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 CO_2 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 O_2 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

Ashish C. Sinha

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.

Perioperative Implications

Preoperative Preparation
- Continue antifungal therapy.
- Evaluate for septic shock.
- Rule out infected lines or catheters; change if indicated.

Monitoring
- If septic, A-line, CVP ± PA catheter, along with standard monitoring.

Airway
- Be careful not to aggravate oral lesion at intubation.

Preinduction/Induction
- Choose drugs based on septic signs and symptoms.
- Worry about hypotension and hypoxemia at induction.

Maintenance
- Choose drugs based on hemodynamic status.
- Choose ventilatory modes based on presence of ARDS.

Extubation
- May have to be delayed if ARDS or septic state requires hemodynamic support.

Adjuvants
- In the presence of compromised renal or hepatic function, modify anesthetic drugs accordingly.

Anticipated Problems/Concerns
- Candidemia presents with a diverse clinical picture, from low-grade fever to fulminant septic shock. There is higher periop mortality in this group of pts.

Carbon Monoxide Poisoning

Peter H. Breen

Risk
- CO is the predominant toxic gas in smoke. (COHb can reach 10% in tobacco smokers.)
- CO poisoning is a major cause of death (early symptoms may be only headache and dizziness).
- CO is produced by all internal combustion engines, incomplete oxidative combustion (e.g., house fires, charcoal and gas grills, malfunctioning butane/propane stoves), and endogenous sources (e.g., by the liver from exogenous exposure to paint stripper).
- No odor, taste, or color and causes no irritation.
- Toxicity potentiated by low inspired O_2 concentration (e.g., smoke inhalation).
- To minimize CO in circle circuit carbon dioxide absorbers, use fresh soda lime, use sevoflurane, and minimize drying (lower FGF and stop FGF during use).
- During GA, use semiclosed circuits, especially when machine has not been used for 2–3 d (e.g., Monday morning).

Perioperative Risks
- Main target organs: Heart and brain
- Heart: Effect can resemble ischemia; potentiated by CAD.
- Brain: Acute loss of consciousness; after initial improvement (lucid window), up to 30% risk of secondary syndrome: chronic psychiatric dysfunction and cerebral and cerebellar syndromes.

Worry About
- Seek other smoke inhalation injury.
- Consider concomitant cyanide poisoning, which potentiates CO toxicity.
- Be alert for CO poisoning in donor for organ transplantation.

Overview
- CO, a colorless, nonirritating, odorless gas, is a natural byproduct of combustion.
- CO binds avidly to Hgb (>200 times more than O_2) to form COHb, which carries no O_2 and causes a left shift in the oxyhemoglobin dissociation curve (decreases O_2 off-loading to tissues).
- CO binds to intracellular hemoproteins such as myoglobin and cytochrome aa_3 (esp cardiac) to inhibit O_2 uptake and metabolism.
- "Classic" cherry-red complexion rarely observed (need COHb >40%; may be obscured by coexistent hypoxia and cyanosis).
- COHb level correlates poorly with clinical condition (symptoms with "normal" COHb).
- Treatment should be guided by symptoms and signs, not by blood COHb concentration.

Etiology
- CO produced by incomplete oxidative combustion (e.g., house fires, malfunctioning butane/propane stoves, home heaters, all internal combustion engines)
- Suicide attempts

Usual Treatment
- Normobaric O_2: $T_{½}$ of COHb decreases from 3.5 hr (air breathing) to 0.75 hr (O_2 breathing).
- Treat clinical symptoms, not just increased COHb.
- General supportive care, especially for other aspects of smoke inhalation injury.
- Hyperbaric O_2 (2.5 atm) decreases COHb $T_{½}$ to 20 min, increases dissolved plasma O_2, and has been shown to decrease the likelihood that delayed neurologic complications will develop. For pts with neurologic Sx (including impaired consciousness), evidence of myocardial ischemia, fetal distress (if pregnant), poisoning in pediatric pts, or other Sx of significant exposure (e.g., COHb >25%), hyperbaric O_2 within 6–8 h of exposure if feasible is recommended.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Thermal/toxic upper airway injury	Fire exposure/smoke inhalation	Perioral burns Airway edema	Laryngoscopy/bronchoscopy
RESP	CO diffuses rapidly into blood, leading to COHb	Dyspnea, tachypnea		Cooximetric COHb: PO_2 usually normal CXR
	Thermal/toxic airway and parenchymal injury		Bronchoconstriction and pulm edema	Bronchoscopy
CV	Lower O_2 content in blood and lower O_2 unloading in tissue	Possibly angina or evidence of heart failure, tachycardia	Cardiac failure	ECG: Ischemic ST-T changes CXR
METAB	Tissue hypoxia leading to acidosis			Lactic acidosis
CNS	Coma, cerebral edema	Temporal headache, N/V, restlessness	Muscle weakness, altered mental status	Abnormal neuropsychometric testing
	Neuropsychiatric syndrome	Cerebral, cerebellar		Can occur after initial recovery

Key Reference: Breen PH, Isserles SA, Westley J, et al.: Combined carbon monoxide and cyanide poisoning: a place for treatment?. *Anesth Analg* 80(4):671–677, 1995.

Perioperative Implications

Preoperative Preparation
- Continuous 100% O_2.
- Document CNS status.
- Consider hyperbaric O_2 if mental status altered or pt has myocardial ischemia or is pregnant.

Monitoring
- Routine monitors (if no lung injury and thus no decreased PaO_2, there may be no tachypnea)
- SpO_2 does not distinguish between O_2Hb and COHb. Thus SpO_2 overestimates O_2Hb during CO poisoning.
- Newer SpO_2 monitors (Masimo Corp., Irvine, CA) can discriminate between O_2Hb and COHb (and metHb).
- Mixed venous oximeter catheters overestimate O_2Hb in presence of COHb.
- Arterial cannulation for frequent blood sampling.
- Venous and arterial COHb levels are almost identical.

Airway
- Airway injury and edema often occur during smoke inhalation, which may require emergent airway management.

Induction
- Avoid cardiac depressant agents.

Maintenance
- 100% O_2 (no N_2O)
- Assess muscle weakness to guide dosage of muscle relaxant.