

Airway

- Rapid-sequence induction or awake FOB intubation may be necessary for symptomatic pts.
- Lung isolation DLT, bronchial blocker or a Uni-vent tube properly positioned) may be necessary to accommodate one-lung ventilation.

Induction

- Hypovolemia often results in BP fluctuations.
- Risk of aspiration.

Maintenance

- No one agent or technique is shown to be superior.
- Hypotension can occur due to mediastinal compression, blood loss, and initial dehydration. Maintain “balanced” fluid management. Role of vasoconstrictors is controversial on anastomosis perfusion. Low-dose dexmedetomidine may be beneficial.
- Oxygenation concerns during one-lung ventilation, the use of 100% O₂, prior pulm disease due to tobacco history, and volu-baro-atelectrauma during mechanical ventilation.
- Lung-protection advocated during mechanical ventilation; lower tidal volumes 5–6 mL/kg recommended with/without PEEP, using either volume or pressure modes of ventilation to maintain adequate oxygenation with plateau inspiratory pressures <25 cm H₂O.

- Hypothermia is a concern in long procedures.
- Placement of NG tube with surgical guidance can decompress the stomach (thus decreasing risk of aspiration and dehiscence).

Extubation

- Continuing risk of aspiration.
- Aim for early extubation either in the OR or within a few hours of surgery. This decreases the need for postop sedation with less fluid requirements and requires presence of good regional techniques.
- Use caution with obese and sleep apnea pts.
- If postop ventilation required, the DLT should be changed to a single lumen tube or bronchial blockers removed.
- A tube exchanger (Cook airway exchanger cath) is indicated if reintubation is deemed difficult (possible edema and fluid shifts) or in case of residual muscle paralysis. DLT is withdrawn over the tube exchanger and a single lumen tube is threaded over. Laryngoscope can be used to move soft tissue that may impede placement.

Adjuncts

- Acetaminophen can be used to supplement analgesia. NSAIDs may increase risk for anastomotic leak.

- Postop metoclopramide should be used with caution due to increased motility and possible anastomosis damage.

Postoperative Period

- Epidural/paravertebral analgesia is beneficial for open procedures. Regional techniques (intercostal blocks) should be used to supplement IV narcotics for MIS.
- Increased risk for supraventricular tachycardia and atrial fibrillation (25%). Rate control is recommended by the AHA, initially with IV amiodarone (class 2A) or diltiazem (class 2B) if BP tolerates. Beta-blockers should be continued in the postop period.
- Pneumonia and anastomotic leak are the other two most common complications.

Anticipated Problems/Concerns

- Airway management concerns: Aspiration risk, reintubation, and extubation criteria.
- Volume status in a dehydrated pt undergoing a lengthy surgical procedure with mediastinal compression and a thoracic epidural.
- Arrhythmias in the postop period; use prophylactic amiodarone.

Cancer, Lung Parenchyma

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Risk

- Lung cancer is the primary cause of cancer death.
- Asbestos exposure increases risk 5-fold.
- Smoking increases risk 15-fold.
- Radon exposure increases risk 2-fold.

Perioperative Risks

- Associated CAD
- Pulm insufficiency following lung tissue resection

Worry About

- Optimization of preop pulmonary status
- Issues secondary to metastatic spread, such as superior vena caval syndrome
- Myasthenic syndrome (Eaton-Lambert) with oat cell carcinoma
- Massive hemoptysis with cancer invasion of bronchial arteries
- Active pneumonia in pulm parenchyma distal to obstructed bronchioles

- Development of postop ARDS, pneumonia, or respiratory failure in 15–20%; higher in elderly
- Development of cardiac complications in 10–15%; higher in elderly

Overview

- Four primary types of lung cancers: squamous cell, or bronchogenic; adenocarcinoma (most common); large cell carcinoma; and small cell carcinoma.
- 70% of pts with COPD need extra postop pulm care.
- Pts often nutritionally depleted.
- Many pts have alcohol abuse history.
- Preop pulm state may limit option of lobectomy.
- Hormonal imbalances common due to hormone secreting tumors:
 - 3% of pts are Cushingoid.
 - 70% of pts with bronchogenic carcinomas have increased ACTH or pro-ACTH.
 - Up to 60% of pts with lung cancer have inappropriate ADH.

- Myasthenic syndrome occurs owing to decreased release of nerve-ending acetylcholine, leading to increased sensitivity to all muscle relaxants.

Etiology

- Environmental factors important (smoking, asbestos exposure, radon exposure).
- Higher incidence in areas located near oil refineries.

Usual Treatment

- Oat cell cancer frequently treated with radiation and chemotherapy (need good renal function).
- Lobectomy or pneumonectomy are common approaches in other types of lung cancers; DLCO of <60% predicts 75% mortality; >100% predicts 100% survival.
- Lobectomy increasingly performed using VATS, while pneumonectomy still primarily performed with a thoracotomy.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Myocardial ischemia, arrhythmia, cor pulmonale	Angina SOB Palpitations SOB	S ₃ gallop Irregular pulse Distended neck veins	Exercise stress test ECG Cath ECHO
RESP	Pneumonia, bronchospasm, COPD	Productive cough, wheezing, SOB, dyspnea	Rhonchi-rales, wheezes, decreased BS, clubbing	CXR; PFTs: MBC, MMEFR, DLCO; ABGs
ENDO	SIADH	Lethargy, increased weight, decreased urine Thin skin, poor wound healing Weight gain, striae	Hypometabolic	Lytes Elevated urine sodium (rarely needed)
	Increased ACTH		Cushingoid, increased BP	Cortisone level (rarely needed)
NM	Eaton-Lambert (myasthenic)	Decreased muscle weakness	Decreased muscle strength with exercise	EMG (rarely needed)
NUTRITION	Wasting DTs	Weight loss, alcohol abuse	Cachexia, BMI change, increased liver size	Liver function tests (especially albumin)

Key References: Lohser J, Slinger P: Lung injury after one-lung ventilation: a review of the pathophysiologic mechanisms affecting the ventilated and the collapsed lung, *Anesth Analg* 121: 302–318, 2015; Chappell D, Jacob M, Hofmann-Kiefer K, et al: A rational approach to perioperative fluid management, *Anesthesiology* 109:723–740, 2008.

Perioperative Implications

Preoperative Preparation

- Resp optimization with bronchodilatation, antibiotics, pulm hygiene, and smoking cessation
- Correction of lyte imbalances

Monitoring and Operative Care

- Routine monitors include temperature monitoring with active warming devices.
- Intra-arterial line and possible pulm cath, but if a PA cath is used, be alert to it being caught in the surgical pulm incision.
- Neuromuscular blockade monitor.
- Thoracic epidural is key for postop pain control.

Airway

- Double-lumen tube or bronchial blocker needed—usually left-sided, unless left pneumonectomy.
- Fiberoptic bronchoscope should be available for positioning of endobronchial tube.

Induction

- Anesthetic choice dependent on associated medical problems.
- Light or no premedication to decrease CO₂ retention.

- When right-sided double-lumen tube used, ensure right upper lobe ventilation (easiest with fiberoptic bronchoscope).

Maintenance

- Nerve damage with lateral position
 - Use axillary roll.
 - Brachial plexus injury with arm hyperextension
 - Pad all pressure points.
- Substantiate pulse oximetric and capnographic readings with ABGs.
- If O₂ saturation falls during one-lung ventilation, PEEP on dependent lung may help. If not, CPAP on nondependent lung may help.
- Intraop fluid restriction, including use of blood and blood products, can significantly decrease postop resp failure.
- With one-lung ventilation, use TV of 4–5 mL/kg ideal body weight and 10 of PEEP in typical patient.

Extubation

- If postop ventilation required and double lumen tube has been used, it needs to be switched to single-lumen tube.
- Extubation should be determined by adequacy of resp variables.

Adjuvants

- Bronchodilators for intraop use, inotropes for myocardial depression, antiarrhythmics for post-lobectomy-pneumonectomy arrhythmias (some advocate prophylactic digoxin—but conflicting reported results)

Postoperative Period

- If pneumonectomy performed, there is a significant risk for postop ARDS.
- Adequate pain management usual for recovery of pulm function:
 - PCA or use of intercostal blocks can be effective.
 - Thoracic epidural most efficacious.
- Be watchful for DTs, inappropriate ADH, and decreased neuromuscular strength.

Anticipated Problems/Concerns

- Intensive pulm toilet postop.
- Employ careful suctioning of bronchial stump because of possibility of rupture.
- Bronchopleural fistula and tension pneumothorax are possible concerns.

Candidiasis

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Risk

- Risk occurs in pts with suppressed immune systems from diseases like AIDS, chemotherapy drugs, and extended steroid therapy.
- Risk factors include current and recent broad-spectrum antibiotic therapy.
- Diabetes, leukemia, and neutropenia also increase risk.
- IV hyperalimentation and prolonged ICU stay increase risk.
- Risk increased via breaches of protective epithelial barrier: Surgical trauma, burn injury, long-term indwelling IV, or bladder catheters.
- Even in healthy individuals, candida can be cultured from the oral cavity in a third to more than half; this increases with chronic illness and duration of hospitalization.
- As systemic bacterial infections have declined with aggressive antibiotic use, systemic fungal infections have correspondingly increased.
- Candida is fourth most common organism recovered from blood cultures.

Perioperative Risk

- Candidemia with septic shock is infrequent in non-immunocompromised pts but has a very high mortality rate, ~30% higher than bacteremic septic shock, and a high likelihood of MOF, along with delayed recovery from this organ failure.
- Pts more likely to have compromised renal function at baseline.

Worry About

- Disseminated candidemia and associated organ dysfunction
- Candidemic septic shock
- Side effects of azole, nystatin, or amphotericin-B therapy

Overview

- Candidemia occurs in 30 cases per 100,000 admissions (in USA) and is associated with ~14.5% increase in mortality, 10-day increase in hospital stay, and ~\$40,000 increase of charges.

- ~50 cases per 1000 pts per y; of these, 10% develop candidemia, with an attributable mortality of 25%.
- ~1% of pts colonized on wards.
- Incidental culture positive to fatal candidiasis.

Etiology

- Among isolated species, ~60% *C. albicans*, ~20% *C. tropicalis*, with the rest in decreasing order, including *C. glabrata*, *C. parapsilosis*, *C. krusei*, and *Candida* spp.
- Can result from antibiotic therapy, because normal flora that keeps fungal growth in check is eliminated with antibiotics.

Usual Treatment

- Oropharyngeal: Oral itraconazole and fluconazole
- Esophageal: Oral and IV fluconazole, oral itraconazole, low-dose IV amphotericin B
- Vulvovaginal: Topical and oral azole agents
- Systemic infections: IV amphotericin B, high dose fluconazole (echinocandin in pts with neutropenia)

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Thrush Endophthalmitis	Dysphagia Visual changes	White oral plaques Ophthalmic lesions	Bleed on scraping Fundoscopic and field of vision
CV	Endocarditis Septic shock	SOB Refractory hypotension	Cardiac murmurs Fever	Auscultation CVP, CO, PCWP
RESP	Pneumonia ARDS	SOB, cough, tachypnea, decreased exercise tolerance	Rapid shallow breathing, hypoxemia, consolidation	PFT, ABG, CXR
CNS	Meningitis Brain abscess	Altered mental status, signs of increased ICP, nausea, vomiting, headache, seizures, loss of appetite	Mental status exam, neck stiffness, photophobia, confusion	CT, MRI, blood cultures, CSF cultures
RENAL	Renal abscess Cystitis	Dysuria, polyuria, low back pain, hematuria	Costovertebral tenderness on affected side	Urine culture, cystoscopy, CT
MS	Fungal osteomyelitis	Tenderness over bone, skin breakdown over infected bone	Moderate to severe bone pain, limited range of motion	X-ray, culture and sensitivity, bone scan
GI	Inflammation through GI tract, intra-abdominal abscess	Dysphagia, abdominal pain, diarrhea	Abdominal tenderness, signs of peritoneal irritation, hepatomegaly, splenomegaly	CT or MRI, endoscopy, abdominal ultrasound

Key References: Pfaller M, Neofytos D, Diekema D, et al: Epidemiology and outcomes of candidemia in 3648 patients: data from the Prospective Antifungal Therapy (PATH Alliance) registry, 2004–2008. *Diagn Microbiol Infect Dis* 74(4):323–331, 2012; Bassetti M, Righi E, Ansaldi F, et al: A multicenter study of septic shock due to candidemia: outcomes and predictors of mortality. *Intensive Care Med* 40(6):839–845, 2014.