can prolong the QT interval. If the decision is made to stop TCAs before surgery, it must be done 2 wk before the surgery to prevent withdrawal symptoms. If TCA treatment will continue through surgery, an ECG must be obtained prior to the start of surgery.

Monitoring
- Routine.
- Anesthesia should be performed in an inpatient setting.

General Anesthesia
- Avoid if possible.
- May cause significant postop resp depression.
- Diaphragmatic pacing stimulation may improve resp compliance and stimulate respirations.
- Extubate when pt is fully awake.

Regional Anesthesia
- May be preferred compared to general anesthesia.
- Case reports have documented successful use of epidural anesthesia.
- Minimize neuraxial extent of blockade to reduce risk of resp depression.

Postoperative Period
- Anticipate prolonged postop ventilation.
- Use nonsedating medications for pain control.

Anticipated Problems/Concerns
- Anticipate hospitalization secondary to prolonged weaning from ventilator.
- Communication with ALS pts may be difficult because pts have weakened oropharyngeal muscles. Prior to anesthesia, determine the best way to communicate with pts (i.e., letter boards) and have family members available to assist.
- Close resp monitoring is essential following anesthesia. Exacerbation of apnea may result from supplemental oxygen.

Anaphylaxis

Karen Hand

Risk
- Lifetime prevalence of anaphylaxis is 0.05% to 2%, most common triggers being food, stings, and iatrogenic causes.
- Occurs in approximately 1 in 10,000 to 1 in 20,000 anesthetic procedures, and 1 in 6500 administrations of neuromuscular blocking agents (NMDAs). Causes 3% of anesthesia-related deaths.
- Females outnumber males 3:1.
- Hx of atrophy, prior anaphylaxis, and prior adverse reaction to anesthesia.

Perioperative Risks
- Significant risks of life-threatening CV collapse, airway compromise, and bronchospasm.
- Most common causes are NMDAs (60%), latex (15%), and antibiotics (15%).
- Increased risk of life-threatening reactions with beta blockers, ACEIs, asthma, and underlying cardiac disease.

Worry About
- Hx of atrophy, prior anaphylaxis, and prior adverse reaction to anesthesia.
- Timing: Most reactions occur around the time of induction or within 10 min of drug administration. May be difficult to distinguish from other drug reactions or mechanical problems.
- Rapid progression: Time to cardiac or resp arrest is within 5 min for anesthetic reactions, compared to 30 min for food and 15 min for stings.
- Diagnostic difficulty: Varied presentations, tachycardia or bradycardia, less than 50% have bronchospasm, cutaneous signs may be absent or occur later in severe reactions.
- Biphasic response: May recur from 4-24 h later

Overview
- Defined as a severe, life-threatening, generalized or systemic hypersensitivity reaction.
- Classified as:
  - Allergic reactions, usually involving IgE.
  - Nonallergic reactions, previously called anaphylactoid.
  - Itching, burning hands, feet, mouth or genitals, abdominal pain, nausea, and a feeling of doom or tunnel vision may be reported by awake pts.
- Most common initial features during anesthesia are pulselessness, desaturation, and difficult ventilation.

Etiology
- Allergic: IgE antibodies crosslink receptors on mast cells and basophils, causing degranulation, releasing many vasoactive substances, incl histamine, in an inflammatory cascade.
- Usually requires prior exposure. However, can occur with NMDAs with first exposure, thought to be due to common quaternary amine in NMBAs and chemicals (e.g., found in cleaners and cosmetics). In Europe, linked with ingredient in cough syrup, pholcodine.
- Can occur with any muscle relaxant, most commonly succinylcholine. Increasing reports with rocuronium; also reported with sugammadex.
- Risk factors for latex allergy include meningomyelocele, as well as allergy to figs, papayas, or avocados. Increased in healthcare workers
- Rarely due to opiates or local anesthetics (more likely intravascular injection or epinephrine)
- Nonallergic: Related to drug dose and speed of injection. Usually less severe than IgE-mediated reactions.

Usual Treatment
- Halt exposure to trigger
- Epinephrine: Standard treatment (e.g., no IV is 0.3 mg IM to outer thigh). Under anesthesia adjust IV dose according to severity of reaction from 10 s mcg to 100 s mcg to multiple 1 mg doses.
- Clinical Severity Scale:
  - Grade 1: Cutaneous or mucous signs.
  - Grade 2: +/– hypotension, tachycardia, dyspnea, GI disturbance.
  - Grade 3: Life-threatening CV or resp collapse.
  - Grade 4: Cardiac arrest.
- IV fluids (large bore IV); may require large volume.
- O_2 and supportive measures.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Head and neck swelling, and potential glottic edema	Will occur suddenly	Swelling	Clinically obvious
CV	Increased or decreased HR, decreased BP and SVR, increased ectopy, acute coronary events		Hypotension, CV collapse	ECG may reveal premature ventricular contractions PVCs or change in P-R interval
RESP	Bronchospasm		Wheezing	Increased peak inspiratory pressure, decreased O_2 saturation
DERM	Urticaria, erythema, hives, edema		Body rash	May be hidden under drapes or absent initially in severe reactions

Key References: Simons FE, Sheikh A: Anaphylaxis: the acute episode and beyond, *BMJ* 346:f602, 2013; Dewachter P, Mouton-Faivre C, Emala CW: Anaphylaxis and anesthesia: controversies and new insights, *Anesthesiology* 111(5):1141–1150, 2009.

Perioperative Implications

Preoperative Preparation
- Prophylactic H1/H2 blockers and steroids may attenuate the severity, although not the incidence of reactions. There is more support for their use in preventing nonallergic reactions.
- Consider administering antibiotics preop rather than at the time of induction.

Monitoring
- Standard ASA monitors are essential to rapidly identify anaphylaxis.
- Always consider anaphylaxis in CV collapse with or without bronchospasm or cutaneous manifestations during induction.
- The airway may swell, making intubation very difficult.

Induction
- Reactions usually occur during induction. Reactions to latex may occur within 30 min.

Maintenance
- Perpetuation of reaction can occur, particularly if due to latex.
- Significant cross-reactivity between NMDAs (approaching 80%).
- Avoid all muscle relaxants in pts with prior reactions.

Extubation
- Ensure stability from a cardiorespiratory viewpoint.
- Assess for airway edema.
- Beware reactions to sugammadex.

Adjuvants
- H1/H2 blockers and steroids may attenuate the biphasic response.
- In case unresponsive to repeated doses of epinephrine, consider norepinephrine, vasopressin, and ECMO.
- Sugammadex has been used in the treatment of anaphylaxis to rocuronium.
- Epinephrine is drug of choice in true anaphylaxis. Delayed administration increases the incidence of the biphasic response and death.

Postoperative Period
- Tryptase levels should be drawn within 30 min to 2 h of a suspected reaction, then compared to baseline levels at 2 wk.
- Skin testing may be done several weeks after initial event to assess etiologic agent.
- Advise patients exactly which drugs they received.
- Obtain immunology consult.

Anticipated Problems/Concerns
- Early aggressive treatment may be critical.

Anemia, Aplastic

Joanne Shay

Risk
- Incidence in USA: 2000 new cases/y.
  - Per million up to age 9.
- Southeast Asia and South Africa have 10-20 times higher incidence.
- Within USA, related to agricultural areas or petrochemical industry and chemical exposures.

Perioperative Risks
- Infection
- Hemorrhage
- LV dysfunction due to high-output state and fluid overload

Worry About
- Sepsis
- Coexisting congenital anomalies, especially renal and cardiac
- Concomitant GI and intracranial hemorrhage
- Difficulty cross-matching blood products after previous multiple transfusions

Overview
- Self-perpetuating disorder resulting in pancytopenia due to a congenital or acquired loss of hemopoietic pluripotent stem cells.
- Fanconi anemia is congenital familial marrow hypoplasia associated with intellectual disability and kidney, spleen, and skeletal hypoplasia.
- Estren-Dameshek anemia is inherited marrow hypoplasia without physical abnormalities.
- Pathophysiology: Reduction or dysfunction of pluripotent stem cells or their microenvironment from toxic or immunologic causes.
- Prognosis for long-term survival has increased to 40% to 75% in those treated with antilymphocyte serum and 60% to 80% in those treated with BMT.
- Two forms of drug-induced aplastic anemia are possible:
  - Hypersensitivity: Not related to dose or duration.
  - "Reversible" reaction: Often resolves with discontinuation; severity proportional to dosage.

Etiology
- Of cases, 50% to 75% are idiopathic.
- Fanconi anemia demonstrates autosomal recessive inheritance with heterozygote frequency of 1 in 300,000-600,000 in USA.
- Drug-induced: Chloramphenicol, NSAIDs, antiepileptics, and gold and sulfa group-containing compounds.
- Environmental toxins include aromatic hydrocarbons (benzene, naphthalene, toluene, and glue), pesticides (DDT and lindane), and radiation.
- Infectious causes include hepatitis C, CMV, EBV, HIV, TB, and toxoplasmosis.
- Sequelae of other processes such as pancreatitis, pregnancy, lupus erythematosus, paroxysmal nocturnal hemoglobinemia, thymoma, and thymic CA.

Usual Treatment
- Pts <55 y are managed with HLA-matched BMT or hematopoietic stem cell transplant.
- Pts >55 y or those unable to find HLA-matched donor receive immunosuppression and immunomodulation Rx, incl ATG, cyclosporine, steroids, androgens, and G-CSF.
- Hematopoietic growth factors such as G-CSF and GM-CSF may improve the short-term hematologic recovery at the risk of long-term clonal evolution to myelodysplastic syndrome and AML.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Epistaxis Oral/mucosal friability	Headache	Stomatitis	CBC, differential, plt PT, PTT, CT scan
RESP	Pulm embolism Pneumonia Interstitial pneumonitis Pulm edema	Dyspnea Hypoxemia	Tachypnea Lung field consolidation Wheezing Crackles	CXR, V/Q scan CT scan ABGs, bronchoscopy, BAL CXR, ABG
CV	LV failure ASD/VSD	Dyspnea Lethargy	Tachycardia, S_3 Displaced posterior MI	ECG ECHO
GI	GI bleeding GI GVHD Hepatic veno-occlusive disease	N/V, diarrhea Melena	Acute abdomen Hypoactive bowel sounds Jaundice	Endoscopy, bleeding scan Selective angiography Albumin, transferrin LFT, liver biopsy
CNS	Microcephaly, meningitis, intracranial hemorrhage	Irritability, lethargy Headache, seizures	Meningismus Papilledema	Lumbar puncture after coagulopathy treated, head CT, MRI
HEME	Pancytopenia Leukemia Paroxysmal nocturnal hemoglobinuria	Bleeding gums, infections Easy bruisability Fatigue, dark urine	Petechiae Retinal hemorrhage Pallor	CBC, differential Reticulocyte count BM biopsy Ham test
METAB	Electrolyte abnormalities Glucose intolerance Hypoproteinemia Hypothyroidism	Long-term hyperalimentation GI GVHD Hypotension, cold intolerance		Electrolytes Ca^{2+}, Mg^{2+}, phosphate, albumin, transferrin TSH, T3, T4

Key References: Miano M, Dufour C: The diagnosis and treatment of aplastic anemia: a review, *Int J Hematol* 101(6):527–535, 2015; Samarasinghe S, Webb DKH: How I manage aplastic aneamia in children, *Br J Haematol* 157:26-40, 2012.

Perioperative Implications

Preoperative Preparation
- Reverse isolation precautions.
- Adequacy of blood products.
- Evaluate for severe neutropenia; coexisting congenital HD may warrant prophylactic antimicrobial therapy.
- Avoid IM and rectal sedation.
- Concomitant steroid therapy and necessity of stress doses.

Monitoring
- Arterial line if indicated.
- Consider CVP or PA cath as indicated.
- Urine output for new-onset hemoglobinuria as first sign of transfusion reaction.