



Sickle cell disease

Sickle cell disease is a group of disorders that affects hemoglobin, the molecule in red blood cells that delivers oxygen to cells throughout the body. People with this disorder have atypical hemoglobin molecules called hemoglobin S, which can distort red blood cells into a sickle, or crescent, shape.

Signs and symptoms of sickle cell disease usually begin in early childhood. Characteristic features of this disorder include a low number of red blood cells (anemia), repeated infections, and periodic episodes of pain. The severity of symptoms varies from person to person. Some people have mild symptoms, while others are frequently hospitalized for more serious complications.

The signs and symptoms of sickle cell disease are caused by the sickling of red blood cells. When red blood cells sickle, they break down prematurely, which can lead to anemia. Anemia can cause shortness of breath, fatigue, and delayed growth and development in children. The rapid breakdown of red blood cells may also cause yellowing of the eyes and skin, which are signs of jaundice. Painful episodes can occur when sickled red blood cells, which are stiff and inflexible, get stuck in small blood vessels. These episodes deprive tissues and organs of oxygen-rich blood and can lead to organ damage, especially in the lungs, kidneys, spleen, and brain. A particularly serious complication of sickle cell disease is high blood pressure in the blood vessels that supply the lungs (pulmonary hypertension). Pulmonary hypertension occurs in about one-third of adults with sickle cell disease and can lead to heart failure.

Frequency

Sickle cell disease affects millions of people worldwide. It is most common among people whose ancestors come from Africa; Mediterranean countries such as Greece, Turkey, and Italy; the Arabian Peninsula; India; and Spanish-speaking regions in South America, Central America, and parts of the Caribbean.

Sickle cell disease is the most common inherited blood disorder in the United States, affecting 70,000 to 80,000 Americans. The disease is estimated to occur in 1 in 500 African Americans and 1 in 1,000 to 1,400 Hispanic Americans.

Causes

Mutations in the *HBB* gene cause sickle cell disease.

Hemoglobin consists of four protein subunits, typically, two subunits called alpha-globin and two subunits called beta-globin. The *HBB* gene provides instructions for making beta-globin. Various versions of beta-globin result from different mutations in the *HBB* gene. One particular *HBB* gene mutation produces an abnormal version of beta-globin

known as hemoglobin S (HbS). Other mutations in the *HBB* gene lead to additional abnormal versions of beta-globin such as hemoglobin C (HbC) and hemoglobin E (HbE). *HBB* gene mutations can also result in an unusually low level of beta-globin; this abnormality is called beta thalassemia.

In people with sickle cell disease, at least one of the beta-globin subunits in hemoglobin is replaced with hemoglobin S. In sickle cell anemia, which is a common form of sickle cell disease, hemoglobin S replaces both beta-globin subunits in hemoglobin. In other types of sickle cell disease, just one beta-globin subunit in hemoglobin is replaced with hemoglobin S. The other beta-globin subunit is replaced with a different abnormal variant, such as hemoglobin C. For example, people with sickle-hemoglobin C (HbSC) disease have hemoglobin molecules with hemoglobin S and hemoglobin C instead of beta-globin. If mutations that produce hemoglobin S and beta thalassemia occur together, individuals have hemoglobin S-beta thalassemia (HbSBetaThal) disease.

Abnormal versions of beta-globin can distort red blood cells into a sickle shape. The sickle-shaped red blood cells die prematurely, which can lead to anemia. Sometimes the inflexible, sickle-shaped cells get stuck in small blood vessels and can cause serious medical complications.

Inheritance Pattern

This condition is inherited in an autosomal recessive pattern, which means both copies of the gene in each cell have mutations. The parents of an individual with an autosomal recessive condition each carry one copy of the mutated gene, but they typically do not show signs and symptoms of the condition.

Other Names for This Condition

- HbS disease
- Hemoglobin S Disease
- SCD
- Sickle cell disorders
- Sickling disorder due to hemoglobin S

Diagnosis & Management

Formal Diagnostic Criteria

- ACT Sheet: FS
https://www.ncbi.nlm.nih.gov/books/NBK55827/bin/HbSS_FS.pdf
- ACT Sheet: FSA
https://www.ncbi.nlm.nih.gov/books/NBK55827/bin/Hb_Sbeta_plus_thal_FSA.pdf
- ACT Sheet: FSC
https://www.ncbi.nlm.nih.gov/books/NBK55827/bin/Hb_SC_FSC.pdf

Genetic Testing Information

- What is genetic testing?
[/primer/testing/genetictesting](#)
- Genetic Testing Registry: Hb SS disease
<https://www.ncbi.nlm.nih.gov/gtr/conditions/C0002895/>

Research Studies from ClinicalTrials.gov

- ClinicalTrials.gov
<https://clinicaltrials.gov/ct2/results?cond=%22sickle+cell+anemia%22>

Other Diagnosis and Management Resources

- Baby's First Test: S, Beta-Thalassemia
<https://www.babysfirsttest.org/newborn-screening/conditions/s-beta-thalassemia>
- Baby's First Test: S, C Disease
<https://www.babysfirsttest.org/newborn-screening/conditions/s-c-disease>
- Baby's First Test: Sickle Cell Anemia
<https://www.babysfirsttest.org/newborn-screening/conditions/sickle-cell-anemia>
- GeneReview: Sickle Cell Disease
<https://www.ncbi.nlm.nih.gov/books/NBK1377>
- Genomics Education Programme (UK)
<https://www.genomicseducation.hee.nhs.uk/resources/genetic-conditions-factsheets/item/86-sickle-cell-anaemia/>
- Howard University Hospital Center for Sickle Cell Disease
<http://huhealthcare.com/healthcare/hospital/specialty-services/sickle-cell-disease-center/disease-information>
- MedlinePlus Encyclopedia: Sickle Cell Anemia
<https://medlineplus.gov/ency/article/000527.htm>
- MedlinePlus Encyclopedia: Sickle Cell Test
<https://medlineplus.gov/ency/article/003666.htm>

Additional Information & Resources

Health Information from MedlinePlus

- Encyclopedia: Sickle Cell Anemia
<https://medlineplus.gov/ency/article/000527.htm>
- Encyclopedia: Sickle Cell Test
<https://medlineplus.gov/ency/article/003666.htm>

- Health Topic: Newborn Screening
<https://medlineplus.gov/newbornscreening.html>
- Health Topic: Sickle Cell Disease
<https://medlineplus.gov/sicklecelldisease.html>

Genetic and Rare Diseases Information Center

- Sickle cell anemia
<https://rarediseases.info.nih.gov/diseases/8614/sickle-cell-anemia>

Additional NIH Resources

- GeneEd
https://geneed.nlm.nih.gov/topic_subtopic.php?tid=142&sid=149
- National Heart, Lung, and Blood Institute
<https://www.nhlbi.nih.gov/health-topics/sickle-cell-disease>
- National Human Genome Research Institute
<https://www.genome.gov/10001219/learning-about-sickle-cell-disease/>
- National Library of Medicine: Changing the Face of Medicine
https://cfmedicine.nlm.nih.gov/activities/sickle_cell.html

Educational Resources

- About Sickle Cell Disease
<http://www.sicklecellinfo.net/>
- Action Medical Research for Children (UK)
<https://www.action.org.uk/category/sickle-cell-anaemia-children>
- American Sickle Cell Anemia Association: Changing Faces, Changing Shapes (video)
<http://www.ascaa.org/education-material-videos.php>
- DNA Learning Center from Cold Spring Harbor Laboratory: Sickle Cell Anemia, 3D Animation with Narration
<https://www.dnalc.org/view/15532-Sickle-cell-anemia-3D-animation-with-narration.html>
- Genetic Science Learning Center, University of Utah
<https://learn.genetics.utah.edu/content/disorders/singlegene/>
- Illinois Department of Public Health
<http://www.idph.state.il.us/HealthWellness/fs/sickle.htm>
- Information Center for Sickle Cell and Thalassemic Disorders
http://sickle.bwh.harvard.edu/menu_sickle.html
- MalaCards: sickle cell disease
https://www.malacards.org/card/sickle_cell_disease

- Merck Manual of Medical Information, Second Home Edition
<https://www.merckmanuals.com/home/blood-disorders/anemia/sickle-cell-disease>
- Michigan Department of Community Health
https://www.michigan.gov/documents/sicklecell_79213_7.pdf
- Nemours Foundation
<https://kidshealth.org/en/parents/sickle-cell-anemia.html>
- Orphanet: Sickle cell anemia
https://www.orpha.net/consor/cgi-bin/OC_Exp.php?Lng=EN&Expert=232
- Swedish National Board of Health and Welfare
<http://www.socialstyrelsen.se/rarediseases/sicklecellanaemia>
- University of Rochester Medical Center
<https://www.urmc.rochester.edu/encyclopedia/content.aspx?ContentTypeID=85&ContentID=P00101>
- Virginia Department of Health
http://www.vdh.virginia.gov/content/uploads/sites/33/2016/11/Parent-Fact-Sheet_SICKLE-CELL-ANEMIA_English.pdf
- Washington State Department of Health: Hemoglobin S Fact Sheet
<https://www.doh.wa.gov/Portals/1/Documents/5220/HbSFactSheet.pdf>
- Your Genes Your Health from Cold Spring Harbor Laboratory
<http://www.ygyh.org/sickle/whatisit.htm>
- Your Genome from Wellcome Genome Campus
<https://www.yourgenome.org/facts/what-is-sickle-cell-anaemia>

Patient Support and Advocacy Resources

- American Sickle Cell Anemia Association
<http://www.ascaa.org/index.php>
- March of Dimes
<https://www.marchofdimes.org/baby/sickle-cell-disease-and-your-baby.aspx>
- National Organization for Rare Disorders (NORD)
<https://rarediseases.org/rare-diseases/sickle-cell-disease/>
- Sickle Cell Disease Association of America
<http://www.sicklecelldisease.org>
- The Sickle Cell Information Center
<http://scinfo.org/>

Clinical Information from GeneReviews

- Sickle Cell Disease
<https://www.ncbi.nlm.nih.gov/books/NBK1377>

Scientific Articles on PubMed

- PubMed
<https://www.ncbi.nlm.nih.gov/pubmed?term=%28Anemia,+Sickle+Cell%5BMAJR%5D%29+AND+%28sickle+cell+anemia%5BTI%5D%29+AND+english%5Bla%5D+AND+human%5Bmh%5D+AND+%22last+720+days%22%5Bdp%5D>

Catalog of Genes and Diseases from OMIM

- SICKLE CELL ANEMIA
<http://omim.org/entry/603903>

Sources for This Summary

- Ashley-Koch A, Yang Q, Olney RS. Sickle hemoglobin (HbS) allele and sickle cell disease: a HuGE review. *Am J Epidemiol*. 2000 May 1;151(9):839-45. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/10791557>
- Gladwin MT, Sachdev V, Jison ML, Shizukuda Y, Plehn JF, Minter K, Brown B, Coles WA, Nichols JS, Ernst I, Hunter LA, Blackwelder WC, Schechter AN, Rodgers GP, Castro O, Ognibene FP. Pulmonary hypertension as a risk factor for death in patients with sickle cell disease. *N Engl J Med*. 2004 Feb 26;350(9):886-95.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/14985486>
- Powars DR, Chan LS, Hiti A, Ramicone E, Johnson C. Outcome of sickle cell anemia: a 4-decade observational study of 1056 patients. *Medicine (Baltimore)*. 2005 Nov;84(6):363-76.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/16267411>
- Schnog JB, Duits AJ, Muskiet FA, ten Cate H, Rojer RA, Brandjes DP. Sickle cell disease; a general overview. *Neth J Med*. 2004 Nov;62(10):364-74. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/15683091>
- Serjeant GR. The emerging understanding of sickle cell disease. *Br J Haematol*. 2001 Jan;112(1):3-18. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/11167776>
- Stuart MJ, Nagel RL. Sickle-cell disease. *Lancet*. 2004 Oct 9-15;364(9442):1343-60. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/15474138>
- Vichinsky E. New therapies in sickle cell disease. *Lancet*. 2002 Aug 24;360(9333):629-31. Review.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/12241949>
- Vichinsky EP. Pulmonary hypertension in sickle cell disease. *N Engl J Med*. 2004 Feb 26;350(9):857-9.
Citation on PubMed: <https://www.ncbi.nlm.nih.gov/pubmed/14985481>

Reprinted from Genetics Home Reference:

<https://ghr.nlm.nih.gov/condition/sickle-cell-disease>

Reviewed: August 2012

Published: December 4, 2018

Lister Hill National Center for Biomedical Communications
U.S. National Library of Medicine
National Institutes of Health
Department of Health & Human Services