MAYO CLINIC LABORATORIES

Test Definition: SMNCS

Spinal Muscular Atrophy Carrier Screening, Deletion/Duplication Analysis, Varies

Overview

Useful For

General population carrier screening for spinal muscular atrophy (SMA)

Carrier screening for reproductive partners of known SMA carriers

Carrier screening for parents of a child with a known deletion of the survival motor neuron 1 gene (*SMN1*) or other family history of SMA

Reflex Tests

Test Id	Reporting Name	Available Separately	Always Performed
CULAF	Amniotic Fluid Culture/Genetic Test	Yes	No
_STR1	Comp Analysis using STR (Bill only)	No, (Bill only)	No
_STR2	Add'l comp analysis w/STR (Bill Only)	No, (Bill only)	No
CULFB	Fibroblast Culture for Genetic Test	Yes	No
MATCC	Maternal Cell Contamination, B	Yes	No

Genetics Test Information

SMN1 exon 7 copy number and SMN2 exon 7 copy number are determined. Also ascertains whether the g.27134T>G polymorphism is present or absent in patients found to have 2 copies of SMN1.

Testing Algorithm

For any cord blood specimen that is received, maternal cell contamination testing may be performed at an additional charge.

For skin biopsy or cultured fibroblast specimens, a fibroblast culture will be performed at an additional charge. If viable cells are not obtained, the client will be notified.

Special Instructions

- Molecular Genetics: Congenital Inherited Diseases Patient Information
- Muscle Biopsy Specimen Preparation Instructions
- Informed Consent for Genetic Testing
- Blood Spot Collection Card-Spanish Instructions
- Blood Spot Collection Card-Chinese Instructions
- Informed Consent for Genetic Testing (Spanish)
- Blood Spot Collection Instructions

Method Name
Dosage Analysis by Droplet Digital Polymerase Chain Reaction (ddPCR)

NY State Available
Yes

Specimen

Specimen Type
Varies

Specimen Required
Patient Preparation: A previous hematopoietic stem cell transplant from an allogenic donor will interfere with testing. For more information about testing patients who have received a hematopoietic stem cell, call 800-533-1710.

Specimen Type: Whole blood
Container/Tube:
Preferred: Lavender top (EDTA) or yellow top (ACD)
Specimen Volume: 3 mL
Collection Instructions:
1. Invert several times to mix blood.
2. Send whole blood specimen in original tube. **Do not aliquot**.
3. Whole blood collected postnatal from an umbilical cord is also acceptable. See Additional Information
Specimen Stability Information: Ambient (preferred) 4 days/Refrigerated 4 days/Frozen 4 days
Additional Information:
1. Specimens are preferred to be received within 4 days of collection. Extraction will be attempted for specimens received after 4 days, and DNA yield will be evaluated to determine if testing may proceed.
2. To ensure minimum volume and concentration of DNA are met, the requested volume must be submitted. Testing may be canceled if DNA requirements are inadequate.
3. For postnatal umbilical cord whole blood specimens, maternal cell contamination studies are recommended to ensure test results reflect that of the patient tested. A maternal blood specimen is required to complete maternal cell contamination studies. Order MATCC / Maternal Cell Contamination, Molecular Analysis, Varies on both the cord blood and maternal blood specimens under separate order numbers.

Specimen Type: Blood spot
Supplies: Card-Blood Spot Collection (Filter Paper) (T493)
Container/Tube:
Preferred: Collection card (Whatman Protein Saver 903 Paper)
Acceptable: PerkinElmer 226 filter paper or blood spot collection card
Specimen Volume: 2 to 5 Blood spots

Collection Instructions:
1. An alternative blood collection option for a patient older than 1 year is a fingerstick. For detailed instructions, see How to Collect a Dried Blood Spot Sample.
2. Let blood dry on the filter paper at ambient temperature in a horizontal position for a minimum of 3 hours.
3. Do not expose specimen to heat or direct sunlight.
4. Do not stack wet specimens.
5. Keep specimen dry.
Specimen Stability Information: Ambient (preferred)/Refrigerated
Additional Information:
1. Blood spot specimens are acceptable but not recommended. Due to lower quantity/quality of DNA yielded from blood spots, some aspects of the test may not perform as well as DNA extracted from a whole blood sample. When applicable, specific gene regions that were unable to be interrogated will be noted in the report. Alternatively, additional specimen may be required to complete testing.
2. Due to lower concentration of DNA yielded from blood spot, it is possible that additional specimen may be required to complete testing.
3. For collection instructions, see Blood Spot Collection Instructions
4. For collection instructions in Spanish, see Blood Spot Collection Card-Spanish Instructions (T777)
5. For collection instructions in Chinese, see Blood Spot Collection Card-Chinese Instructions (T800)

Specimen Type: Cultured fibroblasts
Source: Skin
Container/Tube: T-25 flask
Specimen Volume: 2 Flasks
Collection Instructions: Submit confluent cultured fibroblast cells from a skin biopsy. Cultured cells from a prenatal specimen will not be accepted.
Specimen Stability Information: Ambient (preferred) <24 hours/Refrigerated <24 hours
Additional Information:
1. Specimens are preferred to be received within 24 hours of collection. Culture and extraction will be attempted for specimens received after 24 hours and will be evaluated to determine if testing may proceed.
2. A separate culture charge will be assessed under CULFB / Fibroblast Culture for Biochemical or Molecular Testing. An additional 3 to 4 weeks are required to culture fibroblasts before genetic testing can occur.

Specimen Type: Skin biopsy
Supplies: Fibroblast Biopsy Transport Media (T115)
Container/Tube: Sterile container with any standard cell culture media (eg, minimal essential media, RPMI 1640). The solution should be supplemented with 1% penicillin and streptomycin.
Specimen Volume: 4-mm Punch
Specimen Stability Information: Ambient (preferred) <24 hours/Refrigerated <24 hours
Additional Information:
1. Specimens are preferred to be received within 24 hours of collection. Culture and extraction will be attempted for specimens received after 24 hours and will be evaluated to determine if testing may proceed.
2. A separate culture charge will be assessed under CULFB / Fibroblast Culture for Biochemical or Molecular Testing. An additional 3 to 4 weeks are required to culture fibroblasts before genetic testing can occur.

Specimen Type: Muscle tissue biopsy
Supplies: Muscle Biopsy Kit (T541)
Specimen Volume: 20 to 80mg
Collection Instructions: Prepare and transport specimen per instructions in Muscle Biopsy Specimen Preparation Instructions.
Specimen Stability Information: Frozen (preferred) Ambient/Refrigerated <24hours

Specimen Type: Extracted DNA
Container/Tube:
Preferred: Screw Cap Micro Tube, 2mL with skirted conical base
Acceptable: Matrix tube, 1 mL
Collection Instructions:
1. The preferred volume is at least 100 mcL at a concentration of 75 ng/mcL.
2. Include concentration and volume on tube.
Specimen Stability Information: Frozen (preferred) 1 year/Ambient/Refrigerated
Additional Information: DNA must be extracted in a CLIA-certified laboratory or equivalent and must be extracted from a specimen type listed as acceptable for this test (including applicable anticoagulants). Our laboratory has experience with Chemagic, Puregene, Autopure, MagnaPure, and EZ1 extraction platforms and cannot guarantee that all extraction methods are compatible with this test. If testing fails, one repeat will be attempted, and if unsuccessful, the test will be reported as failed and a charge will be applied. If applicable, specific gene regions that were unable to be interrogated due to DNA quality will be noted in the report.

Forms

1. **New York Clients-Informed consent is required.** Document on the request form or electronic order that a copy is on file. The following documents are available:
-Informed Consent for Genetic Testing (T576)
-Informed Consent for Genetic Testing-Spanish (T826)
2. Molecular Genetics: Congenital Inherited Diseases Patient Information (T521)

Specimen Minimum Volume

See Specimen Required

Reject Due To

All specimens will be evaluated by Mayo Clinic Laboratories for test suitability.

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Varies	Varies		

Clinical & Interpretive

Clinical Information

Spinal muscular atrophy (SMA) is an autosomal recessive neuromuscular disorder characterized by motor neuron

degeneration leading to muscular atrophy with progressive paralysis. It is a genetically complex condition that is traditionally divided into 5 subtypes, depending on the age at which symptoms present and the motor milestones that are achieved. Presentation can range from in utero joint contractures and lack of fetal movement (type 0), to loss of ambulation in adolescence or adulthood (type IV). All patients with SMA develop symmetrical loss of muscle control, most commonly affecting proximal muscles. The American College of Medical Genetics (ACMG) and The American College of Obstetricians and Gynecologists (ACOG) currently recommend offering SMA carrier screening to all couples, regardless of race or ethnicity, before conception or early in pregnancy.

The most common form of SMA is associated with the loss of Survival Motor Neuron (SMN) protein, which is encoded by 2 or more genes on chromosome 5. The majority of SMN protein is expressed by the *SMN1* gene but a small portion of SMN is also contributed by the *SMN2* gene. In fact, *SMN1* produces more than 90% of SMN protein, while *SMN2* produces about less than 10% of residual SMN protein. This occurs because *SMN2* differs from *SMN1* by 5 nucleotide changes, 1 of which leads to alternative exon 7 splicing, and a reduction of *SMN2* expression. Most individuals have 2 copies of *SMN1*, but individuals with as many as 5 copies of *SMN1* have been observed. In addition, individuals may also have 0 to 5 copies of *SMN2*.

SMA is most commonly caused by a homozygous deletion of exon 7 in *SMN1*. However, some patients with this disorder may be compound heterozygotes, with a deletion of 1 copy of *SMN1* and a point mutation in the other allele. The severity of a patient's disease is associated with the number of copies of *SMN2* that are present and 3 or more *SMN2* copies are associated with a milder SMA phenotype.

As the SMA test is a quantitative assay for the number of *SMN1* exon 7 deletions, any result showing 2 *SMN1* copies may in fact have 2 normal copies of *SMN1* in cis (on the same chromosome) and a copy of *SMN1* with the exon 7 deletion on the other chromosome (in trans). This is called the "2+0" carrier genotype. The frequency of the "2+0" carrier genotype differs by ancestry. Previously, it was not possible to distinguish a "2+0" carrier from an individual with 1 copy of *SMN1* on each chromosome. However, following a study performed by Luo et al,(6) it is now possible to provide an adjusted genetic residual carrier risk specific to one’s ancestry, based on the presence or absence of the *SMN1* polymorphism g.27134T>G. The presence of this polymorphism is linked to being a "2+0" carrier in the Ashkenazi Jewish and Asian populations and it increases the chances that one is a "2+0" carrier in other populations. Please see the table below for details.

SMA carrier residual risk estimates.(6)

Ancestry	**Carrier frequency**	**Detection rate based on copy number alone**	**Residual risk after detection of 2 copies of *SMN1***	**Detection rate with addition of *SMN1* g.27134T>G**	**Residual risk of being a 2+0 carrier after absence of *SMN1* g.27134T>G**	**Residual risk of being a 2+0 carrier after presence of *SMN1* g.27134T>G**
Ashkenazi Jewish	1 in 41.1	90%	1 in 345	94%	1 in 580	2+0 Carrier
Asian	1 in 53	92.6%	1 in 628	93.3%	1 in 701.8	2+0 Carrier
African American	1 in 66	71.1%	1 in 121	N/A	1 in 395.7	1 in 33.5

Hispanic	1 in 117	90.6%	1 in 1,061	N/A	1 in 1,762	1 in 139.6
European	1 in 35	94.9%	1 in 632	N/A	1 in 769.3	1 in 28.6

Reference Values

An interpretive report will be provided.

Interpretation

The interpretive report includes an overview of the findings as well as the associated clinical significance.

Cautions

Point mutations are undetectable by this assay. Nor can this assay definitively discriminate between 2 copies of survival motor neuron 1 (*SMN1*) on the same chromosome versus 2 copies on separate chromosomes for patients of most ancestries.

Rare polymorphisms exist that could lead to false-negative or false-positive results. If results obtained do not match clinical findings, additional testing should be considered.

Test results should be interpreted in the context of clinical findings, family history, and other laboratory data. Errors in our interpretation of results may occur if information given is inaccurate or incomplete.

Clinical Reference

1. D'Amico A, Mercuri E, Tiziano FD, Bertini E. Spinal muscular atrophy. Orphanet J Rare Dis 2011;6:71
2. Hendrickson BC, Donohoe C, Akmaev VR, et al. Differences in SMN1 allele frequencies among ethnic groups within North America. J Med Genet. 2009;46(9):641-644
3. Carre A, Empey C. Review of Spinal Muscular Atrophy (SMA) for Prenatal and Pediatric Genetic Counselors. 2016;25(1):32-43
4. Committee on Genetics: Committee Opinion No. 690: Carrier Screening in the Age of Genomic Medicine. Obstet Gynecol. 2017;129(3):e35-e40
5. Committee on Genetics: Committee Opinion No. 691: Carrier Screening for Genetic Conditions. Obstet Gyneco.l 2017;129(3);e41-e55
6. Luo M, Liu L, Peter I, et al. An Ashkenazi Jewish SMN1 haplotype specific to duplication alleles improves pan-ethnic carrier screening for spinal muscular atrophy. Genet Med. 2014;16(2):149-156
7. Prior TW, Nagan N. Spinal muscular atrophy: overview of molecular diagnostic approaches. Curr Protoc Hum Genet. 2016;1:88:9.27.13. Published 2016 Jan 1. doi:10.1002/0471142905.hg0927s88
8. Prior TW, Nagan N, Sugarman EA, Batish SD, Braastad C. Technical standards and guidelines for spinal muscular atrophy testing. Genet Med. 2011;13(7):686-694. doi:10.1097/GIM.0b013e318220d523
9. Prior TW, Leach ME, Finanger EL. Spinal Muscular Atrophy. In: Adam MP, Feldman J, Mirzaa GM, et al., eds. GeneReviews [Internet].University of Washington, Seattle; 1993-2025. Updated September 19.2024. Accessed May 16, 2025.Available at: www.ncbi.nlm.nih.gov/books/NBK1352/

Performance

Method Description
Droplet digital polymerase chain reaction method for detection and quantification of survival motor neuron 1 (*SMN1*) exon 7, *SMN2* exon 7, and *SMN1* rs143838139 (g.27134T>G) associated with spinal muscular atrophy. Mutation nomenclature is based on the following GenBank Accession numbers (build GRCh37 [hg19]): NM_022874.(Unpublished Mayo method)

PDF Report
No

Day(s) Performed
Varies

Report Available
5 to 10 days

Specimen Retention Time
Whole blood: 28 days (if available); Extracted DNA: 3 months, Blood spots: 1 year (if available)

Performing Laboratory Location
Mayo Clinic Laboratories - Rochester Main Campus

Fees & Codes

Fees
- Authorized users can sign in to Test Prices for detailed fee information.
- Clients without access to Test Prices can contact Customer Service 24 hours a day, seven days a week.
- Prospective clients should contact their account representative. For assistance, contact Customer Service.

Test Classification
This test was developed and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. It has not been cleared or approved by the US Food and Drug Administration.

CPT Code Information
81329
88233 (if appropriate)
88240 (if appropriate)

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
SMNCS	SMA Carrier by Del/Dup	49857-6

Result ID	Test Result Name	Result LOINC® Value
113445	Result Summary	50397-9

113446	Result	49857-6
113447	Interpretation	69047-9
113448	Additional Information	48767-8
113449	Specimen	31208-2
113450	Source	31208-2
113451	Released By	18771-6