

Anaesthesia recommendations for **Sickle Cell Disease**

Disease name: Sickle Cell Disease

ICD 10: D57.1

Synonyms: Sickle Cell Anemia, Sickle-Haemoglobin C Disease, Sickle Beta-Plus Thalassaemia and Sickle Beta-Zero Thalassaemia

Disease summary: Sickle cell disease (SCD) is a group of inherited disorders of the beta-haemoglobin chain. Normal haemoglobin has 3 different types of haemoglobin – haemoglobin A, A2, and F. Haemoglobin S in sickle cell disease contains an abnormal beta globin chain encoded by a substitution of valine for glutamic acid on chromosome 11. This is an autosomal recessive disorder. Sickle cell disease refers to a specific genotype in which a person inherits one copy of the HbS gene and another gene coding for a qualitatively or quantitatively abnormal beta globin chain. Sickle cell anaemia (HbSS) refers to patients who are homozygous for the HbS gene, while heterozygous forms may pair HbS with genes coding for other types of abnormal haemoglobin such as haemoglobin C, an autosomal recessive mutation which substitutes lysine for glutamic acid. In addition, persons can inherit a combination of HbS and β -thalassaemia. The β -thalassaemias represent an autosomal recessive disorder with reduced production or absence of β -globin chains resulting in anaemia. Other genotype pairs include HbSD, HbSO-Arab and HbSE.

Sickle haemoglobin in these disorders cause affected red blood cells to polymerize under conditions of low oxygen tension resulting in the characteristic sickle shape. Aggregation of sickle cells in the microcirculation from inflammation, endothelial abnormalities, and thrombophilia lead to ischemia in end organs and tissues distal to the blockage. Inheritance of sickle cell disease predisposes to four main types of crises: vaso-occlusive, splenic sequestration, aplastic and haemolytic. The morbidity and mortality from these events may be manifested as pain, acute chest syndrome (intrapulmonary sickling), pulmonary hypertension, cardiac abnormalities, cerebrovascular haemorrhage/infarct, splenic or hepatic sequestration, autosplenism, renal disease, liver disease, avascular necrosis of the femoral head, priapism, and life-threatening acute haemolytic or aplastic anaemia. Triggers for an acute crisis include hypoxemia, dehydration, acidosis, stress, infection, trauma, hypothermia or in some cases, no identifiable predisposing risk factors.

Current treatment focuses on prevention of complications through early diagnosis by newborn screening, prophylactic antibiotics, hydration, pain management, disease-modifying therapies, and transcranial Doppler screening (with subsequent transfusion therapy) if needed for stroke prevention. Additional emphasis is placed on disease prevention through genetic counseling of gene carriers for sickle haemoglobin. New therapies to cure or ameliorate symptoms include hematopoietic cell transplantation and hydroxyurea therapy. Life expectancy for persons with SCD (all genotypes combined) is reported to be 53 years for men and 58 years old for women.

Due to the vast array of complications of SCD, persons with these disorders often require surgical intervention for treatment or prevention of certain complications. According to the Cooperative Study of Sickle Cell Disease from 1995, 30 day mortality after surgery was reported to be 1.1% with three deaths reported to be related to the surgical procedure and/or anaesthesia (0.3%) with no deaths in children under 14. This study reviewed 717 patients with SCD who underwent over 1,000 surgical procedures over a 10 year period.

Medicine is in progress



Perhaps new knowledge

Every patient is unique

Perhaps the diagnosis is wrong



Find more information on the disease, its centres of reference and patient organisations on Orphanet: www.orpha.net

Typical surgery

Cholecystectomy, adenotonsillectomy, myringotomy, splenectomy, cerebral revascularization, vitreoretinal surgery, hip replacement, renal transplantation, central venous access procedures, dilation and curettage, cesarean section.

Type of anaesthesia

A well conducted general and/or regional anaesthetic technique can be employed in the care of a patient with SCD who has been preoperatively evaluated and prepared for surgery. The choice of a general anaesthetic requires maintaining haemodynamics and ventilation within normally accepted ranges and optimizing the patient's volume status and temperature. Certain patients may require preoperative blood transfusion or hydration to prevent a perioperative SCD crisis. Pain control is critical, especially in the post-operative period to ensure sufficient respiratory effort to avoid acute chest syndrome. Of note, regional anaesthesia can provide redistribution of blood flow and increase capillary and venous oxygen tension in blocked areas but concomitant compensatory vasoconstriction in non-blocked areas may result in decreased venous oxygen tension. Therefore, regional anaesthesia as the only anaesthetic must be used with caution because of the potential for regional hypoperfusion and venous stasis, which can precipitate sickling. In addition, an inadvertent high level of block may compromise respiratory muscles leading to hypoxemia.

The Cooperative Study of Sickle Cell Disease found that SCD related complications after surgery were more frequent in patients who received regional anaesthesia compared with those who received general anaesthesia. A more recent randomized, controlled, multi-centre trial, The Transfusion Alternatives Preoperatively in Sickle Cell Disease (TAPS), reaffirmed the need for preoperative transfusion prior to surgery to avoid life threatening complications such as acute chest syndrome. A combined technique using regional anaesthesia for intraoperative and postoperative pain control and general anaesthesia for surgery might be the safest approach.

Necessary additional pre-operative testing (beside standard care)

- Dependent on procedure and patient's comorbidities
- Haemoglobin electrophoresis
- Complete blood count
- Complete metabolic panel (should include liver function tests)
- Coagulation studies
- Type & screen or cross (order early to identify issues with antibodies and blood availability)
- Chest x-ray/pulmonary function tests
- Electrocardiogram/Echocardiogram
- Transcranial Doppler (all patients with HbSS or HbSB0 disease should undergo TCD annually from age 2-16)
- Polysomnogram (in patients who have obstructive sleep apnea (OSA) or have symptoms concerning for OSA)

Particular preparation for airway management

Patients with SCD with a diagnosis of obstructive sleep apnea (OSA) or suspected OSA may be predisposed to airway collapse during the perioperative period. Preparation should be made to manage a potentially difficult airway; otherwise, no particular preparation is specific to this disease.

Particular preparation for transfusion or administration of blood products

Because patients with sickle cell disease can receive many blood products starting at a young age, these patients remain at high risk for complications related to transfusions, such as alloimmunization, delayed haemolytic transfusion reactions, iron overload and infection such as HIV, hepatitis, and parvovirus B19. These transfusion issues can make it difficult to obtain compatible blood and blood products and therefore deter routine administration of blood and blood products.

The process for typing and cross-matching and banking blood should be started early, since it may take several hours/days to procure the necessary units of blood. Persons with SCD should receive phenotypically matched blood including minor antigens if feasible to decrease the subsequent risk of allo-immunization.

Perioperative blood transfusion is commonly performed to prepare SCD patients for surgery. Transfusion can be accomplished either as a simple transfusion or as an exchange transfusion. The optimal transfusion parameter to decrease sickling in patients is controversial; however, ensuring patients do not exceed a haematocrit of 30% has been shown to minimize the risk of hyperviscosity syndrome. However, it is not always necessary to increase a patient's haematocrit above baseline for simple procedures. Exchange transfusions have the added benefit of reducing haemoglobin S to less than 30% of the total haemoglobin. A study comparing conservative (simple) to aggressive (exchange) transfusion of blood found the conservative transfusion regimen as effective as the aggressive regimen with only half as many transfusion-associated complications. One study suggested that preoperative transfusions might not be necessary for elective minor surgical procedures such as herniorrhaphy, dental/oral surgery, ophthalmological surgery and tympanostomy tube placements in patients who are clinically stable and near their preoperative baseline level of anaemia. However, surgeries such as laparotomy, thoracotomy, tonsillectomy and adenoidectomy pose a much more significant risk of developing postoperative complications. Overall, different studies have had differing opinions regarding preoperative transfusions. A Cochrane review concluded that recommendations cannot be made and further prospective randomization studies must be done.

The decision to transfuse blood and blood products should be based upon the needs of each case, the surgical risk, and the patient's underlying condition. If available, patients with SCD should be assessed by a competent haematologist prior to undergoing surgery.

Particular preparation for anticoagulation

Consideration for deep vein thrombosis should be given to patients who may be immobilized for a prolonged period of time perioperatively.

Particular precautions for positioning, transportation and mobilisation

Early mobilization combined with incentive spirometry and chest physiotherapy may reduce pulmonary complications. Persons with asthma often benefit from post-operative albuterol therapy. Additional benefit may be gained by preoperative transfusion therapy (as above). Avoidance of fluid overload and appropriate pain control may also mitigate the risk of acute complications. Since many persons with SCD are narcotic tolerant, it is important to know the patient's history in order to provide sufficient pain control.

Interactions of chronic disease and anaesthesia medications

Medications taken by sickle cell patients must be evaluated for possible drug interactions with anaesthetic agents on an individual basis.

Anaesthetic procedure

Consider placement of a peripheral intravenous catheter in the preoperative holding area to begin preoperative hydration or allow liberal intake of clear liquids up to 2 hours prior to surgery time. The use of a tourniquet for placement of a peripheral intravenous catheter must be monitored to ensure adequate perfusion to the extremity distal to the tourniquet and to limit the time it is used to only the time needed to accomplish the procedure. Surgical tourniquets providing a bloodless field require careful preparation and monitoring of the SCD patient. Previous reports referred to unusually high levels of foetal haemoglobin. In this case, preoperative transfusion may be necessary and should be discussed with the haematologist.

Routine monitoring should include blood pressure, pulse oximetry, electrocardiogram, end-tidal CO₂ and temperature. Maintaining oxygen saturation above 94% is likely to improve outcomes as well as avoiding hypoxia. Consider increasing the interval of blood pressure measurements if appropriate for the procedure and patient's medical condition. Also, consider the addition of invasive monitors as indicated by procedure or patient condition.

Operating room temperature should be set at a minimum 24°C or maximum achievable based on patient's age and underlying medical condition. Active warming devices are helpful in maintaining normothermia. Hypothermia presents a significantly increased risk of SCD-related complications.

Standard intravenous or volatile anaesthetics can be used, including nitrous oxide.

Antibiotics should be administered when indicated and in set time intervals throughout surgery.

Patients should be well pre-oxygenated with minimal time spent on laryngoscopy and intubation with avoidance of coughing, bucking or laryngospasm to prevent hypoxemia, vomiting and aspiration of gastric contents.

Sickle cell disease patients may have chronic pain syndromes and require higher than normal doses of opioids and multimodal adjuvants for pain control.

Local anaesthetics via neuraxial blocks or peripheral nerve blocks can be used but patients should be monitored closely as there have been case reports of sickle cell crises induced peripheral neuropathy after neuraxial blocks.

In patients who require IV contrast for diagnostic imaging, iodinated contrast is relatively contraindicated because of the high osmolality which can cause shrinkage and subsequent sickling of red blood cells. However, isotonic contrast has been found safe to administer. Pre-imaging hydration is often recommended for patients requiring IV contrast.

Particular or additional monitoring

Patient and surgery dependent.

Possible complications

A common complication is pain from a vaso-occlusive crisis in the postoperative period. This may be triggered by hypothermia, hypoventilation from splinting due to surgical pain or inadequate pain control, inability to mobilize fluids, or insufficient oxygenation. Complication rates were higher for regional anaesthesia than general anaesthesia for surgical procedures. Therefore, judicious use of analgesics, hydration and oxygen supplementation is critical to avoid or reduce the chances of a postoperative complication. It is also crucial to monitor fluid balance to prevent fluid overload.

Persons with SCD are at increased stroke risk compared to the normal population. This risk is elevated in patients with Moyamoya syndrome or prior stroke. Forty one percent of SCD patients will be at risk for recurrent cerebral vascular events after suffering a stroke. No standardized anaesthesia guidelines exist on managing sickle cell patients with Moyamoya disease. Patients need to be comfortable, well hydrated, oxygenated, normothermic and hemodynamically stable. Persons on transfusion therapy for stroke prevention should have their surgery optimally timed to minimize their haemoglobin S burden.

The most common non-sickle cell disease-related complication was found to be fever. The complication rate was lower with general anaesthesia compared to regional anaesthesia for surgical procedures. This was also found to be true for infections. Sickle cell patients are considered immunocompromised and should receive the same considerations in care as other patients with immunocompromised states, such as cancer patients receiving chemotherapy or AIDS. Thus, patients should undergo blood cultures and prophylactic antibiotics as well as chest x-rays if demonstrating symptoms of pulmonary infection.

Post-operative care

Postoperative destination should be determined on an individual basis whether the patient can be posted as an outpatient or will need admission to a regular floor, monitored floor or intensive care unit.

Aggressive respiratory therapy with oxygen, incentive spirometry, chest physiotherapy and bronchodilators should be instituted as well as adequate pain control and hydration.

Transfusion therapy should be administered only if indicated by disease or due to post-operative life-threatening complications

Disease-related acute problems and effect on anaesthesia and recovery

Transfusion reactions from clerical error or alloimmunization pose a constant threat to sickle cell patients. Chronic transfusions can cause development of antibodies to non-ABO blood groups. This might result in delays in obtaining and transfusing blood in an emergency. Suspicion of a transfusion reaction should result in stopping the transfusion and following the institution's protocol for managing patients with a transfusion reaction.

Acute chest syndrome is the leading cause of death among sickle cell patients accounting for 20% to 85% of the deaths according to different studies. The criteria for diagnosis includes the onset of a new lobar infiltrate, as seen on chest x-ray, fever greater than 38.5 Celsius, respiratory distress, or chest pain. It can be triggered by fat embolism and/or infection, especially community-acquired pneumonia. Risk factors associated with respiratory failure include cardiac disease, older age, and a neurologic event. Aggressive therapy is targeted to improving oxygenation, hydration, analgesia, bronchodilator therapy, broad-spectrum antibiotics and transfusion therapy. The mortality rate is 3% according to the National Acute Chest Syndrome Study.

Ambulatory anaesthesia

Consider only for very minor and low risk procedures.

Obstetrical anaesthesia

General anaesthesia was identified as a risk factor for postnatal sickling complications (acute chest syndrome, vaso-occlusive crisis, stroke) in a study involving 55 parturients, while the use of ephedrine was not identified as a risk factor. The risk of maternal death in the maternal population is 17 times greater with general anaesthesia than regional anaesthesia.

Neuraxial techniques can be safely administered but careful monitoring for neuropathy and sickle cell crises is warranted.

References

1. Adu-Gyamfi Y, Sankarankutty M, Marwa S. Use of a tourniquet in patients with sickle-cell disease. *Can J Anaesth* 1993;40:24–72
2. Camous J, N'da A, Etienne-Julan M, Stéphan F. Anesthetic management of pregnant women with sickle cell disease – effect on postnatal sickling complications. *Can J Anesth* 2008;55:276–283
3. Dobson SR, Holden KR, Nietert PJ, Cure JK, Laver JH, Disco D, Abboud MR. Moyamoya syndrome in childhood sickle cell disease: a predictive factor for recurrent cerebrovascular events. *Blood* 2002; 99:3144–3150
4. Firth PG, Head A. Sickle Cell Disease and Anesthesia. *Anesthesiology* 2004;101:766–85
5. Firth PG. Anaesthesia for peculiar cells – a century of sickle cell disease. *Br J Anaesth* 2005;95:287–99
6. Fu T, Corrigan NJ, Quinn CT, Rogers ZR, Buchanan GR. Minor Elective Surgical Procedures Using General Anesthesia in Children With Sickle Cell Anemia Without Pre-Operative Blood Transfusion. *Pediatr Blood Cancer* 2005;45:43–47
7. Gross ML, Schwedler M, Bischoff R, Jet al. Impact of anesthetic agents on patients with sickle cell disease. *Am Surg* 1993; 59: 261–264
8. Howard J, Malfroy M, Llewelyn C, Choo L, Hodge R, Johnson T, Purohit S, et al. The Transfusion Alternatives Preoperatively in Sickle Cell Disease (TAPS) study: a randomised, controlled, multicentre clinical trial. *Lancet* 2013;381:930–938
9. Johnson CS. Arterial Blood Pressure and Hyperviscosity in Sickle Cell Disease. *Hematol Oncol Clin N Am* 2005;19: 827–837
10. Kikuta K, Takagi Y, Nozaki K, Yamada K, Miyamoto S, Kataoka H, Arai T, Hashimoto N. Effects of intravenous anesthesia with propofol on regional cortical blood flow and intracranial pressure in surgery for moyamoya disease. *Surgical Neurology* 2007;68:421–424
11. Koshy M, Weiner SJ, Miller ST et al. Surgery and anesthesia in sickle cell disease. The Cooperative Study of Sickle Cell Disease. *Blood* 1995; 86: 3676–3684
12. Marchant WA, Walker I. Anaesthetic management of the child with sickle cell disease. *Paediatric Anesthesia* 2003;13:473–489
13. Park KW. Sickle cell disease and other hemoglobinopathies. *Int. Anesthesiol Clin* 2004;42:77–93
14. Tsen LC, Cherevil G. Sickle cell induced peripheral neuropathy following spinal anesthesia for cesarean delivery. *Anesthesiology* 2001;95:1298–1299
15. Wang WC. The pathophysiology, prevention, and treatment of stroke in sickle cell disease. *Curr Opin Hematol* 2007;14:191–197
16. Wierenga, KJ, Hambleton IR, Lewis, NA 2001. Survival estimates for patients with homozygous sickle-cell disease in Jamaica: A clinic-based population study. *Lancet* 2001;357:680–683
17. Vichinsky EP, Haberkern CM, Neumayr L, Earles AN, Black D, Koshy M, Pegelow C, et al. A comparison of conservative and aggressive transfusion regimens in the perioperative management of sickle cell disease. The Preoperative Transfusion in Sickle Cell Disease Study Group. *N Engl J Med* 1995;333:206–213
18. Vichinsky EP, Neumayr LD, Earles AN, Williams R, Lennette ET, Dean D, Nickerson B, et al. Causes and Outcomes of the Acute Chest Syndrome in Sickle Cell Disease. *N Engl J Med* 2000;342:1855–1865.

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