Sickle Cell Disease

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Risk

- Affects persons with African, Greek, Turkish, Italian, Arab, Latin American, and Indian ancestry.
- Incidence in USA: Most common disease identified through state-mandated screening, occurring in 1:2647 births; varies by race, occurring in 1:396 African-American births and 1:36,000 Hispanic births.
- Early mortality: Varies by type of disease. In one longitudinal study of pts with sickle cell anemia (i.e., Hgb SS homozygous), median age of death was 42 y in men and 48 y in women; for those with Hgb SC disease, median age of death was 60 and 68 y in men and women, respectively.
- In children, mortality has been decreasing, with rates (deaths per 100 pt-years) of 0.67, 0.37, and 0.15 for years 1983–1990, 1991–1999, and 2000–2007, respectively.

Perioperative Risks

- Complication rate varies by disease severity and surgical risk category, reported to be as high as a 39% overall complication rate and 1.1% 30-day mortality.
- Complications include anemia, stroke, acute chest syndrome, myonecrosis, heart failure, MI, hepatic or splenic sequestration, retinal hemorrhage, hematuria, renal failure, seizure, wound infection, UTI, and unexplained death.

Worry About

- Degree of preop anemia
- Surgical risk category
- Preexisting end-organ dysfunction including CNS, heart, lung, kidney, and immunologic disorders
- Precipitation of vaso-occlusive crisis (by dehydration, stasis, hypoxia, hypothermia, acidemia, pain) and subsequent end-organ ischemia
- Risk of acute or delayed transfusion reactions due to preexisting alloimmunization

Overview

- Broad group of disorders involving pts with sickle cell anemia (Hgb SS homozygous) as well as compound heterozygous pts having one Hgb S allele with another, different hemoglobinopathy allele including Hgb C, Hgb β-thalassemia, Hgb D, and Hgb O Arab.
- Lifelong cause of vaso-occlusive episodes inducing end-organ ischemia and pain.
- In adults, renal insufficiency, leukocytosis, and the severity of hemolytic anemia have been reported to be major risk factors for mortality.
- In children, dactylitis in infancy, Hgb concentration <7 g/dL, and leukocytosis without infection have been reported to predict adverse outcomes, including stroke, recurrent acute chest syndrome, and death.
- End-organ damage due to vaso-occlusion causes morbidity and mortality. Key conditions are pregnancy, heart failure, MI, CVA, acute chest syndrome, sequestration crisis, and severe anemia.
- Sickle Hgb causes a rightward shift (P50 = 31 mm Hg) of oxyhemoglobin dissociation curve, favoring deoxygenated Hgb.
- Hgb S permits deoxygenated Hgb molecules to polymerize into rigid insoluble intraerythrocytic fibers, resulting in sickled erythrocytes.
- Sickled erythrocytes are unable to traverse the microvasculature, leading to tissue ischemia and end-organ damage.

Etiology

- Single amino-acid substitution on β-chain of Hgb at position 6 (Glu → Val).
- Sickled erythrocytes have a shortened life span, leading to chronic hemolysis and anemia.

Usual Treatment

- Vaccines against pneumococcus, *Haemophilus influenzae* type b, and seasonal influenza.
- Prophylactic penicillin therapy.
- Supportive care for vaso-occlusive crisis
- Simple and exchange transfusions; treatment of iron overload.
- Hydroxyurea reduces the incidence of painful crises, acute chest syndrome, hospital admissions, and transfusion requirements.

Assessment Points

System	Effect	Assessment by Hx	PE	Test
HEENT	Hypoxemia due to sleep apnea	Snoring or sleep apnea Hx	Tonsillar hypertrophy	Sleep study
CV	MI; LV and RV dysfunction; CHF Pulmonary hypertension	Angina Sx; poor exercise tolerance; dyspnea	Displaced PMI S_3, S_4	ECG, exercise ECG; ECHO, Hct
RESP	Acute chest syndrome; lung and rib infarction; pneumonia	Previous acute chest syndrome; dyspnea Chest pain	Chest pain; rales; crackles	CXR
GI	Gallstones; sickle girdle syndrome (mesenteric ischemia); hepatic sequestration crisis	RUQ pain; abdominal pain	Jaundice; RUQ tenderness; pallor	RUQ US
HEME	Sickle pain crisis; asplenia or splenic sequestration crisis; anemia; infection	Pain in affected areas; fatigue; sepsis	Pallor; splenic enlargement; flank tenderness; fever	Hgb, Hct, WBC, reticulocyte count, culture data
RENAL	Renal failure and insufficiency	Hematuria; hemodialysis Hx		UA, BUN, serum Cr
OB	Preterm labor and delivery; perinatal mortality; placenta previa; abruptio placentae	Vaginal bleeding		US
CNS	Stroke; intracranial hemorrhage; pneumococcal meningitis; retinopathy and hyphema; seizure	Previous CNS Sx (weakness, TIA, or neurologic dysfunction); headache; vomiting or altered mental status	Focal deficits, stupor or coma; nuchal rigidity	Head CT, EEG, MRI
MS	Leg ulcers; myonecrosis; myofibrosis; dactylitis; shoulder or hip avascular necrosis; osteomyelitis	Pain in affected areas	ROM; skin changes; fever	WBC, UA, x-ray; culture data

Key References: O'Meara M, Davies G: Anaesthesia for patients with sickle cell disease (and other haemoglobinopathis), *Anaesth Intensive Care Med* 14:54–56, 2013; Howard J, Malfroy M, Llewelyn C, et al.: The transfusion alternatives preoperatively in sickle cell disease (TAPS) study: a randomised, controlled, multicentre clinical trial, *Lancet* 381(9870):930–938, 2013.

Perioperative Implications

Preoperative Preparation

- Aggressive exchange transfusion to obtain an Hgb SS <30% demonstrates no benefit over simple transfusions to obtain a Hgb of 10 g/dL with Hgb AA erythrocytes using extended matched transfusions (minor group E, K, C, Fya).
- In Hgb SS and Hgb Sβ0-thal pts undergoing low-medium risk surgery, pts with preop simple transfusions to a target Hgb of 10 g/dL within 10 d prior to surgery had decreased periop complications compared with pts who were not transfused.
- Alkalinization confers no benefit.
- Autotransfusion: Predonated units do not have established efficacy.
- Peripheral venous access may be difficult, and central venous catheters may be required.
- Standard NPO times should be used; ensure adequate hydration by encouraging intake of clear fluids up to 2 h prior to surgery unless clinically contraindicated in which case IV hydration should be considered.

Monitoring

- Routine

Airway

- None

Induction

- If premedication is indicated, avoid oversedation, which may induce hypoxemia and hypercarbia that promotes sickling.
- Retrobulbar blocks appear safe.
- No differences in morbidity or mortality shown among various anesthetic agents or between regional and GA techniques.

Maintenance

- Cardiopulmonary bypass imposes challenges secondary to mechanical hemolysis, inflammation, hypothermia, hemostasis, and platelet activation; while rare, successful case series have been described in adults and children.
- Maintain euvolemia; replace volume loss with warmed, isotonic fluids; maintain normothermia; tourniquet use is relatively contraindicated but described in small case series.

Extubation

- Respiratory depression at emergence may induce hypoxemia/hypercarbia that may promote atelectasis and vaso-occlusion.

Postoperative Period

- Adequate IV hydration until oral fluids are tolerated; early mobilization and incentive spirometry; supplemental O_2 therapy to keep saturation >96%; access pain regularly and provide analgesia; consider multimodal analgesic techniques, particularly in opioid-tolerant pts.

Anticipated Problems/Concerns

- Blood transfusions carry higher risk for acute and delayed transfusion reactions due to alloimmunization.
- Avoid hypoxemia, hypovolemia, acidemia, hypothermia, hypertonicity, or stasis.