Adjuvants
- Routine

Postoperative Period
- Use stir-up regimen and monitor for retained secretions and resp failure.
- Have postop plan for chest physiotherapy.
- Pt may need to continue course of antibiotics.
- Supply supplemental oxygen and monitor SpO_2.
- Check for platypnea-orthodeoxia if right atrial pressures become elevated.

Anticipated Problems/Concerns
- Retained secretions and secondary resp failure
- Right heart decompensation if hypoxemia persists
- Bacteremia from airway manipulations

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Bronchiolitis Obliterans Syndrome

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Risk
- Incidence in USA: 1:40,000
- Racial predilection: None
- Occurs primarily after lung and hematopoietic stem cell transplantation
- Industrial workers exposed to inhalants who have presented with BOS: nylon-flock, battery workers, manufacturer of flavorings (diacetyl butter-like flavoring), and textile workers

Perioperative Risks
- Hypoxemia and severe periop airway obstruction.
- Pulm infection, sepsis, and pulm edema post transplant.
- Injury to tracheal anastomosis due to ETT placement.
- Prolonged intubation (increased sensitivity to medications including muscle relaxants, pulm functions, renal impairment, and pulm edema).
- Complications of immunosuppression (infection, hemorrhage, and renal impairment).
- Preop focus must differentiate between active invasive pulm infection and ongoing chronic rejection with colonization, as well as maximizing medical condition and stratifying risk.

Worry About
- Pulm functions
- Differentiating BOS from untreated invasive pulm infection and other disorders
- Side effects of immunosuppression including infection with invasive techniques, hemorrhage, and renal failure with cyclosporine
- Airway and vascular allograft denervation (physiologic and pharmacologic side effects)
- Other effects of etiologic agents

Overview
- Delayed-onset allograft dysfunction and continual decline in FEV_1 not due to other etiologies of transplant dysfunction; it frequently occurs with signs of airflow obstruction.
- Because BO is difficult to confirm histologically (transbronchial biopsy of larger airways with sporadic involvement often provides insufficient samples and has a high false-negative diagnostic rate), the International Society for Heart and Lung Transplantation proposed a staged clinical definition of BO termed BOS (stages 0 to 3 defined by changes in pulm functions, and based on spirometry, rather than histology).
- BOS clinical staging is important to the clinician because it indicates allograft function.

Etiology
- The mechanism involved in the etiology of BO remains poorly understood.
- Two forms of BOS with inflammation and fibrosis: Rejection-related and non-rejection related.
- After transplant, the syndrome reflects small airway obliterations caused by "chronic rejection."
- Several risk factors, including primary graft dysfunction, lymphocytic bronchiolitis, ischemia-reperfusion injury, acute cellular rejection, mismatches at HLA loci, autoimmunity (collagen V sensitization), persistent neutrophil influx and sequestration (bronchoalveolar lavage neutrophilia), GE reflux with resultant aspiration, loss of cough reflex due to denervation, complication of prematurity (bronchopulmonary dysplasia), toxicant inhalation ("popcorn lung"), and exposure to infectious agents (bacterial, viral, and some atypical organisms including mycoplasma, chlamydia, and fungi) (BO with organizing pneumonia [BOOP]).
- BOS is described after lung, heart-lung, bone marrow, renal, pancreas, and liver and hematopoietic stem cell transplantation; BOS remains the leading cause of death for those who survive beyond 1 y after lung transplantation.

Usual Treatment
- Varies depending on whether or not BOS is rejection related
- Rejection-related BOS: Mainly treated with augmented immunosuppression (systemic corticosteroids, cyclosporine, tacrolimus, and azithromycin) and supportive care, including O_2, bronchodilators, and chest physical therapy
- Non-rejection related BOS is treated with supportive care, anti-infective agents, and medical antireflux therapy, and may respond to steroids (especially toxic fumes and other environmental exposures)
- Newer treatments for rejection-related conditions: Extracorporeal photopheresis, aerosolized cyclosporine, antithymocyte globulin, IV immunoglobulin, statins, bortezomib, interleukin subtype specific antagonists, and montelukast
- Referral to surgeon for potential fundoplication of the GE junction if GE reflux is confirmed
- Severe cases often require lung transplant or even retransplant, with an accompanying increased risk of recurrent BOS and graft dysfunction

Assessment Points

Use previous classification to determine the possible cause of BO, including posttransplantation or environmental exposure(s).

System	Effect	Assessment by Hx	PE	Test
GENERAL	Active infection	Fever and non-rejection related change in status	Increased temp, tachycardia with infection	Increased WBC
RESP	Loss of lung functions (% FEV_1)	Recent change in functional capacity, invasive lung infections, meds, lung colonization (resistant bacteria), risk factors, BOS staging; environmental exposure (e.g., diacetyl production)	Tachypnea, wheezes, cough, fever, cyanosis, pulm edema	CXR, high-resolution computed tomography, PFTs (decreased FEV_1, decreased O_2 saturation hypoxia) bronchoscopy for endobronchial biopsy, culture, bronchoalveolar lavage, lung biopsy (diagnosis)
RENAL	Loss of function due to immunosuppression	Change in status, dialysis	A-V fistula (avoidance for procedures), fluid overload, pulm edema, increased weight	Decreased renal functions, tachycardia, peripheral edema, SOB
HEME	Thrombocytopenia due to medications	Prolonged bleeding	Bruising	CBC with decreased platelets, increased bleeding time

Key References: Meyer KC, Raghu G, Verleden GM, et al.: An international ISHLT/ATS/ERS clinical practice guideline: diagnosis and management of bronchiolitis obliterans syndrome, *Eur Respir J* 44(6):1479–1503, 2014; Feltracco P, Falasco G, Barbieri S, et al.: Anesthetic considerations for nontransplant procedures in lung transplant patients, *J Clin Anesth* 23(6):508–516, 2011.

Perioperative Implications

Preoperative Preparation

- PFTs for BOS staging and resp status and bronchoscopy for biopsy and culture.
- Treat active infections aggressively.
- Evaluate renal functions and adjust periop medications where appropriate.
- Continue anti-infective and immunosuppressive therapy during the periop period and adjust dosing to keep within the indicated therapeutic range.
- Strict aseptic techniques due to immunosuppression.
- Premedication useful due to excessive secretions, but avoid excessive resp depression.
- Reflux prophylaxis.
- Corticosteroids supplementation especially for long, invasive, and stressful procedures.
- Watch for increased sensitivity to opioids, hypercarbia, resp acidosis, bronchial hyperresponsiveness (bronchoconstriction), V/Q mismatch, GE reflux, hyperkalemia, and hypomagnesemia.
- Most common side effect of immunosuppressive drugs: Cyclosporine and tacrolimus (Htn, diabetes, neurotoxicity, and renal failure), glucocorticoids (hyperglycemia, weight gain, osteoporosis, and adrenal insufficiency), and azathioprine (anemia and thrombocytopenia).

Monitoring

- Routine.
- Consider arterial line placement if hypoxic, acidotic, or O_2 saturation is inadequate: invasive monitoring must be carefully weighed against the possibility of infection from intravascular catheters.
- TEE or other continuous CO monitoring systems may be helpful in assessing cardiac function in post heart-lung transplant pts, and when there is evidence of pulm edema and pulm Htn.
- CVP insertion recommended (when necessary) on side of native lung (one-lung transplant).

Airway

- ETT cuff placement should avoid tracheal anastomosis.
- Oral intubation is preferred over nasal intubation (due to infection and thrombocytopenia).
- Anticipate difficult intubation if on chronic corticosteroids due to Cushingoid (moon face) features and limited atlanto-occipital joint mobility.
- Use aseptic tracheal suction technique.

Induction

- Short-acting agents preferred; adjust doses to pt status and to avoid prolonged CV depression.

Maintenance

- Avoid fluid overload; renal dysfunction due to immunosuppressants and disruption of lymphatic drainage in posttransplant pts can lead to pulm edema with fluid overload.
- Significant reductions of cyclosporine or tacrolimus blood levels can be caused by dilution with IV fluids.
- Adjust neuromuscular blocking dosage due to interactions with immunosuppressive agents and adjust dosage if renal impairment. (Cyclosporine enhances the effect of muscle relaxants producing a prolonged block.)
- NSAIDs can cause further renal toxicity in addition to immunosuppressants.
- Prevent additional mechanical obstruction (ventilator-induced disease and excessive tidal volumes) and employ ventilator with capability for variable inspiratory and expiratory ratios.
- Lateral decubitus position may aggravate V/Q mismatch.
- Hyperventilation during mechanical ventilation should be avoided because seizure threshold in pts taking immunosuppressive agents may be lowered.
- Use shorter-acting agents to avoid prolonged CNS, CV, and resp depression to facilitate a swift recovery of functions and timely extubation.

Extubation

- Delay until adequate ventilation is assured (sustained tetanus on monitoring).
- The lack of cough reflex below the tracheal anastomosis makes pts unable to clear secretions, unless they are awake, increasing the risk of silent aspiration.

Adjuvants

- Consider regional technique because it allows opioid sparing, but dense intercostal blockade can delay extubation in pts with poor respiratory reserve.

Postoperative Period

- Monitor for and aggressively treat resp depression, infection, and fluid overload.

Anticipated Problems/Concerns

- Many pts with resting hypoxia and marginal compensated lung functions come to OR for diagnostic lung biopsy. A thoracoscopic technique may be impossible owing to adhesions post heart/lung transplantation or pt's inability to tolerate one-lung ventilation.
- Anticipate further perioperative resp decompensation after open-lung biopsy.
- Arrange postop disposition (monitored bed and ventilator support) depending on preop functional status and the potential for periop complications.

Acknowledgment

We thank Dr. Roy Levitt for his previous contributions to this chapter.

Bronchitis, Chronic

C. William Hanson III

Risk

- Incidence in USA: 14 million
- Race with highest prevalence: Caucasian
- M:F ratio 1:2
- Smoking, second-hand smoke, occupational exposure to pulm toxic substances (radon, coal, silicates, and asbestos)

Perioperative Risks

- Bronchospasm

Worry About

- Airway stimulation at light levels of anesthesia
- Laryngospasm (due to secretions and hyperreactivity)
- Hypoxia
- Hypercarbia

Overview

- Chronic productive cough with periodic exacerbations (most d for at least 3 mo and for at least 2 consecutive y)
- Enlargement of the mucus-secreting glands in the airways with excessive sputum production
- Obstruction of expiratory airways
- Derangement in V/Q relationships
- Chronic hypoxia with right heart failure
- Exacerbations with intercurrent bacterial or viral infections

Etiology

- Acquired, usually due to smoking
- May also be due to asthma or frequent childhood resp infections

Usual Treatment

- Avoidance of environmental irritants such as cigarette smoke (preferably >8–10 wk before elective surgery)
- Antibiotics for acute exacerbations; inefficacious for prophylactic treatment
- Oral glucocorticoids: appropriate for acute exacerbations but not for maintenance therapy
- Periop stress dose glucocorticoid (methylprednisolone, dexamethasone, and hydrocortisone) administration: may be appropriate in pts on prolonged (>3 wk) high dose (≥20 mg prednisone per day) oral steroids
- Short-acting bronchodilators, such as beta agonists or anticholinergics, for acute exacerbations and long-acting beta agonist bronchodilators plus inhaled steroids for long-term maintenance therapy; pts on inhalers may be treated with preintubation inhalation of a beta agonist

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Short, fat neck			
CV	Right heart failure	Exercise tolerance	RV heave Dependent edema	ECG ECHO
	Pulm Htn			PA catheter
RESP	Airways obstruction	Smoking Hx (current, recent, emote) Number and severity of recent exacerbations	Cyanosis	PFT, DLCO, ABGs
MS			Clubbing of fingers	

Key References: Kim V, Criner GJ: Chronic bronchitis and chronic obstructive pulmonary disease, *Am J Respir Crit Care Med* 187: 228–237, 2013; Yamakage M, Iwasaki S, Namiki A: Guideline-oriented perioperative management of patients with bronchial asthma and chronic obstructive pulmonary disease, *J Anesth* 22:412–428, 2008.