

- In spontaneous ventilation, bullae are more compliant than normal lung tissue and preferentially fill. At higher pressures and volumes, bullae are much less compliant than normal lung and therefore have much higher peak pressures than normal tissue and are prone to rupture.

Etiology

- Primary: Unknown but may be genetic; more common in young males
- Secondary: Emphysema, smoking, lung cancer, cystic fibrosis, pneumonia, and tuberculosis

Usual Treatment

- No treatment for asymptomatic, incidental blebs
- First-time rupture of a bleb is treated conservatively, depending on size of pneumothorax; Varies from 100% O₂ to chest-tube placement
- Surgical treatment: indicated for ruptured blebs in those in high-risk occupations that involve frequent changes in barometric pressure or recurrent spontaneous pneumothorax

- Surgical treatment of bullae done for increasing SOB or recurrent pneumothorax
- Surgical approach: Usually VATS, but may require thoracotomy or median sternotomy; laser ablation and mechanical pleurodesis may be utilized

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	CAD, pulm Htn, RV failure	Angina, DOE	Signs of RV failure (palpable PA, peripheral edema)	ECG, stress test, ECHO
RESP	Expiratory obstruction and air trapping V/Q mismatch Hypoxia, hypercarbia Pneumothorax	Exercise tolerance, cough	Pursed-lip breathing, tachypnea	CXR, ABGs, chest CT, V/Q scan
ENDO	Possible steroid use			Glucose
MS	Barrel-chested			

Key References: Bansal S, Surve RM, Venkatapura RJ: Anesthetic management of a paraparetic patient with multiple lung bullae. *J Neurosurg Anesthesiol* 26(1):85–86, 2014; Slinger PD, Campos JH: Anesthesia for thoracic surgery. In Miller RD, Eriksson LI, Fleisher LA, et al., editors: *Miller's anesthesia*, ed 7, Philadelphia, 2010, Churchill Livingstone, pp 1819–1888.

Perioperative Implications

Preinduction/Induction/Maintenance

- Optimize oxygenation and deliver bronchodilators if necessary.
- Regional or neuraxial anesthesia is preferential over general endotracheal anesthesia.
- Some associated conditions may have significant mucus plugging; fiberoptic bronchoscope with suction and irrigating capabilities may be useful.
- Careful attention to hemodynamic monitors and ventilator peak pressures and volumes is essential.
- Have a surgical team available during induction because this is most common time for pneumothorax to occur.
- Recent chest x-ray evaluation for severity of disease and progression is also essential.

Monitoring

- Routine
- Consider arterial line to recognize more rapidly signs of CV collapse from pneumothorax or caval compression

General Anesthesia

- Maintaining spontaneous ventilation through induction can minimize complications. Avoid the use of paralytics or consider mask induction or awake fiberoptic intubation techniques.
- Consider ketamine induction to maintain ventilation for IV induction.

- If disease is unilateral and positive pressure required, a double lumen endotracheal tube can allow you to isolate the diseased lung and not expose it to increased pressure.
- If positive pressure ventilation needed, pressure control ventilation at low pressures with higher rate may be useful, but beware of breath stacking.
- Allow adequate exhalation times to avoid breath stacking (auto-PEEP) by appropriately setting I:E ratio.
- Do not use nitrous oxide under any circumstance.
- Consider use of isoflurane because it is the most bronchodilating-inhalation agent; it may decrease pressure requirements or obstruction in COPD pts.
- Careful attention to spontaneous ventilatory rate and volumes before extubation.
- Avoid high airway pressures from fighting the ventilator.
- If pt paralyzed, assure full reversal before attempt to extubate.
- COPD pts may retain CO₂, so be careful not to drive ET/CO₂ too low and prolong emergence.

Regional Anesthesia

- Preferred technique if possible for most cases.
- Optimize volume status.
- Watch for resp distress from loss of accessory resp muscles from neuraxial anesthesia.

- Epidural may be preferable to spinal to avoid loss of accessory muscles by slowly raising the level by interval dosing.
- Pleurodesis is exquisitely painful and often requires a thoracic epidural to control pain and assure adequate chest excursion during recovery.

Postoperative Period

- Beware of CO₂ narcosis in those who retain CO₂.
- Spontaneous rupture can occur at any time. Continue adequate monitoring and watch for sudden dyspnea, desaturation, and loss of unilateral breath sounds.

Anticipated Problems/Concerns

- Rupture of bleb or bulla will cause a pneumothorax, which may rapidly progress to tension.
- Treatment of choice for tension pneumothorax is needle thoracostomy in second to third intercostal space in midclavicular line (in line with the nipple of a male pt). Most failures of needle thoracostomy occur from placement of needle too medial into the mediastinum.
- Obstructive pulmonary pathology includes bronchoconstriction and accessory muscle use even in the spontaneously breathing pt.
- Positive pressure ventilation is to be avoided, and nitrous oxide is absolutely contraindicated.

Bleomycin Sulfate Toxicity

John F. Rompala

Risk

- Pts with a history of germ cell tumors, lymphomas, squamous cell carcinomas, Kaposi sarcomas, and cervical cancers treated with BLM
- Incidence of BLT is 10–40%; mortality is 1–2%
- Risk of BLT increases with total dose >400 unit, glomerular filtration rate <80 mL/min, or advanced tumor stage at time of diagnosis

- History of concurrent thoracic irradiation cisplatin administration
- Age greater than 40 y
- History of smoking or exposure to high FiO₂s

Perioperative Risks

- Exposure to high FiO₂ may increase risk of developing pneumonitis and potentially lethal ARDS in periop setting.

- Preexisting lung pathology in combination with low FiO₂ may result in hypoxia.
- Risk of pulm injury is greatest within about 8 mo of administration, but BLM likely confers an elevated lifetime risk of BLT.
- Pulm adverse events rarely related to the intrapleural or intralesional administration of BLM.

Worry About

- Periop exposure to high FiO_2 s (>30%)
- Periop hypoxia
- Fluid overload, transfusion of red cells, and prolonged operative time
- Intrapleural administration of BLM, which has been associated with local pain and hypotension requiring symptomatic treatment

Overview

- Antibiotic with antitumor properties isolated from the fungus *Streptomyces verticillus* is used primarily

to treat testicular cancers and lymphomas, as well as some head and neck tumors.

- BLM is also effective for treatment of malignant and recurrent pleural effusions.
- BLM is inactivated by the enzyme BLM hydrolase. Lungs and skin have the lowest levels of BLM hydrolase and thus are more susceptible to injury.
- Cleared by renal excretion. $T_{1/2}$ 4 h.

Etiology

- BLM binds both Fe^{2+} and DNA. The Fe^{2+} is oxidized to Fe^{3+} , resulting in free radicals, which damage DNA, leading to cell death.

- Oxidative damage to cell membranes and fatty acids likely initiates an inflammatory response resulting in myofibroblast proliferation and ultimately pulmonary fibrosis.
- Early reports demonstrated a link between administration of BLM/exposure to high FiO_2 s and subsequent development of lung toxicity and fibrosis.

Assessment Points

System	Effect	Assessment by Hx	PE	Tests
RESP	Pulm fibrosis ARDS with O_2 exposure	Dyspnea, dry cough	Frequently normal Earliest sign is fine rales	CXR: Bilateral infiltrates progressing to consolidation and honeycombing High-resolution CT scan: Ground-glass opacities and fibrosis Decreased O_2 sat PFTs: Restrictive pattern/decreased DLCO
MUCOCUT	Inflammation, dermal fibrosis	Itching, burning, skin tenderness	Stomatitis, alopecia, scleroderma-like skin changes	
HEME	Minimal bone marrow toxicity			CBC

Key References: Reinert T, Baldotto C, Nunes F, et al.: Bleomycin-induced lung injury, *J Cancer Res*, 2013. <<http://dx.doi.org/10.1155/2013/480608>>. (Accessed 24.02.16.); Aakre BM, Efem RI, Wilson GA, et al.: Postoperative acute respiratory distress syndrome in patients with previous exposure to bleomycin, *Mayo Clin Proc* 89(2):181–189, 2014.

Perioperative Implications**Preoperative Preparation**

- In pts with Hx of testicular, squamous cell cancer, or lymphoma, inquire about exposure to BLM, as well as Hx of other risk factors.
- Any pt with abnormal PFTs, or who is clinically symptomatic, should be considered at high risk for development of ARDS.
- Pts receiving BLM within 8 mo of surgery are at higher risk, but BLM exposure most likely confers elevated lifetime risk of BLT.

Intraoperative Management

- Use of low FiO_2 has been mainstay of BLT prevention. Some studies call this practice into question.

It is best to maintain FiO_2 below 30%, but perhaps not at expense of hypoxia.

- Utilize protective lung ventilation strategies.
- Maintain neutral fluid balance with preference toward colloids. Avoid transfusions if possible. Consider invasive monitoring to guide fluid therapy.
- In high-risk pts, pretreatment with corticosteroids (1 mg/kg prednisone) may be helpful in limiting postop ARDS.

Postoperative Period

- Provide adequate oxygenation with the lowest possible inspired FiO_2 .
- Observe carefully for 3–5 d after surgery, for signs of dyspnea, hypoxia, cough, or rales.

- Use PEEP or CPAP to treat postop hypoxia.
- Add methylprednisolone up to 1 mg/kg/d if developing ARDS, and diuretics if clinically indicated.

Anticipated Problems/Concerns

- Pts who had previously received BLM and have received supplemental oxygen are susceptible to lung toxicity and ARDS.
- Maintaining adequate oxygenation with the lowest possible FiO_2 can be difficult.
- Neutral fluid balance and avoidance of transfusions if possible. Invasive monitoring may be useful for guidance.

Blindness

Stanley W. Stead

Risk

- Eye injuries represent 4% of claims analyzed in the ASA Closed Claims Project.
- Majority of entries in the ASA POVL Registry are associated with cardiac and spine cases, with a reported incidence as high as 4.5% and 0.2%, respectively. Other surgical procedures with POVL reported including head and neck, liver transplants, thoracoabdominal aneurysm resections, peripheral vascular procedures, and prostatectomies.
- In the Registry, POVL is most often associated with ION 89% of the time and CRAO 11% of the time.
- Blindness can result from injury to the eye, its surrounding structures (eyelid and conjunctiva), blood supply, and optic nerve.
- Blindness may be transient (glycine absorption), prolonged, or permanent (ION, CRAO, traumatic, and central ischemic events).

neck dissections, complex instrumented spinal fusion surgery, where there is significant facial swelling and venous hemodynamics may be altered (highest incidence: Pts <18 y)

- CRAO: Periocular trauma and rarely bilateral blindness.
 - Procedure dependent factors: improper head positioning, use of a horseshoe headrest when placing the eye in contact with the headrest, anemia, blood loss greater than 1 L, systemic hypotension, and procedure duration greater than 6 h
- Intraocular procedures, procedures around the eye, prone position with padding around the face and eyes, exophthalmos, or ophthalmic nerve blocks
 - 1.5% glycine irrigation during TURP as well as transurethral bladder procedures and hysteroscopic procedures in women

- Low blood-flow states: Systemic hypotension, anemia, and venous drainage impairment of the head and neck
- Operations in physical proximity to the eyes
- During ophthalmic surgery:
 - Movement of pt under either MAC or GA during intraocular surgery
 - Trauma to optic nerve, retinal artery, or vein during orbital or sinus surgery
 - Coughing or substantial Valsalva maneuvers by pt following intraocular surgery
- During ophthalmic nerve block:
 - Perforation of globe
 - Trauma to the optic nerve, retinal artery, and vein

Overview

- Unless associated with glycine irrigating solution, blindness is often an irreversible complication following anesthesia and surgery.
- Blindness is most often associated with injury to the eye, its surrounding structures (eyelid and conjunctive), blood supply, and optic nerve.

Worry About

- Pressure on the globe or contact with eye by foreign objects or solutions
- Positioning of pt, especially prone

Perioperative Risks

- ION: Bilateral blindness in spine procedures in the prone position, cardiopulmonary bypass, head and