Ehlers-Danlos Syndrome (EDS)
Indication-Specific Gene Panel
Including: sequencing and high resolution deletion/duplication analysis

PANEL DESCRIPTION:
Ehlers-Danlos syndrome (EDS) is a family of conditions characterized as connective tissue disorders. There are many subtypes of EDS, which vary greatly in phenotypic presentation but include overlapping features. Common features of this multi-system condition may include joint disease (pain, dislocations, hyperextension), skin manifestations (stretchy, thin, translucent, abnormal scarring, sagging, wrinkly), and in severe cases the rupture of blood vessels and organs. Incidence is specific to each type but is around 1 in 5000 when all types are combined. This indication-specific panel includes 13 genes associated with different subtypes of Ehlers-Danlos syndrome and is designed to detect both sequence-based mutations and small-scale deletions or duplications in these genes of interest.

PANEL DETAILS:
- This panel includes both sequencing and high resolution deletion/duplication analysis of the genes specified.
  - Sequencing is performed using a customized next generation sequencing library. Analysis includes the coding exons of all genes in the panel plus ten bases into the introns and untranslated regions (5' and 3'). Sanger sequencing is performed to confirm variants suspected or confirmed to be pathogenic.
  - Deletion/duplication analysis is performed using a high resolution, custom microarray platform designed to target the genes of interest at the exon level.
- Detection rates are limited to the genes specified; this test does not provide whole genome analysis.
- Gene panels are a more cost-effective approach than single gene testing to confirm or establish a diagnosis. However, if single gene testing is desired for the patient or family members of an individual with a known mutation, that must be ordered separately.

RECOMMENDED TESTING STRATEGY:
Tests below can be ordered individually, however our laboratory’s recommended Comprehensive Testing for EDS includes the following two tests:
- Next Generation Sequencing
  - Next generation sequencing (NGS) analyzes multiple genes at once, making this a cost-effective method of testing genes known to be associated with the indications included in this panel.
- Targeted Deletion/Duplication Analysis
  - If no pathogenic aberrations are detected by NGS, deletion/duplication analysis is performed to identify partial or whole gene deletions and duplications in the associated genes.

DISORDERS INCLUDED IN THIS PANEL:
- Ehlers-Danlos syndrome
  - Arthrochalasia type [COL1A1, COL1A2]
  - Cardiac valvular form [COL1A2]
  - Dermatosparaxis (formerly EDS type VIIc) [ADAMTS2]
  - EDS with progressive kyphoscoliosis, myopathy, and hearing loss [FKBP14]
  - Hypermobility type (formerly EDS type III) [TXNBI] — GeneReviews* [http://www.ncbi.nlm.nih.gov/books/NBK1279/]
  - Musculocontractural type I [CHST14]
  - Occipital Horn syndrome (formerly EDS IX) [ATP7A]
- Periventricular nodular heterotopia variant \([FLNA]\)
- Spondylocheirodysplastic form \([SLC39A13]\)

**INDICATIONS FOR TESTING:**
Please note that a number of connective tissue disorders can have overlapping features to EDS which may warrant utilizing a larger connective tissue panel.
- Joint issues: hypermobility, dislocation, chronic pain
- Skin findings: abnormal or atrophic scars, poor wound healing, spontaneous bruising, thin, translucent, highly elastic, velvety
- Tissue fragility: inguinal and umbilical hernia, hiatal and incisional hernia, recurrent rectal prolapse in early childhood
- Ocular findings: ectopia lentis, myopia, retinal detachment, scleral fragility and rupture of the ocular globe
- Pneumothorax, hemopneumothorax
- Cardiac findings: congenital heart defect, mitral valve prolapse, aortic root enlargement, thoracic aneurysm, aortic dissection, other aneurysms/dissections, extra-aortic vascular events, arterial tortuosity
- Skeletal variants: pes planus, congenital clubfoot, osteoarthritis, scoliosis, Marfanoid appearance
- Personal or family history of: sudden cardiac death, aneurysm/dissection, rupture of internal organ, rectal or uterine prolapse
- Craniofacial anomalies or dysmorphic features

**SPECIMEN COLLECTION & TRANSPORT:**
Complimentary test kits are available upon request, but are not required.

**SAMPLE TYPE and REQUIREMENTS:**
- **blood, > 3 months of age:** 3-5 ml whole blood in an EDTA tube (purple top)
- **blood, newborn:** 1-3 ml whole blood in an EDTA tube (purple top)
- **buccal swab:** 5 swabs
- **extracted DNA:** 5 µg in a DNA microcentrifuge tube

**SHIPPING:**
- Maintain and ship samples at room temperature.
- Coordinate transport for sample to be received in our laboratory within 24-48 hours of collection.
  - **LOCAL:** Call 402-559-5070 (option 1)
  - **OUT OF AREA:** Prior to shipment, please fax the completed test request form to 402-559-7248, including the FedEx® airbill tracking number.
    - Saturday delivery MUST be checked when sending FedEx® on Friday.
    - Please include Internal Billing Reference # 3155070600 on the FedEx® airbill.
  - **Ship To:** Human Genetics Laboratory – Zip 5440
    UNMC Shipping & Receiving Dock
    601 S. Saddle Creek Road
    Omaha, NE 68106

**REQUIRED FORM:** The following form can be downloaded via our website.
- Postnatal Test Request Form

**OPTIONAL FORM:**
- Informed Consent for Genetic Testing

**POTENTIAL TEST RESULTS:**
Once a variant is confirmed, our laboratory team interprets this information in conjunction with the patient’s clinical findings and the scientific literature in order to classify a finding. There are three possible results:
- A **normal** result indicates that sequencing or deletion/duplication analysis of the genes analyzed did not find any pathogenic mutations or variants of uncertain clinical significance (or no clinically-significant chromosome anomalies were identified by microarray analysis).
• An abnormal (or pathogenic) result indicates that a pathogenic mutation was identified (or microarray analysis identified a genomic dosage anomaly [deletion or duplication] or ROH that likely provides an explanation for the individual’s clinical findings). Any available information regarding the phenotype associated with that mutation will accompany the technical details on the report.

• In some cases, the clinical significance of an identified sequence variant (or chromosomal anomaly detected by microarray) may not be well understood. These variants (anomalies) will be reported as variants of uncertain clinical significance (UCS). Any available information about the molecular characteristics of the genetic change and the relationship of the genetic change to phenotype will be included on the report. Over time, as more patients are reported, a variant of uncertain clinical significance may be revised to an informative result, and a revised report will be generated.

• Parental testing may be recommended in order to classify the result as de novo or familial for the purpose of recurrence risk calculation.

**TURN-AROUND-TIMES:** For all sample types, results are typically available in 2-6 weeks.

**BILLING:** Our laboratory offers patient/self-pay, insurance (including Medicare/Medicaid), and client/institution billing options. Verifying coverage requirements or obtaining preauthorization PRIOR TO OR AT THE TIME OF SPECIMEN COLLECTION is often necessary. We provide preauthorization services upon request by calling 402-559-5070 (option 3); the following form is helpful for obtaining the information required by insurance providers and can be downloaded via our website.

• Request for Insurance Preauthorization

In some circumstances, a test may be warranted even though insurance coverage is denied or not guaranteed. For these situations, we request the following form be signed by the patient and submitted with the sample. This helps inform patients of their potential financial responsibility, should the costs of genetic testing not be paid by their insurance provider.

• Advanced Beneficiary Notice of Noncoverage (ABN) – required when billing Medicare

**CPT CODES:**

• Next Generation Sequencing: 81407
• Targeted Deletion/Duplication Analysis: 81228

**PRICING:** For current costs contact the laboratory billing staff at 402-559-5070 (option 3).

**GENE LIST:** (version 1_13)

This panel includes 13 genes.

<table>
<thead>
<tr>
<th>ADAMTS2</th>
<th>COL1A1</th>
<th>COL5A1</th>
<th>FLNA</th>
<th>TNXB</th>
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<tr>
<td>ATP7A</td>
<td>COL1A2</td>
<td>COL5A2</td>
<td>PLOD1</td>
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<tr>
<td>CHST14</td>
<td>COL3A1</td>
<td>FKB14</td>
<td>SLC39A13</td>
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**PANEL OVERLAP:** These genes are also included in the Connective Tissue Disorders panel.

**REFERENCES:**


updated 4/1/2016