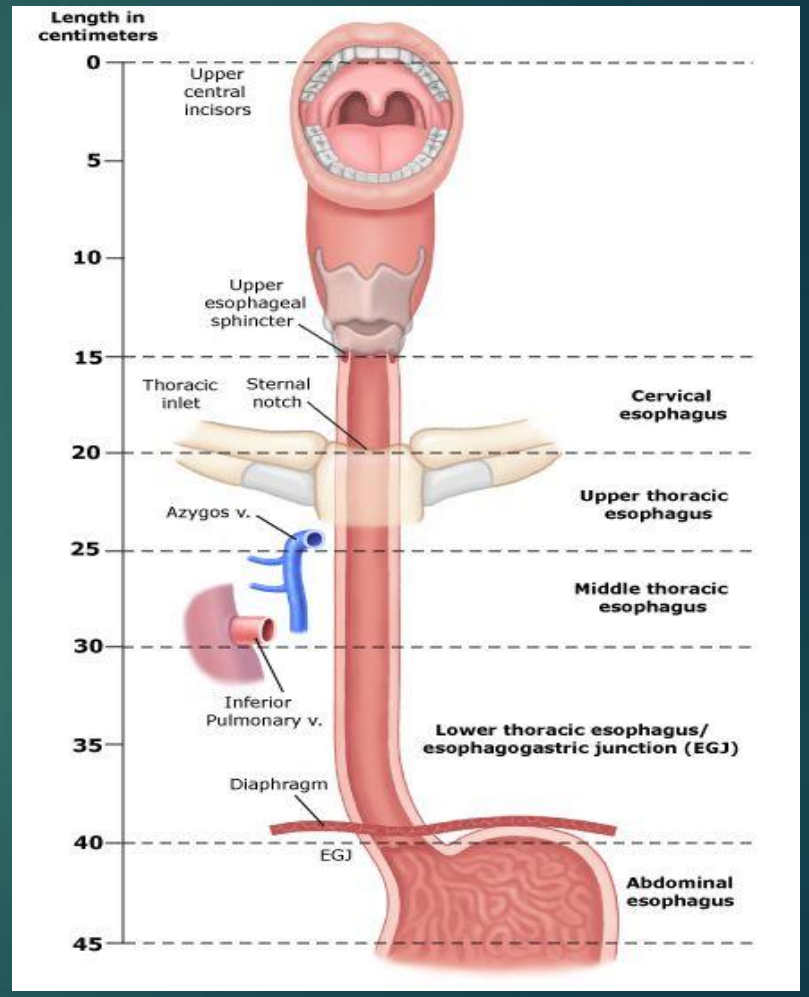
Anesthesia for Minimally Invasive Esophagectomy

BY: ERIC DIVELL

Introduction to the Clinical Problem

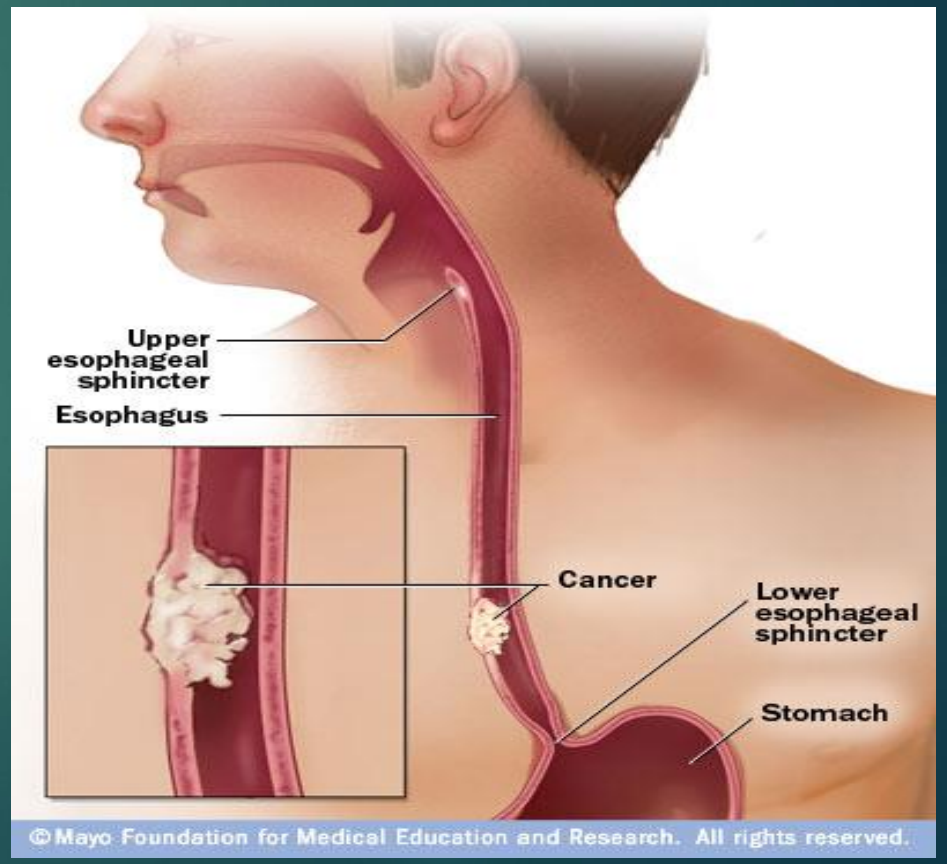
- Esophageal Carcinomas
  - 462,117 individuals diagnosed worldwide (2002)
  - 385,892 died
- Epidimiology
  - Squamous cell carcinoma
    - Increased mortality due to tumor location
    - Upper 1/3 of esophagus
  - Adenocarcinoma
    - Decreased mortality, also due to tumor location
    - Located near the GE junction, lower esophagus



Indications

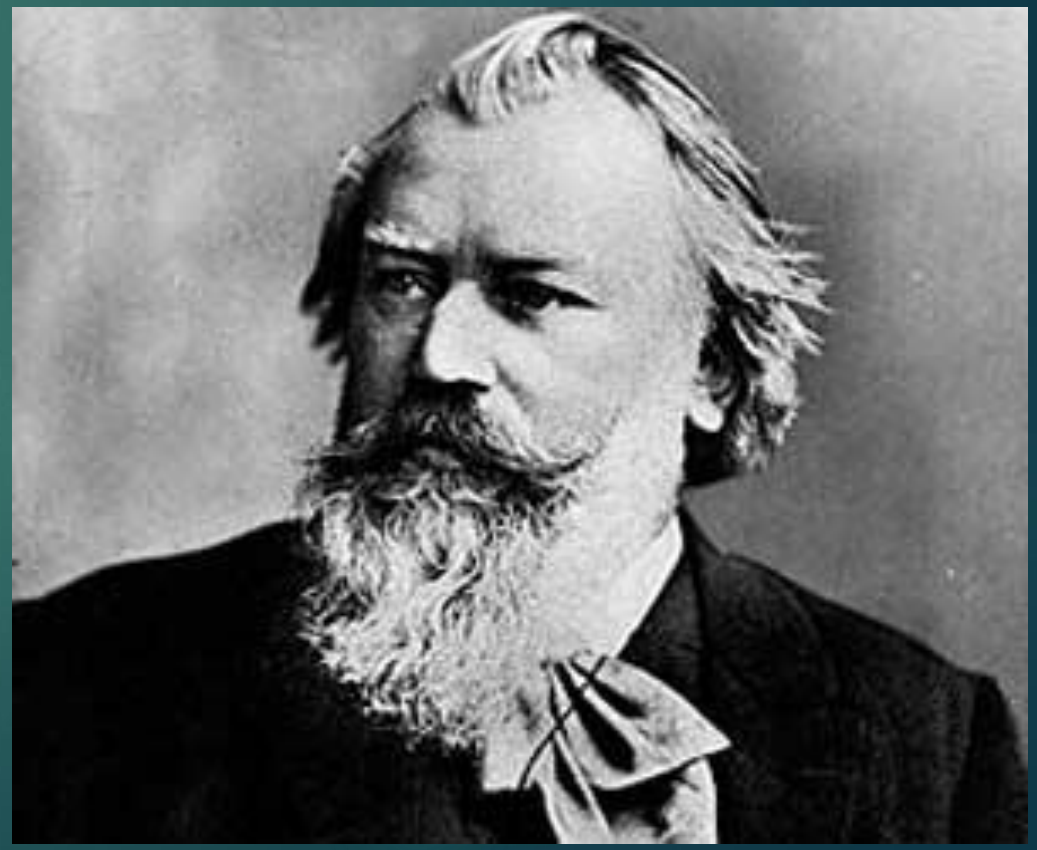
- Most commonly performed for malignant disease of the middle and lower 3rd of the esophagus and gastric cardia, but also for higher and or larger esophageal lesions

- Severe non-malignant disorders:
  - Achalasia
  - Barrett's Esophagus
  - Hiatal Hernia
  - Nondilatable strictures
  - GERD



Early Surgical Approaches

- Dr. Theodore Billroth
  - Pioneer in cervical esophageal mobilization techniques
  - Along with Dr. Czerny, credited with first local excision of esophageal carcinoma
    - Patient survived 1 year
  - Two years later resected more extensive lesion
    - Patient died 2 years later of associated mediastinitis



Early Surgical Approaches

- Dr. Franz Torek
  - Pioneer in thoracic surgery
  - Credited with the 1st thoracic esophagectomy in 1913
    - Utilized left transpleural approach
    - 2 hour, 43 minute procedure
    - Anesthetic: Meltzer-Auer method
    - After 1 week, distal stump was connected to the gastrostomy by rubber tube
    - Patient survived 13 years before dying of unrelated causes

- Dr. Oshawa (Japan)
  - First intrathoracic restoration of esophagogastric continuity (1933)
  - Utilized free thoracotomy without positive pressure ventilation

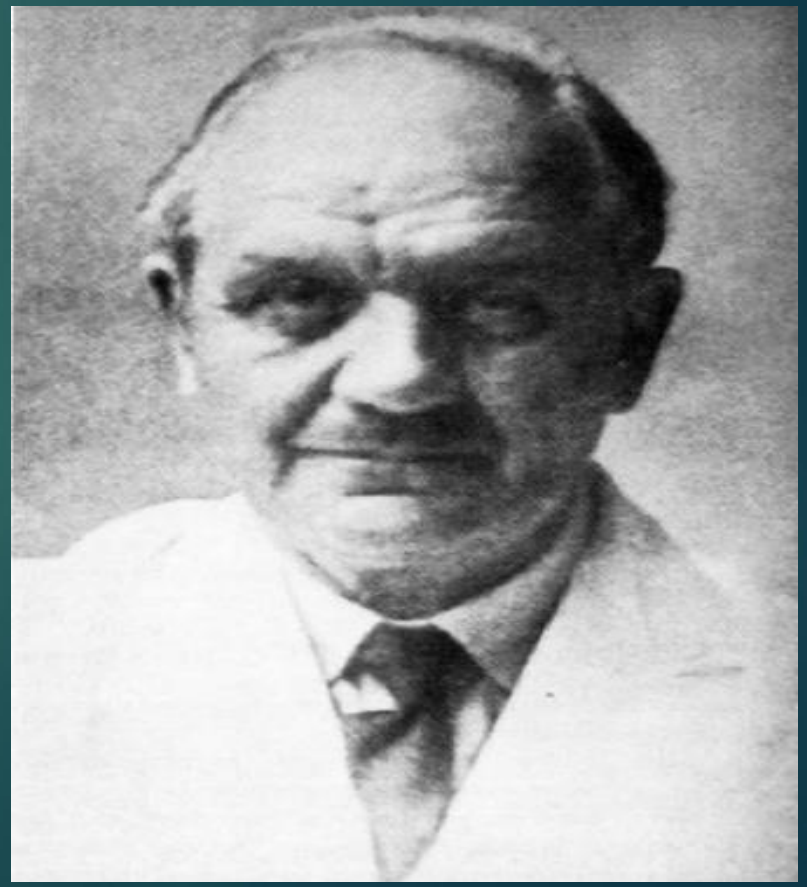
Early Surgical Approaches

- Drs. Marshall, Adams & Phemister
  - Accomplished esophagogastric anastomosis for distal esophageal carcinomas (1937)
- Drs. Sweet & Churchill
  - Developed the basis for the modern approach to transthoracic esophagectomies at Massachusetts General Hospital (1940s-1950s)
- Drs. Sweet & Garlock
  - Performed first supra-aortic esophagogastrostomy with conduit placed in front of the aorta (1942)
  - Utilized Left thoracotomy approach

Dr. Richard Sweet

Modern Surgical Approaches

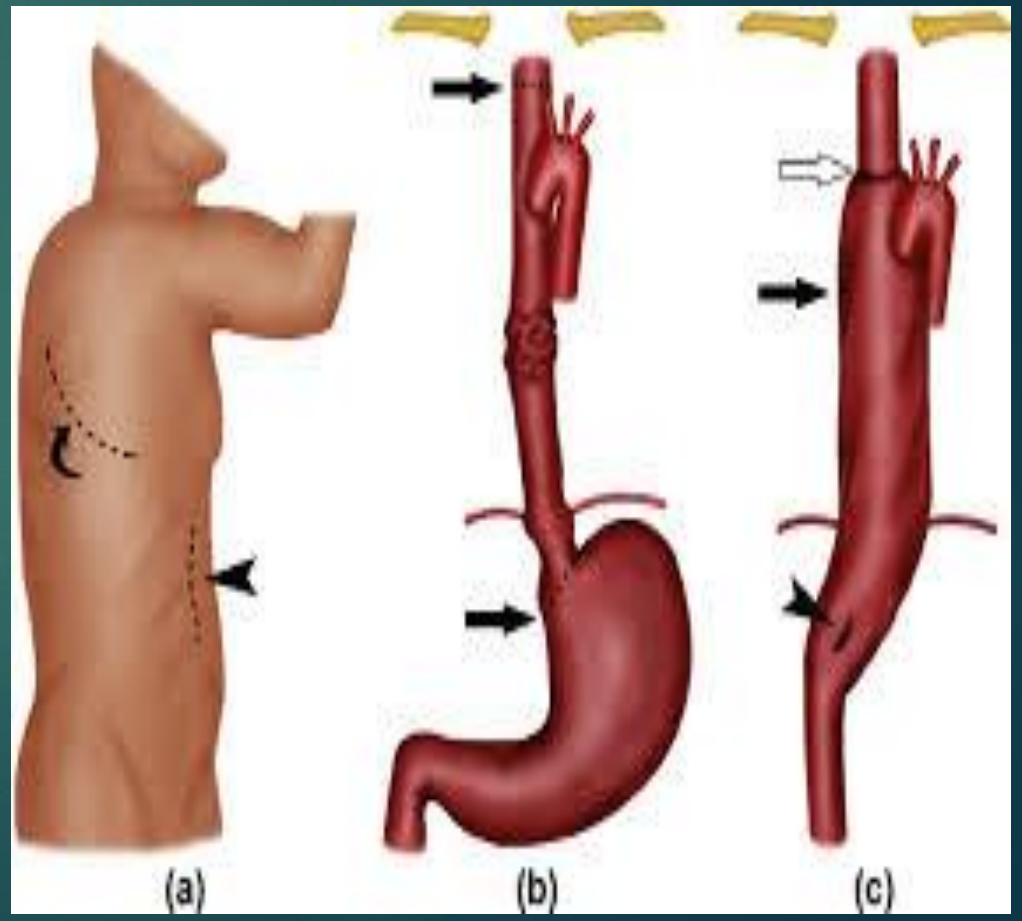
- Dr. Ivor Lewis
  - Credited with the first right-sided thoracotomy approach to an esophagectomy (1946)
  - Utilized a two-phase technique, resecting a lesion on the middle 1/3 of diseased esophagus
  - Made the right thoracotomy standard for majority esophagectomies
  - Ivor Lewis technique is still utilized today



Modern Surgical Approaches

- Ivor Lewis Approach
  - Preferred technique for lesions of the lower esophagus
  - Not for tumors at, or above, the level of the carina
  - Transthoracic esophagectomy via right thoracotomy
  - OLV needed

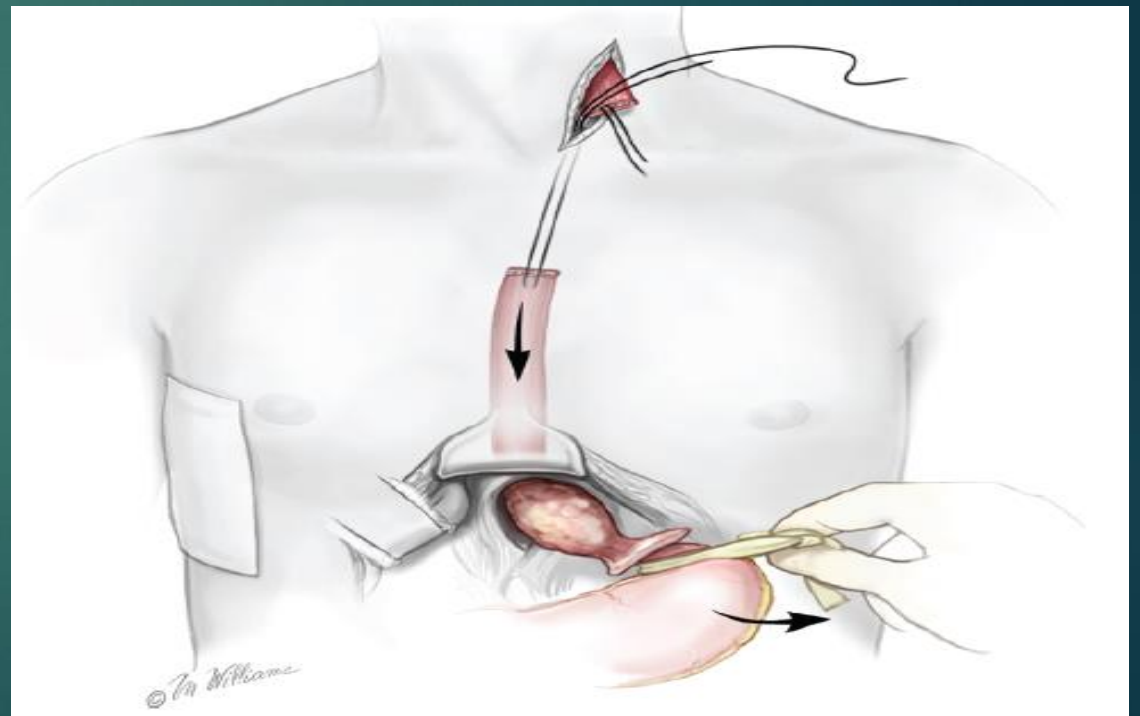
- Transhiatal Approach
  - Performed through left cervical and abdominal incision
  - For grossly diseased esophagus needing surgery
  - OLV not needed



Modern Surgical Approaches

- McKeown Approach (3-hole/tri-incisional method)
  - Preferred approach for esophageal lesions above the GE junction up to the clavicle
  - Similar to the Ivor Lewis method (right thoracotomy), but sequence is different
  - *3rd incision (Cervical) utilized for cervical anastomosis, lymph node dissection
  - *<u>Increased RLN Injury</u>

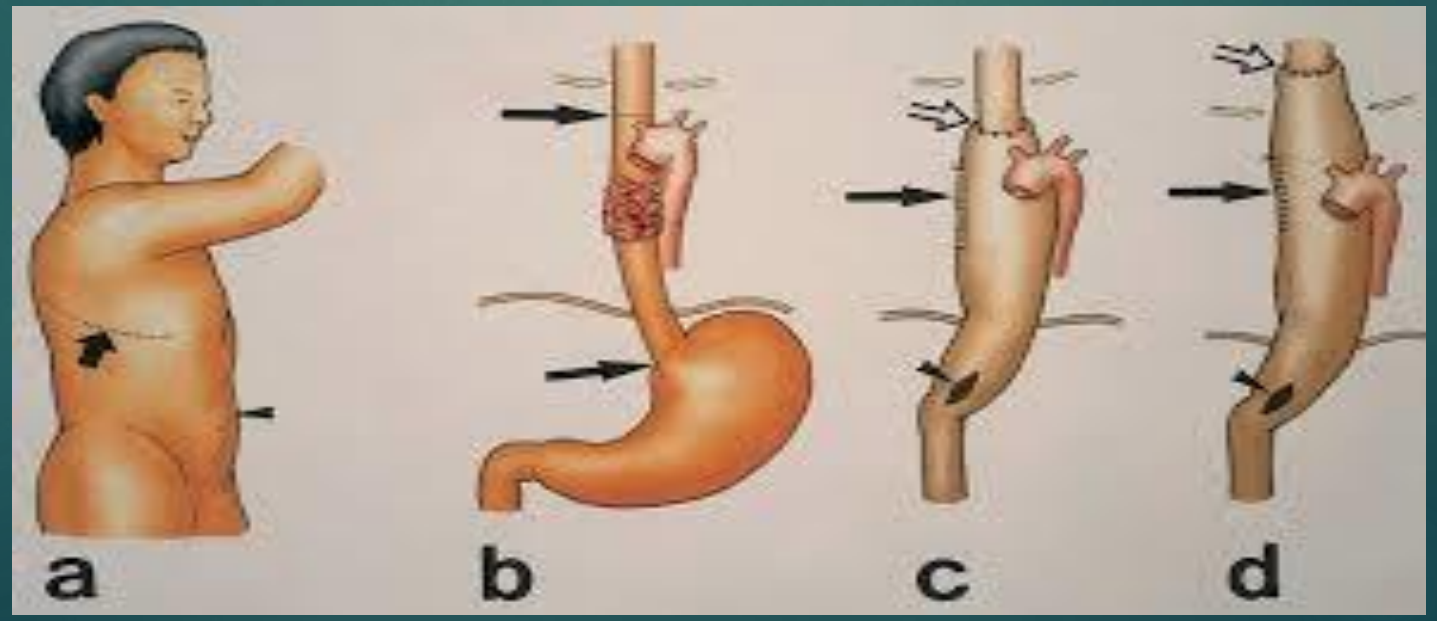
- Minimally invasive option combining thoracoscopy and laparoscopy
  - MIE utilizing McKeown or Ivor Lewis techniques are most often employed
  - Less pain, blood loss, morbidity, faster recovery, and better outcomes
  - *Decreased pulmonary problems



Source: D. J. Sugarbaker, R. Bueno, Y. L. Colson, M. T. Jaklitsch, M. J. Krasna, S. J. Mentzer, M. Williams, A. Adams: *Adult Chest Surgery*, 2nd Edition: www.accesssurgery.com

Surgical Techniques

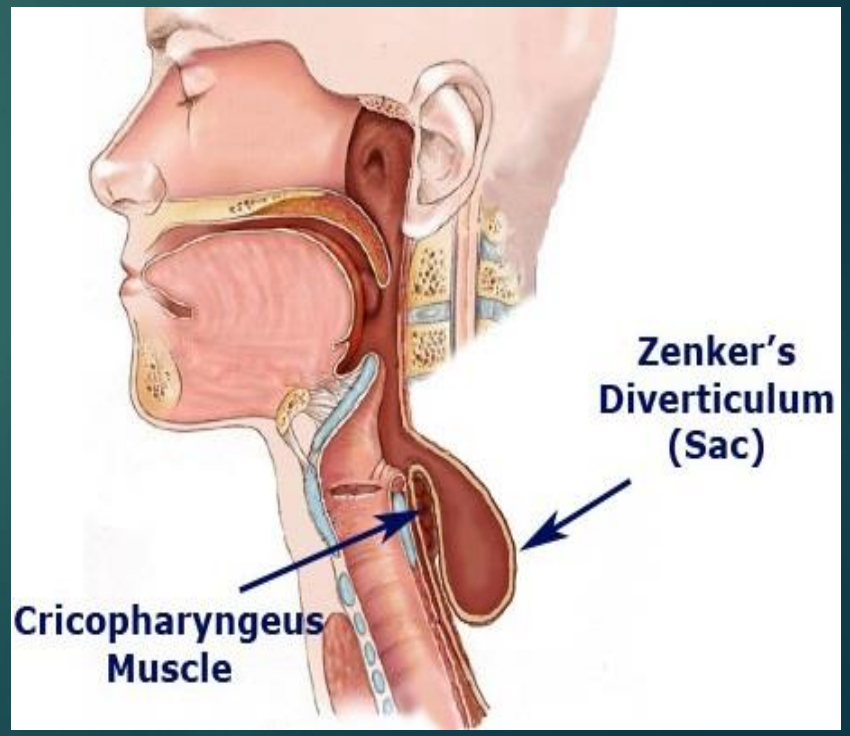
- Although there are advantages and disadvantages to each surgical approach, the final result of any esophagectomy is to use a portion of the stomach to replace the resected, diseased esophagus
- In all approaches, the stomach is mobilized while preserving its blood supply from the right gastroepiploic and gastric arteries. The stomach is then transposed into the chest, and a gastroesophageal anastomosis is fashioned either in the chest (Ivor Lewis and left chest approach) or in the neck (McKeown Approach)



Patient Population Characteristics

- Long-term tobacco and alcohol abuse
  - COPD, emphysema, baseline hypoxemia/hypercarbia
  - Tumors causing tracheal or bronchial compression
  - ETOH---CYP induced, + or – acetaminophen
  - Postoperative mechanical ventilation?

- GI Disorders
  - Achalasia, severe GERD, diverticula (ZENKER'S), gastroparesis
  - Malnutrition/Anorexia



Patient Population Characteristics continued

- Cardiac
  - CAD, HTN, AS, aneurysms
  - Antiplatelet agents and epidural technique
- Chemotherapy/Radiation patients
  - Friable mucosal tissues from chemotherapy/radiation--trauma-free laryngoscopy and intubation
  - Increased insensible fluid losses and increased bleeding
  - Again, possible obstructing/compressing tumor

Anesthetic Considerations

- Pre-op
  - Assess past medical history and aforementioned body systems/tests
  - Educate patient: multiple IVs, Central line, Art line, chest tubes, sore throat, possibility of post op mechanical ventilation/ICU, pain!
  - Airway assessment/management plan--imperative to know status of any tumors that could be compressing trachea
  - Evaluate anticoagulation status--possible continuous epidural placement (d/w anesthesiologist)
  - + or – versed when appropriate (prior to epidural)
  - Aspiration prophylaxis: H2-receptor antagonist (ranitidine 50mg IV), metoclopramide (10mg IV 1 hour pre-op), Sodium citrate 30mL po 10 min preop

Anesthetic Challenges

- Prolonged length of surgery
- One lung ventilation & associated pulmonary complications
- Assessment of fluid status
- Blood pressure management
- Extra-peritoneal C02 accumulation
- Adequate postoperative analgesia

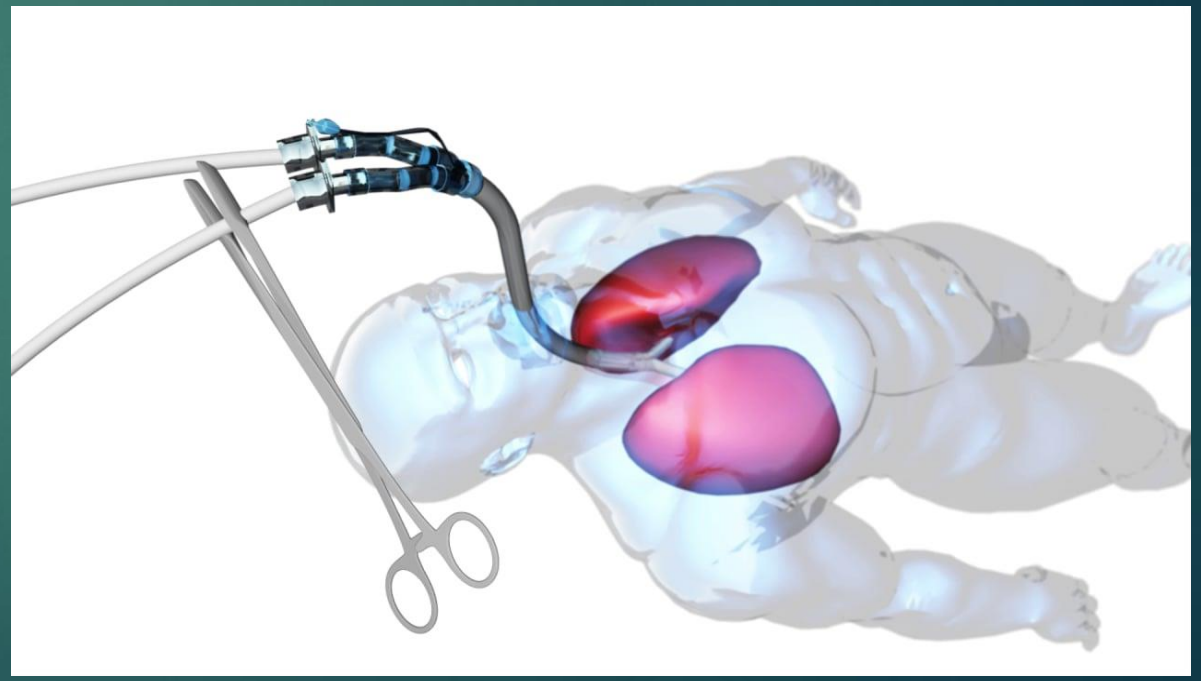
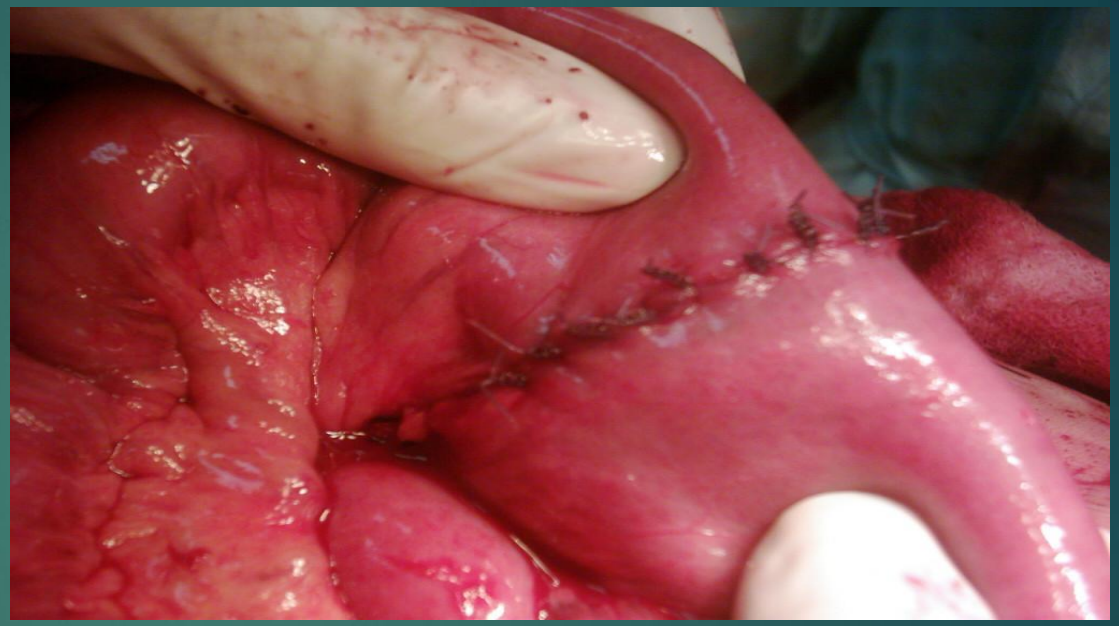


Table 2
Effects of carbon dioxide insufflation during laparoscopy

Physiological system	Effect
Cardiovascular	Hypertension and tachycardia (sympathetic stimulation)
	Hypotension (impaired venous return)
	Bradycardia (vagal stimulation)
	Arrhythmia
Respiratory	Reduced FRC
	Reduce compliance
	Increased ventilatory pressures
	Barotrauma including pneumothorax
	Atelectasis
Renal/metabolic	Reduced renal perfusion
	Activation of the renal–angiotensin–aldosterone system
	Increased antidiuretic hormone
Gastro-intestinal	Raised intra-abdominal pressures and increased risk of gastric regurgitation
	Splanchnic ischaemia
Other	Carbon dioxide embolus
	Complications of extra-peritoneal spread of carbon dioxide (see text)

Anastomotic Healing



- Fluids: Liberal or Restrictive?
  - PVI/SVV
  - CVP/PA catheter
  - Colloids > Crystalloids
- Hypotension & Vasopressors
  - Avoid Hypotension
  - Avoid norepi/phenylephrine in the setting of hypovolemia (PVI>13)
  - Norepi/Phenylepr hine acceptable in normovolemic states (PVI<13)
  - Dobutamine or Dopamine gtt may be more acceptable option for hypotensive states
- Epidural
  - Thoracic epidural shows improved microvascular circulation

Pain Management

- Pre-operative holding area
  - Oxycodone XR 20mg PO if <70 years old; 10mg if >70 years old
  - Celecoxib 400mg PO if <70 years old; 200mg if >70 years old
  - Pregabalin 150mg PO if <70 years old; 75mg if >70 years old

- Intra-operative
  - Thoracic Epidural (with thoracotomy)
    - Dose within 30mins of incision and closure
    - Local anesthetic/Opiate per anesthesiologist
    - Bupivicaine 0.125% and Fentanyl 2mcg/ml
  - Rescue narcotic
  - Tylenol 15mg/kg
  - Intercostal nerve blocks (by surgeon)
  - No intraoperative Ketorolac

Pain Management

- Post-Operative Holding Area
  - Thoracic Epidural PCEA (with open thoracotomy)
    - Rate 6mL/hr with range from 4-10mL/hr with 3 mL bolus
    - Bupivicaine 0.125%
    - Fentanyl 2mcg/mL or Dilaudid 6mcg/mL
  - IV PCA (with VATS or MIE)
  - Ketorolac 15mg IV for shoulder/chest tube pain
  - Rescue IV pain medicine PRN

Patient Controlled Analgesia (PCA) Pain Pump

- Nursing Unit
  - Acetaminophen 1,000mg PO TID
  - Ketorolac 15mg IV Q6 hours x 48 hours
  - Followed by Celecoxib 200mg PO BID <70 years old; 100mg PO BID if >70 years old
  - Pregabalin 75mg PO daily until d/c

Equipment

- Equipment
  - Standard monitors (02 sat, ekg, BP, ETC02, temperature)
  - Arterial line/Central line kits; monitoring (CVP, art.) cables, tranducers, etc.
  - Ultrasound
  - IStat Machine with cartridges
  - Airway: Laryngoscope/blade, double lumen tubes, **straight ETT (8.0-8.5)**, tube exchange catheter (in room), **Kelly Clamps**
  - Fluid warmer with blood tubing, Bair Hugger, water-heated blanket
  - NG tube ready for conclusion of the case (placed by surgeon over the drape)
  - Dopamine/Dobutamine, infusion pump

IV Access & Fluids

- Intravenous access
  - 14-16 gauge IV x2
  - + or - Central line with CVP monitoring
  - Arterial line
- Blood/Fluids
  - Type & Cross 2-4 units PRBC
  - Albumin
  - **Maintain euvolemia while avoiding excess fluid administration

Positioning

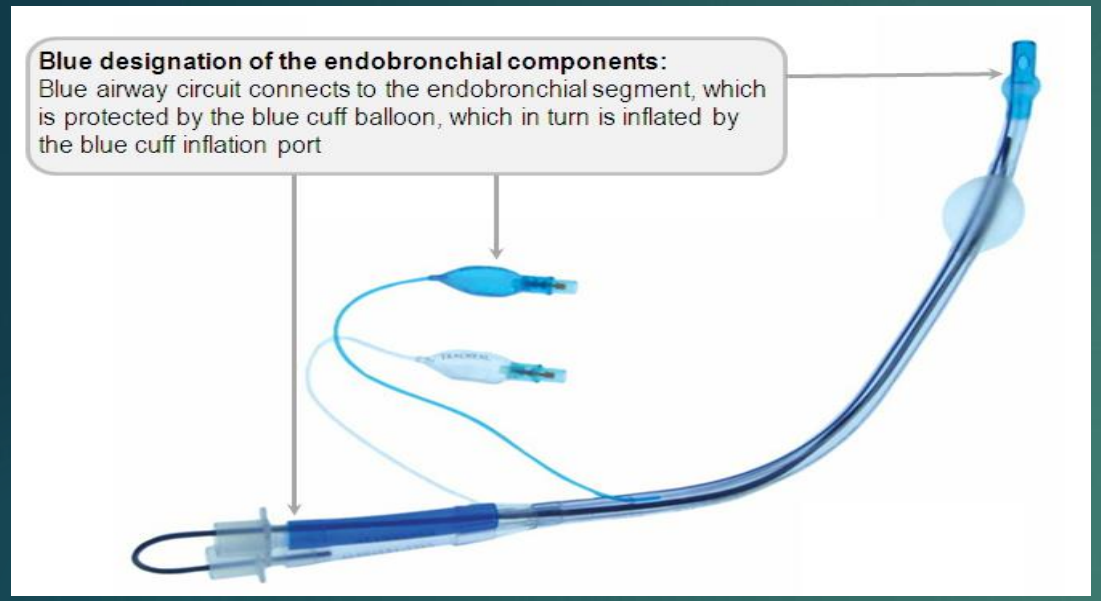
- Positioning
  - Left lateral decubitus (Ivor Lewis), then supine after thoracotomy
  - ***Axillary Roll**
  - Head donut, towels (head and Kelly clamp padding)
  - Upper arm padded table
  - Bean Bag
  - 02 probe on down arm if possible

****<u>RECHECK DLT/BB WITH FIBEROPTIC AFTER POSITIONING!!!</u>**

Induction

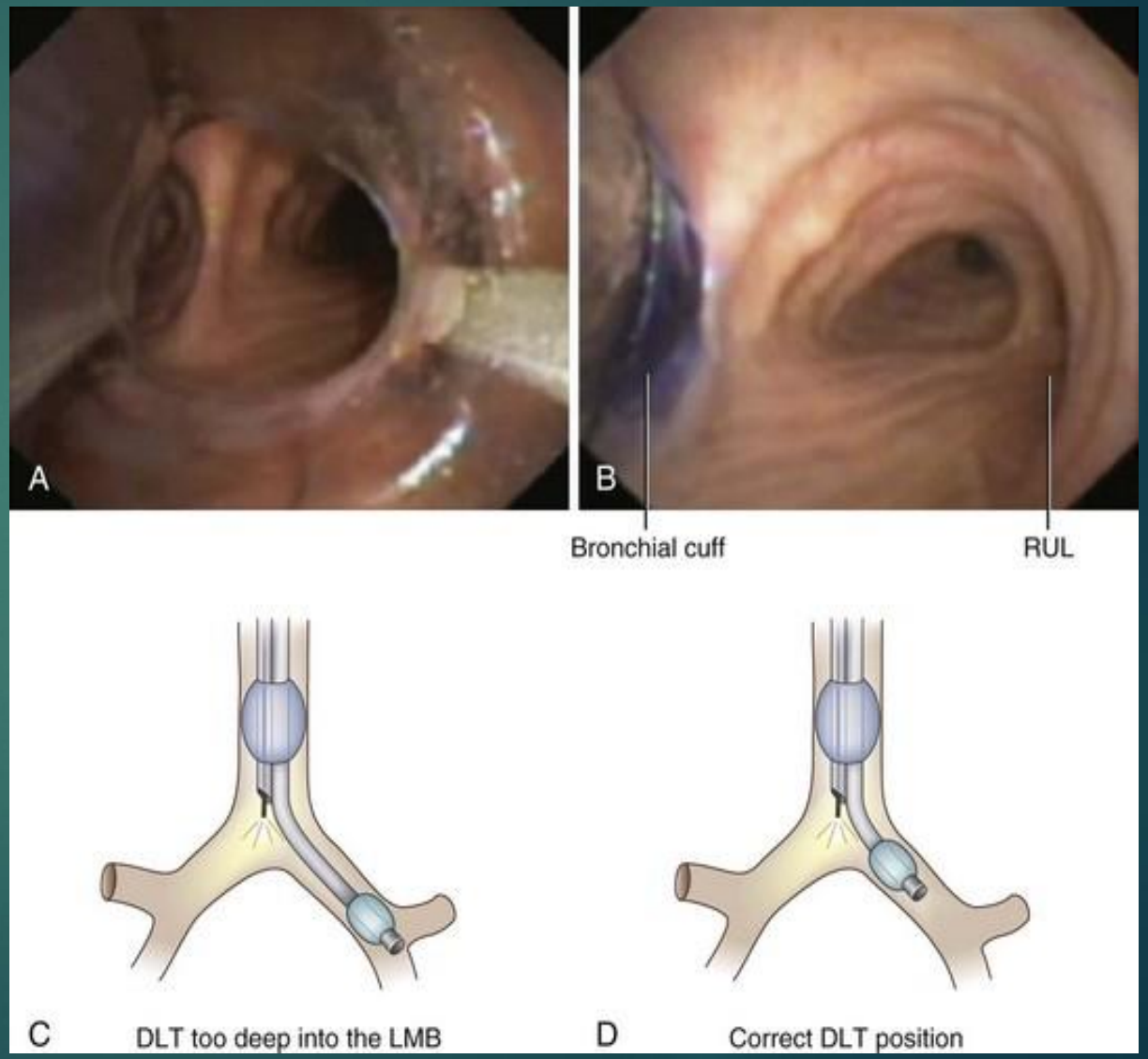
- ***<u>RAPID SEQUENCE INDUCTION</u>
- ***<u>DOUBLE LUMEN TUBE</u>
  - Size based on gender, size, and patient imaging:
    - Usually 35Fr. or 37Fr. for females (also have a 39Fr. Available)
    - Usually 37Fr. or 39 Fr. for males (35Fr. for very small males, sometimes 41 Fr. for larger males)
    - Discuss with surgeon/anesthesiologist
- Bronchial blocker available
- Thoracic Epidural
  - Mainly for the transthoracic and transabdominal approaches
  - T6-T7 dermatome level
  - Many consider gold standard for esophagectomies because of increased blood flow to anastomosis, earlier extubation times, VTE prophylaxis

DLT

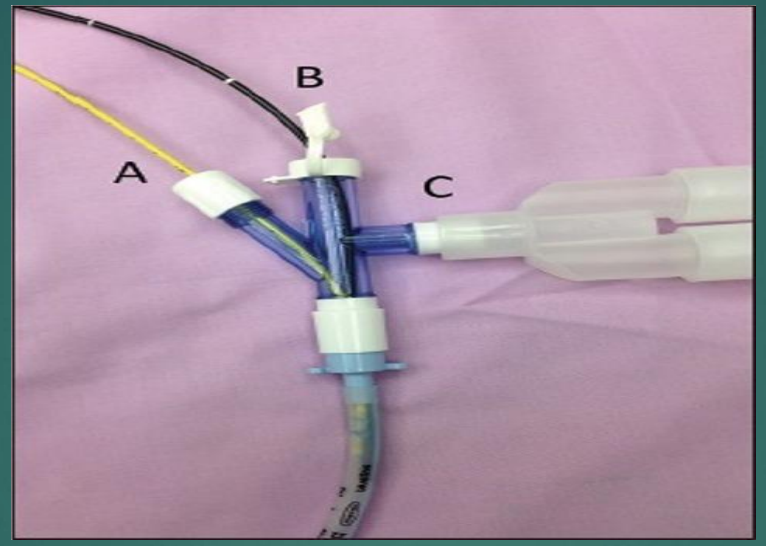


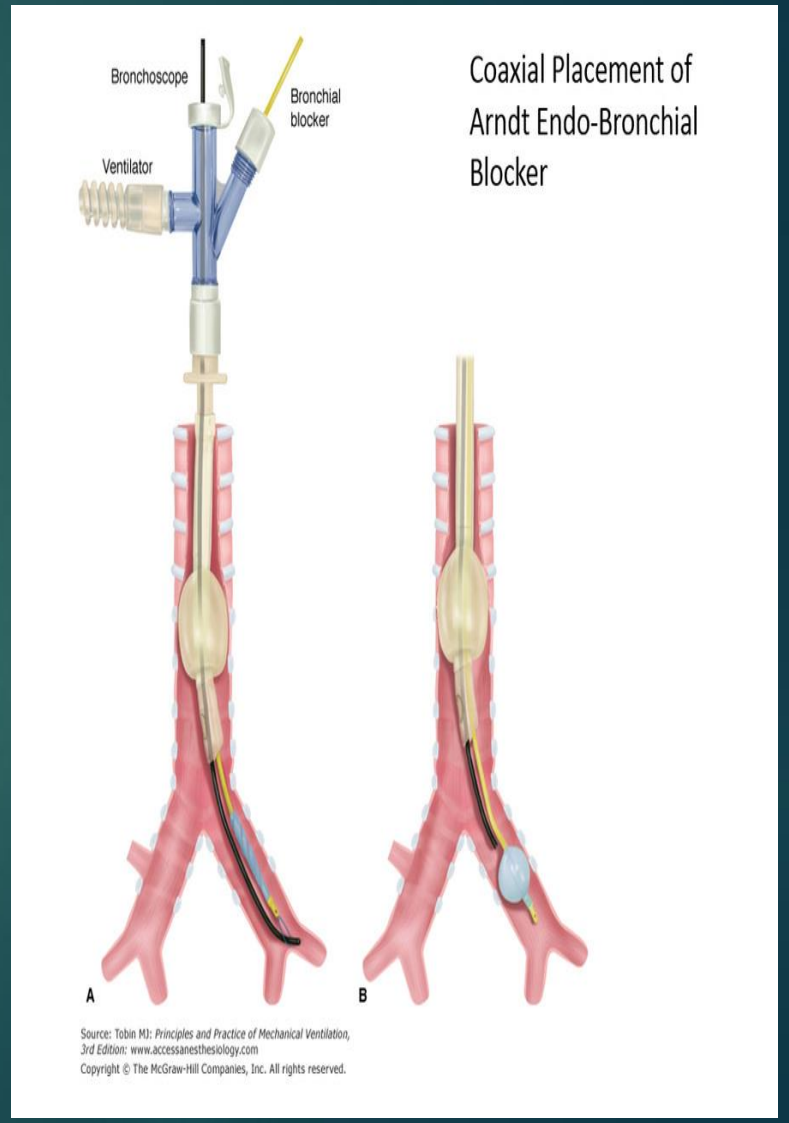
Right DLT

Left DLT



Bronchial Blocker





Maintenance

- One Lung Ventilation
  - After DLT position confirmed and surgeon ready, inflate bronchial cuff (1-2mL)
  - Kelly clamps used to collapse tracheal lumen--*Make sure port cap is opened to allow lung deflation
    - Can assist deflation with soft suction catheter through port cap
    - Lung adhesions may make lung look inflated
  - Ventilator Settings:
    - Tidal volume 6-8mL/kg---decrease TV during OLV
    - Increase respiratory rate to compensate-Permissive hypercapnia acceptable
    - Fi02 50-80% (air/02)—prevents denitrogenation and alveolar collapse
    - PEEP 5-10 cm H20
    - Peak pressures <35 cm H20; Plateau Pressures<25 cm H20 (barotrauma)
    - May need increased expiratory time

Maintenance continued

- Management of Hypoxia during OLV
  - Ensure adequate ETT positioning with fiberoptic scope
  - Suction DLT
  - Increase Fi02 to 100%
  - Optimize PEEP to the dependent, non-operative lung
  - CPAP (blow-by) oxygen to the operative lung—CAREFUL
  - Ensure adequate cardiac output and 02 delivery
  - Recruitment maneuvers on the dependent lung
  - Two-lung ventilation--for severe hypoxemia
- Check ABGs or IStat periodically/PRN
- Maintain muscle paralysis
- Maintain adequate level of anesthesia while providing goal directed decisions to maintain hemodynamics

Maintenance continued

- Once the esophagus is dissected, structures cleared, drains and chest tubes placed, and Intercostal nerve block placed, patient is positioned supine
- DLT is removed and straight ETT is inserted either by DL or with a tube exchanger---REMEMBER---**8.0-8.5 ETT FOR BRONCH AT END OF CASE**.
- Patient is re-prepped/re-draped and Laparoscopic abdominal portion ensues to mobilize and dissect stomach, create the esophagogastric anastomosis, pyloroplasty, and jejunostomy for postoperative feeding
- The previously dissected esophagus is removed through the abdomen, and the anastomosis is brought behind the mediastinum to its re-anastomosis site
- Cervical incision is made to help with attaching anastomosis and for lymph node dissection (McKeown)

Closure and Bronchoscopy

- Once the esophagogastric anastomosis is fully sutured and all surgical checks are done, closure begins
- Have NG tube lubed and ready to place—Surgeon may reach over the drape and place it after closure
- Fiberoptic Bronchoscopy will be performed by the surgeon/resident after closure–fairly quick so plan emergence accordingly

Emergence

- Anticipate extubation for majority of patients
- Consider cardiopulmonary status as well as surgical manipulation (high neck anastomosis-airway edema) for consideration to extubate
- Adequately timed and dosed reversal ☺
  - Consider Suggammadex
- Make sure patient is awake and cooperative when attempting to wean from mechanical ventilation
- Ensure protective reflexes are intact and patient has adequate WOB and VC—adequate TV, Respiratory rate (<25)

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