Disclosure

• Bristol-Meyers-Squibb
  – Scientific Steering Committee for neodjuvant immunotherapy clinical trial (Checkmate 016)
Esophageal Anatomy

Musculation of Esophagus

- Esophageal mucosa
- Submucosa
- Gradual slight muscular thickening
- Phrenoesophageal ligament (ascending or upper limb)
- Diaphragm
- Supradiaphragmatic fascia
- Infradiaphragmatic (transversalis) fascia
- Phrenoesophageal ligament (descending limb)
- Peritoneum
- Cardiac notch
- Longitudinal esophageal muscle
- Circular esophageal muscle
- Substernal fat sling
- Zigzag (Z) line: junction of esophageal and gastric mucosa
- Cardiac part (cardia) of stomach
- Gastric folds (rugae)
- Longitudinal esophageal muscle (cut)
- Circular esophageal muscle (shown here as spiral)
- Cardiac notch
- Collar of Helvetius
- Window cut in middle circular muscle layer of stomach
- Innermost oblique muscle layer of stomach (forms sling)
- Outer longitudinal muscular layer of stomach (cut)

November 1, 2019
Contemporary Staging

TNM - based

- **T-tumor** status: Depth of penetration (T1-4)
- **N-nodal** status: Absent=N0 vs Present=N1,2,3
- **M-met** status: Absent=M0 vs Present=M1a/b
### Table 1. Cancer Staging Categories for Cancer of the Esophagus and Esophagogastric Junction

<table>
<thead>
<tr>
<th>Category</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T category</strong></td>
<td></td>
</tr>
<tr>
<td>TX</td>
<td>Tumor cannot be assessed</td>
</tr>
<tr>
<td>T0</td>
<td>No evidence of primary tumor</td>
</tr>
<tr>
<td>Tis</td>
<td>High-grade dysplasia, defined as malignant cells confined by the basement membrane</td>
</tr>
<tr>
<td>T1</td>
<td>Tumor invades the lamina propria, muscularis mucosae, or submucosa</td>
</tr>
<tr>
<td>T1a&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Tumor invades the lamina propria or muscularis mucosae</td>
</tr>
<tr>
<td>T1b&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Tumor invades the submucosa</td>
</tr>
<tr>
<td>T2</td>
<td>Tumor invades the muscularis propria</td>
</tr>
<tr>
<td>T3</td>
<td>Tumor invades the adventitia</td>
</tr>
<tr>
<td>T4</td>
<td>Tumor invades adjacent structures</td>
</tr>
<tr>
<td>T4a&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Tumor invades the pleura, pericardium, azygos vein, diaphragm, or peritoneum</td>
</tr>
<tr>
<td>T4b&lt;sup&gt;a&lt;/sup&gt;</td>
<td>Tumor invades other adjacent structures, such as the aorta, vertebral body, or trachea</td>
</tr>
<tr>
<td><strong>N category</strong></td>
<td></td>
</tr>
<tr>
<td>NX</td>
<td>Regional lymph nodes cannot be assessed</td>
</tr>
<tr>
<td>N0</td>
<td>No regional lymph node metastasis</td>
</tr>
<tr>
<td>N1</td>
<td>Metastasis in 1-2 regional lymph nodes</td>
</tr>
<tr>
<td>N2</td>
<td>Metastasis in 3-6 regional lymph nodes</td>
</tr>
<tr>
<td>N3</td>
<td>Metastasis in ≥7 regional lymph nodes</td>
</tr>
<tr>
<td><strong>M category</strong></td>
<td></td>
</tr>
<tr>
<td>M0</td>
<td>No distant metastasis</td>
</tr>
<tr>
<td>M1</td>
<td>Distant metastasis</td>
</tr>
</tbody>
</table>
Clinical Staging Modalities

- CT Scan \((T_4,N,M)\)
- EUS/EUS-FNA \((T,N)\)
- PET/CT \((N,M)\)
- Endoscopic Mucosal Resection (EMR)
CT Scan
Endoscopic Ultrasound
EUS

• Accurately defines “T” (71-98%) (*+/− T2)
  – Understages ~ 5 %
  – Overstages ~ 11 %

• Accurately defines “N” (70-88%)
  – Morphology *NOT* histology
    Sensitivity (85-95%) Specificity (50-60%)

• Refinements
  – 20 MHz probe: malignant strictures-T3/4
  – EUS-guided FNA
ENDOSCOPIC FINDINGS: EGD: there was a 1.5 cm Paris 0-IIa + c lesion at 35 cm from the incisors, left posterior esophageal wall at the 8 o'clock position. The lesion was friable. The surrounding mucosa had salmon plaques alternated with normal squamous mucosa. Biopsies of the lesion and plaque were taken. The Z line and GEJ was at 41 cm from the incisors and the diaphragm was at 43 cm. There was no esophagitis or Barrett's esophagus mucosa. There were erosions in the gastric antrum. Biopsies were taken. The duodenum was unremarkable. Retroflexion was normal. The gastroscope was withdrawn and the echoendoscope advanced.

ULTRASONIC FINDINGS: UPPER GI TRACT: The proximal, mid, and distal esophagus had normal wall-layered structure, except for at 35 cm from the incisors where there was a hypoechoic 10 x 2.8 mm lesion extending into the submucosa. The muscularis propria and adventitia were normal. There were at least 3 periesophageal round hypoechoic malignant appearing lymph nodes, the largest measuring 16.8 x 12.9 mm located adjacent to the tumor, outside the right wall of the distal esophagus at about 34 cm. The other distal perisophageal hypoechoic lymph nodes were between 3-7 mm in size. Two 3 and 5 mm lymph nodes heterogeneous oval shaped with fuzzy borders (benign characteristics) with no worrisome characteristics were seen in the above the aortic arch outside the cervical esophagus. There were no celiac axis lymph nodes. The visualized portions of the pancreatic body were normal. There was no pleural effusion. The endoscope was then completely withdrawn from the patient and the procedure completed.

ESTIMATED BLOOD LOSS: None
SPECIMENS REMOVED: Specimens obtained for review.
COMPlications: There were no immediate complications.

STAGING: T_N_M_
1. Esophagus, MX: presence of distant metastasis cannot be assessed.
2. Esophagus, N1: regional lymph node metastasis.
3. Esophagus, T1: tumor invades lamina propria or submucosa.
T - EUS
T1
T2
T3
T4
N - stage

N₀

N₁
EUS - FNA
PET
Endoscopic Mucosal Resection
### Adenocarcinoma G category

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GX</td>
<td>Differentiation cannot be assessed</td>
</tr>
<tr>
<td>G1</td>
<td>Well differentiated, with &gt;95% of the tumor composed of well-formed glands</td>
</tr>
<tr>
<td>G2</td>
<td>Moderately differentiated, with 50%-95% of the tumor showing gland formation</td>
</tr>
<tr>
<td>G3^b</td>
<td>Poorly differentiated, with tumors composed of nest and sheets of cells with &lt;50% of the tumor demonstrating glandular formation</td>
</tr>
</tbody>
</table>

### Squamous cell carcinoma G category

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>GX</td>
<td>Differentiation cannot be assessed</td>
</tr>
<tr>
<td>G1</td>
<td>Well-differentiated, with prominent keratinization with pearl formation and a minor component of nonkeratinizing basal-like cells, tumor cells arranged in sheets, and mitotic counts low</td>
</tr>
<tr>
<td>G2</td>
<td>Moderately differentiated, with variable histologic features ranging from parakeratotic to poorly keratinizing lesions and pearl formation generally absent</td>
</tr>
<tr>
<td>G3^c</td>
<td>Poorly differentiated, consisting predominantly of basal-like cells forming large and small nests with frequent central necrosis and with the nests consisting of sheets or pavement-like arrangements of tumor cells that are occasionally punctuated by small numbers of parakeratotic or keratinizing cells</td>
</tr>
</tbody>
</table>

### Squamous cell carcinoma L category^d

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
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<tbody>
<tr>
<td>LX</td>
<td>Location unknown</td>
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<tr>
<td>Upper</td>
<td>Cervical esophagus to lower border of the azygos vein</td>
</tr>
<tr>
<td>Middle</td>
<td>Lower border of the azygos vein to lower border of the inferior pulmonary vein</td>
</tr>
<tr>
<td>Lower</td>
<td>Lower border of the inferior pulmonary vein to the stomach, including the esophagogastric junction</td>
</tr>
</tbody>
</table>
Cancer of the Esophagus and Esophagogastric Junction: An Eighth Edition Staging Primer

Thomas W. Rice, MD, a, * Hemant Ishwaran, PhD, b Mark K. Ferguson, MD, c Eugene H. Blackstone, MD, a Peter Goldstraw, MD d

a Cleveland Clinic, Cleveland, Ohio
b University of Miami, Miami, Florida
c The University of Chicago, Chicago, Illinois
d National Heart and Lung Institute, Imperial College, London, United Kingdom
Esophageal Cancer Staging

Rice et al. JTO 2017
Clinical Staging

Figure 6. (A) Clinical stage groups (cTNM): adenocarcinoma. (B) Clinical stage groups (cTNM): squamous cell carcinoma.
### Pathologic Staging

**A** pTNM Adenocarcinoma

<table>
<thead>
<tr>
<th></th>
<th>N0</th>
<th>N1</th>
<th>N2</th>
<th>N3</th>
<th>M1</th>
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<tbody>
<tr>
<td>Tis</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1a</td>
<td></td>
<td>IA</td>
<td>IIA</td>
<td>IVA</td>
<td>IVB</td>
</tr>
<tr>
<td>T1b</td>
<td></td>
<td>IB</td>
<td>IIB</td>
<td>IVA</td>
<td>IVB</td>
</tr>
<tr>
<td>T2</td>
<td></td>
<td>IC</td>
<td>IIIA</td>
<td>IVA</td>
<td>IVB</td>
</tr>
<tr>
<td>T3</td>
<td></td>
<td>IIA</td>
<td>IIIB</td>
<td>IVA</td>
<td>IVB</td>
</tr>
<tr>
<td>T4a</td>
<td></td>
<td>IIB</td>
<td>IIIB</td>
<td>IVA</td>
<td>IVB</td>
</tr>
<tr>
<td>T4b</td>
<td></td>
<td>IVA</td>
<td>IVA</td>
<td>IVA</td>
<td>IVB</td>
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</table>

**B** pTNM Squamous Cell Carcinoma

<table>
<thead>
<tr>
<th></th>
<th>N0</th>
<th>L</th>
<th>U/M</th>
<th>N1</th>
<th>N2</th>
<th>N3</th>
<th>M1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tis</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1a</td>
<td></td>
<td>IA</td>
<td>IIA</td>
<td>IIB</td>
<td>IIIB</td>
<td>IVA</td>
<td>IVB</td>
</tr>
<tr>
<td>T1b</td>
<td></td>
<td>IB</td>
<td>IIB</td>
<td>IIB</td>
<td>IVA</td>
<td>IVB</td>
<td>IVB</td>
</tr>
<tr>
<td>T2</td>
<td></td>
<td>IC</td>
<td>IIIA</td>
<td>IVA</td>
<td>IVB</td>
<td>IVB</td>
<td>IVB</td>
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<tr>
<td>T3</td>
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<td>IIIB</td>
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<td>IVB</td>
<td>IVB</td>
<td>IVB</td>
</tr>
<tr>
<td>T4a</td>
<td></td>
<td>IIB</td>
<td>IIIB</td>
<td>IVA</td>
<td>IVB</td>
<td>IVB</td>
<td>IVB</td>
</tr>
<tr>
<td>T4b</td>
<td></td>
<td>IVA</td>
<td>IVA</td>
<td>IVA</td>
<td>IVA</td>
<td>IVA</td>
<td>IVA</td>
</tr>
</tbody>
</table>

**Figure 4.** (A) Pathologic stage groups (pTNM): adenocarcinoma. (B) Pathologic stage groups (pTNM): squamous cell carcinoma.
### Figure 5. Postneoadjuvant pathologic stage groups (ypTNM): adenocarcinoma and squamous cell carcinoma.
### G. Esophageal Cancer

**Clinical Staging:** Pre-treatment Esophageal cancer staging - to be completed if esophageal cancer suspected, documented _OR_ esophagus resection performed. Clinical staging determines the treatment plan.

<table>
<thead>
<tr>
<th>Clinical Staging Done</th>
<th>☐ Yes ☐ No</th>
</tr>
</thead>
</table>

#### Radiologic / Endoscopic Staging Procedures

If Clinical Staging Done is Yes →

- PET or PET/CT: ☐ Yes ☐ No
- CT: ☐ Yes ☐ No
- Bronchoscopy: ☐ Yes ☐ No
- EUS: ☐ Yes ☐ No

#### Invasive Staging Procedures

- VATS – for staging: ☐ Yes ☐ No
- Laparoscopy – for staging: ☐ Yes ☐ No
- Endoscopic Mucosal Resection: ☐ Yes ☐ No
- Other: ☐ Yes ☐ No

**Esophageal Tumor:**

- **T0:** No evidence of primary tumor
- **T1:** Tumor invades lamina propria
- **T2:** Tumor invades muscularis propria
- **T3:** Tumor invades adventitia
- **T4:** Tumor invades adjacent structures

**Clinical Diagnosis of Nodal Involvement:**

- Yes (N1, N2 or N3) ☐ Yes ☐ No

**Esophageal CA Metastases:**

- M0: No Distant Metastasis
- M1: Distant Metastasis

#### Tumor Location (check all that apply):

- Cervical Esophagus (15 – < 20 cm): ☐ Yes ☐ No
- Upper Thoracic (20 - < 25 cm): ☐ Yes ☐ No
- Middle Thoracic (25 - < 30 cm): ☐ Yes ☐ No
- Lower Thoracic, including EG Junction (30 – 42 cm): ☐ Yes ☐ No

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[Diagram of esophagus with anatomical markers]
### Pathological Staging - Esophagus

*Esophagus to be completed if esophageal cancer documented AND esophageal resection performed (Pre-Operative Evaluation – Esophageal Cancer = Yes) (8th Edition)*

#### Esophageal Cancer Results
- □ No cancer found, benign tumor
- □ Esophageal cancer present

#### Esophageal Tumor:
- □ TX  
  Tumor cannot be assessed
- □ T0  
  No evidence of primary tumor
- □ Tis  
  High Grade dysplasia, defined as malignant cells confined to the epithelium by the basement membrane
- □ T1a  
  Tumor invades lamina propria or muscularis mucosa
- □ T1b  
  Tumor invades submucosa
- □ T2  
  Tumor invades muscularis propria
- □ T3  
  Tumor invades adventitia
- □ T4a  
  Tumor invades pleura, pericardium, azygos vein, diaphragm or peritoneum
- □ T4b  
  Tumor invades other adjacent structures such as aorta, vertebral body, or airway.

#### Esophageal CA Nodes:
- □ NX  
  Regional lymph nodes cannot be assessed
- □ N0  
  No regional lymph node metastasis
- □ N1  
  Metastasis in 1-2 regional nodes
- □ N2  
  Metastasis in 3-6 regional lymph nodes
- □ N3  
  Metastasis in 7 or more regional lymph nodes

#### Esophageal CA Metastases:
- □ M0  
  No distant metastasis
- □ M1  
  Distant metastasis

#### Esoph Histopathologic Type:
- □ H1  
  Squamous Carcinoma
- □ H2  
  Adenocarcinoma
- □ Other

#### Esophageal CA Histologic Grade:
- □ GX  
  Grade cannot be assessed
- □ G1  
  Well differentiated
- □ G2  
  Moderately differentiated
- □ G3  
  Poorly differentiated, undifferentiated

Total # of Lymph Nodes sampled/harvested: ________

Esophageal CA Resection Margins Positive: □ Yes □ No
Esophageal Cancer

Resections
Objectives

• Evaluation for metastatic disease
• Resection of primary tumor
• Lymphadenectomy
• Restoration of GI continuity
• Maintain quality of life (ability to eat)
Esophageal Resections

- Ivor Lewis (Transthoracic)
- Transhiatal
- McKeown (Three-incision)
- Thoracoabdominal
- Minimally invasive
  - Ivor Lewis
  - Transhiatal
  - McKeown
Factors in Selection of Approach

- Location, Location, Location
- Stage, Neoadjuvant treatment
- Fitness of patient
- Prior Surgery
- Surgeon expertise/preference
Gastrohepatic Ligament

Dissection of gastrohepatic lig. toward esophageal hiatus
Phrenoesophageal Ligament
Distal Esophagus

Distal esophagus encircled using penrose drain for maneuvering
Short Gastric Vessels

- Dividing omentum & short gastrics
- Right gastroepiploic a.
- Short gastrics ligated & divided
Left Gastric Artery
Right Thoracotomy

- Pleura incised on both sides of esophagus
- Hilum of right lung under pleura
- Dividing Azygos v.
- Azygos arch
- Esophagus
Proximal division of esophagus

Esophagus

Proximal azygos stump

Distal azygos stump
Esophago-gastric Anastomosis
Esophago-gastric Anastomosis

Endo-GIA completes anastomosis
Ivor-Lewis

- Advantages
  - Allows wider thoracic node dissection
  - Lower leak/stricture rate

- Disadvantages
  - Thoracotomy
  - Intrathoracic anastomosis (leak)
Transhiatal Esophagectomy

Sternocleidomastoid muscle
Transhiatal Esophagectomy
Pyloromyotomy
Cervical Esophagus
Transhiatal Dissection

Digital blunt dissection via esophageal hiatus

Trachea

Esophagus

Dissection around esophagus with sponge-stick

Aorta
Blunt dissection around cervical esophagus

Blunt dissection along thoracic esophagus
Cervical Esophagus Divided
Thoracic esophagus withdrawn into abdomen

Gastroepiploic artery & greater curvature of stomach

Resection Completed
Conduit Passed in Posterior Mediastinum
Posterior Staple Line

Stapling side-to-side gastroesophageal anastomosis
Anterior Sutures

- Esophagus
- Stomach
Transhiatal Esophagectomy

• Advantages
  – No thoracotomy
  – Leaks are more manageable

• Disadvantages
  – Cannot visualize thoracic node dissection
  – Recurrent nerve injury
  – Higher leak rate
  – Need longer conduit.
McKeown (three incision)

Order of Operation
1. Thoracic mobilization
2. Abdominal mobilization
3. Cervical anastomosis
Division of gastrohepatic & phrenoesophageal ligaments
Gastroesophageal anastomosis with EEA stapler
Colon Interposition
Colon Interposition
Jejunal Interposition
<table>
<thead>
<tr>
<th>Esophagus Resection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Transhiatal-Total esophagectomy, without thoracotomy, with</td>
<td>□ Partial esophagectomy, distal two-thirds, with thoracotomy only</td>
</tr>
<tr>
<td>cervical esophagostomy (43107)</td>
<td>(43121)</td>
</tr>
<tr>
<td>□ Total esophagectomy without thoracotomy; with colon interposition or small</td>
<td>□ Thoracoabdominal-Partial esophagectomy, thoracoabdominal</td>
</tr>
<tr>
<td>intestine reconstruction (43108)</td>
<td>approach (43122)</td>
</tr>
<tr>
<td>□ Three Incision -Total esophagectomy with thoracotomy; with</td>
<td>□ Partial esophagectomy, thoracoabdominal with colon interposition</td>
</tr>
<tr>
<td>cervical esophagostomy (43112)</td>
<td>or small intestine (43123)</td>
</tr>
<tr>
<td>□ Total esophagectomy with thoracotomy; with colon interposition or small</td>
<td>□ Total or partial esophagectomy, without reconstruction with</td>
</tr>
<tr>
<td>intestine reconstruction (43113)</td>
<td>cervical esophagostomy (43124)</td>
</tr>
<tr>
<td>□ Partial esophagectomy, cervical, with free intestinal graft, including</td>
<td>□ Minimally invasive three incision esophagectomy</td>
</tr>
<tr>
<td>microvascular anastomosis (43116)</td>
<td></td>
</tr>
<tr>
<td>□ Ivor Lewis-Partial esophagectomy, distal two-thirds, with</td>
<td>□ Minimally invasive esophagectomy, Ivor Lewis approach</td>
</tr>
<tr>
<td>thoracotomy and separate abdominal incision (43117)</td>
<td></td>
</tr>
<tr>
<td>□ Partial esophagectomy, with thoracotomy and separate abdominal incision with</td>
<td>□ Minimally invasive esophagectomy, Abdominal and neck approach</td>
</tr>
<tr>
<td>colon interposition or small intestine (43118)</td>
<td></td>
</tr>
</tbody>
</table>
Esophagectomy
A Life–Changing Operation

• Lack of gastric reservoir

• Aperistalsis

• Gastric emptying

• Dumping

  Straight, narrow conduit (drains by gravity)

  Pyloric interventions

  Small frequent meals
• Thank you for your attention and all of your work with the STS database!