Spinal Muscular Atrophy Type 3

This information sheet briefly explains the cause, effects and management of Spinal Muscular Atrophy (SMA) Type 3. It includes sources of further information and support. It is for the families of children diagnosed with SMA Type 3. It may also be useful for healthcare and other professionals.

The glossary at the end explains the words that appear in bold font.

More information on SMA Type 3 and sources of support is available from SMA Support UK’s route map for SMA Type 3: [www.routemapforsma.org.uk](http://www.routemapforsma.org.uk)

SMA Type 3 is a complex condition; there is a lot of information to take in and every child with SMA is different. Your child’s medical team will always be happy to go over any of this with you.

What is Spinal Muscular Atrophy?

Spinal Muscular Atrophy (SMA) is a rare, genetically inherited neuromuscular condition. SMA may affect crawling and walking ability, arm, hand, head and neck movement, breathing and swallowing. SMA is often grouped into ‘Types’. Types of SMA are based on the age at which symptoms first appear and what physical ‘milestones’ a baby or child is likely to achieve. Milestones can include the ability to sit, stand or walk.

There are four main types of SMA: Types 1, 2 and 3 appear in childhood; Type 4 appears in adulthood and is also known as Adult Onset SMA.

These ‘Types’ are not rigid categories. There is a wide spectrum of severity both between the different types of SMA and between children, young people and adults within each type.

There are also other, even rarer forms of SMA with different genetic causes including SMA with Respiratory Distress (SMARD), Spinal and Bulbar Muscular Atrophy (SBMA) and Distal SMA (DSMA).
What causes SMA?

Usually, electrical signals from our brain are sent down our spinal cord along our nerve cells and through to our muscles. This makes it possible for us to consciously contract our muscles and to make them move.

SMA affects a particular set of nerve cells called the lower motor neurons which run from the spinal cord out to our muscles. The lower motor neurons carry messages that make it possible for us to move the muscles we use to crawl and walk, to move our arms, hands, head, and neck, and to breathe and swallow.

For our lower motor neurons to be healthy, we need to produce an important protein called the Survival Motor Neuron (SMN) protein. Our ability to do this is controlled by a gene called Survival Motor Neuron 1 (SMN1).

We all have two copies of the SMN1 gene, one from each parent.

- People who have two faulty copies of the SMN1 gene have SMA.
- People who have one faulty copy of the SMN1 gene are carriers of SMA. Carriers usually do not have SMA or any symptoms of SMA.
- People who have two healthy copies of the SMN1 gene do not have SMA and are not carriers.

SMA is passed from parents to their children through their SMN1 genes. When two people who are carriers have a child together, their child may inherit two faulty SMN1 genes, one from each parent. If this happens, then their child will have SMA.

Having two faulty SMN1 genes means that a child is only able to produce very low amounts of the SMN protein. This causes their lower motor neurons in their spinal cord to deteriorate. Messages from their spinal cord do not efficiently get through to their muscles, which makes movement difficult. Their muscles waste due to lack of use and this is known as muscular atrophy.

In addition to SMN1, we possess a second gene that is able to produce some functional SMN protein. This gene is almost identical to SMN1 and is called the SMN2 gene. However, SMN2 only makes a small fraction of functional protein (about 10%).

For more information on the inheritance of SMA and how SMN2 is linked to the severity of an individual’s SMA please see ‘The Genetics of Spinal Muscular Atrophy’: www.smasupportuk.org.uk/the-genetics-of-sma

What is SMA Type 3?

SMA Type 3 is sometimes called Kugelberg-Welander disease. The symptoms of muscle weakness and floppiness (low tone / hypotonia) usually appear after 18 months of age but
the actual age of onset is very variable and may not appear until late childhood or early adulthood.

Each child with SMA Type 3 is different but the onset of muscle weakness is gradual and children are generally able to walk until late childhood and sometimes into adolescence³.

Sometimes doctors try to indicate the degree of severity within SMA Type 3 by using a decimal classification⁴, for example, 3.1, 3.2, 3.5, 3.9. If you have any queries regarding this please speak to your child’s medical team.

Life expectancy for children diagnosed with SMA Type 3 is normal⁵ and most people live long, fulfilling and productive lives.

How is SMA Type 3 diagnosed?

A doctor will diagnose SMA Type 3 after taking a medical history, physically examining your child and by taking a blood sample for DNA testing. The blood sample is tested for a deletion mutation in the Survival Motor Neuron 1 (SMN1) gene on chromosome 5. The result of this test is usually available within 2 – 4 weeks.

If there is any uncertainty about the diagnosis, further muscle tests such as an electromyogram (EMG) or a muscle biopsy may be discussed, but these are not usually needed to confirm SMA.

What are the effects of SMA Type 3?

This section describes the effects of SMA Type 3 in general terms. But, it’s important to remember that each child with SMA Type 3 is affected differently and the severity of the condition varies from child to child.

Children’s muscle weakness is usually the same on both sides of their body (symmetrical). The muscles closest to the centre of their body (proximal muscles) are usually more severely affected than the muscles furthest from the centre of their body (distal muscles). Generally, children with SMA Type 3 find that their legs are weaker than their arms.

As your child grows, it may be difficult for their muscles to keep up with their daily activities. If your child has been able to, for example, walk or climb stairs, they may lose this ability as they get older. Some children may fall more easily as a result of their muscle weakness. If they are sitting on the floor they may need help getting up. About 50% of children with SMA Type 3 will lose the ability to walk independently by the age of 14⁶ although some people are still able to walk in adulthood.

In SMA Type 3 the muscles supporting the spinal column are weakened. This means that some children will develop a sideways curvature of their spine⁶ (scoliosis). Also, because the
condition reduces children’s ability to move, some joints may become tight (contractures) restricting their range of movement.

Muscle weakness in children with SMA Type 3 mainly affects their limb movement. It doesn’t affect bladder and bowel control but some children may need help with toileting, dressing, and undressing.

Children with SMA Type 3 may become weaker after infections and at times of major growth spurts such as puberty. SMA doesn’t affect a child’s sexual or intellectual development.

What healthcare and support is needed for SMA Type 3?

The Standards of Care for SMA (SoC) were internationally agreed in 2007. They outline best practice and management for the three more common forms of SMA, which includes SMA Type 3. The sections in the SoC headed ‘walkers’ cover best practice and management for SMA Type 3. Though currently being updated, the SoC remain as key guidelines for doctors and families. You can find out how to obtain your copy in the section ‘Further Resources’ (page 9). Though this is a family version, please be aware it is written in a very clinical way.

Your child should receive care from a multidisciplinary healthcare team, which can feel like an overwhelming number of people but they all have an important role to play. You may have contact with specialists in neuromuscular conditions, respiratory medicine, orthopaedics, physiotherapy, occupational therapy, speech and language therapy, dietetics, and a hospital or community consultant paediatrician. If possible one of the team should be your keyworker whose job it is to help co-ordinate services for your family. You can find out more about how these people help in our information sheet ‘Who’s Who of Professionals’: www.smasupportuk.org.uk/whos-who-of-professionals

Children with SMA Type 3 should be seen by their medical team regularly to measure any change in their health and to offer advice and interventions at the right time. The aim is to enable your child to remain healthy and enjoy a good quality of life.

At every appointment with your child’s medical team you should be given time to ask questions and then jointly decide what support is best for your child.

- Breathing

Children with SMA Type 3 do not generally have difficulties with their breathing, but their breathing strength and cough effectiveness should be checked regularly.
You can read an overview of what good respiratory management involves in SoC. As each child with SMA Type 3 is affected differently it’s important to discuss any queries you have with your child’s medical team.
**- Nutrition**

Children with SMA Type 3 rarely have difficulty with their chewing and swallowing but your child’s medical team will provide you with advice and support if necessary.

A healthy diet is important for everyone. Your child’s health visitor, consultant, speech and language therapist or dietitian will be able to provide advice and support on eating and nutrition.

Your child may become overweight if they have reduced mobility. If this happens the extra weight can increase the stress on muscles, bones and joints, making physical activity even more difficult. A dietician will be able to advise on a healthy diet that will suit your child.

Children with SMA Type 3 can become constipated which may cause discomfort. You can discuss how to manage this with your child’s medical team.

**- Posture, movement and mobility**

SMA Type 3 will mean that your child will have difficulties with their posture, movement and mobility. They will need their own exercise routines designed by their physiotherapist to help with this. Routines may include exercises to help maintain their range of motion, reduce any discomfort, stretch any tight muscles and prevent **contracts**. Regular gentle stretching of their tight joints can help to reduce the pain that contracts can cause. If your child does have any pain, do talk to their doctor and physiotherapist. Your child might enjoy doing these exercises in the bath, or a swimming or hydrotherapy pool as the warm water aids buoyancy.

Regular moderate exercise will also help your child to maintain their fitness and stamina and activities such as swimming and horse riding can be adapted to match their physical ability.

Although your child will lose muscle strength over time, it is important that they maintain activities like standing and walking for as long as possible. Walking can help delay the development of **scoliosis** and standing is good for breathing, blood circulation, bladder, bowels, bones and joints.

As your child’s physical abilities change, an occupational therapist will advise what sort of seating will give them the best, most comfortable support. This will make it easier for them to play with toys, eat independently and join in at home and at school.

A physiotherapist will assess your child and provide appropriate equipment to support their standing, walking and positioning. Some children with SMA Type 3 benefit from having splints (sometimes called **orthoses**) for support with standing and walking. Types of orthoses include ankle foot orthoses (AFOs) and knee, ankle, foot orthoses (KAFOs). These will be made specifically for your child by an orthotist who will explain how they will help.

Specialist equipment will enable your child to participate in activities both at home and at school. If your child finds walking increasingly difficult or they are having falls then they may
benefit from using a walking frame or a manual wheelchair. If your child’s weakness increases, a powered (electric) wheelchair may help their independence. Your child’s physiotherapist and occupational therapist will be able to advise you about walking aids and wheelchairs.

As already mentioned, children with SMA Type 3 may develop a sideways curvature of their spine (scoliosis). It is important that the medical team monitors your child regularly so that any increase in curvature is noticed early. This is more likely to develop if your child is no longer able to walk. The degree of the curvature and your child’s age will be factors in deciding how to manage this. Initially this may be with a spinal brace or jacket but surgery to correct scoliosis may be recommended if the scoliosis is contributing to breathing difficulties, is preventing comfortable sitting, or if the curvature has progressed beyond a certain point.

Occupational therapists can give you advice about other adaptations and equipment that will help with your child’s everyday activities such as writing, playing, washing, dressing, cooking and eating, both at home and at school. With appropriate encouragement, adaptations and support, your child will be able to lead as fulfilling a life as their friends.

What other help is available?

A diagnosis of SMA Type 3 with all its complexity can have an enormous impact on families. It’s important for you and your child to have emotional support and plenty of time to talk and ask questions. This can be with members of your child’s medical team, your local General Practitioner (G.P.), health visitor, social worker, psychologist or a counsellor.

To enable your child to participate fully in activities at home, school and in their community, you will need information, advice and support on mobility, education, equipment and sources of funding that will aid their inclusion. You can find out more by talking to your child’s healthcare team, Spinal Muscular Atrophy Support UK (SMA Support UK), and the other people and agencies listed in this leaflet and on the SMA Support UK route map for SMA Type 3: www.routemapforsma.org.uk

SMA Support UK can provide information and support to families affected by SMA in the UK. Our Outreach Workers are able to visit you at home and can discuss with you the health, social, educational, financial and care support that you and your child may be entitled to. We can also put you in touch with our Peer Support Volunteers who have personal experience of living with SMA Type 3. Information about these services is available on our website: www.smasupportuk.org.uk/how-we-can-support-you or please phone us on 01789 267 520 or email: supportservices@smasupportuk.org.uk

Muscular Dystrophy UK also provides information, support and advocacy services, including grants towards specialist equipment, for people affected by a range of neuromuscular conditions. Their website is: www.musculardystrophyuk.org or you can phone them on 0800 652 6352 or e-mail: info@musculardystrophyuk.org

Regional care advisors and sometimes neuromuscular nurse specialists, are attached to NHS neuromuscular clinics in various regions of the UK. They provide support and information to children and adults with muscle diseases and their families. They link up with other
professionals and services so that people receive the local health and social support they need. Regional care advisors’ contact details are available on Muscular Dystrophy UK’s website: www.musculardystrophyuk.org/get-the-right-care-and-support/people-and-places-to-help-you/care-advisors/

- **Financial Support**

Families living in the UK may be eligible for a number of financial benefits to help towards the cost of providing the extra care their child may need. This does depend on your individual circumstances.

For further information about financial benefits visit the Gov.UK website [www.gov.uk](http://www.gov.uk) and look at the sections ‘Benefits’ and ‘Carers and Disability Benefits’. The Department of Work and Pensions (DWP) can be contacted on: 0345 608 8545.

[Contact a Family](http://www.cafamily.org) provide information and support to families who have a child with a disability. This includes information on benefits and grants. They can be contacted on 0808 808 3555 or through their website: [www.cafamily.org.uk](http://www.cafamily.org.uk)

[Disability Rights UK](http://www.disabilityrightsuk.org) publishes free factsheets on a range of benefits and the ‘Disability Rights Handbook’ annually. For further information visit: [www.disabilityrightsuk.org](http://www.disabilityrightsuk.org)

[Turn2Us](http://www.turn2us.org.uk) is a charity which helps people access money available to them through welfare benefits, grants, and other help. They can be contacted on 0808 802 2000 or through their website: [www.turn2us.org.uk](http://www.turn2us.org.uk)

Your health visitor, [neuromuscular](https://www.musculardystrophyuk.org/get-the-right-care-and-support/neuromuscular) care advisor, family support worker, social worker or outreach worker may be able to help you with applications for financial benefits.

There are also a number of charities that may assist you with the cost of general household goods, specialist equipment, and holidays / days out. Please contact SMA Support UK for more information or see the SMA Type 3 route map: [www.routemapforsma.org.uk](http://www.routemapforsma.org.uk)

- **Genetic Counselling**

As a parent with a child with SMA you should be offered a referral for [genetic counselling](https://www.musculardystrophyuk.org/get-the-right-care-and-support/health_and_social_genetics). You can also request a referral from your General Practitioner (G.P.).

Genetic counselling takes place with a healthcare professional who has expert training in [genetics](https://www.musculardystrophyuk.org/get-the-right-care-and-support/neuromuscular). They will help you to understand how SMA is passed on and what the chances are of other people in your family being affected. Genetic counselling also provides you with the opportunity to discuss your choices for any future pregnancies. You will be able to go back to your genetic counsellor at a later date if you have more questions.

As your child and any siblings grow up, they can also ask for genetic counselling, particularly if they are considering having children.
For more information on the genetics of SMA, the chances of having a child with SMA and the tests that can be carried out, please see our leaflet ‘The Genetics of Spinal Muscular Atrophy’: www.smasupportuk.org.uk/the-genetics-of-sma

For information on ‘Future Options in Pregnancy’ please see: www.smasupportuk.org.uk/future-options-in-pregnancy

Is there a treatment or cure for SMA Type 3?

Although there is currently no cure for SMA, this does not mean that nothing can be done. As we have outlined above, there are a range of options aimed at managing symptoms, reducing complications of muscle weakness and maintaining the best quality of life.

There is also considerable amount of research into SMA taking place around the world. This research will not only improve our understanding of the condition but will also help to develop effective treatments.

One area of extensive research is the genetics of SMA and the underlying mechanisms that lead to damage of the nerve cells. The UK is a significant contributor to this, with several UK centres involved in clinical trials and international collaborations. This has led to very encouraging breakthroughs in developing treatments that increase the production of SMN protein by addressing the genetic fault.

- **Nusinersen/ Spinraza™**

The first (and so far, the only) potentially available treatment for SMA is called nusinersen. Essentially the drug targets the SMN2 gene to produce more SMN protein. Nusinersen was developed by pharmaceutical companies Ionis and Biogen which have run clinical trials with infants and children affected by SMA Types 1, 2 or 3. There have not yet been any clinical trials of nusinersen with anyone with SMA Type 4.

On June 1st 2017, the European Commission approved nusinersen for marketing under its brand name Spinraza™ as a treatment for those with 5qSMA. This includes those with SMA Types 1, 2, 3 and 4.

Currently, the only way to access the treatment in the UK is through what is called an Expanded Access Programme (EAP). This EAP is only available to children with SMA Type 1 where both the child’s medical team and the child’s parents/guardians have agreed that it will be of potential benefit and that the child is eligible for the treatment.

Nusinersen’s future availability in the UK depends on the National Institute for Health and Care Excellence (NICE), NHS England, the Scottish Medicines Consortium and other authorities in the devolved nations recommending that the NHS funds the drug in England, Scotland, Wales and Northern Ireland. At this stage, it is not known if the funding of nusinersen treatment will be considered for specific types of 5qSMA only or for all types of 5qSMA.
To find out more about nusinersen and any updates on what progress there has been towards further access in the UK, please go to: [www.smasupportuk.org.uk/nusinersen](http://www.smasupportuk.org.uk/nusinersen)

- **Other developments**

The UK SMA Patient Registry is a database of genetic and clinical information about people affected by SMA. As new treatments for SMA are being developed, they need to be tested in clinical trials. Researchers wanting to find people interested in joining a clinical trial contact the Patient Registry which then contacts the people who have registered to let them know about the potential opportunity. If this is of interest to you, you can sign up with the Patient Registry.

The Registry also helps specialists gain more knowledge about the condition and the number of people affected by SMA. This information helps to develop and improve worldwide standards of care for people with SMA. You can find out more by looking at their website: [www.treat-nmd.org.uk/registry](http://www.treat-nmd.org.uk/registry) e-mailing: registry@treat-nmd.org.uk or phoning: 0191 241 8640.

SMA Support UK’s website also notifies the SMA community about latest developments with other drug treatments, the science behind them and what clinical trials and other research is going on: [www.smasupportuk.org.uk/research](http://www.smasupportuk.org.uk/research) We alert people to new postings via our social media and monthly E-news. You can sign up for mailings at: [www.smasupportuk.org.uk/sign-up-for-mailings](http://www.smasupportuk.org.uk/sign-up-for-mailings).

**Further Resources**

**Standards of Care for Spinal Muscular Atrophy (TREAT-NMD)**

This booklet describes best practice management and treatment for the more common forms of SMA. It is used by doctors but is also available to families. A hard copy can be requested from SMA Support UK. It can also be downloaded from the TREAT-NMD website: [www.treat-nmd.eu/sma/care/family-guide/](http://www.treat-nmd.eu/sma/care/family-guide/)

**Other publications**

Any family with a child with SMA Type 3 may contact supportservices@smasupportuk.org.uk or phone 01789 267520 for a free copy of each of the following publications:

- SMA Type 3 and Me – an illustrated book written for children
- Smasheroo – an illustrated book for young children affected by SMA Type 2 or SMA Type 3
- Tilly Smiles – Tilly has SMA Type 2 and she and her family have written this book to inspire others

Further copies may be ordered from the shop on SMA Support UK’s website: [www.smasupportuk.org.uk/merchandise](http://www.smasupportuk.org.uk/merchandise)
SMA Support UK Information

Leaflets and other resources may be downloaded from the SMA Support UK website: [www.smasupportuk.org.uk/about-sma](http://www.smasupportuk.org.uk/about-sma) Hard copies may be requested by phoning 01789 267 520 or emailing the support services team on: [supportservices@smasupportuk.org.uk](mailto:supportservices@smasupportuk.org.uk)

The UK SMA Patient Registry

This leaflet describes the work of the Registry and how to sign up. A hard copy may be requested from SMA Support UK. It can also be downloaded from: [www.treat-nmd.org.uk/registry](http://www.treat-nmd.org.uk/registry)

Author: SMA Support UK Information Production Team
Version: 2.5
Updated: August 2017
Next full review due: October 2017

Please help us keep on producing information like this.
We receive no government funding and rely on public support.
You can sign up as a reviewer and / or make a donation.

Contact us on [office@smasupportuk.org.uk](mailto:office@smasupportuk.org.uk) or phone 01789 267 520
Or
Go to: [www.smasupportuk.org.uk/donate](http://www.smasupportuk.org.uk/donate)

If you have any feedback about this information, please do let us know at [supportservices@smasupportuk.org.uk](mailto:supportservices@smasupportuk.org.uk)

We are grateful to the writers and reviewers who assist us in our information production. A list of who this includes may be viewed on our website: [www.smasupportuk.org.uk/our-writers-and-reviewers-panel](http://www.smasupportuk.org.uk/our-writers-and-reviewers-panel) or requested from [supportservices@smasupportuk.org.uk](mailto:supportservices@smasupportuk.org.uk)

Whilst every effort is made to ensure that the information in this document is complete, correct and up to date, this cannot be guaranteed and SMA Support UK shall not be liable whatsoever for any damages incurred as a result of its use. SMA Support UK does not necessarily endorse the services provided by the organisations listed in our information sheets.
Glossary of Terms

Amino acid
The individual building blocks of proteins. There are 20 different amino acids that are naturally incorporated into proteins. The specific order of the amino acids determines the structure and function of a protein.

Amniocentesis
The removal of a sample of amniotic fluid (the fluid around an unborn baby) for prenatal testing. Cells in the fluid can be tested for certain genetic disorders.

Amniotic fluid
The fluid surrounding a foetus in the womb.

Anterior Horn
The front part of the spinal cord where the cell bodies of the lower motor neurons are located. Long, slender projections of the motor neurons called axons migrate out from the anterior horn in large bundles of nerves in order to reach muscles.

Anterior Horn Cell
The nerve cells that make up the anterior horn of the spinal cord. Also known as lower motor neurons, these cells are the main cell type affected in SMA.

Antibodies
Proteins made by the body to protect itself from “foreign” substances such as bacteria or viruses.

Atrophy
The wasting or shrinkage of a part of the body. SMA is called Spinal Muscular Atrophy because the lower motor neurons within the spinal cord degenerate, which leads to the wasting of skeletal muscles.

Autosomal recessive inheritance
When a genetic disorder is recessive, two faulty copies of a gene, one from each parent, must come together for the disease to occur. If a person has only one faulty copy, they do not usually have the symptoms of the disease, but are known as carriers because they can pass on the faulty gene to their children. A disease is autosomal when the faulty gene is found on one of the autosomes. SMA is usually an autosomal recessive condition.

Autosome
Any of the 22 pairs of chromosomes found in the human body that are not involved in the determination of sex. They are identical in both males and females. Each pair of autosomes (one from the father, one from the mother) contain genes for the same traits (characteristics).
Axon
The long, slender main projections of a nerve cell. Axons carry electrical impulses away from the cell body (where the nucleus is) to its target, such as muscles.

Carrier
This term relates to autosomal recessive inheritance and X-linked recessive inheritance patterns. A person who has both a faulty copy and a healthy copy of a gene is a carrier. Carriers usually have no symptoms due to the healthy copy of the gene, but they may pass on a condition to their children. In the case of SMA, carriers have one faulty copy of the Survival Motor Neuron 1 (SMN1) gene and one healthy copy of SMN1. Two individuals who each carry the SMN1 mutation have a 25% (1 in 4) chance of having a child with SMA for each pregnancy. A child must inherit two copies of the faulty SMN1 gene to develop SMA, one copy from each parent.

Cell
The basic building block of all known living organisms. Cells come in many different forms such as motor neurons (a type of nerve cell), keratinocytes (main cell type of the skin), or erythrocytes (red blood cells).

Central nervous system (CNS)
The central nervous system consists of the brain and the spinal cord. The CNS is connected to other tissues and organs in the body, such as skeletal muscles, by the peripheral nervous system (PNS).

Chorionic villus sampling (CVS)
CVS is a way to test if an unborn baby has SMA. A sample of chorionic villous cells (placental tissue) is removed using a needle. This is usually done between the eleventh and fourteenth week of a pregnancy. The cells can then be genetically tested for SMA.

Chromosomes
Chromosomes are compact bundles of DNA. Humans have 46 chromosomes in each cell (with a few exceptions, including sperm and egg cells). They inherit 23 from their mother and 23 from their father to make 23 pairs.

Clinical
The observation and treatment of patients, rather than laboratory studies that do not directly involve patients.

Clinical trial
A trial done on humans, usually to test a treatment or intervention, or to find out more about a disease.

Contracture
A tightness in the connective tissue and tendons around a joint that results from weakness and inability to move a joint through its full range of motion.
**Deletion mutation**
Genetic material (part of the DNA) missing from a chromosome or gene.

**Diagnosis**
Identifying a disease from its signs and symptoms or from its genetic cause. A clinical diagnosis is given when a doctor sees enough signs or symptoms to be confident that a person has the disease in question. In genetic disorders, a genetic diagnosis is given when a genetic test has been performed and the fault in the gene that is known to cause the disease is found. Doctors who are experts in SMA can usually diagnose the condition with a high degree of accuracy from the clinical signs and symptoms alone. However, genetic tests are usually recommended for all genetic disorders to increase certainty, to make sure any treatment is correctly targeted and to enable the family to have prenatal testing in future pregnancies if they wish.

**Distal**
Anatomical term meaning situated away from the centre of the body, towards the extremities. Distal muscles, such as those found in the hands and feet, are typically less affected by the more common forms of SMA compared to proximal muscles, such as those involved in breathing.

**DNA (Deoxyribonucleic acid)**
DNA is the molecule that contains the genetic instruction manual to build all known organisms. DNA is often compared to a set of blueprints, a recipe, or a code, since it contains the instructions needed to construct other components of cells, such as proteins.

**Electromyogram (EMG)**
A test that assesses the electrical activity of the muscles and the nerves controlling the muscles. It is used to help diagnose neuromuscular disorders. There are two kinds of EMG: intramuscular and surface. An intramuscular EMG involves inserting a needle electrode, or a needle containing two fine-wire electrodes, through the skin into the muscle. A surface EMG involves placing an electrode on the surface of the skin.

**Embryo**
The name given to the developmental stage from fertilised egg up until about eight weeks of pregnancy when the embryo becomes a foetus.

**Enzyme**
A protein which initiates, facilitates or speeds up a chemical reaction. Almost all of the processes that occur in our body require enzymes. Examples include the digestion of food and the growth and building of cells.

**Foetus (fetus)**
The term used for an unborn baby after the eighth week of development until birth.
**Gene**
A section of DNA that carries the information to produce a specific protein. Genes are the unit of heredity that are passed from one generation to the next. We usually possess two copies of each gene, one inherited from each of our parents. When genes are altered through mutation, this can affect the structure and function of the proteins that they produce, leading to disease.

**Genetic counselling**
Information and support provided by a genetic specialist to people who have genetic disorders in their families or are concerned about a genetically transmitted condition. Genetic counselling helps families understand things like how the condition is passed on, what the chances are of children being affected, and which other family members may be at risk of carrying the affected gene. It also helps affected teenagers / young adults to understand their future choices.

**Genetic disorders**
Conditions resulting from alterations to an individual’s genes. Genetic disorders can be caused by defects in one or more genes, or whole chromosomes.

**Genetic testing**
The examination of an individual’s genes to identify any faults that could cause a genetic disorder.

**Genetics**
The study of genes and inheritance.

**Heredity**
The passing of traits (characteristics) through the inheritance of genes from one generation to the next.

**Hypotonia**
Decreased / low muscle tone, sometimes described as floppiness.

**Inheritance**
The process by which an individual acquires traits (characteristics) from his or her parents.

**Molecule**
Two or more atoms chemically bonded together. For example, water is a molecule made up of two hydrogen atoms and one oxygen atom bonded together (H₂O).

**Motor neurons**
The nerve cells that connect the brain and spinal cord to skeletal muscles allowing conscious muscle contraction (movement). They act as a message delivery system: electrical signals originating in the brain are fired down the spinal cord along upper motor neurons; the electrical signals continue along lower motor neurons, which project out to skeletal muscles to control movement. Lower motor neurons are located in the anterior horn of the spinal
cord and are the main cell type affected by SMA. In SMA, low levels of the Survival Motor Neuron (SMN) protein cause the deterioration of lower motor neurons leading to muscle weakness and atrophy.

**Muscle biopsy**
Removal of a small amount of muscle tissue for analysis.

**Mutation**
A permanent change in the DNA sequence of a gene that can be inherited by subsequent generations. Dependent upon the type of mutation and where it occurs within the gene, it might have no effect on the protein produced, or it might disturb the protein’s function causing a genetic disorder such as SMA.

**Nerve Cells**
Also called neurons, nerve cells allow the quick transmission of electrical signals throughout the body. Different types of nerve cell make up the nervous system which functions to allow us to perceive and react to our surroundings. For example, the brain sends a signal along the nerves to tell a muscle to contract (move). Nerve cells are important for both involuntary (unconscious) functions like the beating of the heart and voluntary (conscious) functions like moving your arm.

**Neuromuscular**
Anything that relates to the nerves, muscles or the neuromuscular junction.

**Neuromuscular Junction (NMJ)**
The specialised connection, known as a synapse, between the lower motor neurons and skeletal muscle fibres. The NMJ allows signals from the nerves to get through to the muscles enabling them to contract (move).

**Nucleus**
The control centre of a cell that contains the DNA wrapped up within chromosomes.

**Occupational Therapy**
The use of assessment and treatment to help promote independent daily living skills.

**Orthopaedic**
Relating to the musculoskeletal system: the body’s muscles and skeleton, including the joints, ligaments, tendons, and nerves.

**Orthoses (also orthosis and orthotics)**
Devices or aids manufactured to prevent or assist movement of the spine or limbs or to provide support for joints and muscles. For example: splints, spinal jacket / brace, ankle-foot orthoses (AFOs), knee ankle-foot orthoses (KAFOs).
Peripheral nervous system (PNS)
Consists of the nerve cell extensions found outside of the central nervous system (CNS). The PNS acts to connect the CNS with the muscles and internal organs. The lower motor neuron axons and their connections with the muscle (neuromuscular junctions) are found within the PNS.

Physiotherapy
Physical techniques used to promote, maintain and restore physical function of the body.

Prenatal testing
The genetic testing for diseases or conditions in a foetus or embryo. This is done by removing a sample of fluid or tissue by procedures such as amniocentesis or chorionic villus sampling (CVS).

Protein
Proteins consist of chains of amino acids arranged in very specific orders. The order of amino acids within a chain is determined by the genetic code (DNA). Different genes have the “instructions” for making different proteins. Proteins are the building blocks of our bodies and are essential for the structure, function, and regulation of cells, tissues and organs. Examples of different proteins include enzymes, hormones, antibodies and the survival motor neuron (SMN) protein.

Proximal
Anatomical term meaning situated close to the centre of the body. Proximal muscles, such as those found in the hips, shoulders and neck, are more affected than distal muscles in most forms of SMA.

Rare Disease
The European Union (EU) considers diseases to be rare when they affect not more than 5 per 10,000 persons in the EU.

Recessive
Autosomal recessive describes a form of inheritance in which two faulty copies of a gene are required in order for a person to be affected by a genetic disorder. This means that a faulty copy of a gene is inherited from each parent. Survival Motor Neuron 1-associated SMA is an autosomal recessive condition. In X-linked recessive conditions, two faulty copies of the gene are needed for the genetic disorder to show in females, but only one faulty copy in males. This is because X-linked recessive conditions are caused by mutations in genes found on the X chromosome, but that are missing from the Y chromosome. Males have one X and one Y chromosome, while females have two X chromosomes.

Respiratory
Relating to breathing.

RNA (ribonucleic acid)
RNA is very similar to DNA in that it carries genetic information. It plays an important role in the creation of proteins.
**Scoliosis**
Sideways curvature of the spine.

**Skeletal muscle**
Consciously controlled muscle that attaches to bones allowing movement. Examples include the biceps, triceps, and thigh muscles.

**Spinal**
Relating to the spine.

**Spinal cord**
The bundle of nervous tissue within the spine. It includes nerve cells and extends out from the brain. The brain and spinal cord make up the central nervous system (CNS).

**Survival Motor Neuron 1 (SMN1)**
The gene that when mutated or deleted can lead to the development of SMA. For our lower motor neurons to survive and thrive we need a certain amount of the full-length SMN protein produced by the SMN1 gene.

**Survival Motor Neuron 2 (SMN2)**
The gene that can have an impact on the severity of SMA because it is able to produce a small amount of functional SMN protein. In people with a fault in the SMN1 gene, this can be important because the more copies of SMN2 that someone has, the more functional SMN protein they can produce. Individuals with more severe forms of SMA, for example Types 1 and 2, usually have fewer copies of the SMN2 gene than those with SMA Type 3.

**Survival Motor Neuron (SMN) gene**
A gene that produces the Survival Motor Neuron protein. Mutations in the SMN1 gene are the cause of some forms of SMA. There are two types of SMN genes - SMN1 and SMN2.

**Survival Motor Neuron (SMN) protein**
Produced from both the SMN1 and SMN2 genes, the SMN protein is required for the survival of lower motor neurons. If there is no SMN protein in a cell, the cell will die. Of all the different cell types, the lower motor neurons seem to be most affected by low levels of SMN protein.

**Symmetrical**
The same on both sides of a central point.

**Tissue**
A collection of cells that work together to perform a common function. For example, organs are formed from multiple tissues.

**Virus**
Viruses consist of genetic material (DNA or RNA) surrounded by a protective coat of protein. They are capable of latching onto cells and getting inside them. Some viruses (like...
the cold virus or flu virus) cause people to become ill. But, their ability to get inside cells also means that certain viruses can be used to deliver treatments into the cell.

References


