The National MPS Society, Inc.

Families Joining Together

Common bonds unite the lives of those affected by mucopolysaccharidoses (MPS) and mucolipidoses (ML) disorders – the need for support and the hope for a treatment.

The National MPS Society is committed to making a difference through support, research, education and advocacy. Families from around the world gain a better understanding of these rare genetically determined disorders through the Society's help in linking them with health care professionals, researchers, and perhaps most importantly, each other.

Individuals affected with MPS and ML and their families have a resource. One that stands ready to help — one resource that takes an active role in fostering the courage necessary to confront these disorders every day.

Join the National MPS Society and enjoy a variety of benefits, including:

- *Courage, our quarterly newsletter that shares stories and information about people with MPS or ML.*
- *News about various National MPS Society-sponsored conferences and gatherings, where families and leading MPS and ML scientists, physicians and researchers are brought together.*
- *Information on local events like regional picnics and fundraisers. Opportunities for families to meet each other and help raise community awareness of these rare genetic diseases.*
- *A listing in our annual directory of members, which assists families in locating each other.*

For more information or to join the National MPS Society, please visit:
www.mpssociety.org
or contact us by e-mail at
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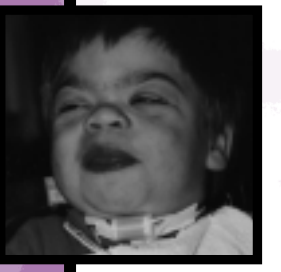
MPS

The National MPS Society, Inc.



Management of MPS and ML

Mucopolysaccharidosis (MPS)
Mucolipidoses (ML)

MPS

The National MPS Society, Inc.

Introduction

Management consists of supportive care and the treatment of complications. The progressive nature of organ involvement dictates the need for constant evaluation of clinical status. The goal of the systematic evaluation is to improve the quality of life for the MPS/ML patient and the family.

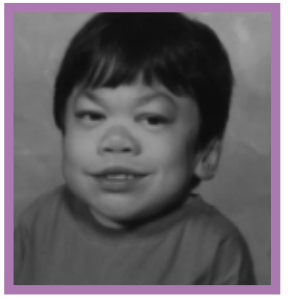
This booklet is organized based on a systems approach to clinical problems. No one physician or medical care provider is able to deal with all the medical problems that can occur in an individual with MPS/ML. Each system or subspecialty area will be presented as a section with a review of the clinical features, diagnostic procedures that are available and management/treatment options.

front cover
top: Carly, age 3, MPS IV A
middle: Daniel, age 5, MPS II
bottom: Anthony, age 9, MPS VII

Medical Overview

Central nervous system (Neurology)

The brain and the spinal cord are protected from injury by the cerebrospinal fluid that circulates around them. In individuals with MPS/ML, the circulation of the fluid over time may become blocked so that it cannot be taken back into the bloodstream. The blockage (communicating hydrocephalus) causes increased pressure inside the head, which can press on the brain and cause headaches and possible delayed development. Physical signs of hydrocephalus may include decreased consciousness, ataxia (unbalanced movements), headaches, vomiting, and "sunset eyes." Because the hydrocephalus that occurs in MPS/ML develops very slowly over months to years, the typical signs are not commonly seen or are assumed to be due to the progressive brain involvement that occurs in MPS/ML. The lack of papilledema (swelling around the optic disk) does not rule out hydrocephalus in individuals with MPS/ML.



Tetsuya, age 16, ML III

If hydrocephalus is suspected, an imaging study of the brain (CT or MRI scan) should be performed. A lumbar puncture with pressure measurement is another way to assess if hydrocephalus exists. If your doctor confirms that communicating hydrocephalus is present, it can be treated by the insertion of a thin tube (shunt), which drains fluid from the brain into the abdomen (ventriculoperitoneal or VP shunt). The shunt has a pressure sensitive valve, which allows spinal fluid to be drained into the abdomen when the pressure around the brain becomes too high.

Shunting of communicating hydrocephalus is believed to improve quality of life. It is suspected, but not proven that hydrocephalus may contribute to neurologic deterioration. Therefore, early detection and treatment of hydrocephalus should be considered.

A computed tomography (CT) or magnetic resonance imaging (MRI) scan should be performed routinely at diagnosis. Periodic CT or MRI scans to monitor for communicating hydrocephalus should be performed on all children with MPS or ML. The frequency of imaging studies depends on the degree of neurologic involvement of each child and the results of the previous scan. For management purposes, it is important to keep in mind that children with greater neurologic involvement have a higher risk for developing hydrocephalus. Progressive enlargement of the ventricles and/or elevated cerebral spinal fluid (CSF) pressure are two criteria for considering shunting in individuals with MPS/ML who are at risk for hydrocephalus.

Hydrocephalus with elevated CSF pressure commonly occurs in MPS I, MPS II, MPS VI and MPS VII and may be associated with some degree of cortical atrophy (loss of brain cells). Children with MPS III routinely develop enlarged ventricles, but elevated CSF pressure has never been documented. In MPS III, the enlarged ventricles are believed to be due to cortical atrophy and not elevated CSF pressure. However, Robertson et al, *European Journal of Pediatrics*, 157: 635, 1998, have reported that shunting in individuals with MPS III may decrease hyperactivity and aggressive behavior.

Seizures are a complication most common among patients with the severe forms of MPS. Seizures are common in Sanfilippo syndrome and may occur in up to one half of these individuals, typically in the late stages of the disorders. In MPS disorders, the seizures are most likely secondary to the progressive brain damage that occurs due to the stored material. There are many effective medications to treat seizures, and the specific medication prescribed depends on the type of seizure experienced. Evaluation by a neurologist is recommended to determine the best medication to use. An electroencephalogram (EEG) may be needed to confirm the diagnosis of a seizure disorder and aid your neurologist in selecting the best medication to control the seizures. In general, the seizures that occur in individuals with MPS are not difficult to control, but can be very alarming to parents.

Vision

There may be problems with vision caused by changes to the retina, due to glaucoma or due to corneal clouding. It is often difficult to determine which combination of problems is responsible for the decrease in eyesight. An ophthalmologist (eye doctor) can perform special studies to help determine whether the problem is due to an effect on how light enters the eye (the cornea) or on how the eye responds to light (the retina or optic nerve disease). An initial evaluation at the time of diagnosis and routine evaluations by a pediatric ophthalmologist are recommended for all individuals with MPS/ML.

Corneal clouding, glaucoma and retinal degeneration are common eye problems in MPS/ML. The cornea (circular window at the front of the eye) can become cloudy due to storage of glycosaminoglycans (GAG), previously called mucopolysaccharides, which disrupt the clear layers of the cornea. Individuals with corneal clouding may not tolerate bright lights (photophobia) due to uneven refraction of the light. Wearing caps with visors or sunglasses can help. If corneal clouding is severe, it usually will reduce sight, especially in dim light. Glaucoma (increased pressure in the globe of the eye) may also occur in MPS, especially MPS I, and is typically treated with medications. Glaucoma is another cause of photophobia in MPS.

Storage in the retina (the tissue in the back of the eye involved in vision) can result in degeneration of the retina. Retinal degeneration often leads to night blindness (difficulty seeing in lower light) and loss of peripheral vision. Night blindness can result in an individual not wanting to walk in a dark area at night or waking up at night and being afraid. The addition of a night light in a hall or bedroom may be beneficial.

For individuals with significantly reduced vision due to corneal clouding, cornea transplantation has been performed. Cornea transplantation is usually beneficial, but poor vision may persist because of underlying involvement of the retina or optic nerve. It is usually very difficult for the ophthalmologist to visualize the retina prior to surgery. If retinal degeneration and/or optic nerve atrophy is present, even with a clear cornea, decreased vision may persist. Recurrence of corneal clouding in the transplanted cornea has been reported in some individuals. The recurrence is believed to be due to GAG slowly diffusing into the cornea from the surrounding tissues.

Hearing

Hearing loss (deafness) is common in all types of MPS/ML disorders. The hearing loss may be conductive or sensorineural (nerve) deafness or both (mixed deafness) and may be made worse by frequent ear infections. Conductive hearing loss is an abnormality in the conduction of sound, involving the middle ear bones, while sensorineural hearing loss is a defect in the transmission of sound along the nerve.

Conductive Deafness

Correct functioning of the middle ear depends on the pressure behind the eardrum being the same as the pressure in the outer ear canal and in the atmosphere. This pressure is equalized by the Eustachian tube, which runs to the middle ear from the back of the throat. If the tube is blocked due to GAG deposits and/or inflammation, the pressure behind the eardrum will drop and the drum will be drawn in. If this negative pressure persists, fluid from lining of the middle ear may build up. The build up of fluid can result in the frequent otitis media (ear infections) as seen in MPS/ML. The continued presence of fluid (middle ear infections) after antibiotic treatment is common and in time can become thick like glue.

To remove the fluid, a small incision is made in the eardrum (myringotomy) and the fluid is sucked out. A small ventilation tube (standard or T-tube) is then inserted to keep the hole open and allow air to enter from the outer ear canal and fluid to drain out. In MPS/ML, the storage in the Eustachian tube may require long-term tube placement.

The standard ventilation tubes placed in the eardrum may quickly fall out. If this happens, the surgeon may decide to use T-tubes, which usually stay in place much longer. It is expected that once the ventilation tube is in place, fluid should drain, resulting in fewer ear infections and improved hearing. Most children with MPS/ML require a light, general anesthetic for myringotomy and tube placement.

Sensorineural (nerve) Deafness

In most cases, the cause of permanent nerve deafness is damage to the tiny hair cells in the inner ear. It may be accompanied by conductive deafness, in which case the hearing loss is referred to as mixed deafness. Nerve or conductive deafness can be managed by the fitting of a hearing aid or aids in most individuals. Hearing is traditionally tested with an audiogram. However, children with MPS/ML often have trouble cooperating with the hearing test, so an ABR (auditory brain stem response) can be done to assess hearing. For many individuals with MPS/ML, sedation or general anesthesia may be required to perform an ABR.

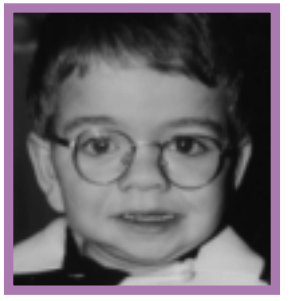
In general, it is felt that hearing aids are underutilized in MPS/ML disorders. It is important that individuals with MPS/ML have their hearing monitored regularly so problems can be treated early to maximize the child's ability to learn and communicate. The frequency of the hearing evaluations should be determined by an audiologist and/or ear, nose and throat (ENT) specialists.

Airway

A very common and severe problem for many individuals with MPS/ML is airway obstruction. Obstruction of the airway can be caused by narrowed or blocked nasal passages, a large tongue, enlarged adenoids and tonsils, abnormal trachea (wind pipe) and decreased rib movement with breathing.

The tonsils and adenoids often become enlarged and can partly block the airway. It is not uncommon for the adenoids to re-enlarge after having been once removed. The neck is usually short, which contributes to problems in breathing. The trachea becomes narrowed by storage material and is often more floppy or softer than usual due to abnormal cartilage rings in the trachea. Nodules or excess folding of airway tissue above the vocal cords can further block the airway. The normal relaxation of the airway muscles and decreased tone during sleep also is a significant contributing factor to airway narrowing. The combination of storage in the airway and normal narrowing during sleep explains why the airway obstruction in MPS/ML is initially a problem during sleep. As storage progresses, airway obstruction can occur at any time and is usually worse with upper respiratory illness.

The shape of the chest is frequently abnormal and the junction between the ribs and the breast-bone (sternum) is not as flexible as it should be. The chest is therefore rigid and cannot move freely to allow the lungs to take in a large volume of air. The muscle at the base of the chest (diaphragm) is pushed upward by the enlarged liver and spleen, further reducing the space for the lungs. When the lungs are not fully expanded, there is an increased risk of infections (pneumonia).



Sam, age 3, MPS I

Obstructive sleep apnea (temporary stopping of breathing during sleep) is the most common airway problem in MPS/ML. Obstructive sleep apnea is characterized by loud snoring, apnea, frequent awakenings or arousals, and fatigue during the day. Apnea may occur for short periods while asleep. Pauses in breathing of up to 10-15 seconds are considered normal. This noisy breathing which stops and starts can be very frightening for family or friends to hear. Parents may fear that their child is dying. The fatigue during the day is secondary to never achieving a deep sleep due to frequent awakening caused by decreased oxygen levels in the blood. Airway obstruction and valvular heart disease is a serious problem which can lead to heart failure with right-sided hypertrophy (increase in size) of the heart because the heart strains to provide enough oxygen in the blood by attempting to work harder.

If an individual with MPS/ML has significant snoring or episodes of interrupted breathing (apnea), he or she should be evaluated by a pulmonologist (lung specialist) using a polysomnogram (sleep study). Many individuals with MPS/ML may be very noisy breathers for years and not develop significant airway obstruction. A sleep study is a non-invasive way to assess the airway status.

A sleep study is performed by spending a night in a special room at the hospital. Monitors are placed on the skin and connected to a computer to measure the levels of oxygen in the blood, heart rate, breathing rate and effort, airflow through the nose and brain waves during sleep. From this study, the doctors can assess how much blockage to breathing is present, how much trouble the person is having moving air into the lungs during sleep, and how much effect this has on his or her body. Flexible bronchoscopy can be used to directly visualize the airway to better determine the problem areas causing narrowing and/or obstruction. Routine pulmonary function testing and sleep studies are recommended in individuals with mild MPS/ML to assess airway problems. Individuals with MPS/ML who have airway disease are at increased risk for problems associated with anesthesia (See separate booklet titled, "Is Your Child Having an Anesthetic?").

Sleep apnea can be improved in some individuals by removing the tonsils and adenoids, opening the airway with nighttime CPAP (continuous positive airway pressure) or BiPAP (bilevel positive airway pressure) treatment or tracheostomy. Removal of tonsils and adenoids will help in some cases to lessen the obstruction and make breathing easier, but adenoid tissue may grow back. Nighttime CPAP or BiPAP are methods to open the airway using air pressure, which can help the airway stay open. This treatment involves placing a mask on the face each night and having air pumped into the airway to keep it from collapsing. This may seem to be an extreme measure, but many people are able to accept it. CPAP or BiPAP can greatly improve the quality of sleep, as well as help prevent or reduce heart failure caused by low oxygen levels at night.

In severe cases of sleep apnea, in particular with heart failure, a tracheostomy (a permanent opening is made in the trachea in the front of the neck) may be needed. Most families will try to avoid a tracheostomy because it is invasive and seemingly disruptive of normal daily activities. In fact, many feel that individuals with MPS/ML should receive a tracheostomy earlier than they do. Individuals with a tracheostomy have improved nighttime breathing and decreased episodes of sleep apnea.

Heart

The progressive storage of GAG in individuals with MPS/ML can result in abnormal heart valves, narrowing of the coronary arteries and weakening of the heart muscle (cardiomyopathy). The aortic and mitral valves are affected in many individuals with MPS/ML. The heart valves are designed to open and close in combination to allow blood to be pumped in one direction and to prevent blood from flowing back in the opposite direction. The damaged valves in individuals with MPS/ML may not open fully (resulting in stenosis) or are unable to close tightly (resulting in regurgitation). Both conditions cause the heart to pump harder and increase the risk of heart failure. Individuals with MPS/ML may have slowly progressive valvular heart disease for years without any apparent clinical effects. Coronary artery disease due to narrowing of the blood vessels in the heart can lead to heart attacks and death. Cardiomyopathy (weak heart muscle) and endocardiofibroelastosis (stiff heart) are conditions that can occur in children with Hurler syndrome and other severe types of MPS/ML.

Your doctor may hear heart murmurs (sounds caused by turbulence in blood flow in the heart) if the valves become damaged by stored GAG. If a valve is damaged, it may not open fully and/or shut firmly, leading to abnormal flow, turbulence and a murmur. Most individuals with MPS/ML have some degree of murmur or leakage due to abnormal heart valves.

As heart problems occur so frequently in MPS/ML, all such individuals should be seen on a regular basis by a cardiologist. All individuals with MPS/ML should have an electrocardiogram (EKG) and an echocardiogram (ECHO), as often as your cardiologist thinks necessary, to show whether any heart problems are beginning. The echocardiogram is painless and similar to the ultrasound screening of babies in the womb. It can identify problems with the heart muscle, heart function, and heart valves, but like many tests, it cannot detect all possible problems, such as coronary artery disease.

In people who are severely affected, the muscle of the heart may be damaged by storage of glycosaminoglycans resulting in cardiomyopathy, and the heart also may be put under strain by having to pump blood through abnormal lungs causing corpulmonale or right heart failure. A number of affected individuals have high blood pressure, which is probably due to blockage of blood vessels. Obstructive airway disease and associated upper respiratory infections can lead to pulmonary hypertension and eventually cause cardiac failure. Management of airway disease can help prevent further stress on the heart.

Medications are available to help manage the congestive heart failure and hypertension that can occur in MPS/ML. If the heart failure is due to valvular disease, an operation may be possible to replace the damaged valves. Heart valve replacement has been performed on many individuals with milder forms of MPS, such as Hurler-Scheie, Scheie, mild Hunter and Maroteaux-Lamy syndromes.

Carpal Tunnel Syndrome

Carpal tunnel syndrome is caused by compression of the median nerve in the wrist due to accumulation of glycosaminoglycans in the nerve canal. The wrist or carpus consists of eight small bones known as the carpals, which are joined by a band of fibrous proteins called ligament. Nerves have to pass through the wrists in the space between the carpal bones and the ligaments. Thickening of the ligaments causes pressure on the nerves, and this can cause irreversible nerve damage.

Physical signs of carpal tunnel syndrome are numbness, tingling, pain, clumsiness and weakness of the hand. The nerve damage may cause the muscle at the base of the thumb to waste away and will make it more difficult for a child to oppose his thumb in a position for a normal grasp. Loss of function of the thumb is a significant sign of carpal tunnel syndrome. Although many individuals with MPS/ML may not complain of pain, the carpal tunnel syndrome may be severe.

Children with MPS/ML should be monitored for carpal tunnel syndrome with nerve conduction studies on a regular basis. Detection and treatment of the problem is most effective prior to severe nerve damage. Be persistent, as many physicians may not believe that carpal tunnel syndrome is present without the classic symptoms. Most individuals affected by MPS/ML do not have the classic symptoms of carpal tunnel syndrome even with severe nerve entrapment and damage. Similar types of nerve compression can happen elsewhere in the body and cause localized weakness or pain.

Carpal tunnel syndrome can be treated with splinting, anti-inflammatory medications and surgery to decompress the nerve. A study by Haddad et.al. (1997) found that the majority of children with MPS/ML who have carpal tunnel syndrome did not complain of symptoms. None of the cases in the study worsened after surgical decompression of the nerve. Better neurophysiological recovery was seen in children with mild cases of carpal tunnel syndrome. Therefore, detection and treatment in the early stages of nerve compression, before severe nerve damage occurs, allows for the best outcome.

Bowel Problems

Many children with MPS/ML suffer periodically from loose stools and diarrhea. The cause of this is not fully understood. Occasionally the problem is caused by severe constipation and leakage of loose stools from behind a solid mass of feces. More often, however, parents describe it as coming straight through. It is thought that there may be a defect in the autonomic nervous system, which controls those bodily functions usually beyond voluntary control. Studies have found storage in the nerve cells in the intestine and it seems likely that abnormal motility in the bowel is the cause of the diarrhea.

An examination by your pediatrician, supplemented by an X-ray if necessary, may establish the cause of the diarrhea. The problem may disappear as the child gets older, but it can be made worse by antibiotics prescribed for other problems. The episodic diarrhea in some individuals with MPS/ML appears to be affected by the diet, and elimination of some foods can be helpful.

If antibiotics have caused the diarrhea, a feeding of plain live-culture yogurt is often helpful during episodes of diarrhea. This provides a source of lactobacillus to help prevent the growth within the bowel wall of organisms that can cause diarrhea or make it worse. A diet low in roughage also may be helpful.

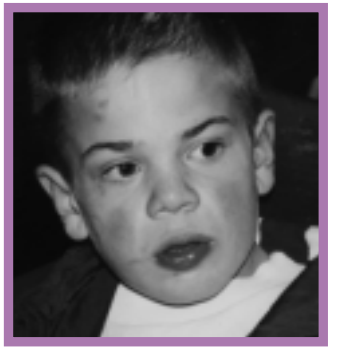
Constipation may become a problem as the child gets older and less active and as the abdominal muscles weaken. If an increase in roughage in the diet does not help or is not possible, the doctor may prescribe laxatives or a disposable enema, which is easy to use.

Liver and Kidney

Although the liver can be very enlarged and occasionally affect the ability to breathe, problems associated with significant abnormal function of the liver have not been reported in individuals with MPS/ML. Individuals with MPS usually have elevated GAG in their urine, but significant kidney problems also have not been reported.

Hernia

In many individuals with MPS/ML, the abdomen bulges out due to poor posture, weakness of the muscles and the enlarged liver and spleen. Frequently part of the abdominal contents will push out behind a weak spot in the wall of the abdomen. This is called a hernia. The hernia can come from behind the navel (umbilical hernia) or in the groin (inguinal hernia). Inguinal hernias commonly occur before the individual has been diagnosed with MPS/ML. Inguinal hernias should be repaired because of the high risk of entrapment and subsequent damage to the bowel in the area of herniation. Umbilical hernias usually occur later than inguinal hernias and are not usually repaired unless they are causing problems. It is very common for an umbilical hernia to recur even with the best surgeon. The abnormal connective tissue secondary to GAG storage is believed to be the cause of the very high recurrence rates after attempted repair.



Ryan, age 9, MPS III A

Dental Issues

The teeth can be widely spaced and poorly formed with fragile enamel. Delayed eruption of the permanent teeth is common. It is important that the teeth are well cared for because tooth decay is more likely to occur and may be the cause of unexplained pain. Teeth should be cleaned regularly, and if the water in your area has not been treated with fluoride, the child should have daily fluoride tablets or drops.

Cleaning inside the mouth with a small sponge on a stick soaked in mouthwash will help keep the mouth fresh and avoid bad breath. Even with the best of dental care, an abscess around a tooth can develop due to abnormal formation and/or a microfracture of the tooth. Irritability, crying and restlessness can sometimes be the only sign of an infected tooth in a severely involved individual.

If an individual with MPS/ML has a heart problem, he or she should be given antibiotics before and after any dental treatment. This is because certain bacteria in the mouth may get into the bloodstream and cause an infection on an abnormal heart valve, potentially damaging it further. If teeth need to be removed under an anesthetic, this should be done in the hospital under the care of an experienced anesthesiologist and dentist and never in the dentist's office.

Skeletal System (Orthopedics)

Most individuals with MPS/ML tend to have problems with bone formation (dysostosis multiplex) and growth. This leads to bone and joint problems as well as neurological problems if nerves get compressed by bone or deposits of glycosaminoglycans.

Neck

The bones that stabilize the connection between head and neck can be malformed (odontoid dysplasia) in people with MPS/ML, making the neck unstable. If severe pain or pain associated with weakness or tremors in the arms or legs occurs, studies of the neck (MRI and flexion-extension X-rays) should be performed to evaluate for slippage (subluxation) of the neck vertebrae. Cervical fusion surgery is usually required to connect the bones to each other so they do not slip anymore.

Problems in the cervical spine are perhaps the most serious facing patients with Morquio syndrome. The neck problems need to be discussed at the time of diagnosis because serious problems can occur before 5 to 6 years of age. With odontioid dysplasis the neck can become unstable, which places the spinal cord at risk for life-threatening injury. The spinal cord is a large bundle of nerves that carries messages between the brain and the rest of the body. If the cord is compressed or squeezed (cervical myelopathy) and treatment is not initiated, there may be gradual worsening nerve damage on the individual with paralysis or death. Children with Morquio syndrome should be referred to an orthopedic surgeon at an early age and a close watch should be kept on the condition of the cervical spine. MRI studies or X-rays should be preformed with the head bent forward and with the neck straight (flexion and extension view) and repeated as the years pass to monitor the situation. A baseline study of the neck is recommended at the time of diagnosis.

Spine

The bones of the spine (vertebrae) normally line up from the neck to the buttocks. Individuals with MPS/ML often have poorly formed vertebrae that may not stably rest on top of each other. One or two of the vertebrae in the middle of the back are sometimes abnormally shaped or slightly smaller than the rest. Backward slippage of the vertebrae can cause an angular curve (kyphosis or gibbus) to develop, but it usually does not need treatment. Bracing is sometimes used for management of kyphosis (front to back curvature of the spine) and scoliosis (side to side curvature of the spine).

Severe curvature of the spine, kyphosis or scoliosis, may require surgical intervention. In general, fusion with bone is the best alternative, and hardware, like rods, are not tolerated well. In any case, the soft bones make the surgery and recovery difficult. Many patients end up needing multiple procedures. An orthopedic surgeon who has previous experience with individuals with MPS/ML may need to be consulted to obtain the best outcome.

Hip

Some individuals with MPS/ML, especially MPS III, have been recognized to have significant abnormalities of the hip joint (hip dysplasia) resulting in increased pain and decreased ability to walk normally. Abnormal formation of the hip joint may result in an increased risk of injury to the hip. Treatment with non-steroidal anti-inflammatory medications has been beneficial for some individuals.

Miscellaneous Issues

Physical Therapy

Joint stiffness is common in all forms of MPS/ML, and the maximum range of motion of all joints may become limited, which can cause significant loss of function. Range-of-motion exercises (passive stretching and bending of the limbs) may offer some benefits in preserving joint function and should be started early in the clinical course. Exercises that cause pain should be avoided. Once significant limitation has occurred, increased range of motion may not be achieved, although further limitation may be minimized. It is common sense for individuals to be as active as possible to maintain their joint function and improve their general health. The physical therapist may be able to suggest ways of achieving this through a combination of daily activities and passive range-of-motion exercises.

Later in the individual's life the joint stiffness may cause pain, but this may be relieved by warmth and ordinary pain medication. The limited movement in the shoulders and arms may make dressing difficult. Stiff hips and knees with tight heel cords can make walking more difficult. Anti-inflammatory drugs such as ibuprofen can help with joint pain, but their use should be monitored closely to make sure that irritation and ulcers in the stomach do not occur.

Anesthetics

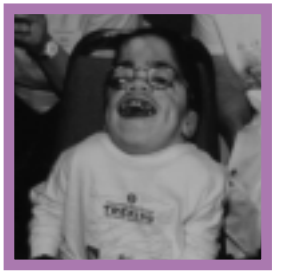
Giving a general anesthetic to an individual with MPS/ML is a skilled task, which should always be undertaken by an experienced anesthesiologist. You should inform your child's school or any other caregivers of this in case you cannot be contacted. If you have to go to a different hospital in an emergency, you should tell the anesthesiologist that there might be problems with intubation (placement of the breathing tube). The airway can be very small and may require a very small endotracheal tube. Placing the tube may be difficult and require the use of a flexible bronchoscope to place it gently. In addition, the neck may be somewhat lax, and repositioning the neck during anesthesia or intubation could cause injury to the spinal cord. For some individuals, it is as difficult to remove the breathing tube after the surgery is completed as it was to place it initially. Please advise the physicians of the critical nature of these problems and that many problems, including death, have occurred during anesthesia of individuals with MPS/ML. For any elective surgery in a child with MPS/ML, it is important to pick a pediatric anesthesiologist who has experience with difficult airways. This may require that the surgery be performed not at a local hospital, but at a regional medical center. See separate booklet titled, "Is Your Child Having an Anesthetic?"

Diet

There is no scientific evidence that a particular diet has any helpful effect on people with MPS/ML, and symptoms such as diarrhea tend to come and go naturally. Some parents, however, find that a change in their child's diet can ease problems such as excessive mucous, diarrhea or hyperactivity. Reducing the intake of milk, dairy products and sugar, as well as avoiding foods with too many additives and coloring have all been said to help some individuals. It would be advisable to consult your doctor or a dietician if you plan major changes to make sure that the proposed diet does not leave out any essential items. If your child's problems are eased, you could try reintroducing foods one at a time to test whether any particular food appears to increase the child's symptoms.

It is important to note that no diet or dietary supplements can prevent the storage of glycosaminoglycans because glycosaminoglycans are actually created by the body. Reducing sugar intake or other dietary components cannot reduce the storage material.

Some individuals with MPS/ML have severe neurological problems in the late stages of their disease, resulting in increasing problems with feeding. As chewing and swallowing become more of a problem, the time required by the caregiver for feeding can become very prolonged. Placement of a gastrostomy tube (G-tube) may be needed to allow adequate nutrition to prevent weight loss and to improve the quality of life for the individual with MPS/ML and caregivers. Any individual being considered for G-tube placement should be evaluated for gastroesophageal reflux (GERD) because G-tube placement may worsen existing GERD.

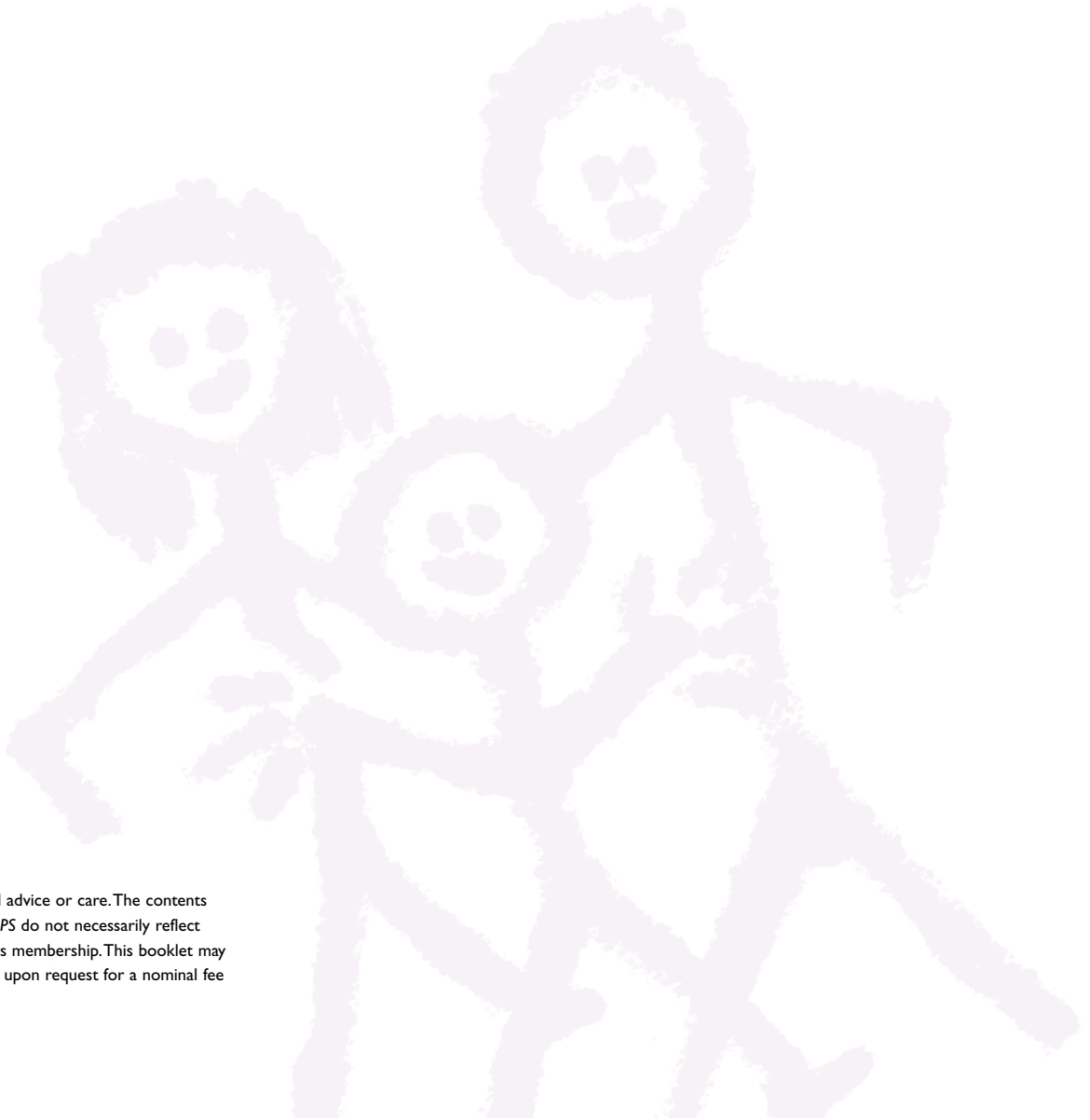


Kristofer, age 18, MPS VI

Hyperactivity

Hyperactivity is a common and sometimes very severe problem in individuals with MPS, especially MPS III. Many children with MPS II and MPS III go through a hyperactive stage when they are into everything, difficult to control, and unaware of danger. In general, the hyperactivity reaches a peak at the time of maximum development and then decreases slowly as the child with MPS starts to regress. It is better to adapt the house to the child because it is difficult to modify the hyperactivity with medication. A yard where the child can run about safely is a great asset. Consistency in behavior modification programs by all caregivers can be helpful for some hyperactive children with MPS .

It can be helpful if the child can join a play group, attend school or an after-school program where a variety of activities occupy the child. Ideally there should be space for the child to run about and use up energy. This also allows the child to keep fit for as long as possible. Many children are calmed by the movement of a car and will travel well. Some children with MPS have difficulty with loud and busy environments. Some parents find it very helpful if they can set aside a room or part of a room in the house especially for their child with MPS.



The National MPS Society, Inc.