection.</td>
<td>SLT. Lung isolation not required. Sudden hypotension or dysrhythmias likely during retrosternal dissection. Possible uni- or bilateral pneumo- or hemothorax</td>
</tr>
<tr>
<td><strong>“Three-stage” esophagectomy</strong></td>
<td>Right thoracotomy followed by simultaneous upper abdominal &amp; left cervical incisions.</td>
<td></td>
<td>DLT. Collapse of right lung critical. Hypotension less likely. Lung isolation not required following thoracotomy.</td>
</tr>
<tr>
<td><strong>Laryngopharyngoesophagectomy</strong></td>
<td>ENT: Collar (neck) incision ± pectoralis flap, end tracheostomy. Thoracic: transhiatal or “three hole”</td>
<td>Laryngeal or esophageal cancer not suitable for local resection.</td>
<td>DLT vs. SLT depends on thoracic approach. Intraoperative collaboration w/ENT re: airway management. Discuss pre-operatively.</td>
</tr>
</tbody>
</table>
# ANESTHESIA FOR ESOPHAGECTOMY PATHWAY

## Pre-op

### Pre-Anesthesia Assessment Clinic
- Chart review, patient history
- Reason for surgery (typically esophageal CA) & previous treatment (chemo, radiation)
- Vital signs, BMI
- Previous anesthetic history
- Attention to cardiac & pulmonary function (most pts have objective testing), & chronic pain issues
- Airway assessment & evaluation of aspiration risk due to esophageal obstruction
- Lab tests: CBC, CMP, PT/PTT. EKG. Type & Cross 2 units RBC.
- Review CXR, Chest CT. Note location & size of tumor. Cervical tumor more likely to cause airway/intubation issues
- Pre-op patient education & instructions
  - Stopping anticoagulants
  - Diabetic orders, if applicable
  - NPO guidelines
  - Continuing beta-blockers
  - Continuing antihypertensives

### Induction Room
- Review pre-anesthesia assessment, confirm NPO status
- Order standard infusions of phenylephrine & EPINEPHrine (NOTE: EPINEPHrine is used primarily as a bolus medication as does NOT need to be set up with infusion tubing)
- Review surg consent & orders (attention to Left vs. Right approach.)
- Labs, diagnostic tests & chart review
- Confirm or establish two peripheral IV lines, 18-16 ga ideal. Use standard tubing for blood administration.
- Place thoracic epidural, T6-8 level. If right thoracotomy, approach epidural & tape to left. If left thoracoabdominal incision, approach & tape epidural to right side.
- Place arterial line, either side. For left thoracotomy approach, right arm is more available intra-op. For right approach, left arm is more available. One arm is available for several hrs after positioning for difficult a-line.

### Additional Operating Room Set-Up:
- Alaris pump with carrier fluid & phenylephrine infusion.
- Epidural pump & standard epidural infusion.
- Fluid warmer.
- In addition to standard resuscitation medications, syringes of EPINEPHrine (16 mcg/cc) & esmolol (10 mg/cc) should be prepared.
- Prepare left DLT of appropriate size, with one size smaller in room for backup. Fiberoptic scope & tower.

## Intra-op

### Standard operating room table, anesthetist at head. Patient position supine for abdominal & cervical incisions, lateral for thoracic incisions.
- Monitors: standard ASA monitors, plus arterial line, Foley catheter. Central line rarely necessary, but if indicated discuss optimal location with surgeon before placement. Consider with low LVEF, tumor potentially invading aorta, pulmonary artery or vein.
- Place thoracic epidural, T6-8 level. If right thoracotomy, approach epidural & tape to left. For left thoracotomy approach, right arm is more available intra-op. For right approach, left arm is more available. One arm is available for several hrs after positioning for difficult a-line.
- Place thoracic epidural, T6-8 level. If right thoracotomy, approach epidural & tape to left. For left thoracoabdominal incision, approach & tape epidural to right side.
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- Prepare left DLT of appropriate size, with one size smaller in room for backup. Fiberoptic scope & tower.

## Post-op

### Specific Complications & Emergencies
- Sudden hypotension and/or bradycardia or tachycardia due to manipulation of pulmonary vessels, mediastinum. More likely to happen during left-sided approach than right-sided.
- If unexplained intra-op hypotension occurs, check with surg team for cardiac or pulmonary manipulation.
- Arrhythmias, often atrial. Usually transient.
- Inadequate left upper lobe deflation (if ventilating right lung) or inadequate LUL ventilation causing hypoxemia (if ventilating left lung) due to tip of DLT migrating too distally down left main bronchus.
- Inadequate lung isolation due to bronchial cuff migrating out of left main bronchus. This commonly happens during patient repositioning from supine to lateral or at time of lung retraction during left-sided resection.
- Hemorrhage due to laceration of mediastinal vessels (very rare)

### Pain Management:
- Thoracic epidural analgesia. It is critical that the epidural is functioning prior to discharge from PACU. Replace epidural or consider epidurogram if there is any question of correct location. Note that neck incisional pain will not be covered by epidural.
- For acute post-op pain, consider adjusting PCEA rate rather than a bolus. An epidural bolus, especially of lidocaine 1.5% can cause significant hypotension. If an epidural bolus is planned, consider a prophylactic IV fluid bolus.

### Disposition:
- PICU
Virginia Mason Standardized Pathways for Esophagectomy

- Currently 30 regimented parameters in place

- Today
  - Anesthesia management
  - Peri-operative fluid and transfusion protocols
  - Post-operative mobilization
  - Peri-operative nutrition
  - Complications assessment
Near-total esophagectomy: The influence of standardized multimodal management and intraoperative fluid restriction

Joseph M. Neal, M.D., Robert T. Wilcox, M.D., Hugh W. Allen, M.D., and Donald E. Low, M.D.

**Background and Objectives:** Esophagectomy can be associated with high morbidity and mortality. We present our experience managing these patients using a standardized multimodal approach that emphasizes intraoperative fluid restriction and early extubation.

**Methods:** This case series includes 56 consecutive patients over a 2-year period (1999-2000) that underwent near-total esophagectomy at a high-volume center. Surgical approach was determined by patient and tumor characteristics; intraoperative fluid replacement was conservative; and patient-controlled epidural anesthesia/analgesia was used to promote early extubation, enteral feeding, and ambulation.

**Results:** Overall morbidity was 18%; in-hospital and 30-day mortality was zero. Intraoperative urinary volume averaged 0.57 mL/kg/h. No patient developed postoperative renal dysfunction or pulmonary complications. All patients were extubated in the operating room. First ambulation averaged 1.6 days after surgery. Median intensive care unit and hospital stays were 1 and 10 days, respectively. Side effects from thoracic epidural analgesia were minimal.

**Conclusions:** Significant reduction in esophagectomy-related morbidity is possible using a standardized multimodal approach in routine clinical practice. Intraoperative fluid restriction may facilitate early extubation and reduce pulmonary complications without compromising renal function. This preliminary observation warrants further study in a randomized clinical trial. *Reg Anesth Pain Med* 2003;28:328-334.

**Keywords:** Esophagectomy, Epidural analgesia, Perioperative outcome, Fluid management, Multimodal management
### Esophagectomy: Intraoperative Management Over Time

<table>
<thead>
<tr>
<th>Years</th>
<th>Esophagectomy (n)</th>
<th>OR Minutes</th>
<th>Est. Blood Loss</th>
<th>IVF (intraop) mL/case</th>
<th>Blood Transfused intraop/postop (n=patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991-1995</td>
<td>76</td>
<td>413</td>
<td>370 mL</td>
<td>5050 mL</td>
<td>11 / 5 21%</td>
</tr>
<tr>
<td>1996-2000</td>
<td>117</td>
<td>401</td>
<td>213 mL</td>
<td>4430 mL</td>
<td>6 / 1 6%</td>
</tr>
<tr>
<td>2001-2005</td>
<td>148</td>
<td>389</td>
<td>174 mL</td>
<td>4120 mL</td>
<td>0 / 6 4%</td>
</tr>
<tr>
<td>2006-2010</td>
<td>168</td>
<td>395</td>
<td>170 mL</td>
<td>2840 mL</td>
<td>1 / 10 6%</td>
</tr>
</tbody>
</table>
Virginia Mason Standardized Pathways for Esophagectomy

- Currently 30 regimented parameters in place

- Today
  - Anesthesia management
  - Peri-operative fluid and transfusion protocols
  - Post-operative mobilization
  - Peri-operative nutrition
  - Complications assessment
Post-Esophagectomy Clinical Pathways
Current Mobility Goals

- Up in chair 4-6 hours post-op
- Walking in hall within 12 hours post-op
- 6-8 walks > 200 feet/day by POD 2
- Independent mobility Day 4
Results

- PCEA 335 98.5%
- O.R. Extubation 338 99.5%
- Jejunostomy 330 97.0%
- Mobilizes POD #1 292 85.9%
- Mobilization 2009-2012
  - Day of Surgery 72%
  - POD #1 92%
Virginia Mason Standardized Pathways for Esophagectomy

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- Today
  - Anesthesia management
  - Peri-operative fluid and transfusion protocols
  - Post-operative mobilization
  - Peri-operative nutrition
  - Complications assessment
Nutritional Algorithm Associated with Neoadjuvant Chemoradiation for Esophageal Cancer

Presentation Assessment:
- Wt Loss >10% in 3 Mo.
- BMI <18.5 Kg/m²
- Dysphagia to all solids
- Zubrod score 2 or 3
- Albumin <3.25 g/dl

Staging Assessment
- CT, PET, Physiologic Assessment
- EGDUS – long esophageal stricture
- Consider SEMS

Tumor Board
- Stage IIa (±), IIb, III Resectable Stage IV
- Recommendation for neoadjuvant chemoradiation

Nutritional Concerns
- SEMS
- Routine CXR 2 Weeks
- Elective Stent Removal 2-4 Weeks
- Feeding Jejunostomy 14 FG
- Done in conjunction with
  1. Port Placement
  2. Diagnostic laparoscopy and washings
- Cycle to Nocturnal Feeds

Nutritionally Stable
Discussion of nutritional status is now a routine component of tumor board.

Preoperative nutritional approach last 245 resections 2005-2011

- PEG: 7 (placed by referring institution)
- Jejunostomy*: 50
  44 (placed in conjunction with additional procedure)
- Removable Stent: 12

*Surgical Jejunostomy 14 fg
Virginia Mason Standardized Pathways for Esophagectomy

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- Today
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  - Peri-operative fluid and transfusion protocols
  - Post-operative mobilization
  - Peri-operative nutrition
  - Complications assessment
## Virginia Mason Esophagectomy Database 1991-2009

<table>
<thead>
<tr>
<th>Individual Complications</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial Fibrillation</td>
<td>81</td>
<td>16</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>42</td>
<td>8</td>
</tr>
<tr>
<td>Delirium</td>
<td>46</td>
<td>9</td>
</tr>
<tr>
<td>Anastomotic Leak</td>
<td>19</td>
<td>3.7</td>
</tr>
<tr>
<td>Chyle Leak</td>
<td>20</td>
<td>3.9</td>
</tr>
<tr>
<td>Mortality</td>
<td>2</td>
<td>0.4</td>
</tr>
</tbody>
</table>
## Outcome in Delirium and Non-Delirium Groups Following Esophagectomy

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Delirium Group (%) (n = 46)</th>
<th>Non-Delirium Group (%) (n = 454)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of Hospital Stay (days)</td>
<td>13.98 ± 7.54</td>
<td>10.88 ± 5.67</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>ICU stay (days)</td>
<td>3.59 ± 3.82</td>
<td>2.68 ± 1.92</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>10 (21.74)</td>
<td>36 (7.93)</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>5 (10.87)</td>
<td>12 (2.64)</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Re-intubation</td>
<td>5 (10.87)</td>
<td>8 (1.76)</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>In-hospital mortality</td>
<td>0 (0)</td>
<td>2 (0.44)</td>
<td>0.89</td>
</tr>
<tr>
<td>Survival (days)</td>
<td>1105 ± 910</td>
<td>1273 ± 1428</td>
<td>0.28</td>
</tr>
<tr>
<td>Overall Costs</td>
<td>28223 ± 13018</td>
<td>22702 ± 9689</td>
<td>&lt; 0.05</td>
</tr>
</tbody>
</table>
Enhanced Recovery: Peri-Operative Assessment

SF – 36
QLQ – C30
QLQ – PATSAT32

CAM
Mini Mental Exam
Esophagectomy—It’s Not Just About Mortality Anymore: Standardized Perioperative Clinical Pathways Improve Outcomes in Patients with Esophageal Cancer

Donald E. Low • Sonia Kunz • Drew Schembre • Henry Otero • Tom Malpass • Alex Hsi • GuoBin Song • Richard Hinke • Richard A. Kozarek

Received: 16 May 2007 / Accepted: 19 July 2007 / Published online: 31 August 2007
© 2007 The Society for Surgery of the Alimentary Tract

Abstract

Background Esophageal resection (ER) remains the standard therapy for early esophageal cancer; however, because of concerns regarding high levels of morbidity and mortality reported in analyses of national databases, many patients are relegated to less effective endoscopic or chemotherapeutic approaches.

Methods All patients undergoing esophagectomy by a single surgeon for cancer or high-grade dysplasia between 05/91–05/06 were prospectively entered into an IRB-approved database. All aspects of work-up and treatment were guided by an evolving standardized perioperative clinical pathway.

Results Three hundred forty consecutive patients, mean age of 64 (33–90), underwent ER for Barrett’s esophagus (17) or invasive cancer stages I-87, II-133, III-94, IV-9. One hundred thirty-nine (41%) had neoadjuvant therapy. Sixty-three percent were American Society of Anesthesiologists class III or IV, and five different operative approaches were used. Patients were managed intraoperatively with a “fluid restriction” protocol. Mean intraoperative blood loss was 230 cc. 99.5% of patients were extubated immediately, and mean ICU and hospital stays were 2.25 (1–30) and 11.5 (6–49) days, respectively. Postoperative analgesia was managed with patient-controlled epidural analgesia in 98.5%, and 86% were mobilized on day 1 after surgery. Complications occurred in 153 patients (45%), most commonly atrial dysrythmia (13%), and postoperative delirium (11%). Anastomotic leaks occurred in 13 patients (3.8%). Mortality occurred in one patient (0.3%). No significant differences were seen in length of stay, operative time, blood loss, or complications in patients receiving neoadjuvant therapy. For stages I, II, and III, patients between 1998–2004 Kaplan–Meier 5-year cumulative survival was 92.4, 57.1, and 34.5%, respectively.

Conclusions Surgical treatment of esophageal cancer can be done with moderate morbidity and very low mortality, and the expectation of improved levels of survival, especially in early-stage patients. Standardized perioperative clinical pathways can provide the infrastructure for the treatment of these patients and should include increased efforts to minimize blood loss and transfusions, improve postoperative pain control and extubation rates, and facilitate early mobilization and discharge. ER, as sole therapy or in combination with radiation/chemotherapy, should remain the standard of care in patients with early and locoregional esophageal cancer.
Goals in Esophagectomy Pathways

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PCEA</td>
<td>335</td>
<td>98.5%</td>
</tr>
<tr>
<td>Extubation in O.R.</td>
<td>338</td>
<td>99.5%</td>
</tr>
<tr>
<td>Avoid transfusion</td>
<td>310</td>
<td>91%</td>
</tr>
<tr>
<td>Post-operative jejunostomy</td>
<td>340</td>
<td>100%</td>
</tr>
<tr>
<td>Mobilization POD #1</td>
<td>171</td>
<td>50%</td>
</tr>
</tbody>
</table>
# Demographics and Evolution of Outcomes VMMC 1991-2012

## Demographics

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Total Patients 600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Mean)</td>
<td>64 → 66 NS</td>
</tr>
<tr>
<td>BMI (Mean)</td>
<td>26 → 28 p=.03</td>
</tr>
<tr>
<td>Charlson (+Age)</td>
<td>4 → 5 p=.02</td>
</tr>
<tr>
<td>Diabetes Incidence</td>
<td>p=.0004</td>
</tr>
<tr>
<td>Clinical Stage III</td>
<td>p=.01</td>
</tr>
<tr>
<td>Neoadjuvant Chemoradiation</td>
<td>p=.0001</td>
</tr>
</tbody>
</table>
### Outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>1991-2012</th>
<th>1991-2012</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative blood loss</td>
<td>300 cc</td>
<td>150</td>
<td>.0001</td>
</tr>
<tr>
<td>Operative fluids</td>
<td>5000 cc</td>
<td>2800 cc</td>
<td>.0001</td>
</tr>
<tr>
<td>ICU stay</td>
<td>2</td>
<td>1</td>
<td>.0001</td>
</tr>
<tr>
<td>Hospital stay</td>
<td>10</td>
<td>8</td>
<td>.0001</td>
</tr>
<tr>
<td>In hospital mortality</td>
<td>.5%</td>
<td>.4%</td>
<td>NS</td>
</tr>
</tbody>
</table>
List of Visitors to VM

- Visiting Groups to Virginia Mason to Observe Esophageal Cancer Pathways:
  - Leister UK
  - Rotterdam NE
  - Liverpool UK
  - Dublin IR
  - London (Guildford) UK
  - Adelaide AU
  - Belfast IR
  - Newcastle UK
  - Moscow Russia
## Guildford Pathway Translocation

<table>
<thead>
<tr>
<th></th>
<th>VMMC Pathway</th>
<th>Non-Pathway</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1 Mobilisation %</strong></td>
<td>93</td>
<td>8.3</td>
<td>&lt;0.05 (2v4)</td>
</tr>
<tr>
<td><strong>Complications %</strong></td>
<td>47</td>
<td>67</td>
<td>&lt;0.05 (2v4)</td>
</tr>
<tr>
<td><strong>ICU Stay (days)</strong></td>
<td>1 (0-22)</td>
<td>4 (2-20)</td>
<td>&lt;0.05 (2v4)</td>
</tr>
<tr>
<td><strong>Hospital Stay (days)</strong></td>
<td>8 (6-54)</td>
<td>17 (12-30)</td>
<td>0.09 (2v3)</td>
</tr>
</tbody>
</table>

Pathway

<table>
<thead>
<tr>
<th></th>
<th>Pathway</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day 1 Mobilisation %</strong></td>
<td>100</td>
</tr>
<tr>
<td><strong>Complications %</strong></td>
<td>25</td>
</tr>
<tr>
<td><strong>ICU Stay (days)</strong></td>
<td>3 (1-5)</td>
</tr>
<tr>
<td><strong>Hospital Stay (days)</strong></td>
<td>7 (6-37)</td>
</tr>
</tbody>
</table>
Impact of a multidisciplinary standardized clinical pathway on perioperative outcomes in patients with oesophageal cancer

S. R. Preston¹, S. R. Markar², C. R. Baker¹, Y. Soon¹, S. Singh¹ and D. E. Low²

¹Oesophago-Gastric Unit, Royal Surrey County Hospital, Guildford, UK and ²Department of Thoracic Surgery, Virginia Mason Medical Center, Seattle, Washington, USA

Correspondence to: Dr D. E. Low, Department of Thoracic Surgery, Virginia Mason Medical Center, 1100 Ninth Avenue, Seattle, Washington 98111, USA (e-mail: Donald.low@vmmc.org)

Background: Defined clinical pathways can contribute to improved outcomes in patients undergoing oesophageal cancer surgery. A standardized oesophagectomy clinical pathway (SOCP) established at the Virginia Mason Medical Center (VMMC) in Seattle, Washington, USA was introduced into the Royal Surrey County Hospital (RSCH), Guildford, UK in 2011. The aim of this study was to see whether transfer and implementation of an oesophagectomy care pathway could change postoperative outcomes significantly.

Methods: Three consecutively accrued study groups were examined at the RSCH: patients operated on immediately before the introduction of SOCP (group 1), patients operated on after the introduction of SOCP but not included in the pathway (group 2), and patients managed according to the SOCP (group 3). Outcomes were compared with those of patients who had surgery at the VMMC between 2009 and 2011 using the SOCP (group 4).

Results: There were 12 patients in each of the first three groups and 74 in group 4. All groups were similar with respect to body mass index, medical co-morbidities and clinical stage. The median age of patients in group 3 was significantly lower than that in group 1, and median American Society of Anesthesiologists score was significantly better in group 3 compared with group 4. Following initiation of the SOCP there was an increase in immediate extubation (8 of 12 in group 1 versus 12 of 12 in group 3) and first-day mobilization (1 of 12 versus 12 of 12 respectively), and a reduction in complications (9 of 12 versus 4 of 12), length of critical care stay (4 (2–20) days in group 1 versus 3 (1–5) days in group 3) and length of hospital stay (17 (12–30) to 7 (6–37) days respectively). Patients not on the pathway but who had surgery during the same interval experienced small but non-significant improvements in length of critical care and hospital stay, and in first-day mobilization.

Conclusion: The study demonstrated improvement in short-term outcomes after oesophagectomy following the adoption of an established multidisciplinary standardized postoperative pathway.

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Paper accepted 13 September 2012

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On its face, the ERAS program is a combination of simple, low-risk interventions that, when used in an integrated approach, can reduce LOS and complications are ill and less likely to participate in various postoperative ERAS activities such as ambulation and early refeeding. However, multivariable analysis showed that early refeeding is not widely adopted in the United States. An ERAS program requires a multidisciplinary collaboration between surgeons, anesthesiologists, and nurses.

Nearly all ERAS programs include a preoperative education session to promote patient participation in postoperative components of the protocol such as ambulation and oral intake.
Outcomes of Esophageal Resection: Other Issues

- The surgeon is only a part of the process

  HOWEVER

- Surgeon leadership is the key requirement to initiate major institutional and attitudinal change

  HOWEVER

- Specific involvement and empowerment of our medical, anesthetic and Allied Health caregivers is imperative

  AND

- If we as surgeons don’t continue to demonstrate improved outcomes, we will become marginalized in the treatment of esophageal cancer
Overall Goals for the Surgical Treatment of Esophageal Cancer

- **Operative Goals**
  - R0 resection
  - Appropriate lymphadenectomy
  - Minimize surgical impact on patient including blood loss
  - Functional reconstruction
  - Minimize morbidity
  - Make mortality an outlier

- **Commit to long-term monitoring of patient's functional outcome**
  - Q.O.L.
  - PAT SAT

- **Monitor long-term outcomes**
  - Personal database
  - STS database
## Guildford Pathway Translocation

<table>
<thead>
<tr>
<th></th>
<th>VMMC</th>
<th>Pre-Pathway</th>
<th>Non-Pathway</th>
<th>Pathway</th>
<th>P value</th>
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<tr>
<td><strong>Day 1 Mobilisation %</strong></td>
<td>93</td>
<td>8.3</td>
<td>42</td>
<td>100</td>
<td>&lt;0.05 (2v4)</td>
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<td><strong>Complications %</strong></td>
<td>47</td>
<td>67</td>
<td>58</td>
<td>25</td>
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<td><strong>ICU Stay (days)</strong></td>
<td>1 (0-22)</td>
<td>4 (2-20)</td>
<td>3 (2-9)</td>
<td>3 (1-5)</td>
<td>&lt;0.05 (2v4)</td>
</tr>
<tr>
<td><strong>Hospital Stay (days)</strong></td>
<td>8 (6-54)</td>
<td>17 (12-30)</td>
<td>13 (8-22)</td>
<td>7 (6-37)</td>
<td>&lt;0.05 (2v4) 0.09 (2v3)</td>
</tr>
</tbody>
</table>
Ivor Lewis Esophagectomy

Advantages:

- Two standardized incisions *easiest to teach*
- Thoracic and abdominal dissections done under direct vision
- Allows extensive (completely) thoracic or abdominal lymphadenectomy
- Easily adaptable to minimally invasive techniques
- Flexibility in location of anastomosis
- Direct visualization for dissection of mid-thoracic tumors

** Minimal intra-operative cardiac manipulation/retraction
?? Feasible to perform as two surgical/subspecialty teams??
Quick Links
- Hospital Safety Score
- Competitive Benchmarking Reports
- Compare Hospitals Now
- Policy Leadership
- Leapfrog Hospital Survey
- Join the Leapfrog Group

Who We Are
On behalf of purchasers and employers across the country, The Leapfrog Group aims to:

- Inform Americans about their hospital safety and quality
- Promote full public disclosure of hospital performance information
- Help employers provide the best healthcare benefits to their employees

News & Events
- Competitive Benchmarking Reports for Hospitals Now Available for Pre-Order
- Deadline extended for Modern Healthcare Purchasing Power Survey
- See ALL News »
<table>
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<th>Hospital</th>
<th>Heart Bypass Surgery</th>
<th>Heart Angioplasty</th>
<th>Weight Loss Surgery</th>
<th>Aortic Valve Replacement</th>
<th>Abdominal Aortic Aneurism Repair</th>
<th>Pancreatic Resection</th>
<th>Esophageal Resection</th>
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<tr>
<td>Highline Medical Center Burien, WA</td>
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<td>Declined To Respond</td>
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<td>Declined To Respond</td>
<td>Declined To Respond</td>
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<td>Northwest Hospital and Medical Center Seattle, WA</td>
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<td>Seattle Children’s Hospital ANCC Magnet Hospital Seattle, WA</td>
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Although there have been no randomized trials comparing definitive chemoradiation with surgical resection, there is little doubt that non-operative therapy offers comparative opportunity for cure with less intendant morbidity and mortality.
Comparing Outcomes after Transthoracic and Transhiatal Esophagectomy: A 5-Year Prospective Cohort of 17,395 Patients

Rafe C Connors, MD, Brian C Reuben, MD, Leigh A Neumayer, MD, FACS, David A Bull, MD, FACS

**BACKGROUND:** Debate continues over whether transhiatal esophagectomy (THE) offers decreased morbidity and mortality compared with transthoracic esophagectomy (TTE). To definitively answer this question, we used the Nationwide Inpatient Sample database to compare morbidity and mortality after THE and TTE.

**STUDY DESIGN:** Using ICD-9 procedure codes, we queried the Nationwide Inpatient Sample database for patients undergoing THE and TTE. Multivariate statistical analysis was completed to compare morbidity, mortality, length of stay, and hospital volume analysis between the groups.

**RESULTS:** Between 1999 and 2003, 17,395 patients included in the Nationwide Inpatient Sample underwent esophagectomy. Mean patient age was similar in those undergoing THE and TTE (61.9 versus 62.0 years, respectively). Overall morbidity and mortality after esophagectomy were 50.7% and 8.8%, respectively. In-hospital mortality after THE was 8.91% compared with 8.47% after TTE (p = 0.642). Multivariate regression analysis showed no difference in the incidence of mediastinitis, wound, infectious, pulmonary, gastrointestinal, cardiovascular, systemic, procedure-related, or overall complications or hospital length of stay between the two groups. Controlling additionally for hospital volume showed high-volume centers (more than 10 esophagectomies per year) had significantly lower mortality rates than low-volume centers (10 or fewer esophagectomies per year, p = 0.024). Additionally, low-volume centers have a higher incidence of gastrointestinal and systemic complications in the TTE group (p = 0.048 and p = 0.038, respectively).

**CONCLUSIONS:** This large-volume, multicenter study constitutes the largest cohort in the literature to compare outcomes after THE and TTE. These findings indicate the outcomes after THE and TTE for esophageal disease are equivalent, although higher-volume centers will have lower morbidity and mortality. (J Am Coll Surg 2007;205:735–740. © 2007 by the American College of Surgeons)
## Evolution of Surgical Approaches at VMMC Over Time 1991-2012

<table>
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<th>Approach</th>
<th>Range</th>
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<tbody>
<tr>
<td>Transhiatal</td>
<td>3.7 - 15.1%</td>
</tr>
<tr>
<td>Ivor Lewis</td>
<td>8.7 - 47.2%</td>
</tr>
<tr>
<td>Lt thoracoabdominal</td>
<td>47.8 - 83.7%</td>
</tr>
<tr>
<td>Other</td>
<td>2.5 - 9.5%</td>
</tr>
<tr>
<td>MIE</td>
<td>0 - 4%</td>
</tr>
</tbody>
</table>
Patients Qualifying for Mobility: "New" View

- Patients Who Cannot Possibly Participate:
  - Medical directive for bed rest (e.g. unstable spine)
  - Coma
  - Severe Hemodynamic Instability
  - Modest Hemodynamic Instability
  - High FiO2/PEEP
  - Delirium
  - Ventilator Dependent
  - Stroke
  - Critical Illness Polyneuropathy

These patients are inconvenient, but not impossible.
Minimally invasive Ivor Lewis esophagectomy

Jon O. Wee, MD, and Christopher R. Morse, MD

Minimally invasive intrathoracic anastomosis after Ivor Lewis esophagectomy for cancer: a review of transoral or transthoracic use of staplers

K. W. Maas · S. S. A. Y. Biere · J. J. G. Scheepers · S. S. Gisbertz · V. Turrado Rodriguez · D. L. van der Peet · M. A. Cuesta

Minimally Invasive Esophagectomy Provides Equivalent Oncologic Outcomes to Open Esophagectomy for Locally Advanced (Stage II or III) Esophageal Carcinoma

Rajneesh K. Singh, MD; Thai H. Pham, MD; Brian S. Diggs, PhD; Serene Perkins, MD; John G. Hunter, MD

Technique of Minimally Invasive Ivor Lewis Esophagectomy

Arjun Pennathur, MD, Omar Awais, DO, and James D. Luketich, MD

Heart, Lung, and Esophageal Surgery Institute, University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania

Thoracic Epidural – Effect on Outcomes Following Esophagectomy

- **Documented Benefits:**
  1. Improved post-operative pain relief
  2. Earlier recovery of GI function
  3. Earlier extubation
  4. Earlier mobilization

- **Potential Benefits:**
  1. Reduced pulmonary complications
  2. Reduced anastomotic leak
  3. Improved gastric conduit microcirculation
Epidural Management

- 15% defect rate (one-sided block, block too high or too low, not in epidural space)
- Utilizing the postop instrument films during thoracic surgery, we’ve been evaluating epidural placement to streamline the recognition of an inadequate block
- Lower image shows contrast in paravertebral location
Current Virginia Mason Recommendations Regarding Immediate Post-Operative Fluid, Epidural and Transfusion Management

1) Standard post-op fluid administration ½ ml/kg D5-1/2 NS Basal Rate to max 100cc/Hr
2) PCEA rate Bupivacaine 0.05%, Hydromorphone 10micgm/cc (8ml/hr)
3) Maintain MAP >70mmHg
4) If MAP <70mmHg – 500 cc bolus x2 over 60-90 minutes
5) Add IV infusion norepinephrine after 1 litre turn down basal rate PCEA
6) Give up to 2nd fluid bolus over 4-6 hours then surgical staff review
7) No utilization of epidural boluses: Utilize epidural rate changes for post-op pain
8) No transfusions unless Hct <25 (staff review)
58% undergoing esophageal resection have undergone neoadjuvant chemoradiotherapy

30% of patients present for surgery with Hct <30

Patients not transfused unless HCT <25 on consecutive days (unless history of current myocardial ischemia)
# Esophagectomy: Intraoperative Management Over Time

<table>
<thead>
<tr>
<th>Years</th>
<th>Esophagectomy (n)</th>
<th>OR Minutes</th>
<th>Est. Blood Loss</th>
<th>IVF (intraop) mL/case</th>
<th>Blood Transfused intraop/postop (n=patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991-1995</td>
<td>76</td>
<td>413</td>
<td>370 mL</td>
<td>5050 mL</td>
<td>11 / 5 21%</td>
</tr>
<tr>
<td>1996-2000</td>
<td>117</td>
<td>401</td>
<td>213 mL</td>
<td>4430 mL</td>
<td>6 / 1 6%</td>
</tr>
<tr>
<td>2001-2005</td>
<td>148</td>
<td>389</td>
<td>174 mL</td>
<td>4120 mL</td>
<td>0 / 6 4%</td>
</tr>
<tr>
<td>2006-2010</td>
<td>168</td>
<td>395</td>
<td>170 mL</td>
<td>2840 mL</td>
<td>1 / 10 6%</td>
</tr>
</tbody>
</table>
Comparing Outcomes After Transthoracic and Transhiatal Esophagectomy: A 5-Year Prospective Cohort of 17,395 Patients

- Multivariate regression analysis showed no difference in
  - Mediastinitis
  - Infections
  - Pulmonary
  - Gastrointestinal
  - Cardiovascular
  - Systemic
  - Procedure-related or overall complications
  - Hospital L.O.S.

- High-volume centers (>10 esophagectomies/yr) demonstrated significantly lower mortality p=0.024

Diversified Approach to Esophageal Resection

IMPORTANT ISSUES:
TUMOR
- Location proximal $\rightarrow$ distal
- Length
- Size
- Invasion T3 / T4
- Other factors - liver lesions
  - pulmonary nodules
  - lymphadenopathy
- Histology EG junction/Signet
Diversified Approach to Esophageal Resection

IMPORTANT ISSUES:
PATIENT

- Body habitus
- Co-morbidities - Cardiac
  - Pulmonary
- Previous surgery
- Previous resections
- Abnormal anatomy
Diversified Approach to Esophageal Resection

**IMPORTANT ISSUES:**

**SURGEON**

- Training/Philosophy
- Experience
- Facilities (video assisted, robotics)
- Anesthesiology support
Fast Tracking After Ivor Lewis Esophagogastric Resection

Robert James Cerfolio, MD, FCCP; Ayesha S. Bryant, MSPH; Cynthia S. Bass, MSN, CRNP; Jeana R. Alexander, RN, BSN; and Alfred A. Bartolucci, PhD

Objectives: We streamlined our care using an algorithm for the postoperative care of patients who undergo Ivor Lewis esophagogastric resection to try to reduce hospital stay to 7 days and maintain safety and patient satisfaction.

Methods: A consecutive series of 90 patients who underwent elective esophageal resection by one general thoracic surgeon were studied. An algorithm to guide postoperative care was used, featuring avoidance of the ICU, early ambulation, jejunal tube feeds starting on postoperative day (POD) 1, removal of nasogastric tube and epidural on POD 3, a gastrografin swallow on PODs 4 or 5, and discharge on POD 7.

Results: There were 90 patients (70 men). Fifty-two patients (58%) underwent preoperative radiation and chemotherapy. Esophagectomies were done for cancer or high-grade dysplasia. Forty-two of the last 55 patients (77%) went directly to the floor. Sixteen patients (17.7%) had major complications, which included pneumonia in 5 patients and aspiration pneumonia in 4 patients. There were no anastomotic leaks, and there were four operative deaths (4.4%). There was a greater incidence of failure to fast track, and to have a major complication in patients who underwent neoadjuvant treatment (p = 0.025 and p = 0.048, respectively). Median hospital stay was 7 days (range, 6 to 74 days). Complications or mortality could not be definitively attributed to fast tracking. Ninety-seven percent reported excellent satisfaction with their hospital stay, and four patients were readmitted within 1 month of discharge.

Conclusions: Fast tracking patients using an algorithm after esophageal resection is safe and delivers minimal morbidity and mortality, and a high patient satisfaction rate. A median hospital stay of 7 days is possible, and the ICU can be avoided in most patients.

(CHEST 2004; 126:1187-1194)