

CONCERT GENETIC TESTING: AORTOPATHIES AND CONNECTIVE TISSUE DISORDERS

See [Important Reminder](#) at the end of this policy for important regulatory and legal information.

OVERVIEW

Hereditary connective tissue disorders are a group of disorders that affect the connective tissues that support the skin, bones, joints, heart, blood vessels, eyes, and other organs. While specific features vary by type, an unusually large range of joint movement (hypermobility) and cardiovascular disease (such as thoracic aortic aneurysms and dissections) are features that are present in many hereditary connective tissue disorders. Medical management may differ based on the underlying genetic etiology. A diagnosis may be made based on clinical examination; however, it can be difficult to reliably diagnose a hereditary connective tissue disorder based on clinical and family history alone.

Accurate diagnosis of a hereditary connective tissue disorder can lead to changes in clinical management, including surveillance of the aorta, surgical repair of the aorta, when necessary, pharmacologic management, as well as surveillance for multisystem involvement in syndromic conditions with risk for thoracic aortic aneurysms and dissection.

POLICY REFERENCE TABLE

Below is a list of higher volume tests and the associated laboratories for each coverage criteria section. This list is not all inclusive.

Coding Implications

This clinical policy references Current Procedural Terminology (CPT[®]). CPT[®] is a registered trademark of the American Medical Association. All CPT codes and descriptions are copyrighted

2022, American Medical Association. All rights reserved. CPT codes and CPT descriptions are from the current manuals and those included herein are not intended to be all-inclusive and are included for informational purposes only. Codes referenced in this clinical policy are for informational purposes only. Inclusion or exclusion of any codes does not guarantee coverage. Providers should reference the most up-to-date sources of professional coding guidance prior to the submission of claims for reimbursement of covered services.

Coverage Criteria Sections	Example Tests (Labs)	Common CPT Codes	Common ICD Codes	Ref
Known Familial Variant Analysis for Aortopathies and Connective Tissue Disorders				
Known Familial Variant Analysis for Aortopathies and Connective Tissue Disorders	Targeted Mutation Analysis for a Known Familial Variant	81403		13
Connective Tissue Disorders Multi-Syndrome Panels				
Comprehensive Connective Tissue Disorders Multigene Panel	Heritable Disorders of Connective Tissue Panel (GeneDx)	81410, 81411	I71.00 through I71.9, M35.7, Q79.60-Q79.69, Q12.1, Q87.40 through Q87.43, Q87.5,	4, 5, 7, 8, 9
	Invitae Connective Tissue Disorders Panel (Invitae Corp)			
Marfan Syndrome				
FBN1 Sequencing and/or Deletion/Duplication Analysis	FBN1 Full Gene Sequencing and Deletion/Duplication (Invitae)	81408, 81479	I71.00 through I71.9, Q12.1, Q87.40-Q87.43	1, 7
	Marfan Syndrome via FBN1 Gene (Prevention Genetics)			
Loeys-Dietz Syndrome				
Loeys-Dietz Syndrome Multigene Panel	Loeys-Dietz Syndrome Panel (Prevention Genetics)	81405, 81408, 81479	I71.00 through I71.9	1, 8, 14
	Loeys-Dietz Syndrome Panel (Invitae)			
Familial Thoracic Aortic Aneurysm and Dissection (TAAD)				
Familial Thoracic Aortic Aneurysm and	Thoracic Aortic Aneurysm Panel (Cincinnati Children’s Hospital Medical	81405, 81406, 81408, 81479	I71.00 through I71.9, Q87.5	1, 2, 9,

Dissection (TAAD) Multigene Panel	Center- Molecular Genetics and Cytogenetics Laboratories)			
	TAAD Panel Next Generation Sequencing (DDC Clinic Laboratory)	81410, 81411		
	TAADNext (Ambry Genetics)			
	Marfan syndrome, Loeys-Dietz syndrome, Familial thoracic aortic aneurysms & dissections, and Related disorders NGS Panel - Comprehensive (CTGT)			
	Marfan Syndrome and Thoracic Aortic Aneurysm and Dissection NGS Panel (Sequencing & Deletion/Duplication) (Fulgent Genetics)			
	Marfan/TAAD Panel (GeneDx)			
	Aortopathy Comprehensive Panel (Invitae)			
Ehlers-Danlos Syndrome				
Classic Ehlers-Danlos Syndrome (cEDS)				
Classic Ehlers-Danlos Syndrome Multigene Panel	COL5A1 Full Gene Sequencing and Deletion/Duplication (Invitae)	81479, 81408	M35.7, Q79.61 through Q79.62	3
	Ehlers-Danlos Syndrome, Classic Type via the COL5A2 Gene (Prevention Genetics)			
	Ehlers-Danlos syndrome, classic type NGS panel (CTGT)			
Vascular Ehlers-Danlos Syndrome (vEDS)				
COL3A1 Sequencing and/or Deletion/Duplication Analysis	COL3A1 Full Gene Sequencing and Deletion/Duplication-Diagnostic (Invitae)	81479	Q79.63	3, 6
Comprehensive Ehlers-Danlos Syndrome Multigene Panels				
Comprehensive Ehlers-Danlos	Ehlers-Danlos Syndrome Panel (Invitae)	81405, 81406, 81408, 81479		3, 5

Syndrome Multigene Panels	Ehlers-Danlos Syndromes (EDS) Panel (PreventionGenetics)		M35.7, Q79.60 through Q79.69	
Other Covered Connective Tissue Disorders				
Other Covered Connective Tissue Disorders	See list below	81400 through 81408		10, 11, 12

OTHER RELATED POLICIES

This policy document provides coverage criteria for genetic testing for cardiovascular disorders. Please refer to:

- **Genetic Testing: Cardiac Disorders** for coverage criteria related to arrhythmias and cardiomyopathies.
- **Genetic Testing: Multisystem Inherited Disorders, Intellectual Disability, and Developmental Delay** for coverage criteria related to genetic disorders that affect multiple organ systems.
- **Genetic Testing: Prenatal Diagnosis (via amniocentesis, CVS, or PUBS) and Pregnancy Loss** for coverage related to prenatal and pregnancy loss diagnostic genetic testing.
- **Genetic Testing: Preimplantation Genetic Testing** for coverage criteria related to genetic testing of embryos prior to in vitro fertilization.
- **Genetic Testing: General Approach to Genetic Testing** for coverage criteria related to aortopathies and connective tissue disorders not specifically discussed in this or another non-general policy.

CRITERIA

It is the policy of health plans affiliated with Centene Corporation® that the specific genetic testing noted below is **medically necessary** when meeting the related criteria:

KNOWN FAMILIAL VARIANT ANALYSIS FOR AORTOPATHIES AND CONNECTIVE TISSUE DISORDERS

- I. Targeted mutation analysis for a known familial variant (81403) for an aortopathies and connective tissue disorder is considered **medically necessary** when:
 - A. The member/enrollee has a [close relative](#) with a known pathogenic or likely pathogenic variant causing the condition.
- II. Targeted mutation analysis for a known familial variant (81403) for an aortopathies and connective tissue disorder is considered **investigational** for all other indications.

[back to top](#)

CONNECTIVE TISSUE DISORDERS

Comprehensive Connective Tissue Disorders Multigene Panel

- I. Comprehensive connective tissue disorders multigene panel analysis (81410, 81411)* is considered medically necessary when:
 - A. The member/enrollee meets criteria for at least one of the following (see specific coverage criteria sections below):
 1. [Marfan Syndrome](#)
 2. [Loeys-Dietz Syndrome](#)
 3. [Classic Ehlers-Danlos Syndrome](#)
 4. [Vascular Ehlers-Danlos Syndrome \(vEDS\)](#)
- II. Comprehensive connective tissue disorders multigene panel analysis (81410, 81411) is considered investigational for all other indications.

*If a panel is performed, the appropriate panel code should be used

[back to top](#)

MARFAN SYNDROME

***FBNI* Sequencing and/or Deletion/Duplication Analysis**

- I. *FBNI* sequencing and/or deletion/duplication analysis (81408, 81479) to confirm a diagnosis of Marfan syndrome is considered **medically necessary** when:
 - A. The member/enrollee has some of the below symptoms of Marfan syndrome, but does **not** meet the following clinical criteria for a definitive diagnosis:
 1. Aortic root enlargement (Z-score of 2 or greater) or dissection, **AND** one of the following:
 - a) Ectopia lentis, **OR**
 - b) At least two of the following systemic symptoms reaching a score of 7 or higher (points are in parentheses):
 - (1) Wrist AND thumb sign (3), **OR**
 - (2) Wrist OR thumb sign (1), **OR**
 - (3) Pectus carinatum deformity (2), **OR**
 - (4) Pectus excavatum or chest asymmetry (1), **OR**
 - (5) Hindfoot deformity (2), **OR**
 - (6) Plain flat foot (pes planus) (1), **OR**
 - (7) Pneumothorax (2), **OR**
 - (8) Dural ectasia (2), **OR**
 - (9) Protrusio acetabulae (2), **OR**
 - (10) Reduced upper segment / lower segment AND increased arm span/height ratios (1), **OR**
 - (11) Scoliosis or thoracolumbar kyphosis (1), **OR**
 - (12) Reduced elbow extension (1), **OR**
 - (13) 3 of 5 facial features (dolichocephaly, downward slanting palpebral fissures, enophthalmos, retrognathia, malar hypoplasia) (1), **OR**
 - (14) Skin striae (1), **OR**
 - (15) Myopia (1), **OR**
 - (16) Mitral valve prolapse (1), **OR**
 - B. The member/enrollee has a [close relative](#) with a documented clinical diagnosis of Marfan syndrome, **AND**
 1. The member/enrollee does not have any of the following:

- a) Ectopia lentis, **OR**
 - b) Multiple systemic features (see above), **OR**
 - c) A dilated aortic root (if over 20 years, greater than two standard deviations; if younger than 20, greater than three standard deviations).
- II. *FBNI* sequencing and/or deletion/duplication analysis (81408, 81479) to establish or confirm a molecular diagnosis of Marfan syndrome is considered **investigational** for all other indications.

*Full explanation of each feature and calculation can be found at <https://www.marfan.org/dx/score>

[back to top](#)

LOEYS-DIETZ SYNDROME

Loeys-Dietz Syndrome Multigene Panel

- I. Loeys-Dietz syndrome (LDS) multigene panel analysis (81405, 81408, 81479) to establish or confirm a diagnosis of Loeys-Dietz syndrome is considered **medically necessary** when:
- A. The member/enrollee meets at least two of the following:
 - 1. Characteristic facial features, including widely spaced eyes and craniosynostosis, **OR**
 - 2. Bifid uvula or cleft palate, **OR**
 - 3. Tortuosity of the aorta and its branches, **OR**
 - 4. Aortic dilatation and dissection, **OR**
 - 5. Joint hypermobility, **OR**
 - 6. The member/enrollee has a [first-degree relative](#) with a clinical diagnosis of LDS, **AND**
 - B. The panel includes, at a minimum, the following genes*: *SMAD2*, *SMAD3*, *TGFB2*, *TGFB3*, *TGFBRI*, and *TGFBRI2*.

- II. Loeys-Dietz syndrome (LDS) analysis (81405, 81408, 81479) to establish or confirm a diagnosis of Loeys-Dietz syndrome is considered **investigational** for all other indications.

* If the member/enrollee has both aortic root enlargement and ectopia lentis, *FBNI* should either be included in the panel or should have been previously performed and the results were negative.

*If a panel is performed, the appropriate panel code should be used

[back to top](#)

FAMILIAL THORACIC AORTIC ANEURYSM AND DISSECTION (TAAD)

Familial Thoracic Aortic Aneurysm and Dissection (TAAD) Multigene Panel

- I. Familial thoracic aortic aneurysm and dissection (TAAD) multigene panel analysis (81405, 81406, 81408, 81410, 81411, 81479) to establish a genetic diagnosis for TAAD is considered **medically necessary** when:
- A. The member/enrollee has aortic root enlargement or has had thoracic aneurysm or a type A or type B aortic dissection, **AND**
 - B. The member/enrollee does not otherwise meet diagnostic criteria for another connective tissue disorder, **AND**
 - C. The member/enrollee has a family history of dilation or dissection of the aortic root, consistent with autosomal dominant inheritance. **AND**
 - D. The panel includes, at a minimum, the following genes: *ACTA2*, *FBNI*, *MYH11*, *TGFBR1*, *TGFBR2*.
- II. Thoracic aortic aneurysm and dissection (TAAD) multigene panel analysis (81405, 81406, 81408, 81410, 81411, 81479) to establish a genetic diagnosis for TAAD is considered **investigational** for all other indications.

*If a panel is performed, the appropriate panel code should be used

[back to top](#)

EHLERS-DANLOS SYNDROME

Classic Ehlers-Danlos Syndrome (cEDS) Multigene Panel

- I. Classic Ehlers-Danlos syndrome multigene panel analysis (81408, 81479) to establish or confirm a diagnosis of cEDS is considered **medically necessary** when:
 - A. The member/enrollee has skin hyperextensibility and atrophic scarring, **AND**
 - B. The member/enrollee meets at least one of the following:
 1. Generalized joint hypermobility, **OR**
 2. At least three of the following:
 - a) Easy bruising, **OR**
 - b) Soft, doughy skin, **OR**
 - c) Skin fragility (or traumatic splitting), **OR**
 - d) Molluscoid pseudotumors, **OR**
 - e) Subcutaneous spheroids, **OR**
 - f) Hernia, **OR**
 - g) Epicanthal folds, **OR**
 - h) Complications of joint hypermobility (e.g., sprains, luxation/subluxation, pain, flexible flatfoot), **OR**
 - i) Family history of a [first-degree relative](#) that has a clinical diagnosis of cEDS, **AND**
 - C. The panel is limited to the following genes: *COL5A1*, *COL5A2*, and *COL1A1*.
- II. Classic Ehlers-Danlos syndrome multigene panel analysis (81408, 81479) to establish or confirm a diagnosis of cEDS is considered **investigational** for all other indications.

[back to top](#)

Vascular Ehlers-Danlos Syndrome (vEDS)

COL3A1 Sequencing and/or Deletion/Duplication Analysis

- I. *COL3A1* sequencing and/or deletion/duplication analysis (81479) to establish or confirm a diagnosis of vEDS is considered **medically necessary** when:

- A. The member/enrollee meets any of the following:
1. Arterial rupture or dissection under the age of 40, **OR**
 2. Spontaneous sigmoid colon perforation in the absence of known diverticular disease or other bowel pathology, **OR**
 3. Uterine rupture during the third trimester in the absence of previous C-section and/or severe peripartum perineum tears, **OR**
 4. Carotid-cavernous sinus fistula (CCSF) formation in the absence of trauma, **OR**
 5. The member/enrollee has a [close relative](#) with a clinical diagnosis of vEDS, **OR**
 6. The member/enrollee has at least two of the following minor criteria:
 - a) Bruising unrelated to identified trauma and/or in unusual sites such as cheeks and back, **OR**
 - b) Thin, translucent skin with increased venous visibility, **OR**
 - c) Characteristic facial appearance, **OR**
 - d) Spontaneous pneumothorax, **OR**
 - e) Acrogeria, **OR**
 - f) Talipes equinovarus, **OR**
 - g) Congenital hip dislocation, **OR**
 - h) Hypermobility of small joints, **OR**
 - i) Tendon and muscle rupture, **OR**
 - j) Keratoconus, **OR**
 - k) Gingival recession and gingival fragility, **OR**
 - l) Early onset varicose veins (under the age of 30 and nulliparous if female).
- II. *COL3A1* sequencing and/or deletion/duplication analysis (81479) to establish or confirm a diagnosis of vEDS is considered **investigational** for all other indications.

[back to top](#)

Comprehensive Ehlers-Danlos Syndrome Multigene Panels

- I. Comprehensive Ehlers-Danlos syndrome (EDS) multigene panel analysis (81405, 81406, 81408, 81479) is considered **investigational** for all indications, including hypermobile EDS.

[back to top](#)

OTHER COVERED CONNECTIVE TISSUE DISORDERS

The following is a list of conditions that have a known genetic association. Due to their relative rareness, it may be appropriate to cover these genetic tests to establish or confirm a diagnosis.

- I. Genetic testing to establish or confirm one of the following connective tissue disorders (81400, 81401, 81402, 81403, 81404, 81405, 81406, 81407, 81408, 81411, 81410) to guide management is considered **medically necessary** when the member/enrollee demonstrates clinical features* consistent with the disorder (the list is not meant to be comprehensive, see II below):
 - A. Arthrochalasia EDS (*COL1A1*, *COL1A2*)
 - B. Brittle cornea syndrome (*ZNF469*, *PRDM5*)
 - C. Cardiac-valvular EDS (*COL1A2*)
 - D. Classical-like EDS (*TNXB*)
 - E. Dermatosparaxis EDS (*ADAMTS2*)
 - F. [Epidermolysis Bullosa](#)
 - G. [Kyphoscoliotic EDS](#) (*PLOD1*, *FKBP14*)
 - H. Musculocontractural EDS (*CHST14*, *DSE*)
 - I. Myopathic EDS (*COL12A1*)
 - J. Periodontal EDS (*CIR*, *CIS*)
 - K. Spondylodysplastic EDS (*B4GALT7*, *B3GALT6*, *SLC39A13*)
- II. Genetic testing to establish or confirm the diagnosis of all other connective tissue disorders (81400, 81401, 81402, 81403, 81404, 81405, 81406, 81407, 81408) not specifically discussed within this or another medical policy will be evaluated by the criteria outlined in *General Approach to Genetic Testing* (see policy for coverage criteria).

*Clinical features for a specific disorder may be outlined in resources such as [GeneReviews](#), [OMIM](#), [National Library of Medicine](#), [Genetics Home Reference](#), or other scholarly source.

[back to top](#)

NOTES AND DEFINITIONS

1. Close relatives include first, second, and third degree blood relatives:
 - a. **First-degree relatives** are parents, siblings, and children
 - b. **Second-degree relatives** are grandparents, aunts, uncles, nieces, nephews, grandchildren, and half siblings
 - c. **Third-degree relatives** are great grandparents, great aunts, great uncles, great grandchildren, and first cousins

BACKGROUND AND RATIONALE

Known Familial Variant Analysis for Aortopathies and Connective Tissue Disorders

Genetic Support Foundation

The Genetic Support Foundation’s Genetics 101 information on inheritance patterns says the following about testing for familial pathogenic variants:

Genetic testing for someone who may be at risk for an inherited disease is always easier if we know the specific genetic cause. Oftentimes, the best way to find the genetic cause is to start by testing someone in the family who is known or strongly suspected to have the disease. If their testing is positive, then we can say that we have found the familial pathogenic (harmful) variant. We can use this as a marker to test other members/enrollees of the family to see who is also at risk.

Comprehensive Connective Tissue Disorders Multigene Panel

GeneReviews: Classic Ehlers-Danlos Syndrome

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online. The GeneReviews for Ehlers-Danlos Syndrome (EDS) states that “Molecular genetic testing approaches can include concurrent (or serial) single-gene testing, use of a multigene panel, and more comprehensive genomic testing. A multigene panel that includes *COL5A1*, *COL5A2*, *COL1A1*, and other genes of interest may...be considered.”

GeneReviews: Hypermobile Ehlers-Danlos Syndrome

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online.

Per the Hypermobility Ehlers-Danlos Syndrome (EDS) GeneReviews, “if an individual's personal or family history is suggestive of one of the other types of EDS or another hereditary disorder of connective tissue or arterial fragility syndrome, analysis of an associated gene or multigene connective tissue disease panel may be appropriate.

GeneReviews: FBN1-Related Marfan Syndrome

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online.

Per the FBN1-Related Marfan Syndrome Gene Reviews, “molecular genetic testing approaches can include a combination of gene-targeted testing (single-gene testing, multigene panel) and comprehensive genomic testing (exome sequencing, genome sequencing) depending on the phenotype. A Marfan syndrome / Loeys-Dietz syndrome / familial thoracic aortic aneurysms and dissections multigene panel that includes *FBN1* and other genes of interest is most likely to identify the genetic cause of the condition while limiting identification of variants of uncertain significance and pathogenic variants in genes that do not explain the underlying phenotype.”

GeneReviews: Loeys-Dietz Syndrome

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online.

Per the Loeys-Dietz Syndrome (LDS) GeneReviews, “When the clinical findings suggest the diagnosis of LDS, molecular genetic testing approaches can include serial single-gene testing or use of a multigene panel. A multigene Marfan syndrome / Loeys-Dietz syndrome / familial thoracic aortic aneurysms and dissections panel that includes *SMAD2*, *SMAD3*, *TGFB2*, *TGFB3*, *TGFBRI*, and *TGFBRI2* as well as a number of other genes associated with disorders that include aortic aneurysms and dissections may be offered by clinical laboratories.”

GeneReviews: Heritable Thoracic Aortic Disease

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online.

Per the Heritable Thoracic Aortic Disease GeneReviews, “A multigene panel that includes some or all of the 16 genes discussed in this *GeneReview* may be considered.”

GeneReviews: Arterial Tortuosity Syndrome

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online.

Per the Arterial Tortuosity Syndrome GeneReviews: “Molecular genetic testing approaches can include a combination of gene-targeted testing (multigene panel) and comprehensive genomic testing (exome sequencing, exome array, genome sequencing) depending on the phenotype. A multigene panel that includes *SLC2A10* and other genes of interest is likely to identify the genetic cause of the condition while limiting identification of variants of uncertain significance and pathogenic variants in genes that do not explain the underlying phenotype.

Marfan Syndrome - *FBN1* Sequencing and/or Deletion/Duplication Analysis

American College of Medical Genetics and Genomics (ACMG)

American College of Medical Genetics and Genomics (2012) issued guidelines on the evaluation of adolescents or adults with some features of Marfan syndrome (MFS), which recommendations included the following:

- If there is no family history of MFS, then the subject has the condition under any of the following four situations:
 - A dilated aortic root (defined as greater than or equal to two standard deviations above the mean for age, sex, and body surface area) and ectopia lentis
 - A dilated aortic root and a mutation [pathogenic variant] in *FBN1* that is clearly pathologic
 - A dilated aortic root and multiple systemic features
 - Ectopia lentis and a mutation [pathogenic variant] in *FBN1* that has previously been associated with aortic disease.
- If there is a positive family history of MFS (independently ascertained with these criteria), then the subject has the condition under any of the following three situations:
 - Ectopia lentis
 - Multiple systemic features or
 - A dilated aortic root (if over 20 years, greater than two standard deviations; if younger than 20, greater than three standard deviations)

Molecular testing of *FBN1* has a role in the equivocal cases where patients have some of these features but not enough to meet a clinical diagnosis. (p. 173)

Loeys-Dietz Syndrome Multigene Panel

American College of Medical Genetics and Genomics (ACMG)

American College of Medical Genetics and Genomics (2012) issued guidelines on the evaluation of adolescents or adults with some features of Marfan syndrome (MFS) (including Loeys-Dietz syndrome), which recommendations included the following:

Genetic testing for Loeys-Dietz Syndrome (LDS) can aid in the diagnosis of LDS in addition to physical exam, echocardiography, dilated eye exam and MRI of the head, neck, thorax, abdomen and pelvis. Features of LDS include characteristic facial features, craniosynostosis, bifid uvula or cleft palate, tortuosity of the aorta and its branches, aortic dilatation and dissection, and joint hypermobility.

Patients have had mutations in one or another of the receptors for TGF β . In a patient found to have consistent facial features, bifid uvula, and arterial tortuosity, the diagnosis can be confirmed with molecular testing. Tortuosity can sometimes be isolated (e.g., found only in the head and neck). (p. 175)

MacCarrick et al; 2014

MacCarrick et al (2014) proposed a nosology in which a mutation in *TGFBR1*, *TGFBR2*, *SMAD3* or *TGFB2* in combination with documented aneurysm or dissection should be sufficient for the diagnosis of LDS. (p. 576)

GeneReviews: Loeys-Dietz Syndrome

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online. The GeneReviews for Loeys-Dietz syndrome (Loeys and Dietz, 2018) indicates the diagnosis of Loeys-Dietz syndrome is established in a proband (by definition a person without a known family history of LDS) who has a heterozygous pathogenic (or likely pathogenic) variant in *SMAD2*, *SMAD3*, *TGFB2*, *TGFB3*, *TGFBR1*, or *TGFBR2* and EITHER of the following: (page 4)

- Aortic root enlargement (defined as an aortic root z-score ≥ 2.0) or type A dissection
- Compatible systemic features including characteristic craniofacial, skeletal, cutaneous, and/or vascular manifestations found in combination. Special emphasis is given to arterial tortuosity, prominently including the head and neck vessels, and to aneurysms or dissections involving medium-to-large muscular arteries throughout the arterial tree.

Familial Thoracic Aortic Aneurysm and Dissection (TAAD) Multigene Panel

American College of Medical Genetics and Genomics (ACMG)

American College of Medical Genetics and Genomics (Pyeritz, 2012) issued guidelines on the evaluation of adolescents or adults with some features of Marfan syndrome (MFS) (including TAAD), which recommendations included the following (pages 174 through 175):

Genetic testing for TAAD can aid in the diagnosis in addition to physical exam, family history, dilated eye exam, echocardiography and vasculature imaging. They include diagnostic criteria of autosomal dominant history of dilatation or dissection of the aortic root, ascending aorta or descending aorta in the absence of major criteria for the diagnosis of Marfan syndrome or other connective tissue disease.

American College of Cardiology Foundation

The American College of Cardiology Foundation and 9 other medical associations published joint evidence-based guidelines (Hiratzka et al, 2010) for the diagnosis and management of thoracic aortic disease, including Marfan syndrome, which included the following guidelines regarding genetic testing (p. 1520):

- If the mutant gene (FBN1, TGFBR1, TGFBR2, COL3A1, ACTA2, MYH11) associated with aortic aneurysm and/or dissection is identified in a patient, first-degree relatives should undergo counseling and testing. Then, only the relatives with the genetic mutation [pathogenic variant] should undergo aortic imaging.

GeneReviews: Heritable Thoracic Disease GeneReviews

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online. The recommended diagnostic testing for TAAD (Milewicz and Regalado, 2017) per the GeneReview overview is as follows:

- Molecular genetic testing is warranted in an individual with a thoracic aneurysm or aortic dissection when features of a syndrome are present, the family history is positive, and/or aortic disease onset is at a younger than expected age. (page 12)
- Aortic dissection can be either type A or type B

EHLERS-DANLOS SYNDROME

Classic Ehlers-Danlos Syndrome (cEDS) Multigene Panel

International EDS Consortium

The 2017 International Classification of the Ehlers-Danlos Syndromes (p. 11 and 13) included the following clinical features for the associated conditions. Confirmatory molecular testing is needed to reach a final diagnosis.

Classical EDS (cEDS):

Major criteria

1. Skin hyperextensibility and atrophic scarring
2. Generalized joint hypermobility (GJH)

Minor criteria

1. Easy bruising
2. Soft, doughy skin
3. Skin fragility (or traumatic splitting)
4. Molluscoid pseudotumors
5. Subcutaneous spheroids
6. Hernia (or history thereof)
7. Epicanthal folds
8. Complications of joint hypermobility (e.g., sprains, luxation/subluxation, pain, flexible flatfoot)
9. Family history of a first degree relative who meets clinical criteria

Minimal Criteria **suggestive** for cEDS:

- Major criterion (1): skin hyperextensibility and atrophic scarring
Plus
- Either major criterion (2): GJH
- And/or: at least three minor criteria

More than 90% of cEDS patients harbor a heterozygous mutation in one of the genes encoding type V collagen (*COL5A1* and *COL5A2*). Rarely, specific variants in the genes encoding type I collagen (*COL1A1*) can be associated with a cEDS-phenotype. (p. 13)

Vascular Ehlers-Danlos Syndrome (vEDS) - COL3A1 Sequencing and/or Deletion/Duplication Analysis

The 2017 International Classification of the Ehlers-Danlos Syndromes (Malfait et al, 2017, p. 16) included the following clinical features for the associated conditions:

Vascular EDS (vEDS)

Major criteria

1. Family history of vEDS with documented causative variant in *COL3A1*

2. Arterial rupture at a young age
 3. Spontaneous sigmoid colon perforation in the absence of known diverticular disease or other bowel pathology
 4. Uterine rupture during the third trimester in the absence of previous C-section and/or severe peripartum perineum tears
 5. Carotid-cavernous sinus fistula (CCSF) Formation in the absence of trauma
- Minor criteria
1. Bruising unrelated to identified trauma and/or in unusual sites such as cheeks and back
 2. Thin, translucent skin with increased venous visibility
 3. Characteristic facial appearance
 4. Spontaneous pneumothorax
 5. Acrogeria
 6. Talipes equinovarus
 7. Congenital hip dislocation
 8. Hypermobility of small joints
 9. Tendon and muscle rupture
 10. Keratoconus
 11. Gingival recession and gingival fragility
 12. Early onset varicose veins (under age 30 and nulliparous if female)

Minimal criteria suggestive for vEDS:

A family history of the disorder, arterial rupture or dissection in individuals less than 40 years of age, unexplained sigmoid colon rupture, or spontaneous pneumothorax in the presence of other features consistent with vEDS should all lead to diagnostic studies to determine if the individual has vEDS. Testing for vEDS should also be considered in the presence of a combination of the other “minor” clinical features listed above. Even for experienced clinicians the clinical diagnosis of vEDS may be difficult. Because of implications for treatment, natural history, and recurrence risk, the diagnosis of vEDS rests on the identification of a causative variant in one allele of *COL3A1*.

Patients with vEDS typically harbor a heterozygous variant in the *COL3A1* gene, encoding type III collagen, with the rare exception of specific heterozygous variants in *COL1A1*. Verification of clinical diagnosis via Molecular screening by Sanger sequencing of *COL3A1*, or targeted resequencing of a gene panel that includes *COL3A1* and *COL1A1* is indicated. When no variant is identified, this approach should be complemented with a CNV detection strategy to identify large deletions or duplications.

Hypermobile Ehlers-Danlos syndrome

GeneReviews

GeneReviews is an expert-authored review of current literature on a genetic disease, and goes through a rigorous editing and peer review process before being published online.

GeneReviews for Hypermobile Ehlers-Danlos syndrome (hEDS) (Levy, 2018) states that diagnosis of hEDS is based entirely on clinical evaluation and family history. The gene(s) in which mutation causes hEDS are unknown and unmapped.

[back to top](#)

Reviews, Revisions, and Approvals	Revision Date	Approval Date
Policy developed.	03/23	03/23

REFERENCES

1. Pyeritz RE; American College of Medical Genetics and Genomics. Evaluation of the adolescent or adult with some features of Marfan syndrome. *Genet Med.* 2012;14(1):171-177. doi:10.1038/gim.2011.48
2. Hiratzka LF, Bakris GL, Beckman JA, et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the diagnosis and management of patients with thoracic aortic disease. A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines, American Association for Thoracic Surgery, American College of Radiology, American Stroke Association, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society of Interventional Radiology, Society of Thoracic Surgeons, and Society for Vascular Medicine [published correction appears in *J Am Coll Cardiol.* 2013 Sep 10;62(11):1039 to 40]. *J Am Coll Cardiol.* 2010;55(14):e27-e129. doi:10.1016/j.jacc.2010.02.015
3. Malfait F, Francomano C, Byers P, et al. The 2017 international classification of the Ehlers-Danlos syndromes. *Am J Med Genet C Semin Med Genet.* 2017;175(1):8-26. doi:10.1002/ajmg.c.31552
4. Malfait F, Wenstrup R, De Paepe A. Classic Ehlers-Danlos Syndrome. 2007 May 29 [Updated July 26, 2018]. In: Adam MP, Ardinger HH, Pagon RA, et al., editors. *GeneReviews*[®] [Internet]. Seattle (WA): University of Washington, Seattle; 1993 to 2023. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK1244/>
5. Levy HP. Hypermobile Ehlers-Danlos Syndrome. 2004 Oct 22 [Updated 2018 Jun 21]. In: Adam MP, Ardinger HH, Pagon RA, et al., editors. *GeneReviews*[®] [Internet]. Seattle

- (WA): University of Washington, Seattle; 1993 to 2023. Available from:
<https://www.ncbi.nlm.nih.gov/books/NBK1279/>
6. Byers PH. Vascular Ehlers-Danlos Syndrome. 1999 Sep 2 [Updated 2019 Feb 21]. In: Adam MP, Ardinger HH, Pagon RA, et al., editors. GeneReviews[®] [Internet]. Seattle (WA): University of Washington, Seattle; 1993 to 2023. Available from:
<https://www.ncbi.nlm.nih.gov/books/NBK1494/>
 7. Dietz H. Marfan Syndrome. 2001 Apr 18 [Updated 2022 Feb 17]. In: Adam MP, Ardinger HH, Pagon RA, et al., editors. GeneReviews[®] [Internet]. Seattle (WA): University of Washington, Seattle; 1993 to 2023. Available from:
<https://www.ncbi.nlm.nih.gov/books/NBK1335/>
 8. Loeys BL, Dietz HC. Loeys-Dietz Syndrome. 2008 Feb 28 [Updated 2018 Mar 1]. In: Adam MP, Ardinger HH, Pagon RA, et al., editors. GeneReviews[®] [Internet]. Seattle (WA): University of Washington, Seattle; 1993 to 2023. Available from:
<https://www.ncbi.nlm.nih.gov/books/NBK1133/>
 9. Milewicz DM, Regalado E. Heritable Thoracic Aortic Disease Overview. 2003 Feb 13 [Updated 2017 Dec 14]. In: Adam MP, Ardinger HH, Pagon RA, et al., editors. GeneReviews[®] [Internet]. Seattle (WA): University of Washington, Seattle; 1993 to 2023. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK1120/>
 10. Adam MP, Ardinger HH, Pagon RA, et al., editors. GeneReviews[®] [Internet]. Seattle (WA): University of Washington, Seattle; 1993 to 2023. Available from:
<https://www.ncbi.nlm.nih.gov/books/NBK1116/>
 11. Online Mendelian Inheritance in Man, OMIM[®]. McKusick-Nathans Institute of Genetic Medicine, Johns Hopkins University (Baltimore, MD). World Wide Web URL:
<https://omim.org/>
 12. MedlinePlus [Internet]. Bethesda (MD): National Library of Medicine (US). Available from: <https://medlineplus.gov/genetics/>
 13. Genetic Support Foundation. Genetics 101 Inheritance Patterns: Familial Pathogenic Variant. Accessed 10/4/2022. <https://geneticsupportfoundation.org/genetics-101/#>
 14. MacCarrick G, Black JH 3rd, Bowdin S, El-Hamamsy I, Frischmeyer-Guerrero PA, Guerrero AL, Sponseller PD, Loeys B, Dietz HC 3rd. Loeys-Dietz syndrome: a primer for diagnosis and management. *Genet Med*. 2014 Aug;16(8):576-87. doi: 10.1038/gim.2014.11. Epub 2014 Feb 27. PMID: 24577266; PMCID: PMC4131122.

[back to top](#)

Important Reminder

This clinical policy has been developed by appropriately experienced and licensed health care professionals based on a review and consideration of currently available generally accepted standards of medical practice; peer-reviewed medical literature; government agency/program

approval status; evidence-based guidelines and positions of leading national health professional organizations; views of physicians practicing in relevant clinical areas affected by this clinical policy; and other available clinical information. The Health Plan makes no representations and accepts no liability with respect to the content of any external information used or relied upon in developing this clinical policy. This clinical policy is consistent with standards of medical practice current at the time that this clinical policy was approved. “Health Plan” means a health plan that has adopted this clinical policy and that is operated or administered, in whole or in part, by Centene Management Company, LLC, or any of such health plan’s affiliates, as applicable.

The purpose of this clinical policy is to provide a guide to medical necessity, which is a component of the guidelines used to assist in making coverage decisions and administering benefits. It does not constitute a contract or guarantee regarding payment or results. Coverage decisions and the administration of benefits are subject to all terms, conditions, exclusions and limitations of the coverage documents (e.g., evidence of coverage, certificate of coverage, policy, contract of insurance, etc.), as well as to state and federal requirements and applicable Health Plan-level administrative policies and procedures.

This clinical policy is effective as of the date determined by the Health Plan. The date of posting may not be the effective date of this clinical policy. This clinical policy may be subject to applicable legal and regulatory requirements relating to provider notification. If there is a discrepancy between the effective date of this clinical policy and any applicable legal or regulatory requirement, the requirements of law and regulation shall govern. The Health Plan retains the right to change, amend or withdraw this clinical policy, and additional clinical policies may be developed and adopted as needed, at any time.

This clinical policy does not constitute medical advice, medical treatment or medical care. It is not intended to dictate to providers how to practice medicine. Providers are expected to exercise professional medical judgment in providing the most appropriate care, and are solely responsible for the medical advice and treatment of members/enrollees. This clinical policy is not intended to recommend treatment for members/enrollees. Members/enrollees should consult with their treating physician in connection with diagnosis and treatment decisions.

Providers referred to in this clinical policy are independent contractors who exercise independent judgment and over whom the Health Plan has no control or right of control. Providers are not agents or employees of the Health Plan.

This clinical policy is the property of the Health Plan. Unauthorized copying, use, and distribution of this clinical policy or any information contained herein are strictly prohibited. Providers, members/enrollees and their representatives are bound to the terms and conditions expressed herein through the terms of their contracts. Where no such contract exists, providers, members/enrollees and their representatives agree to be bound by such terms and conditions by providing services to members/enrollees and/or submitting claims for payment for such services.

Note: For Medicaid members/enrollees, when state Medicaid coverage provisions conflict with the coverage provisions in this clinical policy, state Medicaid coverage provisions take precedence. Please refer to the state Medicaid manual for any coverage provisions pertaining to this clinical policy.

Note: For Medicare members/enrollees, to ensure consistency with the Medicare National Coverage Determinations (NCD) and Local Coverage Determinations (LCD), all applicable NCDs, LCDs, and Medicare Coverage Articles should be reviewed prior to applying the criteria set forth in this clinical policy. Refer to the CMS website at <http://www.cms.gov> for additional information.

©2023 Centene Corporation. All rights reserved. All materials are exclusively owned by Centene Corporation and are protected by United States copyright law and international copyright law. No part of this publication may be reproduced, copied, modified, distributed, displayed, stored in a retrieval system, transmitted in any form or by any means, or otherwise published without the prior written permission of Centene Corporation. You may not alter or remove any trademark, copyright or other notice contained herein. Centene[®] and Centene Corporation[®] are registered trademarks exclusively owned by Centene Corporation.