

# Neuromuscular Disorders

## What Are Neuromuscular Disorders?

Neuromuscular disorders affect the nerves, especially those outside the brain and spinal cord (peripheral nerves). They also affect skeletal muscles, such as those in the trunk, arms and legs.

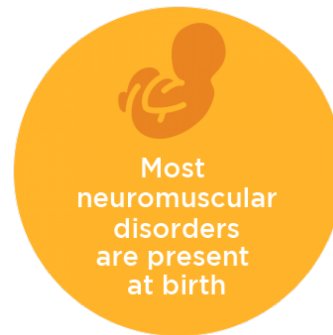
These disorders can be stable and unchanging (static), or can grow worse over time (progressive).

Most neuromuscular disorders:

- Are present at birth (congenital).
- Have a genetic component.
- Can affect several generations in a family.

Congenital neuromuscular disorders include:

- Muscular dystrophy.
- Myotonic dystrophy.
- Spinal muscular atrophy.
- Peripheral neuropathies (such as Charcot-Marie-Tooth disease).
- Generalized muscle and nerve issues (such as mitochondrial disorders).



## Types of Neuromuscular Disorders

There are hundreds of neuromuscular disorders, many with subtypes related to specific genetic causes. Although some muscle disorders look similar and have similar treatments, most require unique treatment strategies.

## Muscular Dystrophy

**Duchenne muscular dystrophy (DMD):** This common neuromuscular disorder affects males almost exclusively, but some females show mild characteristics of the disorder. With DMD, an abnormal gene on the X chromosome prevents the production of an important muscle protein called dystrophin. Eventually, muscle cells break down, resulting in muscle weakness and lost mobility.

**Becker muscular dystrophy (BMD):** BMD is similar to DMD, but with this disorder the abnormal gene does make some dystrophin. However, it either makes an abnormal form of dystrophin or not enough of it. As a result, some males with this form appear less affected than males with Duchenne muscular dystrophy.

**Facioscapulohumeral muscular dystrophy:** This disorder mainly affects the face, shoulders and upper arms. Muscle weakness results from a defect on chromosome 4, found throughout the body. Over time, other muscles and body parts can show slow—but progressive—weakening.

**Congenital muscular dystrophy (CMD):** This group of disorders leads to severe muscle weakness noticeable from birth. CMD affects both males and females. Most forms affect bone development, heart and lung function, brain function and mobility. Types of CMD include:

- Merosin-deficiency.
- Ullrich.
- Bethlem myopathy.
- Integrin-deficient.
- Fukuyama.
- Muscle-eye-brain disease.
- Walker-Warburg syndrome.
- CMD with rigid spine syndrome.

**Myotonic muscular dystrophy:** This type affects all or most muscles and some organs. The term “myotonic” refers to an inability to relax a muscle normally.

## Spinal Muscular Atrophy (SMA)

**SMA** affects nerves as they exit the spinal cord. Because the nerves lack a gene that helps maintain their function, they eventually stop carrying signals from the brain to the muscles, which can result in muscle weakness and loss of muscle mass (known as atrophy).

- **SMA I:** Also called infantile onset or Werdnig-Hoffmann disease, SMA I is the most severe form of the condition. Symptoms of SMA I usually develop by the time an infant is 6 months old. Most infants diagnosed with SMA I

show severe muscle weakness and floppiness (also known as hypotonia). They have difficulty gaining strength and can't sit on their own. The muscle weakness also causes difficulty with swallowing and breathing.

- **SMA II**: Sometimes called intermediate SMA, SMA II causes muscle weakness and hypotonia, but the problems are less severe than with SMA I. Babies and toddlers with type 2 spinal muscular atrophy learn to sit on their own, but have trouble standing or walking. As they grow, some children lose the ability to stand and move freely. At that point, they need to use mobility devices, such as powered wheelchairs.
- **SMA III**: Also called late-onset SMA (or Kugelberg-Welander disease), SMA III develops in children 18 months or older. Children who have SMA III walk on their own, but might have trouble jumping or using stairs. The severity of this form varies widely. Some people aren't diagnosed until adulthood. In those cases, the condition is sometimes called **SMA IV**, or **adult-onset SMA**.

## Charcot-Marie-Tooth (CMT) Disease

**CMT disease** affects the nerves that stimulate and receive messages from muscles. CMT also affects vital cells that support and protect nerves. As a result, muscle tissue begins to lose mass and weaken. CMT has many types, each linked to one or more genetic changes (mutations). The type of CMT determines the severity of the condition, and its most appropriate treatment.

## Friedreich's Ataxia (FA)

FA mainly affects the spinal cord and the nerves that extend from the spinal cord to the muscles. It's caused by an abnormal gene passed down through a family. FA also affects the part of the brain that helps coordinate movement (the cerebellum), and can affect heart muscle and function. FA can cause muscle weakness and loss of balance and coordination.

## Mitochondrial Myopathies

Mitochondria are the parts of muscle cells that create the energy needed for a muscle to tighten (or contract). Myopathy is a term that refers to a disease of muscle tissue. Mitochondrial myopathies are characterized by malfunctioning mitochondria. Causes and results vary, and new forms are discovered frequently. Most types lead to some form of muscle weakness. Others affect specific parts of the body. The most common mitochondrial myopathies are:

- Kearns-Sayre syndrome.
- Leigh syndrome and maternally-inherited Leigh syndrome.
- Mitochondrial DNA depletion syndrome.
- Mitochondrial encephalomyopathy, lactic acidosis and stroke-like episodes.

- Mitochondrial neurogastrointestinal encephalomyopathy.
- Myoclonus epilepsy with ragged red fibers.
- Neuropathy, ataxia and retinitis pigmentosa.
- Pearson syndrome.
- Progressive external ophthalmoplegia.

## Metabolic Myopathies

Metabolic myopathies disrupt the ability of muscles to turn nutrients (usually glucose or another carbohydrate) into energy.

Normally, that conversion process happens thousands of times every second and involves many steps, each linked to a nutrient, protein or other substance. Understanding the exact type of metabolic myopathy is important, because treatments exist for some specific deficiencies.

The most common forms of metabolic myopathy are:

- Acid maltase deficiency (also known as AMD, Pompe disease, glycogenosis type 2, lysosomal storage disease).
- Carnitine deficiency.
- Carnitine palmitoyl transferase deficiency.
- Debrancher enzyme deficiency (also known as Cori or Forbes disease, glycogenosis type 3).
- Lactate dehydrogenase deficiency (also known as glycogenosis type 11).
- Myoadenylate deaminase deficiency.
- Phosphofructokinase deficiency (also known as Tarui disease, glycogenosis type 7).
- Phosphoglycerate kinase deficiency (also known as glycogenosis type 9).
- Phosphoglycerate mutase deficiency (also known as glycogenosis type 10).
- Phosphorylase deficiency (also known as McArdle disease, myophosphorylase deficiency, glycogenosis type 5).

## Juvenile Dermatomyositis (JDM)

**JDM** is a common form of inflammatory myopathy. It can involve the muscles or their blood supply. With JDM, a red or purplish rash can develop on the face, neck, shoulders, or upper arms and legs. The inflammatory process can lead to muscle deterioration, muscle weakness and joint problems.

## What Causes Neuromuscular Disorders?

Kids and adults who develop neuromuscular disorders typically have a defective, duplicated or missing gene (genetic disorder). Most neuromuscular disorders are present at birth. However, many go undiagnosed for several years, either because symptoms take time to appear or because the conditions are so rare, they can be difficult to diagnose.

People who pass defective genes to their children are called carriers. Because they don't often experience the effects of the defective gene, most carriers are unaware of the issue until their child is diagnosed.

With some disorders, a child won't experience any symptoms unless both parents are carriers. In many cases, the same two parents might have some children who are affected and others who aren't. Often, the child is the first in the family to develop the condition.

It's not clear whether or not environmental factors contribute to genetic abnormalities. However, neuromuscular conditions generally aren't caused by accidents or injuries.

## **Neuromuscular Disorders Symptoms and Effects**

Most neuromuscular disorders cause obvious muscle weakness that worsens as a child grows. With some disorders, the weakness is obvious at birth. Others require a thorough physical exam to identify.

### **Developmental Delays**

Many children who have neuromuscular disorders learn to roll, crawl, stand and walk, though they might learn new skills more slowly than typically developing children do. For example, most babies hold their heads up at 2 to 3 months, and sit by themselves at 6 months. Babies who have a neuromuscular disorder might develop those skills later, or not at all.

As they grow older and larger, some babies and young children might lose certain skills or have more problems with them. For example, they might have trouble getting up from the floor, or have unusual or labored walking patterns. Younger children might have trouble swallowing, eating, drinking and learning to talk. Infants with severe neuromuscular disorders move very little and cry weakly.

### **Muscle Weakness**

Muscle weakness describes how much muscle strength (as opposed to muscle tension) a muscle produces to move a joint. Muscle strength also helps kids perform tasks, such as picking up toys.

In most cases, neuromuscular disorders prevent muscles from strengthening. Sometimes, trying to strengthen a muscle weakened by a neuromuscular disease can make the disease worse.

### **Muscle Tone**

Muscle tone is different from muscle strength. Muscle tone refers to the degree of tension in a resting muscle.

Muscle tone typically poses a problem only when it's extremely low (hypotonia) or unusually high (hypertonia).

Hypotonia in babies can be one sign of a neuromuscular disorder. Young children who have symptoms of hypotonia are often described as floppy or having low tone. Low tone doesn't necessarily mean a child has a neuromuscular disease. However, hypotonia and muscle weakness should be evaluated by a knowledgeable team as soon as possible to ensure appropriate care and treatment. A qualified professional should run tests as soon as possible because these dangerous symptoms can affect breathing and feeding.

## Secondary Conditions

As neuromuscular disorders progress—especially if not well managed by a team of specialists—a child might experience secondary conditions, such as:

- Muscle or joint stiffness (contractures).
- Deformed bones (especially the spine).
- Trouble breathing and eating.

Because most neuromuscular disorders can't be cured, the goal of treatment is to avoid or lessen the severity of secondary issues.

## Neuromuscular Disorders Diagnosis and Treatment

Some neuromuscular disorders can be diagnosed with a blood test alone. Others require a muscle or nerve biopsy. A biopsy involves making a small incision, removing a piece of tissue, and examining it in a laboratory. Clinical examinations can also lead to diagnoses.

Because some disorders respond best to early treatment, it's important to get an accurate diagnosis as soon as you suspect your child has a neuromuscular disorder. Early treatment can also help prevent some secondary effects of the conditions.

Although most neuromuscular disorders can't be cured, proper treatment can lower the intensity and slow the progression of its symptoms. At Gillette Children's Specialty Healthcare, we design treatments to maximize function, increase independence, and improve the quality of your child's life.

Sometimes, medicines can slow the loss of muscle function. Although it's rare, early and accurate diagnosis paired with proper management can help some kids lessen the effects of a neuromuscular disorder.

If your child has a neuromuscular disorder, you'll work closely with our physicians and genetic counselors. Our team of internationally recognized experts will identify the disorder, helping you understand its causes and the likelihood of other family members developing it.

Additionally, your child might receive care in:

- Adaptive recreation and personal training services.

- **Assistive technology devices.**
- **Aquatic therapy.**
- **Augmentative communication devices.**
- **Bracing/orthoses.**
- **Customized seating.**
- **Manual and powered mobility equipment.**
- Medication.
- Mobility training.
- **Occupational therapy.**
- **Physical therapy.**
- **Speech and language therapy.**

## Integrated Care

If your child has a neuromuscular disorder, our specialists work closely with you to ensure accurate testing and develop a customized treatment plan. Because most neuromuscular conditions aren't curable, regular checkups are necessary to slow the progression of symptoms and avoid secondary complications.

Your child will benefit from the supportive treatments of our program, which is supported by the Muscular Dystrophy Association. Treatments might include rehabilitation therapies, assistive technology or medicine—as well as services for family members.

## Medical and Specialties

- **Cardiology.**
- **Endocrinology.**
- **Medical genetics and genetic counseling.**
- **Neurology.**
- **Orthopedics.**
- **Rehabilitation medicine.**
- **Pulmonology and respiratory care.**

## Testing and Diagnostic Services

- Blood and urine analysis.
- Echocardiogram and electrocardiogram tests.
- **Electromyography tests.**
- Functional ability tests.
- Genetic and DNA tests.
- Manual muscle tests.
- Muscle biopsies.
- **Pulmonary function tests.**
- **Swallowing study (fluoroscopy and videofluoroscopy).**

## Family Support

- **Child life specialists.**
- **Dieticians.**
- **Psychologists.**
- **Neuropsychologists.**
- **Social workers.**
- **Therapeutic recreation specialists.**

Make An Appointment **651-290-8707** Refer a Patient **651-325-2200**

This information is for educational purposes only. It is not intended to replace the advice of your health care providers. If you have any questions, talk with your doctor or others on your health care team.

If you are a Gillette patient with urgent questions or concerns, please contact Telehealth Nursing at **651-229-3890**.