

Assessment Points

System	Effect	Assessment by Hx	PE	Test
CV	Arrhythmogenicity due to electrolyte disturbances, hypovolemia	Assess for clinically symptomatic bradycardia, heart block, CHF	Auscultation of heart sounds, ECG	Continuous ECG monitoring
RENAL	Metabolic acidosis, polyuria, K^+ , Mg^{2+} , Ca^{+2} , PO_3^- loss in urine	Assess GFR and residual renal function.	Assess for dehydration	ABG, UA, BMP
CNS	Lyte imbalance, hypoglycemia may cause confusion/disorientation and/or seizures; rarely muscle weakness	Evaluate pt compliance	Lung sounds: rales, edema of extremities	Neurologic assessment

Key References: Klootwijk ED, Reichold M, Unwin RJ, et al.: Renal Fanconi syndrome: taking a proximal look at the nephron, *Nephrol Dial Transplant* 30(9):1456–1460, 2015; Pandey R, Garg R, Chakravarty C, et al.: Lowe's syndrome with Fanconi syndrome for ocular surgery: perioperative anesthetic considerations, *J Clin Anesth* 22(8):635–637, 2010.

Perioperative Implications

Preoperative Concerns

- Existence of any other coexisting genetic/metabolic disorder should be ruled out by thorough Hx, physical exam, and special test(s).
- Preop ABGs, ECG.
- Preop electrolytes level (K^+ , Mg^{2+} , Ca^{+2} , PO_3^-) and glucose in the morning of surgery.
- Correction of electrolyte imbalances (K^+ , Mg^{2+} , Ca^{+2} , PO_3^-).

- Metabolic acidosis corrected by administering $NaHCO_3^-$ preop to maintain plasma bicarbonate levels at about 20 mEq/L.

Induction/Maintenance

- During laryngoscopy, special attentions to avoid overextension and pt positioning to prevent injury to the rickety bones
- Closely monitoring acid-base and fluid-electrolytes imbalance during the surgery
- Monitoring volume status by UO and CVP

Postoperative Period

- Postop labs of urine analysis, serum lytes, calcium, phosphorous, glucose, BUN, creatinine, albumin, and hematologic profile are used to guide postop care
- ECG monitoring in PACU (hypokalemia)

Anticipated Problems/Concerns

- Lyte imbalances warrant monitoring and correction periop
- Potential hypovolemia
- Other coexisting metabolic/genetic disorder(s)

Fat Embolism

Shamsuddin Akhtar

Risk

- Long bone fractures and pelvic fractures:
 - 80–100% fat embolism
 - Less than 1–30% FES
- Male-female ratio: 4:1
- Adult greatly increased over pediatric
- Multiple fractures >single fractures
- Pathologic fractures >traumatic fractures
- Total hip, total knee replacement, intramedullary nailing:
 - 27–100% fat embolism
 - Unknown incidence FES
- Unusual causes: Liposuction, fat injection, bone marrow harvest and/or transplantation, vertebroplasty, cardiopulmonary bypass, CPR, burns, pancreatitis, sickle cell disease, osteomyelitis, fatty liver, soft tissue injury

Perioperative Risks

- FES: <10% mortality
- Preexisting FES: Respiratory failure/ ARDS, RV dysfunction, shock, coagulopathy, neurologic dysfunction
- Intraop fat embolism: Shock, hypoxemia

Worry About

- Preexisting FES: Hypoxemia, reduced pulm compliance, pulm Htn, RV failure, hypotension, cardiac arrest, coagulopathy
- Intraop embolism: Hypotension, RV failure, hypoxemia, paradoxical embolization, stroke, neurologic dysfunction (delirium to coma, postop)

Overview

- Fat particles (globules of marrow fat) traveling into blood and lung.
- Must distinguish fat embolism, from FES (triad of hypoxemia, petechiae, and neurologic abnormalities). Fat embolism is more common than FES.
- FES can produce mild pulm dysfunction to severe ARDS.
- Pulm Htn and acute RV failure may occur in severe cases of FES.
- Typically the onset of signs and symptoms of FES happen 12–72 h following injury.
- Fat embolism occurs commonly during femoral reaming and cementing in hip arthroplasty.
- FES is confounded with cement reaction during arthroplasty.

Etiology

- Most frequently follows orthopedic trauma with release of marrow fat into venous circulation
- Pathology produced by mechanical obstruction by intravascular fat passing into the pulm and systemic arterial circulation and by production of endogenous inflammatory mediators

Usual Treatment

- Early fracture fixation to decrease embolization.
- Use of noncemented prosthesis or venting of femoral shaft may reduce embolization during hip arthroplasty.
- Unreamed nailing for fracture fixation to reduce embolization.
- O_2 therapy to maintain $SaO_2 > 90\%$.
- Low tidal volume ventilation strategy with PEEP as for ARDS.
- Aggressive hemodynamic support with fluid and/or inotropes for shock and/or RV failure.
- Factor replacement for coagulopathy with bleeding.
- Corticosteroids, heparin, ethanol, dextran, aspirin, and prophylactic vena caval filter are of unproven benefit.

Assessment Points				
System	Effect	Assessment by Hx	PE	Test
CV	Intravascular fat Hypoperfusion Pulm Htn RV failure	Fever Syncope Dyspnea	Hypotension Tachycardia Oliguria Vasoconstriction Mental status changes	Fat staining of blood Bronchoalveolar lavage, macrophage staining TTE/ TEE, CVP, PA cath Lactic acidosis
RESP	ARDS Hypoxemia	Dyspnea	Tachypnea Cyanosis Rales	Pulse oximetry CXR, ABGs Pulm compliance (on mechanical ventilation)
HEME	Thrombocytopenia DIC Anemia	Bleeding	Bleeding (rare)	CBC Plts PT, PTT D dimer Fibrinogen
DERM	Capillary fat embolism		Petechiae (60%) Axilla, chest Base of neck Conjunctiva Oral mucous membranes	
CNS	Neurologic injury Cerebral edema	Mental status changes	Delirium Confusion, agitation Focal deficits (rare) Seizure (rare) Coma (rare)	MRI

Key References: Akhtar S: Fat embolism, *Anesthesiol Clin* 27(3):533–550, 2009; Kwiatt ME, Seamon MJ: Fat embolism syndrome, *Int J Crit Ill Inj Sci* 3(1):64-68, 2013.

Perioperative Implications

Preoperative Preparation

- Avoid sedatives and/or narcotics if hypoxemic and not mechanically ventilated or with obtundation.

Monitoring

- Arterial cath
- TTE/TEE, CVP, and PA cath to diagnose and manage RV failure and/or pulm Htn

Airway

- May have ARDS; decreased FRC and O₂ reserve and limited tolerance for apnea.
- May already be intubated and ventilated in severe cases.

Induction

- Minimize myocardial depression.

- Avoid increases in PA pressures (hypoxemia, hypercarbia, acidosis).

Maintenance

- CV: Anticipate decrease in BP with femoral reaming/cementing; anesthetic reduction, fluid, vasopressors; pts with RV dysfunction may require longer-term inotropic support.
- Resp: Pts with ARDS may require increased FIO₂ and PEEP; use lung protective strategy, ARDSnet protocol.
- Heme: Factor replacement for coagulopathy with bleeding.

Extubation

- Maintain intubation and mechanical ventilation in hemodynamically unstable pts and those requiring increased FIO₂, PEEP or with reduced compliance.

- Pts with CNS involvement may have a prolonged or exaggerated response to anesthetics and narcotics and may require intubation postop for airway protection/patency.

Anticipated Problems/Concerns

- Embolism during femoral reaming, prosthesis cementing.
- FES may be delayed by up to 72 h following fat embolism.
- Pts with ARDS may be difficult to ventilate and oxygenate.
- Hypotension is due to RV dysfunction and pulm Htn.

Foreign Body Aspiration

Ahmed Alshaarawi | Jeffrey R. Kirsch

Risk

- Most prevalent in children ages ≤3 y.
- In adults, elderly are most susceptible to FB aspiration. Risk factors include Alzheimer disease or dementia, stroke, loss of consciousness due to trauma, alcohol intoxication, or drug overdose.
- Foods are most commonly aspirated foreign objects.

Perioperative Risks

- Hypoxemia due to FB obstruction
- Fragmentation of the FB and distal dislodgement during retrieval

- Severe inflammation due to presence of high oil contents in a FB, leading to bulky granulation resulting in bronchial stenosis, bronchiectasis, pneumonia, and lung abscess

Worry About

- Exacerbation of hypoxemia due to ineffective ventilation during either diagnosis or treatment secondary to sedation or prolonged periods of apnea during extraction of FB
- Prolonged extraction of FB, airway swelling, and bleeding, which may lead to further respiratory compromise

Overview

- Pts with FB aspiration may present with cough, stridor, wheezing, throat pain, drooling, dysphagia, respiratory distress, and hypoxemia (oxygen saturation <90%).
- Subglottic FBs are often aspirated into the right main bronchus, likely due to the less acute angles of the right bronchus.

Usual Treatment

- Flexible and rigid bronchoscopy.
- Bronchotomy or lung resection may be performed in rare occasions, especially when the FB aspiration is diagnosed late (>1 wk).

Assessment Points

System	Effect	Assessment by Hx	PE	Test
RESP	Hypoxemia	Choking, coughing	Dyspnea, dysphagia, respiratory distress	Pulse oximetry, radiographic imaging, bronchoscopy

Key References: Won C, Michaud G, Kryger MH: Upper airway obstruction in adults. In Grippi MA, Elias JA, Fishman JA, et al., editors: *Fishman's pulmonary diseases and disorders*, ed 5, New York, NY, 2015, McGraw-Hill Education; Duan L, Chen X, Wang H, et al.: Surgical treatment of late-diagnosed bronchial foreign body aspiration: a report of 23 cases, *Clin Respir J* 8(3):269–273, 2014.