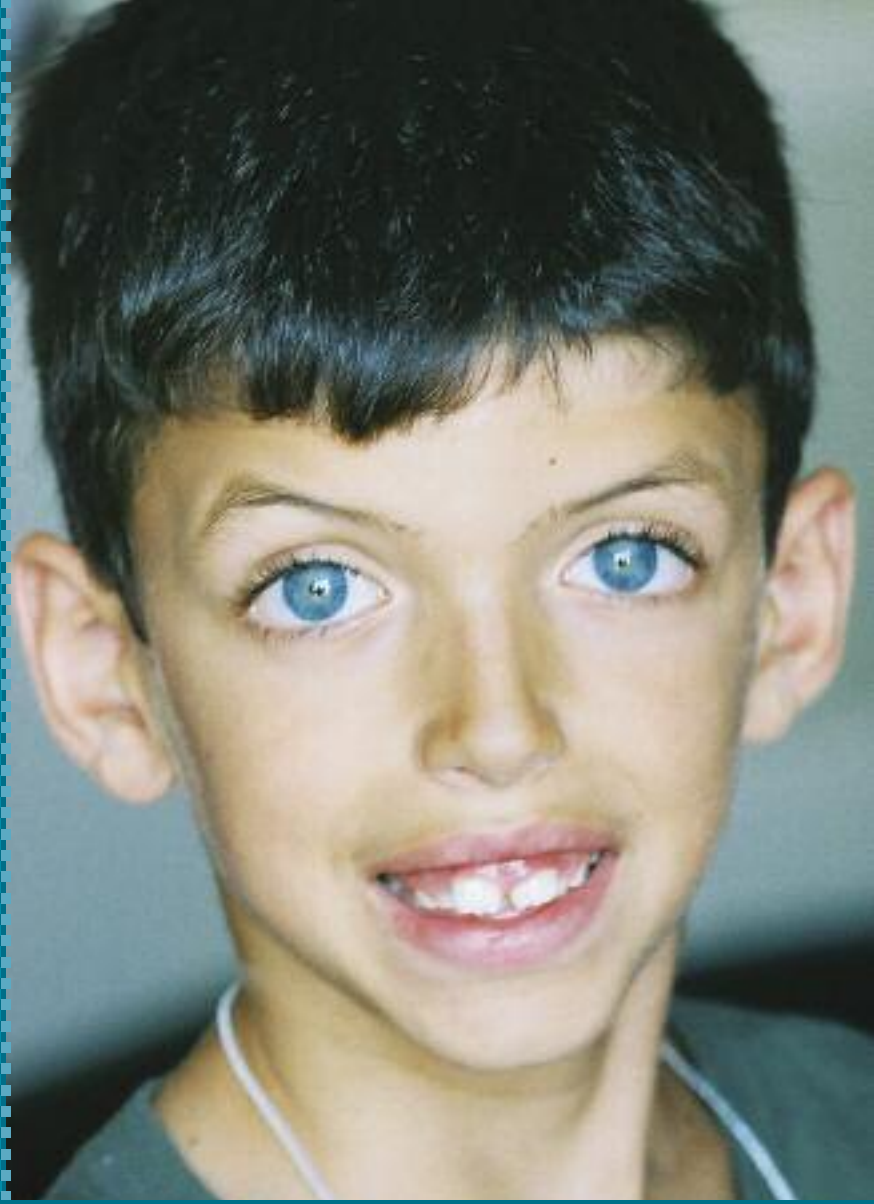

A Guide to Marfan Syndrome and Related Disorders

by The Marfan Foundation

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THE MARFAN FOUNDATION

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"Do not see yourself as a Marfan patient, but as a person with Marfan syndrome. Don't just survive. Thrive!"

– Maryann Roney, R.N.

In loving memory of Cheryll Gasner

Acknowledgments

This book has evolved from an earlier one, *The Marfan Syndrome*, by Reed E. Pyeritz, MD, PhD, and Cheryl Gasner, MN, C/FNP, which itself was derived from the original co-authored by Julia Conant, MD. We thank all of them for their invaluable contributions through the years. We are also grateful to all the esteemed physicians and researchers of our Professional Advisory Board who have contributed to various improvements to each successive edition of this resource.

The photographs in this book appear courtesy of Rick Guidotti of Positive Exposure (positiveexposure.org) and Timothy Joyce. We thank them for contributing their skills and talents to help illustrate the features and faces of Marfan syndrome.

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"Tall Paul" has what is frequently considered a classic Marfan body type. But it is important to note that not everyone with Marfan syndrome is extremely tall and thin.

INTRODUCTION

In 1896, a French pediatrician named Antoine Bernard-Jean Marfan described a 5-year-old girl whose arms, legs, fingers and toes were disproportionately long and thin, whose muscle development was poor, and whose spine curved abnormally. In the early to mid twentieth century, physicians described people with similar skeletal features as well as problems affecting the heart and blood vessels, eyes, lungs, central nervous system, skin and teeth. Today, when seen enough in combination, these features have come to be known as Marfan syndrome. There are also a number of related disorders that have many of the same features.

Because it affects so many parts of the body, Marfan syndrome is very complicated. It is difficult to diagnose and calls for treatment by many different medical specialists. It also affects people differently—some have all of its features, while others have only a few. Some people experience severe problems and other people feel its effects only lightly. However, because it is potentially life-threatening, it should never be taken lightly, now matter how mild the symptoms.

This book was created to help readers understand the basics of Marfan syndrome diagnosis and treatment, as well to provide guidance on the lifestyle and practical issues commonly encountered by people with Marfan syndrome or a related disorder. Perhaps you have recently been diagnosed with Marfan syndrome—*what should you expect?* Or your child's pediatrician has suggested he or she be evaluated for Marfan syndrome—*what does that entail?* Or maybe your new spouse has Marfan syndrome and you want to have children—*what are the risks and can you do anything to minimize them?* This book aims to address these and many other questions.

Of course there are countless other questions that cannot be

addressed in a 96-page book, or which can only be answered by an individual's physicans. Readers are encouraged to be assertive in seeking help and information from their own doctors and to take advantage of all of the resources, most of them free, offered by The Marfan Foundation. Our network of local volunteer groups, telephone and email helpline, clinic directory and other resources provide information and support for people affected by Marfan syndrome and related disorders throughout the U.S.

800-8-MARFAN
800-862-7326
support@marfan.org
www.marfan.org

Use the contact information shown at left to obtain the resources mentioned on the following pages.

Visit www.marfan.org to find out how we can help.

PART I
MARFAN 101

1. WHAT IS MARFAN SYNDROME?

Marfan syndrome is a genetic disorder of the connective tissue. Connective tissue is the glue and the scaffolding of the body, but is important in many more functions as well, such as development before birth and growth after birth. All organs contain connective tissue, and the manifestations of Marfan syndrome appear in many parts of the body, especially in the bones and ligaments (the skeletal system), the heart and blood vessels (the cardiovascular system), the eyes (the ocular system), the lungs (the pulmonary system), and the fibrous membrane covering the brain and spinal cord (the nervous system).

There are hundreds of genetic disorders of connective tissue, including a few which closely resemble Marfan syndrome. They are termed "genetic" because all have their basis in a change (mutation) in one gene or another and, because relatives have genes in common, these conditions may affect more than one person in a family. Not all are inherited in the same pattern as Marfan syndrome.

The term "syndrome" refers to the fact that a group of physical signs or changes occur together often enough for a pattern to be recognized. This pattern is essential in understanding the cause of this syndrome, in predicting the medical course of affected individuals and in devising forms of treatment.

About 1 in 5,000 people have Marfan syndrome. This includes men and women of all races and ethnic groups.

2. WHAT CAUSES MARFAN SYNDROME?

Marfan syndrome is caused by a variation (mutation) in the gene that tells the body how to make fibrillin-1—a protein that is an important part of connective tissue.

This variation results in an increase in a protein called transforming growth factor beta, or TGF-ß. The increase of TGF-ß causes problems in tissue throughout the body, which create the features associated with Marfan syndrome and cause medical problems for people who have it.

People can inherit Marfan syndrome, meaning that they get the mutation from a parent who has the disorder. This is the case in about three out of four people with Marfan syndrome. Other people have a spontaneous mutation, meaning that they are the first person in their family to have Marfan syndrome. People with Marfan syndrome have a 50% chance of passing the mutation on each time they have a child.

People are born with Marfan syndrome but may not notice any features until later in life. Marfan syndrome features can appear at any age, including in infants and young children. They often get worse as people age.

3. WHAT IS THE PROGNOSIS FOR PEOPLE WITH MARFAN SYNDROME?

There is no cure for Marfan syndrome, but with early diagnosis, proper treatment and careful management of the disorder, it is possible for people to live a normal life span. The outlook today for people with Marfan syndrome is far brighter than it was a few decades ago. In the days before open-heart surgery, the average life expectancy was reduced by a third. Now, early diagnosis and careful management have greatly improved the prognosis and increased life expectancy. Medical and surgical treatments continue to improve and offer hope to even the most severely affected infants, children and adults. In addition, proper management can relieve or prevent many of the complications that interfere with daily activities.

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PART II
DIAGNOSIS

1. HOW IS MARFAN SYNDROME DIAGNOSED?

Although scientists have determined that Marfan syndrome is caused by a variation in the fibrillin-1 gene on chromosome 15, there is no simple test that can conclusively diagnose Marfan syndrome. Therefore, diagnosis is made primarily through a clinical evaluation. Genetic testing may be helpful in some situations (see page 22).

Because most features of Marfan syndrome progress with age, the diagnosis is often more obvious in teens or adults. But children, even newborns, can and should be examined. For these reasons, the diagnostic evaluation should be performed by physicians experienced with the condition. The evaluation should include:

- A detailed medical and family history.
- A complete physical examination.
- A thorough eye examination by an eye specialist (ophthalmologist) using a slit lamp to look for lens dislocation after fully dilating the pupil.
- An electrocardiogram (EKG) and an echocardiogram to look for involvement of the cardiovascular system that may be not evident from the physical examination.

Other imaging tests, such as a computerized tomography (CT) scan or magnetic resonance (MRI) of the lower back, may help identify dural ectasia, a back problem that is very common in people who have Marfan syndrome.

2. IF YOU SUSPECT MARFAN SYNDROME

If you suspect that you or a family member may have Marfan syndrome, find a doctor who is knowledgeable about the condition. Ideally, the diagnostic process should be coordinated by a medical geneticist (a doctor who specializes in genetic conditions such as Marfan syndrome). A second choice is a cardiologist (heart doctor). Make sure the cardiologist has treated people who have Marfan syndrome. You can find a doctor by:

- Asking your primary doctor for a referral
- Calling the doctor referral service at your local hospital
- Calling your insurance provider
- Calling our help center at 800-8MARFAN

You should also compile a health history for you and your family, recording:

- Past illnesses, operations, and hospitalizations
- Medications
- Reasons you think you or your family member might have Marfan syndrome
- Family members who have, or might have, Marfan syndrome
- Family members who died of a heart or vascular problem; it is also important to understand the nature or cause of the problem

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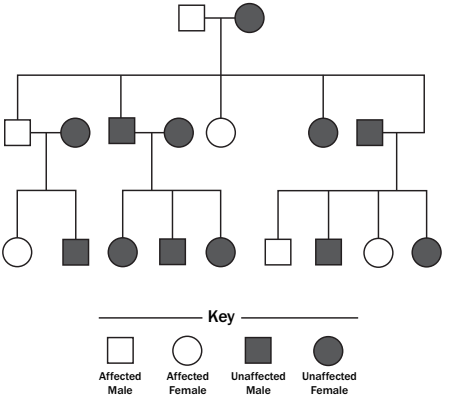
Visit the our website to download the Family Health History Kit

The Role of Heredity

We each have two copies of most genes in each of our cells but when we have children we transmit only one copy. For disorders in which a mutation or change in one copy of a gene is sufficient to produce a clinical condition, the resulting disorder is referred to as a dominant disorder. Marfan syndrome is a dominant disorder in which one copy of the *FBN1* gene has a mutation that affects the function of the protein, fibrillin-1, produced under the direction of the gene. In the situation in which one parent has the disorder, the altered copy of the gene can be inherited from an affected parent. Each child of an affected individual has a 50% chance to inherit the mutated copy and develop Marfan syndrome. If they inherit the normal copy from their affected parent, then they are not at risk to develop Marfan syndrome and, equally important, cannot pass that altered copy to their own children. About 25–30% of people with Marfan syndrome do not have an affected parent, which means that the mutation arose in the course of making either the egg or the sperm from which that person developed. This is because during the course of copying the genes every time a cell divides, errors (mutations) can occur.

The range of severity of the condition can vary greatly among affected relatives. This is called variable expression. Most people who have the Marfan gene will show some physical features, even if they are very mildly affected. Therefore it is very important for relatives of a person with Marfan syndrome to have a careful evaluation.

Genetic pedigree of a family with Marfan syndrome



3. HOW DIFFERENT BODY SYSTEMS ARE AFFECTED

Marfan syndrome features occur in many different parts of the body. A person rarely has every feature. Some of these features are clearly visible, while others, such as heart problems, need special tests to find them. It is important that a person with Marfan features see a doctor who knows about Marfan syndrome.

A. Bones and Joints (Skeletal System)

Bones and joints are affected in many different ways. A person with Marfan syndrome will usually but not always be tall, slender and somewhat loose jointed or limber. The arms, legs, fingers and toes may be disproportionately long when compared with the trunk. Limberness in the feet and ankles may produce a flat arch (pes planus), inward rotation (pronation), or both.

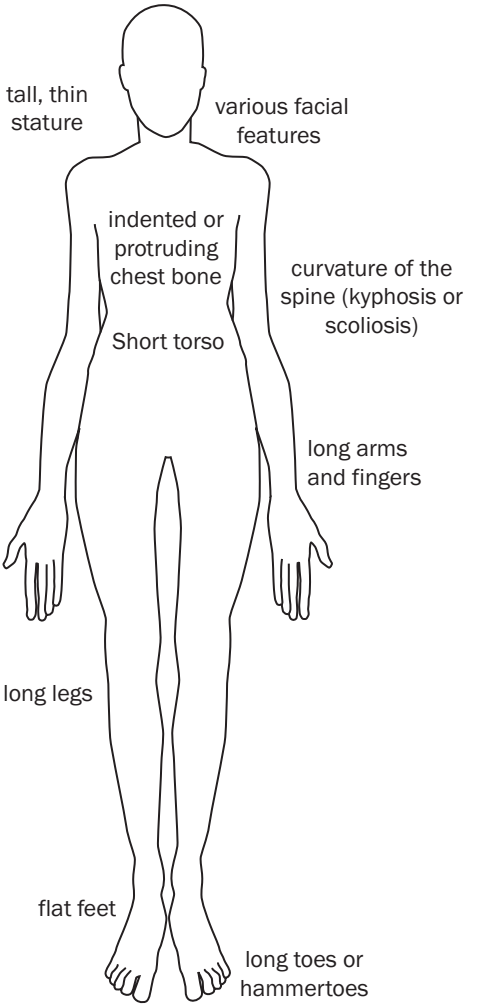
Abnormal spinal curvature is common and may become quite severe without treatment. Any side-to-side curvature greater than a few degrees is abnormal and is called scoliosis. When viewed from the side, the spine ordinarily curves in a double-S shape. People with Marfan syndrome may have accentuation or reversal of one or more of these curves; straightening or bowing inwards of the upper back (thoracic lordosis) is one such alteration. Many people also have a "hunched" back (kyphosis).

The breastbone (sternum) may either protrude (commonly called a pigeon breast; the medical term is pectus carinatum) or indent (funnel chest or pectus excavatum) due to overgrowth of the ribs.

The roof of the mouth (palate) is often highly and narrowly arched and the teeth are crowded. The lower jaw (mandible) often recedes, which may accentuate a common overbite (malocclusion). The face may appear long and narrow, in keeping

with the general body shape. Infants often have deeply set eyes and appear older than their unaffected brothers or sisters at the same age.

Figure 1. Common Skeletal Features in Marfan Syndrome



Note: Not all people with Marfan syndrome have the "typical" body type.

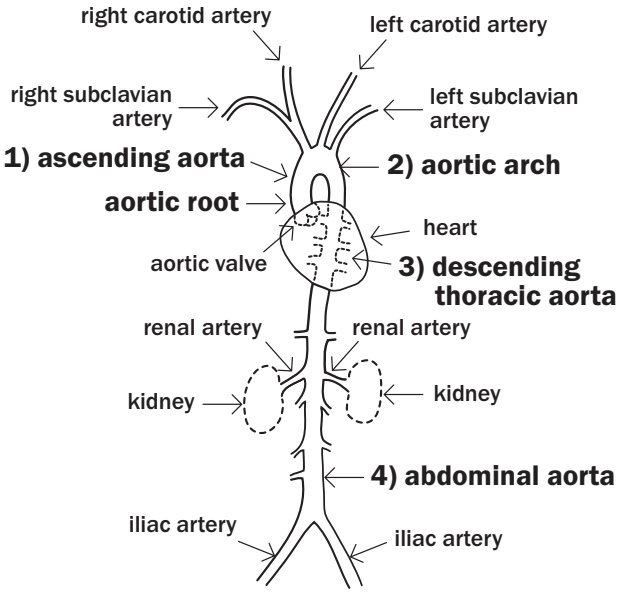
B. Heart and Blood Vessels (Cardiovascular System)

Problems with the heart and blood vessels are common in people with Marfan syndrome. In fact, nine out of ten people with Marfan syndrome experience such problems. The most serious problem is enlargement of the aorta (the main blood vessel that carries blood away from the heart). Heart valves can also be affected. Less often, people have problems in blood vessels other than the aorta.

The diagram below shows the main sections of the heart and aorta. As you can see, the aorta has four segments:

1) aortic root and ascending aorta
2) aortic arch
3) descending thoracic aorta
4) abdominal aorta.

Figure 2. Diagram of Aorta



Following are some common types of heart and blood vessel problems in people with Marfan syndrome:

i. Aortic Dilation and Aortic Aneurysms

Aortic dilation and aortic aneurysms are very serious problems because a significantly enlarged aorta is at risk for dissection (tear) or rupture. Aortic dilation (enlarged aorta) and aortic aneurysms (bulging sides of the aorta) can occur along any segment of the aorta. For most people with Marfan syndrome, the problem starts in the aortic root (aortic segment closest to the heart.) Doctors use a person's age, height, and weight to determine whether the aorta is enlarged.

Doctors use the term Z-score to describe the size of an aorta. The Z-score is a number that determines how far a measurement is from normal. In Marfan syndrome, this is in reference to the size of the aorta. It is used because measurements change dramatically from childhood to adulthood, so the measurement alone is not informative unless relative to age and size (body mass). Both the aortic measurement and Z-score are important, though for children, the Z-score may be emphasized because the aorta is still growing, whereas in adults, a greater emphasis is placed on the aortic size. Therefore, people with Marfan syndrome should talk with their doctors about what size aorta is within normal limits for them.

ii. Aortic Dissection

Aortic dissection is a tear between layers of the aorta. Blood begins to flow between the layers and can lead to an aneurysm or rupture. Most people know when this happens because of severe pain in the center of their chest, stomach (abdomen), or back.

There are two types of aortic dissection:

- *Dissection of the Ascending Aorta*
  The most common dissection in Marfan syndrome, a dissection of the ascending aorta is life-threatening.

If this kind of dissection happens, people need immediate surgery. Most ascending dissections in Marfan syndrome also descend into the descending and abdominal aorta.

- *Dissection of the Descending Aorta*
  Dissection of the descending aorta can often be managed with medication and monitoring. People only need surgery if they have serious complications, such as loss of blood flow to vital organs or an aorta that is severely dilated.

iii. Mitral Valve Prolapse

This is a "billowing" (motion) of the mitral valve when the heart contracts. Symptoms can include irregular or rapid heartbeats and shortness of breath. Some people also experience leaking of the mitral valve (mitral valve regurgitation). A small amount of leaking is often not a problem, but a person may need surgery if the mitral valve leaks a lot. Sometimes, mitral valve prolapse can cause a heart murmur, an abnormal sound that can be heard through a stethescope.

Mitral valve prolapse is present in 5% of the general population; having mitral valve prolapse does not mean a person has Marfan syndrome.

iv. Aortic Regurgitation

Aortic regurgitation is when the aortic valve does not fully close and blood leaks back into the heart. The only symptoms a person may have are forceful heartbeats and shortness of breath during light activity. Aortic regurgitation often happens because of aortic dilation (when the aorta is so enlarged that the valves cannot fully come together). Aortic regurgitation can also cause a heart murmur.

C. Eyes (Ocular System)

Marfan syndrome can affect the eyes in many ways. For this reason, people with Marfan syndrome should see an ophthalmologist (a medical doctor who takes care of the eyes) to find out if they have any eye problems and to care for their eyes. Some features of the Marfan eye that can cause vision problems include:

i. Dislocated lenses

About 60% of people with Marfan syndrome have dislocated lenses in one or both eyes. This means the lens, located at the front of the eye, has slipped out of place because the tissue that holds the lense in place becomes weakened. The lens can slip in any direction—up, down, to the side or back. It can slip a little or completely out of place, and anywhere in between. Because the lens is out of place, dislocated lenses cause problems with seeing clearly. Babies and children can have dislocated lenses. For most people, dislocated lenses occur before age 20, although lenses can dislocate at any age. Dislocated lenses are rare in the general population, so people with dislocated lenses should be tested for Marfan syndrome if there is not another known cause.

Dislocated lenses occur rarely in the general population, but frequently among people with Marfan syndrome, including babies and young children.

ii. Severe Myopia

Nearsightedness (when objects in the distance are blurred).

iii. Astigmatism

Blurred vision caused by an irregular curve of either the lens or the cornea. The cornea is the layer of tissue covering of the very front of the eye.

iv. Amblyopia

When one eye does not develop normal vision during early childhood (sometimes called "lazy eye").

v. Strabismus

When the eyes point in different directions. Sometimes the eyes turn inward resulting in "crossed eyes," but the eyes can also turn outward or downward.

vi. Retinal Detachment

When the layers at the back of the eye pull away. A person with a retinal detachment needs to see an eye doctor right away. See the section on eye emergencies on page 49.

vii. Glaucoma

A disease of the eye caused by increased pressure inside the eye. Glaucoma will develop in about 35% of people with Marfan syndrome, often at an earlier age than the general population. Untreated glaucoma can cause blindness.

viii. Pre-senile Cataracts

Clouding of the eye lens before age 60. Cataracts are common in older people who do not have Marfan syndrome, but people with Marfan syndrome can get cataracts at younger ages—even before age 40.

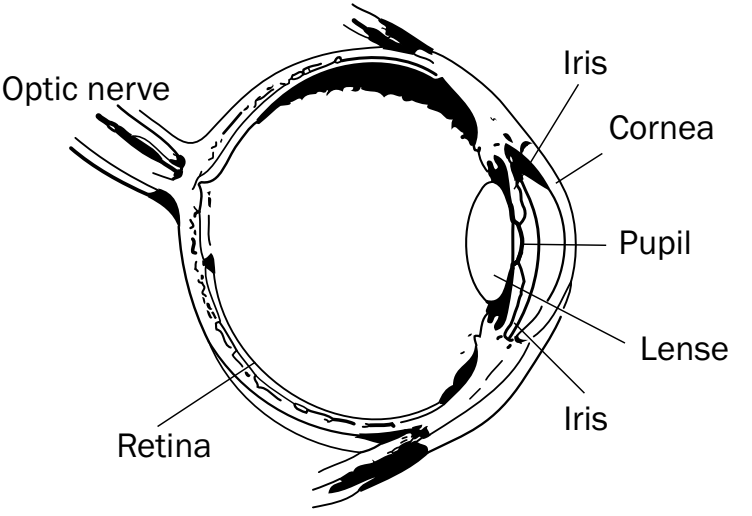
Unlike dislocated lenses, all of the other eye problems listed above also occur in the general population. For this reason, doctors do not always realize they are a part of a person's Marfan syndrome. It is important to know that even though these problems occur in the general population, they are much more common in people who have Marfan syndrome.

Some other eye features often occur in people who have Marfan syndrome that do not usually cause vision problems,

but they can help doctors decide whether or not a person has Marfan syndrome. They include:

- Flattened curve of the cornea. This feature may make it more difficult to fit contact lenses.
- Larger than normal corneas.
- Difficulty in completely dilating (opening) the pupils when the doctor does an eye exam.
- Obvious sunken eyeballs (enophthalmos).

Figure 3. The Eye



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D. Lungs (Pulmonary System)

Lung function is typically measured by a series of procedures called pulmonary function tests (PFTs). The standards for what is considered 'normal' lung volumes and function are based, in part, on a person's height. Since a person with Marfan syndrome is tall because of long legs, the typical standards used by the specialists who interpret PFTs overestimate what that person's lung volumes should be. This often leads to a diagnosis of 'restrictive lung disease', when in fact the lungs are perfectly adequate for the size of the chest. However, some features of Marfan syndrome can affect the lungs and interfere with normal breathing and restful sleep. These are described below. The potential for lung problems should offer a powerful incentive for people with Marfan syndrome to avoid or quit all forms of smoking.

i. Pectus Deformities

Depression of the breast bone (pectus excavatum) can reduce the space available for the lungs somewhat. This is usually not a problem unless the person also has severe scoliosis and lordosis of the upper spine. A pectus excavatum also interferes with the mechanics of expanding the lungs. The primary symptom is shortness of breath during exercise. A protrusion of the breast bone (pectus carinatum) has little effect on lung volumes or function.

ii. Pneumothorax

One possible effect of a mutation in fibrillin-1 is pneumothorax, in which air escapes the lung into the space between the lung and the inner lining of the chest. The symptoms of this are shortness of breath, a dry cough, and often sudden onset of pleuritic chest pain (pain that gets worse when you take a deep breath). The pain may be confused with an aortic dissection or heart attack, and should always prompt evaluation in an emergency

room. A pneumothorax is most common in people who have a 'bleb' or bubble of lung tissue, typically at the top of the lungs.

iii. Emphysema

Emphysema is a condition in which the walls of the tiny air sacs in the lungs are damaged so they cannot push all the used air out of the lungs. Approximately 10–15% of people with Marfan syndrome have emphysema, but it may be under-diagnosed. Symptoms include shortness of breath during activity, frequent bronchitis (often as a result of common colds or viruses settling in the chest) and low blood oxygen. The diagnosis can be confirmed by a chest x-ray, CT scan, pulmonary function test or arterial blood test.

iv. Asthma

Asthma, which is very common in the general population, is also present in the Marfan community. People with Marfan syndrome who have asthma should see a respiratory specialist who can co-ordinate care with other specialists because the conventional treatments for asthma—beta-agonists—have the opposite effect of beta-blockers (which are prescribed to many people with Marfan syndrome).

v. Sleep Apnea

Some people with Marfan syndrome have sleep disordered breathing (sleep apnea), which can have a number of causes. One seems to be laxity of the connective tissues of the airways, which then further relax during sleep and cause partial obstruction to air flow. People with sleep apnea are often overweight, but thin people with Marfan syndrome are also at risk. Any person who snores excessively, sleeps fitfully, seems to have pauses in breathing or gasps for air while sleeping, has a headache on awakening in the morning, or regularly falls asleep during the day, should be evaluated by their doctor. Sleep disordered breathing might be the explanation.

E. Central Nervous System

The central nervous system—the brain and spinal column—are surrounded by fluid contained in a membrane called the dura, which is primarily made up of connective tissue. The enlargement of this membrane is referred to as dural ectasia. Dural ectasia also includes perineural cysts and meningocele cysts.

Dural ectasia is present in more than 60% of people affected with Marfan syndrome. Research suggests that the presence of dural ectasia does not always cause problems, although it sometimes causes back, stomach and leg pain as well as headaches in people with Marfan syndrome.

Dural ectasia is best identified through MRI imaging, particularly of the lower spine. A mylogram, CT scan or plain spinal films may also reveal the presence of dural ectasia.

F. Skin

Stretch marks on the skin (striae atrophicae) may occur in anyone, particularly as a result of rapid growth during adolescence, pregnancy or marked weight gain and loss. People with Marfan syndrome are prone to develop stretch marks, often at an early age and without weight change. The marks tend to appear in body parts subject to stress, such as the shoulders, hips and lower back. Although some people find them of cosmetic concern, they pose no risk and warrant no treatment, which is fortunate because there is no effective means of preventing or removing them. Stretch marks are red or purple in color when they first appear, but become pale over time.

Features associated with Marfan syndrome

Bones & Joints (Skeletal System)

- A chest that sticks out (pectus carinatum) or sinks in (pectus excavatum)
- Arm span greater than height
- Reduced upper to lower segment ratio (lenght of torso, from shoulders to legs, shorter than the length of legs)
- Positive wrist sign (thumb and little finger overlap when grasping the other wrist)
- Positive thumb sign (thumb extends beyond palm when placed flat)
- Curvature of the spine (scoliosis) with a curve greater than 20 degrees
- Vertebrae (spine bones) that slip over each other (spondylolisthesis)
- Flat feet (pes planus)
- Extra-deep hip sockets (where the thigh bone meets the hip), also called protrusion acetabulae
- Very flexible joints throughout your body
- The roof of the mouth (palate) is highly arched and teeth are very crowded
- Certain facial features such as: a long, thin face; deep-set eyes; receding chin; or down-slanting eyes

Heart and Blood Vessels (Cardiovascular System)

- The part of the aorta closest to the heart is enlarged or bulges out (ascending aortic dilation or aneurysm)
- The layers of the ascending aorta are separated and may tear (dissection of the ascending aorta)
- A “floppy” mitral valve (mitral valve prolapse, or MVP)
- Enlarged pulmonary artery without any known cause, before age 40
- Calcium deposits in the mitral valve, before age 40
- A part of the aorta—either in the chest (descending thoracic aorta) or stomach (abdominal aorta)—is enlarged, before age 50
- Tearing (dissection) of the aorta in the chest or stomach, before age 50

Features associated with Marfan syndrome

Eyes (Ocular System)

- Dislocated lenses (ectopia lentis)
- Severe myopia
- Detached retina
- Abnormally flat cornea
- Increased axial length of globe
- Underdeveloped (hypoplastic) iris or underdeveloped (hypoplastic) dilator muscle causing increased constriction of the pupil (miosis)

Lungs (Pulmonary System)

- Sudden collapse of the lung for no known reason (spontaneous pneumothorax)
- Extra-large air sacs at the top of the lung (apical blebs)

Central Nervous System

- Swelling of the sac around the spinal column (dural ectasia)

Skin

- Skin stretch marks, not due to pregnancy or weight gain
- Recurrent hernia

Note: Some of the above characteristics are not part of the 2010 Revised Diagnostic Criteria, but are seen with increased frequency in people with Marfan syndrome; therefore, they may contribute to encouraging a person to seek out a diagnosis.

4. GENETIC TESTING

The use of genetic testing for the diagnosis of genetic disorders can be very complicated. This is certainly true for Marfan syndrome. Input from a geneticist or genetic counselor may be necessary to achieve a full understanding of the capabilities and limitations of genetic testing for Marfan syndrome.

A genetic test alone can not tell you if you do or do not have Marfan syndrome. However, following are some situations in which genetic testing may be helpful:

- Children with a parent who has Marfan syndrome because the features identified by clinical evaluation may not yet be evident. A child with a positive genetic test but no clinical features should be monitored on an ongoing basis.
- Individuals who have one of the cardinal features of Marfan syndrome—aortic dilatation or dissection or ectopia lentis (dislocated lens)—but no other obvious signs of the disorder.
- When a diagnosis can not be determined based on clinical evaluation alone, a genetic test may be helpful in considering differential diagnosis (diagnosis of a related condition).
- Families with a history of aortic aneurysm or dissection may choose genetic testing to identify individuals in the family who may be at risk.
- Adults with Marfan syndrome who are considering having children often consider genetic testing to pursue preimplantation or prenatal diagnosis options.

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More information can be found in our booklet *Genetic Testing for Marfan Syndrome.*

5. IF YOU DO NOT MEET THE DIAGNOSTIC CRITERIA

A person with Marfan features may or may not have Marfan syndrome. Following are some diagnoses that doctors can make:

Marfan syndrome

A doctor makes this diagnosis when a person has enough features of the disorder to mee the diagnostic criteria for Marfan syndrome.

Non-specific Connective Tissue Disorder

Not enough features of Marfan syndrome and/or borderline aortic root measurements. Follow-up echocardiograms are recommended.

Potential Marfan Syndrome

If an *FBN1* mutation is identified but aortic root measurements are too small to meet criteria.

Another Genetic Disorder

A person who does not meet the diagnostic criteria for Marfan syndrome may instead have another genetic disorder. These related disorders include: Ehlers-Danlos syndrome, Loeys-Dietz syndrome, MASS phenotype, familial aortic aneurysm, Sticklers syndrome, ectopia lentis syndrome, and mitral valve prolapse syndrome. More information about these disorders is provided in section V of this book.

No specific diagnosis

This is when a person has Marfan features but does not meet the diagnostic criteria for any known disorder. Many people with

Marfan features (whether they have a diagnosis or not) need medical treatment and follow-up care. Make sure to talk with your doctor about the care that is right for you.

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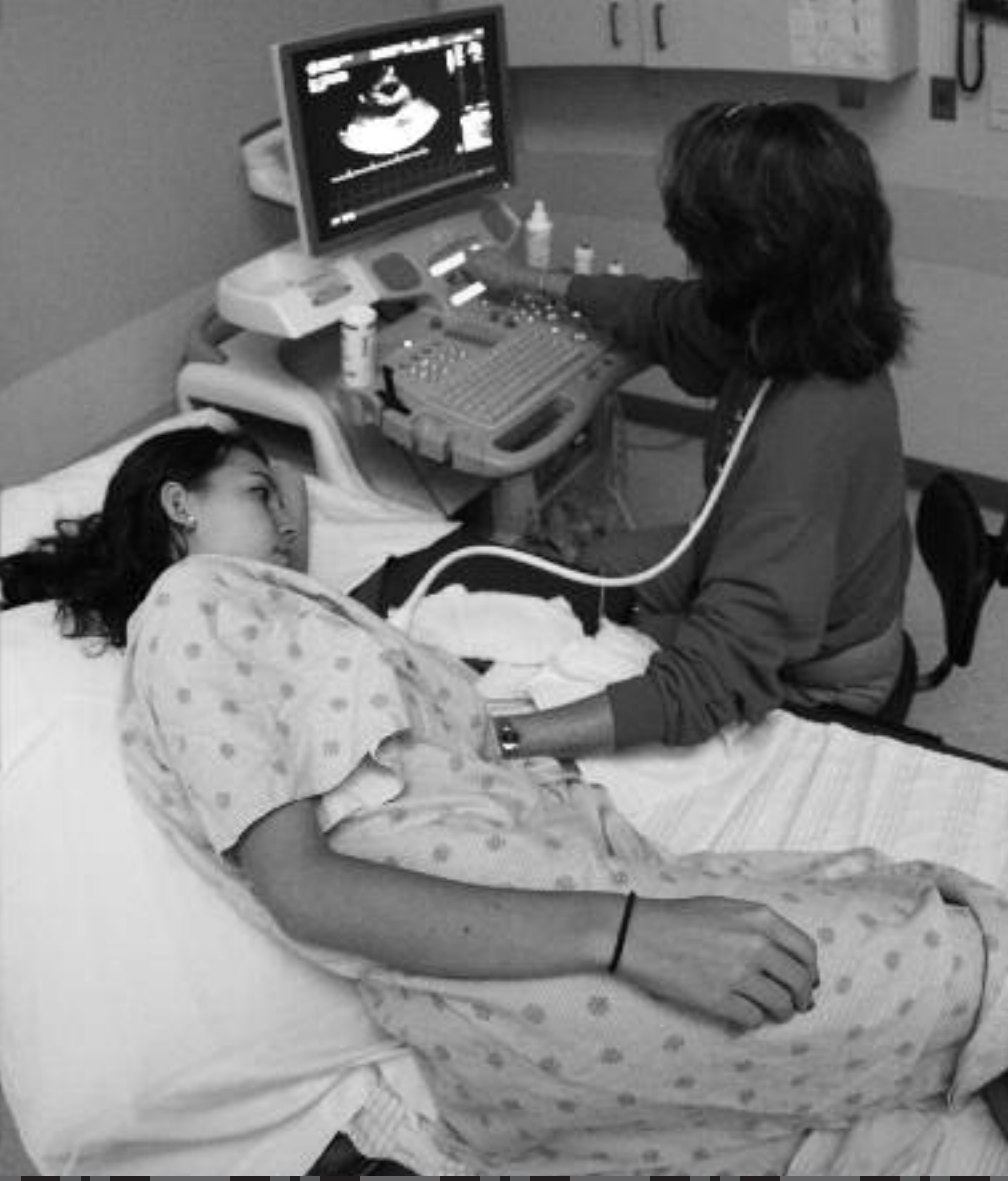


PART III
TREATMENT

1. ROUTINE TREATMENT

There is no cure for Marfan syndrome. However, a range of treatment options can minimize and sometimes prevent complications. Appropriate specialists will develop individualized treatment programs and the approach a doctor uses depends on which systems are affected.

Every person needs a physician who can be turned to for "routine" illnesses and questions. Most physicians who provide these services know about Marfan syndrome only superficially, and may not feel comfortable taking care of the specialized problems that people with Marfan syndrome might develop. In addition to a personal physician (usually an internist, pediatrician or general practitioner), it is important to have one doctor who understands all aspects of Marfan syndrome—someone who can evaluate all of the systems that might be affected, coordinate referral to specialists when needed, and counsel about prognosis, treatment and inheritance.

This doctor may be a medical geneticist, most of whom tend to be located at medical centers affiliated with medical schools, as are many of the specialists who have the most experience with Marfan syndrome. For most people, an annual or semi-annual visit to such a center will provide the necessary medical follow-up for Marfan syndrome.

Following are some of the important treatment considerations by body system.

About half of all people with Marfan syndrome develop scoliosis, although only about one third of those need treatment.

A. Bones & Joints (Skeletal System)

i. Scoliosis

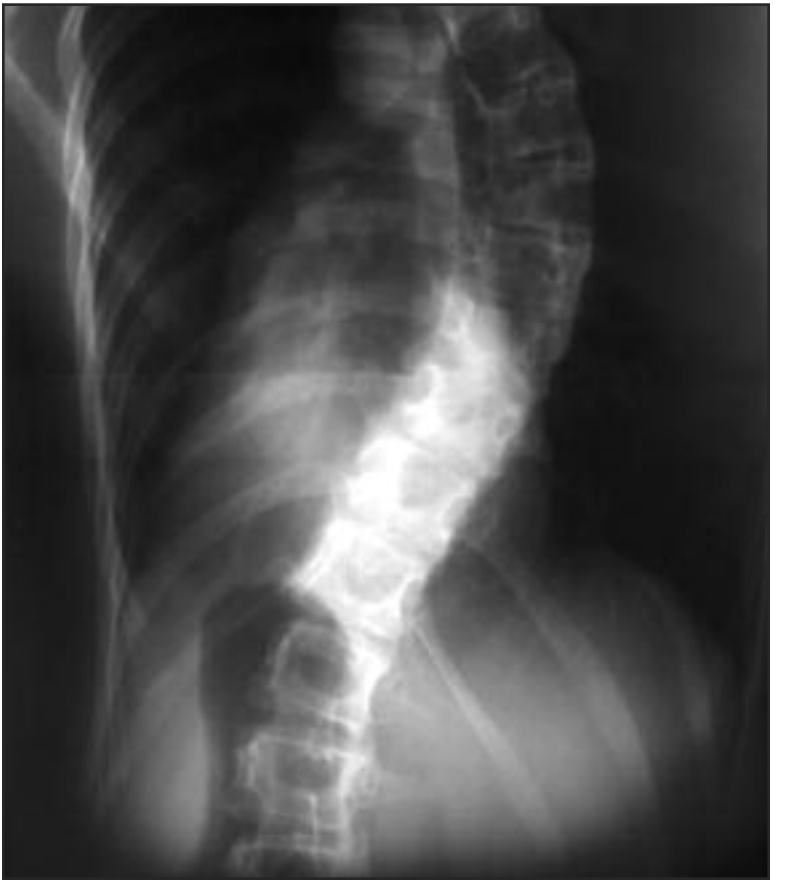
Scoliosis is a spinal curvature in which the vertebrae twist, usually into an S-shape or spiral shape. It is caused by the abnormally loose ligaments of the spine and the rapid growth of the child with Marfan syndrome. Scoliosis can affect any part of the spine, and it may be mild or severe. About 50% of people with Marfan syndrome develop scoliosis, although only about one-third of those with scoliosis need treatment.

All children are usually checked for scoliosis in school in the fifth grade. However, children with Marfan syndrome should be checked for scoliosis by their pediatricians even before fifth grade, then at each annual physical exam. This is done by having the child bend forward while the back is examined by a doctor or nurse. If a child does not show signs of scoliosis by the start of middle school, he or she probably will not develop it later to a significant degree. Scoliosis rarely begins in adulthood.

The term progression refers to scoliosis becoming more severe. The chance of a curve progressing, or worsening, depends on how much growth a person has left and the size of the current curve. Curves are measured by the angle between the vertebrae (as seen on the x-ray on the following page), given as a number or degrees (°). A small curve (less than 20°) in an adolescent has a low chance of worsening. A moderate curve (20°–40°) has a greater chance of worsening in a child or adolescent. A large curve (more than 40°) almost certainly will progress, in either a child or an adult. This is because there is already so much imbalance in the spine that gravity will continue to worsen it.

Most children are checked for scoliosis in fifth grade; children with Marfan syndrome should be checked earlier and again each year.

Figure 4. Spine X-Ray of Person with Marfan Syndrome



Treatment is sometimes recommended because scoliosis can cause many problems, including back pain, decreased lung function, and posture and shape disturbances. A child with scoliosis should have his or her back checked one or two times per year. An adult with scoliosis should have it examined every one to three years. If the curve is increasing and is more than 20º, some treatment is usually recommended in growing children and adolescents because exercise alone will not prevent a

curve from progressing. Following are some treatments that can help with scoliosis:

Back Braces

A back brace is often recommended for children with scoliosis between 20º and 40º. A brace is a custom-molded, padded plastic "jacket" that fits around the trunk, from shoulders to waist, and temporarily straightens the spine. As a result, it stops the worsening process. However, the brace cannot permanently straighten the curve. When the brace is removed, the spine will gradually return to its original curvature.

The goal of the brace is simply to keep the curve from getting worse with growth. It is usually worn 23 hours per day. The time off is for bathing and dressing. In addition, the patient may remove the brace for swimming or sports. The brace is worn until growth is complete. For girls, this is usually until age 14 or 15; for boys, it is 16 to 17.

The brace works in many, but not all, people with Marfan syndrome. If the curve is too great or progressive, bracing will not prevent the need for surgery.

Surgery

If the curve becomes more than 40º to 50º, surgery is considered so that lung problems, back pain and further deformity can be avoided. If surgery is chosen, it is usually safer and more effective to correct the curve before it progresses further. Therefore, if the curve is greater than 40º, surgery may be a possible treatment option.

Scoliosis surgery involves straightening the spine with metal rods and fusing it in the straightened position. The rods are placed deep under the back muscles, against the vertebrae, so that they cannot be felt. While the rods are holding the spine straight, bone chips grow together to fuse the spine and permanently hold it straight. Sometimes, the surgery is performed through

a posterior approach, from the back. If the curve is very large or rigid, it may be performed using both an anterior approach, going to the spine from the front and removing the deformed spinal disks, and posterior approach.

Scoliosis surgery is usually successful. A blood transfusion is often needed, but the patient may be transfused his or her own blood if the blood is stored a few months prior to surgery. Complications—such as the rods coming loose, the spine not fusing or nerve damage—may happen, but they are rare. Usually, it takes one to two months before the patient may return to school or work.

ii. Hunched Back (Kyphosis)

This is a curve best seen from the side. It is normal for people to have a slight kyphosis in the upper spine. However, increasing curves can cause deformity or back ache in some people. Kyphosis does not usually lead to a decrease in pulmonary function. Kyphosis in people with Marfan syndrome may occur in the upper (thoracic) spine or in the lower (lumbar) spine.

The treatment for kyphosis is similar to the treatment for scoliosis. In a growing child, a brace is often effective. In an older patient or in someone with more severe kyphosis, the brace does not help. Exercises may help prevent pain, but if not, surgery is an option. It is done in almost the same way as scoliosis surgery, although it is less commonly needed. People with kyphosis should be careful to get enough calcium and take up a mild exercise program to prevent osteoporosis, which may make the condition worse.

iii. Pectus Deformities

The two most common chest abnormalities related to Marfan syndrome involve the breastbone (sternum). Pectus excavatum is a sunken (or excavated) sternum. It develops to varying degrees in many people with Marfan syndrome, as well as in children

who are not affected. It may impair the breathing in more severe cases, especially when there are other abnormalities in the spine, heart or lungs. For some people, it may become a cosmetic concern.

There is no brace available to correct pectus excavatum; the only treatment option is surgery. There are often good medical reasons, in addition to cosmetic reasons, to repair a severe pectus excavatum. If needed, surgery should be performed in mid to late adolescence by a thoracic surgeon.

Surgery consists of raising the deformed sternum and ribs, straightening them and holding them with a metal bar. It requires several days of hospitalization. The success rate is high. The metal bar is removed after four to six months in a brief outpatient procedure. Afterward, the sternum will look much improved, although there is usually slight residual abnormal chest shape that cannot be fixed completely without taking undue risks. In a few cases, the deformity may recur if it is corrected early in life.

In pectus carinatum, there is a protrusion of the sternum outward. Some people with Marfan syndrome have a pectus excavatum on one side of the chest and a protrusion on the other. Pectus carinatum does not cause compression of the heart or lungs, but may still be cosmetically displeasing to a child or teenager. Sometimes a brace can effectively push inward on the sternum to change its outward growth pattern, but this is not used often. Surgery is another option.

The only treatment for pectus excavatum (sunken sternum) is surgery. If needed, it should be performed in mid to late childhood.

Rotation of the ribs is a side effect of scoliosis. The ribs on the side of the curve usually protrude farther in the back. If spine

surgery is done, the ribs often straighten out. Rarely, an operation on the ribs themselves is needed.

iv. Feet

People with Marfan syndrome frequently have feet that are long and slender. The shape of the foot varies, but in most affected people, the arch is flatter than normal. In others, the arch is higher than normal. Treatment is not usually required. An arch support cannot make a flat foot develop an arch, but it may improve the gait or lessen discomfort.

Foot pain is sometimes a problem for people with Marfan syndrome. This is due to the stresses of a large frame on the flexible feet. Special cushions, inserts or orthotics may help. Wearing shoes with low heels, or no heels, is recommended. The key is to try different shoe styles to find one that is comfortable. Foot surgery is rarely needed. Surgery should be undertaken only after careful trials of non-operative treatments.

People with Marfan syndrome may also have curled toes (claw toes or hammer toes). Wearing tight shoes can make this worse.

v. Other Orthopedic Issues

Marfan syndrome is thought of as a condition of loose ligaments. Yet a dislocation or sprain of any major joints (such as a shoulder, knee or ankle) seem no more common than in the general population. One reason may be that people with Marfan syndrome limit themselves from intense physical activity or twisting exercises in order to avoid stress on the heart or aorta. Another probable reason is that the major ligaments in their joints are not weak; they are just a little loose.

People with Marfan syndrome may have more aches in the back and limbs than other people. This may have something to do with the mechanics of living in a large body, with all of the

attendant stresses, along with the laxity of the joints. Aches can be treated with heat, an over-the-counter analgesic (such as Tylenol®) and modification of activities. The chance of a return to normal function, with these treatments, is excellent.

Other problems may include:

Spondylolisthesis

This refers to a slip forward of one vertebra upon the one below it. This usually happens near the lower end of the spine. It can occur in anyone, but the forward slipping is more common in people with Marfan syndrome. Someone with this condition usually has a low back ache or stiffness and is unable to bend forward to touch their toes. Usually there is no neurologic damage, except in very severe cases. Treatment options include exercise or braces for mild cases; if slipping is greater than 30%, surgery may also be considered.

Dural Ectasia

A finding more unique to Marfan syndrome is swelling (ectasia) of the spinal cord sac (dura). This occurs because the spinal cord sac cannot withstand the pressure of the spinal fluid. If swelling occurs, it is frequently in the lower part of the lumbar or sacral spine. Sometimes, the enlarged sac will actually expand into adjacent spaces, such as the pelvis.

Symptoms of dural ectasia include low back ache and a burning sensation, numbness or weakness in the legs. The symptoms resemble any back ache; however, enlarged dura can be seen on magnetic resonance imaging (MRI) or computed tomography (CT).

For treatment, medication or spinal shunting (inserting a tube into the spinal sac to help relieve the pressure from the fluid that accumulates around the base of the spine) may help in severe cases. It is best to leave mild cases alone.

Protrusio Acetabulae

In some people with Marfan syndrome, the hip sockets become deep during growth. This is called protrusio acetabulae. The acetabulum is the socket of the hip joint. The cause of this condition is not known. It does not cause problems or symptoms in childhood, but in adulthood, the deepened sockets can lead to earlier arthritic change, which is noted with aching in the hips or groin. Some people with this diagnosis need to have artificial hips in middle age or later. This affects less than 5% of people with Marfan syndrome.

B. Heart and Blood Vessels (Cardiovascular System)

Problems with the heart and blood vessels are common in people with Marfan syndrome, and potentially life-threatening. People with Marfan syndrome should be tested regularly for cardiovascular problems and treatments range from medication to surgery.

i. Tests to Monitor Cardiovascular Condition

People with Marfan syndrome must have regular tests to monitor their cardiovascular condition. These help find problems before there is an emergency. Tests may be performed annually or more often, in some cases every three months. Following are some tests doctors often use.

- *Echocardiogram*
  Shows all the heart structures including blood valves and the part of the aorta closest to the heart.
- *MRI or CT scans*
  Shows all segments of the aorta.
- *TEE*
  A special type of echocardiography that shows the ascending and descending thoracic aorta in addition to the heart valves.

An echocardiogram is a painless test during which high-frequency sound waves (ultrasound) are bounced through the chest wall and off the heart to produce a sonar picture of how the valves move.

ii. Medications

Medications can help treat many types of cardiovascular problems. Medications include:

- *Beta-blockers*
  Beta-blockers help lower blood pressure and reduce the force of heartbeats. They may help prevent or slow down aortic dilation (enlarged aorta) and can reduce the risk of aortic dissection (tears between layers of the aorta). For many people with Marfan syndrome, beta-blockers are a first choice medication.
- *Angiotensin receptor blockers (ARB's)*
  Recent research has shown that one ARB drug, Losartan, may prevent aortic growth. A clinical trial is now underway to compare this medication to beta-blockers in people who have Marfan syndrome.
- *Angiotensin Converting Enzyme inhibitors (ACE-i)*
  Angiotensin Converting Enzyme inhibitors also help control blood pressure and ease stress on the aorta. They may be prescribed if a person does not react well to beta-blockers or angiotensin receptor blockers.

iii. Surgery

Most people with Marfan syndrome who have heart problems are helped by planned surgery—surgery performed before there is an aortic dissection or other life-threatening problem. After

surgery, people must take blood pressure medication and will need tests (such as CT or MRI scans) at least once a year. Some people need more surgery later on. In all cases, it is important that the surgery performed by doctors who are familiar with Marfan syndrome. Following are the three most common types of surgery:

- *Repair of the Ascending Aorta*
  When the aorta reaches a certain size, surgery to repair the ascending aorta may be recommended. While surgery has risks and benefits, studies show that this type of surgery can be very successful when done by doctors experienced in treating people with Marfan syndrome.
- *Aortic or Mitral Valve Repair or Replacement*
  Aortic valve surgery may need to be done when the ascending aorta is replaced. A person needs mitral valve surgery if the mitral valve leaks so much that the heart must pump extra hard. People whose heart valves are replaced with a mechanical valve must take blood thinners for the rest of their lives. They also will need to take antibiotics before any dental work.
- *Repair of the Descending Thoracic or Abdominal Aorta*
  This surgery is done when there is a sudden or large change in the size of the descending thoracic or abdominal aorta or if these parts of the aorta reach a very large size.

C. Eyes (Ocular System)

i. Lens Dislocation

The symptoms of lens dislocation depend on severity and may vary from mild myopia to severe myopia, astigmatism and fluctuating vision. In addition, vision may be severely blurred. Lens dislocation can only be confirmed by an ophthalmologist who uses a slit-lamp eye examination after fully dilating the pupil.

Approximately 65% of people with Marfan syndrome will develop dislocated lenses, typically, but not always, before the age of ten. Dislocated lenses are rarely seen at birth, but may occur by three to four months of age. Lens dislocation is not a single event and may be progressive, as seen in 16% of pediatric cases and 8% of adults. Lens dislocation tends to affect both eyes but may be worse in one eye than in the other.

Lens removal is one treatment for lens dislocation. Possible reasons to consider lens removal include glaucoma, retinal detachment, corneal edema and intraocular inflammation. People with even a total lens dislocation may not need surgery for decades. In the largest study of people with Marfan syndrome, the most common reasons for surgery were lens dislocation with fluctuating vision, progressive cataracts, and uncorrectable vision.

Although vision is impaired with a dislocated lens, the lens can still help balance the pressures in the eye between the anterior and posterior chambers (the parts of the eye in front of and in back of the iris). Lens removal in young children raises the risk for retinal detachment and makes surgery for lens replacement later in life, when the eye is fully grown, riskier and technically difficult. It is a good idea to delay, if medically possible, lens removal and implantation of lenses until the later teen years, once the eye is more likely to have finished growing. A decision to remove the lenses depends upon the need for improved vision versus the stability of the ocular measurements.

If artificial lens implantation surgery is recommended, posterior, as opposed to anterior, chamber lenses are usually the better choice for people with Marfan syndrome because they tend to have large eyes and deep anterior chambers. Standard anterior chamber lenses are often too small, and may result in complications such as excess movement of the lenses (windshield wiper effect), inflammation of the iris, glaucoma, pain and the need for corneal transplantation. Posterior chamber lenses should always be sutured in place.

Approximately 65% of people with Marfan syndrome will develop dislocated lenses, often before the age of 10.

ii. Refractive Errors in Children

There are many causes of refractive errors in children with Marfan syndrome. Often, the eyeball is large or too long, which keeps light rays from focusing on the retina and causes myopia or nearsightedness. In other cases, the position of the lens or the shape of the eye (if it is shaped like a football) may cause astigmatism. In either case, it is important for the child's eyes to be checked regularly to ensure the proper prescription. From a diagnostic and treatment standpoint, it is essential to evaluate the eyes of all children as early as possible because if the brain has not perceived good vision in both eyes by the age of ten or 12 at the latest, achieving good vision might not be possible.

It is essential to evaluate the eyes of children as early as possible; do not wait until they are of school age.

iii. Amblyopia and Strabismus

Amblyopia is the medical term used when the vision in one of the eyes is reduced because the eye and the brain are not working together properly. The eye looks normal, but it is not being used normally because the brain is favoring the other eye. This condition is also sometimes called lazy eye.

Strabismus is when the two eyes do not focus on the same object simultaneously. One eye may drift in or out compared to the other eye. The eyes may alternate fixating on an object or one eye may fixate more. It occurs in people with Marfan syndrome at a higher rate than in the general population. In the general population, the deviating eye more commonly turns inward, to-

ward the nose. In people with Marfan syndrome, the deviating eye usually turns outward. The eyes may also deviate vertically. Strabismus can cause loss of depth perception, double vision, and amblyopia, or a lazy eye. However, amblyopia is often present first and leads to strabismus, but once amblyopia has been successfully treated, the strabismus may correct itself.

When treating amblyopia, the goal is to stimulate use of the weaker eye by blurring vision of the better eye and help the part of the brain that manages vision to improve function.

There are two principal treatments. With one, eye drops of a long-acting dilating agent such as atropine are used in the stronger eye to blur the vision and provoke use of the weaker eye. It is important to make sure that the vision in the medically blurred eye is worse than the vision in the amblyopic eye.

Using an eye patch is another option. An opaque, adhesive patch is worn over the stronger eye for several hours a day for weeks to months.

Before starting amblyopia therapy, the prescription of eyeglasses has to be maximized. About 95% of Marfan people with strabismus will attain excellent vision if they are wearing the proper glasses and are treated for amblyopia.

iv. Eye Concerns in Adults

Adults with Marfan syndrome often experience cataracts, glaucoma and retinal detachments. Approximately 30% of people with Marfan syndrome will develop glaucoma in their lifetime. Repair of complications from an earlier surgery may occur in older people, although the incidence of needed repairs may become less frequent because the outcomes from contemporary surgery are now much better.

Laser Eye Surgery

Laser correction can correct myopia (nearsightedness) up to -10 diopters. (A diopter is a measurement used by eye doctors to de-

termine the prescription for eye glasses.) Most people with Marfan syndrome do not qualify because their nearsightedness is greater than -10 diopters. Minor cases of myopia can be corrected via laser surgery in people with Marfan syndrome if they do not have lens dislocation. If they do have a lens dislocation, laser surgery is not advised because it will make the dislocation worse. Additional information is needed about the experiences of those with Marfan syndrome who have had laser correction of myopia to help determine if this procedure is worth the risk for affected people.

Retinal Detachment

These early symptoms may indicate a retinal detachment:

- Flashing lights
- New floaters
- A gray curtain moving across your field of vision

These symptoms do not always mean a retinal detachment is present, but you should see your eye doctor immediately if any of these signs occur. Head trauma can cause retinal detachment in anybody, and those who are highly myopic are always predisposed to retinal detachment. For people with Marfan syndrome, however, retinal detachment can happen spontaneously.

See your doctor immediately if you see flashing lights, new floaters or a gray curtain moving across your field of vision.

D. Lungs (Pulmonary System)

i. Pectus Deformities

While surgery can correct the pectus, there is no evidence that lung function will improve. Scoliosis is typically corrected early,

but it can be progressive and cause more problems with pulmonary restriction. Serial pulmonary function tests can determine the progress of the lung restriction. Lung problems can be worse if another airway disease, such as asthma or emphysema, is present. Supplemental oxygen and pulmonary rehabilitation are recommended to improve the quality of life.

Pulmonary rehabilitation is an array of activities and therapies such as nutritional counseling, energy-conserving techniques and breathing strategies, involving specialists like respiratory therapists, physical and occupational therapists, dietitians or nutritionists, and psychologists or social workers.

ii. Pneumothorax

"Small" pneumothorax is treated in the hospital with supplemental oxygen. "Moderate to large" pneumothorax is treated by chest tube evacuation and possibly pleurodesis. Chest tube evacuation involves inserting a tube between the ribs into the space around the lungs to help drain the air and allow the lung to re-expand. Pleurodesis is the process of re-adhering the lung to the chest wall to prevent air from being able to cause the lung to collapse from the outside. This can be done chemically (not recommended) or surgically.

Pneumothorax is common in people with Marfan syndrome. People who require treatment for it should tell the surgeons that they have Marfan syndrome and may need aortic surgery in the future. This will enable the surgeons to make the best treatment recommendation.

iii. Emphysema

The conventional treatment for emphysema is supplemental oxygen, bronchodilator (which opens up the bronchial tubes) and aggressive treatment of infections. Research is underway on other methods that may be useful.

iv. Asthma

Most people with Marfan syndrome take beta-blockers to help ease the pressure on the aorta. However, beta-agonists, which have the opposite effect, are the conventional treatment for asthma. Since beta-blockers should not be used for children with severe asthma or reactive airway disease, you should speak to your doctor about other options you may have.

v. Sleep Apnea

Continuous positive airway pressure (CPAP) is considered by many experts to be the most effective treatment for sleep apnea. A nasal CPAP machine provides supplemental oxygen. A mask, worn over the nose and/or mouth while you sleep, is hooked up to a machine that delivers a continuous flow of air into the nostrils. The positive pressure from air flowing into the nostrils helps keep the airways open so that breathing is not impaired. In some cases, people with Marfan syndrome may have trouble finding a CPAP mask that fits comfortably so will have to try several masks to find one that works. They may also require a special type of mouthpiece (mandibular advancement device) or other gadget to help the mask fit properly. In rare cases, surgery may be necessary.

E. Dental and Orthodontic Issues

Many people with Marfan syndrome have narrow jaws and high, arched palates, which can create dental and orthodontic problems. There is limited research regarding specific management of the orthodontic problems commonly seen in people with Marfan syndrome, but seeking orthodontic care is an important part of Marfan syndrome management, particularly in children.

In addition, people with mitral valve prolapse and artificial heart valves are at risk for infection of the heart and heart valves (endocarditis) when they have dental work, and should follow

their doctor's recommendations to prevent it (Endocarditis Prophylaxis).

According to the American Association of Orthodontists, children should see an orthodontist by the age of seven. This is particularly true for children with Marfan syndrome. Many treatment options are possible for a growing child. However, as a patient becomes a teenager and an adult, the number of treatment options becomes more limited.

When a child is seven or eight, it is possible to recognize a narrow upper jaw, which is a common characteristic in children with Marfan syndrome. A narrow upper jaw causes the upper teeth on the side of the mouth to be set inside the lower teeth creating a posterior crossbite. Normally, the upper teeth overlap the lower teeth.

i. Endocarditis

Endocarditis is the inflammation of the lining of the heart cavity and valves. People with mitral valve prolapse or an artificial heart valve can develop endocarditis during dental procedures and other medical situations where there is an increased likelihood that bacteria can enter the blood stream. Endocarditis is a terrible complication for anyone, but particularly so in a patient who has had surgical reconstruction of the aorta with placement of an artificial valve. This is a condition that is almost incurable by medicine alone, and nearly always requires surgery to remove the artificial valve and Dacron graft. Not only is the operation itself of much higher risk than the original operation, but there remains a substantial chance that not all of the infected tissue will be removed, and that recurrent endocarditis will occur.

Precautions must be taken prior to any procedure that may introduce bacteria into the bloodstream. This includes routine dental work. Many dental procedures go below the gum line and provide an opportunity for bacteria to enter the blood

stream. People with Marfan syndrome should advise their dentist of their heart problems so that the dentist can consult with the cardiologist about the need for antibiotics prior to beginning the dental work.

Precautions must be taken prior to any procedure that may introduce bacteria into the bloodstream, including routine dental work.

ii. Tempromandibular Joint Syndrome (TMJ)

The tempromandibular joint (TMJ) joins the two halves of the jaw, and moves during chewing and speaking. Just as with other joints of the body, the TMJ can be loose and prone to develop wear-and-tear arthritis. This leads to pain, first with chewing, but eventually at all times. A prosthodontist (a dental specialist who replaces missing teeth and restores natural ones) should be consulted for TMJ and jaw problems.

2. EMERGENCIES

A. Cardiovascular Emergencies

In the event of unexplained chest, back, or abdominal pain, it is critical to inform emergency medical personnel if a person has Marfan syndrome. People with Marfan syndrome are at up to 250 times greater risk of aortic dissection than the general population. The pain may be "severe," "sharp" or "tearing" and may travel from the chest to the back and/or stomach. Sometimes, the pain is less severe, but a person still has a feeling that "something is very wrong." If a dissection is suspected, a person needs to go to a hospital emergency room right away.

Unless someone has a known diagnosis of Marfan syndrome, reports of chest pain would not automatically raise the possibility of aortic dissection in the emergency room. It is therefore important that people with Marfan syndrome convey their condition to doctors and nurses in an emergency situation to ensure that they receive appropriate care.

Following are some recommendations for communicating effectively with emergency department staff.

i. Complete the Emergency Preparedness Kit

Before any emergency arises, complete the Emergency Preparedness Kit, available in the patient toolkit on our website, and keep it handy in case an emergency occurs.

ii. Bring Information About Marfan Syndrome to the Emergency Department

Visit our website to download fact sheets on Marfan syndrome which can be given to hospital staff to ensure they understand the disorder and its link to aortic dissection.

800-8-MARFAN
800-862-7326
support@marfan.org
www.marfan.org

Patient Toolkit

Download the Patient Toolkit at www.marfan.org.

Emergency Alert Card

A tri-fold card that expresses the urgency of proper evaluation of chest/back/abdominal pain in the emergency room. Carry this with you at all times to help ensure that ER personnel will take your concerns seriously in the event of an emergency.

Family Health History

Complete this form to compile important health information about you and your family members. Can also be used to determine other health risks not related to Marfan syndrome.

Emergency Preparedness Kit

Complete this kit to be prepared in the event of an emergency with all of your personal medical information available in a single file. Includes emergency contacts, allergies, medications and dosage, medical and surgical history, healthcare proxy, etc.

Ritter Rules

Life-saving reminders to recognize, treat and prevent thoracic aortic dissection, a deadly tear in the large artery that carries blood away from the heart. Named for actor John Ritter, who died of a thoracic aortic dissection, Ritter Rules combine knowledge with action. Know the urgency, symptoms, who is most at risk and which imaging tests are required to diagnose this medical emergency.

iii. Describe the Pain Completely

Be prepared to answer the following questions. If the doctor does not ask, speak up and tell him or her anyway.

- Where is the pain located?
- How severe is the pain?
- When did it start?
- What does the pain feel like?
- Does the pain radiate (move) to other areas of the body (e.g. the back, neck or arms)
- Is this kind of pain like anything you have ever felt before?

iv. Express a Sense of Urgency

Emphasize to the nurse or doctor that the patient:

- Has Marfan syndrome
- Is at high risk for aortic dissection
- Is concerned about the pain being from a dissection

v. Carry an Emergency Alert Card

We have created an Emergency Alert Card for people to carry which identifies them as a person with Marfan syndrome or a related disorder and being at increased risk for aortic dissection. The card also identifies the proper tests the hospital should do to rule out aortic dissection. The card can be printed out from the patient toolkit on our website.

vi. Wear a Medical Alert Bracelet

Medical alert bracelets are helpful, especially if a person is unable to provide their medical history. The bracelet can relate

a few key words or phrases that may be helpful to emergency department personnel. People with Marfan syndrome might want to include on their bracelet: Marfan syndrome, aortic aneurysm, risk for aortic dissection, heart valve and Coumadin®. Talk to your doctor to decide what is most important to include on your bracelet.

vii. Contact Your Primary Care Doctor

Provide emergency department staff with the patient's primary care physician's name and phone number. Ask them to call at once for any additional information that may be needed for appropriate treatment.

viii. Be Familiar with Tests that Confirm or Rule Out a Diagnosis of Aortic Dissection

The diagnostic test used to confirm aortic dissection should be that test which the specific institution can perform in the most timely and accurate manner. This is usually a CT scan of the chest with IV contrast or a transesophageal echocardiogram. An MRI is occasionally used as a first test. If the patient has an allergy to IV dye, shellfish or Iodine, this should be mentioned to the emergency department personnel. It is important to remember that a chest x-ray may not show an aortic dissection and, if dissection is suspected, a normal chest x-ray should not deter further evaluation.

Interview local hospitals to find out if they are able to offer the appropriate tests easily in the emergency deparment, as well as if they are equipped to perform emeregency cardiac surgery should it be necessary.

ix. Prepare Family Members Before an Emergency Arises

In some emergency situations, the patient may not be able to communicate adequately. Family members should be prepared to tell emergency department personnel about the patient's

health, especially his or her experience with Marfan syndrome, aortic aneurysm, prior dissection or heart surgery and medications. They should also be able to provide the name and phone number of the patient's doctor for obtaining further medical information.

x. Be Persistent

It can be intimidating to be in an emergency room. However, it is important to be proactive and, if necessary, persistant to ensure that doctors understand the situation and provide appropriate treatment. If the department has multiple doctors, it is entirely acceptable to request another doctor's opinion.

B. Eye Emergencies

Marfan syndrome significantly increases a person's risk of retinal detachment, a serious condition that should be treated as an emergency. Because of the risk of retinal detachment, people with Marfan syndrome should avoid activities that can result in sudden or severe blows to the head.

Retinal detachment is a separation of the light-sensitive membrane in the back of the eye (the retina) from its supporting layers. Early symptoms that may indicate a retinal detachment are:

- Bright flashes of light, especially in peripheral vision
- Translucent specks of various shapes (floaters) in the eye
- Blurred vision
- Shadow or blindness in a part of the visual field of one eye

The symptoms may occur gradually or quite suddenly. They do not always mean a retinal detachment is present, but they do require seeing an eye doctor immediately. The longer one waits for treatment, the greater the chance that the retinal detachment

will become more severe, and the more severe the detachment, the less vision may return. Untreated retinal detachment usually results in permanent, severe vision loss or blindness.

As in any emergency, it is best to be prepared in advance. Complete our Emergency Preparedness Kit before an emergency occurs and keep it handy.

C. Lung Emergencies

People with Marfan syndrome can be at increased risk of spontaneous pneumothorax. While this condition is usually not life threatening, it should be considered an emergency.

Spontaneous pneumothorax is a collection of air or gas in the space between the lungs and the chest that "collapses" the lung and prevents it from inflating completely. Symptoms of a pneumothorax include sudden, sharp chest pain and and feelings of tightness in the chest. Shortness of breath, rapid heart rate, rapid breathing, cough and fatigue are other symptoms of pneumothorax. The skin may develop a bluish color (cyanosis) due to decreases in blood oxygen levels.

Examination of the chest with a stethoscope reveals decreased or absent breath sounds over the affected lung. The diagnosis is confirmed by chest x-ray.

Small pneumothorax is treated in the hospital with supplemental oxygen. Moderate to large pneumothorax is treated by chest tube evacuation and possibly pleurodesis (mechanical or chemical pleural "scarring").

Physicians who care for people with Marfan syndrome should assume that all patients will eventually require aortic replacement. Therefore, any thoracic procedure (a procedure involving the area of the chest which contains the heart and lungs) should take into account the possibility of future aortic surgery. If supplemental oxygen or chest tube insertion does not successfully treat the pneumothorax, doctors may recommend pleurodesis, which involves "scarring" the lung surface to attach

the lung to the chest wall. The best pleurodesis method for individuals with Marfan syndrome is mechanical rather than chemical pleurodesis, because mechanical pleurodesis makes cardiac surgery easier.

As in any emergency, it is best to be prepared in advance. Complete our Emergency Preparedness Kit and take the completed document with you to the hospital.

PART IV
LIVING WITH MARFAN SYNDROME

1. Lifestyle Considerations

A. Lifestyle and Attitude

Many people with Marfan syndrome feel that major life decisions, such as education, occupation, marriage and children, have been only slightly influenced by their diagnosis. Others feel that Marfan syndrome has been the major consideration in all such decisions. Although occupations and recreational activities that involve vigorous physical activity or lifting should be avoided, the vast majority of individuals easily adapt to these restrictions. People affected by Marfan syndrome hold positions of prominence in all different professions. Most who choose careers in the professions or the home find few impediments to success. Frequently, friends, colleagues and clients are unaware that a medical condition exists. Each person needs to make individual decisions about whom to tell and how much to explain about Marfan syndrome.

B. Physical Activity Guidelines

Exercise is beneficial to both the physical and emotional well-being of people with Marfan syndrome. The average life expectancy of people with Marfan syndrome is now in the 70's, making regular, gentle exercise an important general health measure. Most people should exercise regularly through low-intensity, low-impact activities adapted to meet their specific orthopedic, cardiovascular and ophthalmologic requirements. People with Marfan syndrome should always avoid contact sports because of the risk of damaging the aorta and injuring the eyes. Strenuous activities also should be avoided because of the stress placed on the aorta. Every activity has gradations, and no recommendation holds true in all circumstances. For example, shooting baskets in the driveway is different from playing a full-court basketball game, and bicycling ten miles in one hour on

a level course is different from competing in a triathlon. In short, it is essential for each individual with Marfan syndrome to discuss physical activities, and specific activity levels, with his or her physician so that exercise can be incorporated safely into the regular healthcare routine.

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support@marfan.org
www.marfan.org

Find Full Physical Activity Guidelines, prepared by our Professional Advisory Board, at Marfan.org.

C. Having Children

Having children is a personal decision, one that should be made solely by prospective parents, after understanding potential risks to the child and the mother. Each offspring of an affected parent has a 50% chance of developing Marfan syndrome. Because of variable expression of the Marfan gene, it is not possible to predict how severely a child who inherits the gene will be affected.

There are two basic approaches a couple might use to have a biological child without Marfan syndrome. One uses amniocentesis or chorionic villus sampling of the fetus early in pregnancy to determine if the fetus is affected. The other uses in-vitro fertilization with pre-implantation genetic diagnosis. Both methods require knowledge of the location of the parental mutation as determined by either mutational or linkage analysis. Either method takes time to obtain the test results. Therefore it is important to undergo the testing prior to becoming pregnant. Since this is a complex and rapidly changing area of medicine, prospective parents should discuss the latest status of available options with their doctors and genetic counselors. Often this type of analysis is covered by health insurance.

Pregnancy poses additional risks to women with Marfan syndrome because of the increased stress on the cardiovascular system. While there is no clear distinction between women who

can and cannot tolerate pregnancy, several points seem established. Women who have significant heart valve problems should not attempt pregnancy. As the aortic diameter exceeds the normal by more than about 10% (40 millimeters), the risk of tearing the wall of the aorta increases. Women are well advised to complete childbearing early in life. All women should have a cardiac evaluation before becoming pregnant. Women who have had composite graft surgery of the aorta need special guidance because of the potential for harmful effects of Coumadin® on the developing fetus. Any pregnancy in a woman affected by Marfan syndrome should be considered "high-risk" (a term obstetricians use) and her aorta should be evaluated by echocardiography every six weeks or so. Delivery should be by the least stressful method possible; usually this means a normal vaginal delivery. Cesarean section is not necessary solely because of Marfan syndrome, but may be chosen for any of the reasons usually applied in labor.

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Our resource Pregnancy & Family Planning offers more detailed information on pregnancy and having children.

2. PSYCHOLOGICAL AND SOCIAL ASPECTS

A. Common Reactions of Affected Adults

An adult who learns that he or she has Marfan syndrome is usually aware of some sort of health problems already, but no label had ever been placed on those assorted problems. Other aspects of the syndrome, such as aortic enlargement, might not be discovered until the label "Marfan" is attached and specific tests, such as an echocardiogram, performed. The individual and family may feel frustrated and frightened by the situation and the sudden "loss of health." Adjusting to the diagnosis is usually associated with difficulties—social, emotional, economic and psychological. These adjustments may, and often should, take place over a period of time.

It is important for an adult with Marfan syndrome to get correct medical information about the condition and to understand the need for, and benefit of, proper medical care. It is not uncommon for them to be confused or even stunned when first learning of the diagnosis, or to experience denial. This denial can be destructive when it results in avoidance of appropriate medical care or in the continuation of activities, such as vigorous sports or occupations that can be harmful.

The genetic nature of Marfan syndrome may involve recommendations for testing of relatives and may influence plans for having children.

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800-862-7326
support@marfan.org
www.marfan.org

Our help center is staffed by a registered nurse and a social worker who can address both medical and social questions.

B. Common Reactions of Parents Who Have a Child with Marfan Syndrome

Parents who do not have Marfan syndrome may feel responsible for their child having the condition, even though this was obviously unintentional and usually unavoidable. Initially, parents may feel numb and later may feel angry and sad. A parent who has Marfan syndrome may feel even more responsible, particularly if he or she had genetic counseling and understood the risk of a child inheriting the syndrome.

Not all parents need counseling, but all parents do need to recognize and cope with their initial reactions to learning that their child has Marfan syndrome. Often a professional, such as a genetic counselor, a social worker, a psychologist, or a member of the clergy with knowledge of genetic disorders, can help parents cope with the impact of the diagnosis. Meeting other parents who are grappling with the same issues, or already have, can be extremely helpful in combating the loneliness of facing this situation. Children with Marfan syndrome should participate in everyday activities, within the physicians' guidelines, and should not be separated from their peers.

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support@marfan.org
www.marfan.org

Our online community offers dozens of online support groups you can join, including one for parents and one for teens.

C. Informing Family Members about Marfan Syndrome

A genetic diagnosis such as Marfan syndrome affects the entire family. Couples may experience a temporary strain in their relationship when they first learn that their child has Marfan syndrome. They need to communicate with each other their hopes and their fears.

Grandparents may blame themselves for their grandchild's condition, or may place the blame on "the other family." They often do not understand the diagnosis, deny the reality of it, and place faith in a reassuring acquaintance or in a miracle cure. If grandparents can be included in discussions about Marfan syndrome, they will make an easier adaptation to the diagnosis and potentially provide more support for the parents.

Unaffected brothers and sisters also need support. They may feel guilty that they "escaped" Marfan syndrome or fearful that they may still become affected. They may need special time with their parents to talk about their feelings, ask their questions, or get reassurance that their parents care as much about them as their sibling.

Questions that may be asked by family members who have Marfan syndrome and those who don't include:

- Why did this happen to me?
- What did I do to cause this to happen?
- What risk is there that I will have a child with Marfan syndrome?
- Is there a cure?
- How will my friends/fiancée/boss react?
- What career can I choose?
- Am I, like my genes, abnormal?

All of these questions are natural. The answers to most appear elsewhere in this booklet. However, it is important to realize that everyone has a number of genes that are not normal, even if they don't result in a physical problem. A positive self-image is not dependent on one's genes.

D. Informing Young Children about Marfan Syndrome

While there is no "right" way to tell a young child that he or she has Marfan syndrome, having this information available from the beginning gives both the child and the family more control. It is best that a child learns about how he or she is special from a parent or his or her own physician, so that they do not find out from a teacher, health professional performing a test, or relative who unintentionally lets the name Marfan syndrome slip. If a child has to have a lot of medical involvement, even s urgery, from early on, explaining that there is a medical reason helps him or her feel that it is not pure bad luck or his or her fault. If the child is having no problems, and just has yearly evaluations, parents nonetheless need to make it clear why these evaluations are important.

The situation can be even more challenging if a relative has had a difficult time because of Marfan syndrome and a child fears that he or she will have the same problems. At the same time, having a parent or other relative with Marfan syndrome who appears well and happy can also help to ease a child's concerns.

Two instances when a child's curiosity is likely to be piqued are when physical activities have to be curtailed and when other children comment on any unusual physical appearance or treatment, such as being tall, wearing a back brace or eyeglasses, or having to sit on the sidelines during gym class. Parents should talk with their child's teachers to keep them informed about what the child already understands.

Parents of young children with Marfan syndrome often want to know how to encourage development of a positive self-image in their child, especially when their child has Marfan features that affect their appearance. It is important to identify the special gifts that the child has, at an early age, and to emphasize that characteristics such as beauty are about much more than

appearance. Parents can read stories, cite examples, and explain to a child that while she or she has an indented chest, or is taller than their schoolmates, or must wear glasses, it is only one aspect of who they are as a person. They should refrain from the urge to fight their child's battles and the desire to be over-protective. Making an exception for them in all circumstances only makes them feel even more different and out of place.

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www.marfan.org

We have produced two illustrated books for children diagnosed with Marfan syndrome: *Marfan Syndrome A–Z* (for children ages 4–7) and *Marfan Does Not Mean Martian* (for ages 8–12).

E. Informing Adolescents about Marfan syndrome

Many teenagers believe that they look different from others, whether or not this is true. Those with Marfan syndrome may feel particularly self-conscious about the way they look. When they are first told of the diagnosis, they sometimes feel relieved to find a reason for being taller than their friends, for having thick glasses, a curved spine, or a chest that protrudes or indents.

Often, they feel annoyed or frightened that they need frequent doctor appointments, and upset if medication is prescribed—one more intrusion into their everyday routine. Parents should reassure them that preventive treatment for Marfan syndrome has advanced rapidly, and continues to advance, and help them understand their treatment.

Frequently, teenaers are angry, particularly if they must give up a competitive sport, such as basketball or soccer, that has been an integral part of their lives. They may direct their anger at their physician, their parents or themselves. Channeling their athletic interests into less physically stressful sports, such as golf or bowling, into becoming the team manager, or playing in the

band may be good alternatives. Another strategy is to develop other skills or talents that had been dormant.

Counseling can be helpful to teenagers and young adults with Marfan syndrome. Often it is beneficial for a young person to talk with another young person who has Marfan syndrome. If surgery has been recommended, it can be very helpful to speak with someone who has had the same or similar surgical procedure, remembering at the same time that Marfan syndrome varies from person to person, even within the same family, and experiences with major events like surgery tend to vary as well.

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Our booklet *Marfan Syndrome: A Guide for Teens* provides medical, psychological and social information.

F. Advocating for Your Child at School

Parents need to educate their child's teachers and other school staff about Marfan syndrome and its potential obstacles to learning. Marfan syndrome does *not* affect intelligence, but some of the features associated with it, such as poor vision and impaired motor skills, do require certain accommodations. If a child with Marfan syndrome has ADHD, it can be managed with medication, but it is important that this be coordinated with the cardiologist

When a school-age child is first diagnosed with Marfan syndrome, or if that child transfers to a new school, parents should approach the principal in a friendly manner, tell them about Marfan syndrome, and try to establish a spirit of cooperation. They should reach out to their child's teachers, the school nurse and the guidance counselor. A good attitude is to think of it as building a team to help the child maximize his or her potential.

To advocate for a child in school, a parent must first educate the educators, and then work with them to take whatever measures will help the child succeed. For example, if the child has poor vision, they may be moved to sit closer to the front of the

class or given print-outs of material on the board which they can more easily read. If a child has impaired motor skills, they may be allotted extra time to complete a handwriting assignment or allowed to use thicker writing implements or a computer. To relieve them of the physical stress of carrying too many heavy books, they may be given a second set to keep at home. If they are prescribed beta-blockers, which can cause fatigue and reduce concentration, they may receive extra time to complete a test. In some cases, a child with Marfan syndrome may benefit from an individualized program arranged through a school's special education department.

Teachers and other school staff should also be encouraged to treat children with Marfan syndrome as they would other children, as long as physical restrictions are not at issue. Children should be held to the same academic standards as their peers, and they should not be singled out in ways that can make them uncomfortable. Although they cannot participate in sports at the same level as other children, their aptitude for other activities, academic and extracurricular, is just as high. In addition, children with Marfan syndrome often look older than their classmates, and schools need to be made aware that this doesn't mean they are more mature or ready to skip a grade.

Parents should maintain regular contact with their "team" at the school, and adjust it if there are changes in policies or personnel. Tight budgets and crowded classrooms often mean teachers and other school staff are very busy juggling the needs of all their students. Touching base with them regularly can help focus their attention on the needs of a child with Marfan syndrome.

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www.marfan.org

Marfan Syndrome: Need-to-Know Information for the School Nurse **can be helpful in working with your child's school.**

3. INSURANCE ISSUES

A. Overview

Everybody should have health insurance, but for people with Marfan syndrome it is absolutely critical. In the U.S., most people receive health insurance coverage through their employers or government programs such as Medicare, while a smaller number purchase coverage independently.

Employer-based health insurance varies widely and is usually limited to full-time employees. In addition, many smaller employers may not offer it at all. The Health Insurance Portability and Accountability Act (HIPAA) offers protection for people receiving employer-based coverage, including those with pre-existing conditions, while the Consolidated Omnibus Budget Reconciliation Act (COBRA) provides continued coverage in the event of job loss. More information about employer-based insurance is provided on page 66.

Government health insurance programs provide coverage for seniors (Medicare), low-income people (Medicaid) and low-middle income children (Children's Health Insurance Program or CHIP). The latter two are managed at the state level and so vary from state to state.

People who cannot get insurance through an employer and are not eligible for government insurance may buy individual plans, but they are usually very expensive.

In addition to health insurance, people with Marfan syndrome may wish to consider getting other types of insurance policies, such as disability and life insurance.

The Georgetown Health Policy Institute offers a state-by-state consumer guide to getting and keeping health insurance online at www.healthinsuranceinfo.net.

The Department of Health and Human Services has a guide to low-cost insurance programs for children. The Foundation for Health Coverage Education offers a state-by-state guide of healthcare choices and 24-hour help line.

Some people with Marfan syndrome have been denied coverage for health, disability and life insurance because of their condition. Insurance is regulated at the state level, and some states have programs in place to guarantee health insurance (usually with restrictions and at above average cost) for those who are denied through regular channels. The situation changes monthly, and if you or a family member have problems, you should get the latest information from your state insurance commissioner.

B. Obtaining Coverage

It is impossible to cover all of the potential situations and solutions in a few paragraphs. However, a few generalities are in order.

i. Always answer questions on application forms honestly. Information provided in applications may find its way into national databases and be forever retrievable by other insurance providers.

ii. Do not submit any application until you thoroughly understand the policy for which you are applying.

iii. Plan ahead. This is especially important as children approach the age when they are no longer eligible for coverage through a parent's policy.

iv. The best solution for health, disability and life insurance is almost always a group policy through an employer. Unfortunately, the benefit package may become the major reason for taking or retaining a particular job.

v. Appeal denials of both coverage and specific claims. Individuals can usually handle a first appeal, but subsequent appeals may require help from physicians or even a lawyer.

v. Lobby state and Federal representatives to legislate effective health insurance coverage for everyone in the United States. Many people lack any health insurance and many more have inadequate coverage.

vi. Never give up or permit a policy to lapse until alternative coverage is in place.

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support@marfan.org
www.marfan.org

We will write personalized letters of support for appeals.

C. Maintaining Coverage

A change of employer or occupation is a crucial time. Before-making commitments to a change, investigate thoroughly the policies available through a potential employer. Smaller employers generally have less flexible, more restrictive health insurance policies, and the employer is less likely to tolerate or provide coverage for an employee who might require extensive medical care.

For people who leave or lose their job with a company that has more than 20 employees, COBRA mandates that the employer offer continuation of coverage for 18 months, although the departing employee must pay the premium. Under some circumstances, coverage can be extended beyond 18 months. If the company goes out of business, however, coverage is lost.

Minor children who reach the age when they are no longer covered under parental policies pose special problems. Options should be fully explored before the transition occurs.

When considering a job change, make sure to learn about the health insurance coverage provided by your prospective

Rights and Restrictions of Employer-based Insurance:

- Employers are not required to offer health coverage to their employees and/or their dependents.
- You can and should find out about a prospective employer's health benefits.
- Check the list of excluded benefits in particular.
- An employer cannot deny a job offer based on a disability.
- You cannot be excluded or dropped from your group health plan due to a Marfan syndrome or related disorder diagnosis. If you, your spouse, and/or dependent(s) are eligible for group health benefits from an employer, the Health Insurance Portability and Accountability Act of 1996 (HIPAA) will protect you from losing your health insurance.
- Even if you do not want your new employer to know that you have Marfan syndrome or a related disorder, failure to disclose information about your medical history or a pre-existing condition if asked by a health plan is considered fraud.
- If your child has Marfan syndrome or a related disorder and is currently insured by your/your spouse's employer, you should examine your manual to know exactly when your child will no longer be covered. This may occur at a specific age, when he or she enrolls in a student health plan, or when your child moves away from home. Your child with Marfan syndrome or a related disorder will be protected under the provisions of the Consolidated Omnibus Budget Reconciliation Act of 1985 (COBRA) and HIPAA if he or she has been covered under a group health plan in the past. If you want to put your child on his or her new school's health insurance, carefully read the plan before doing so.

employer. Some things to keep in mind are:

- Does the plan include disability services?
- Does it cover major surgeries? If so, what percentage of the cost does the plan cover?
- Does it provide discounts on medication?
- Are you allowed to visit the health care provider of your choice? If not, does the plan provide in-network access to doctors that are familiar with Marfan syndrome and related disorders?
- Does it cover out-of-state doctors/surgeons?
- Does it cover treatment for genetic disorders/pre-existing conditions?
- Are you responsible for a co-payment?

Going without health coverage for more than 63 days will result in the loss of some legal protections, so stay insured if at all possible.

D. What To Do If You Do Not Have Health Insurance

Various governmental assistance programs are available. Medicaid is administered by states with eligibility determined by income, age or disability. Medicare is a federal program available to people who have worked and are over age 65, or who have been on Social Security Disability Income for 24 months. Supplemental Security Income (SSI) is a federally administered program that provides financial support for individuals who meet income and disability criteria. If you qualify for SSI, then you also qualify for Medicaid. The central number to call to locate your local Social Security Administration office is 800-772-1213.

Some states have programs for people with certain conditions. The local March of Dimes Birth Defects Foundation can be helpful in identifying state or private agencies that might provide assistance.

If you are medically disabled, you may be eligible for Social Security benefits like Social Security Disability Insurance (SSDI), Supplemental Security Income (SSI), Medicare, and Medicaid.

PART V RELATED DISORDERS

Sometimes a person may have one or more features of Marfan syndrome, but not have enough features to meet the diagnostic criteria for Marfan syndrome. "Differential diagnosis" is the process of weighing the probability of one disease or disorder versus that of other diseases or disorders possibly accounting for a patient's illness or symptoms.

People may have disorders related to Marfan syndrome, such as other connective tissue disorders or metabolic disorders that closely resemble Marfan syndrome. A doctor will likely consider several conditions in the differential diagnosis to determine the actual diagnosis. Also, some people may have been incorrectly diagnosed with Marfan syndrome when they actually have a related disorder.

Regardless of the diagnosis, it is important to follow recommended treatments for the particular symptoms that do exist. For example, a person may not have enough features to be diagnosed with Marfan syndrome, but can still have an enlarged aorta. In this case, the aorta should still be monitored at regular intervals even though there is no Marfan diagnosis. If the condition is hereditary, ensure proper evaluation of other family members who may be at risk.

On the following pages are tables listing fifteen related disorders and their relation to Marfan syndrome. They include:

- Loeys-Dietz Syndrome
- Familial Thoracic Aortic Aneurysm Syndrome (FTAA)
- FTAA with biscuspid aortic valve (BAV)
- FTAA with patent ductus arteriosus (PDA)
- Arterial Tortuosity Syndrome (ATS)
- Familial Ectopia Lentis (Dislocated Lens)
- Shprintzen-Goldberg Syndrome

- Ehlers-Danlos Syndrome
- Homocystinuria
- Weill-Marchesani Syndrome
- Congenital Contractural Arachnodactyly (CCA) or Beals Syndrome
- Stickler Syndrome
- MASS Phenotype
- Marfanoid Habitus (Marfan Body Type)
- Mitral Valve Prolapse Syndrome

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More information is available on our website about disorders related to Marfan syndrome.

CONDITION	SYMPTOM OVERLAP WITH MARFAN SYNDROME
Loeys-Dietz Syndrome	• Aortic root enlargement and dissection. • Variable skeletal findings • Dural Ectasia • Stretch Marks
Familial Thoracic Aortic Aneurysm Syndrome (FTAA)	• Aortic enlargement (root or acending) and dissection.
FTAA with biscuspid aortic valve (BAV)	• Aortic enlargement (root or ascending) and dissection.
FTAA with patent ductus arteriosus (PDA)	• Aortic enlargement and dissection.

DISCRIMINATING FEATURES	GENE
• Craniosynostosis • Diffuse aortic and arterial aneurysms and dissections • Arterial tortuosity • Gastrointestinal problems • Cleft palate/bifid uvula • club foot • cervical spine instability • Lens dislocation not found • Hypertelorism • Thin and velvety skin • Easy bruising • Translucent skin • Dystrophic scars	*TGFBR1/ 2*
• Lack of marfanoid skeletal features • Diffuse aortic and arterial aneurysms and dissections (TGFBR 1 and TGFBR 2) • Iris flocculi (ACTA2) • Levido reticularis (ACTA2 (common in other connective tissue disorders including Marfan) • Occlusive vascular diseases include stroke, Moyamoya disease and coronary artery disease (ACTA2) • BAV and PDA (ACTA 2) • Dislocated lenses not found • Dural ectasia not found • Male predominance	*TGFBR1* *TGFBR2* *ACTA2**
• Male predominance • Aortic stenosis can occur	Unknown
Frequent PDA	*MYH11*

** The genes listed account for approximately 20% of FTAA. Many genes not yet identified.*

CONDITION	SYMPTOM OVERLAP WITH MARFAN SYNDROME
Arterial Tortuosity Syndrome (ATS)	• Aortic enlargement and dissection
Familial Ectopia Lentis (Dislocated Lens)	• Eye lens dislocation • Common skeletal findings
Shprintzen-Goldberg Syndrome	• Mitral valve prolapse • Skeletal findings • Myopia
Ehlers-Danlos Syndrome (vascular, valvular, kyphoscoliotic type)	• Skeletal Findings • Valve prolapse and Aortic enlargement and dissection in selected types only

DISCRIMINATING FEATURES	GENE
• Generalized arterial tortuosity • Arterial stenosis • Facial dysmorphism	*SLC2A10*
• Aortic root dilation/aneurysms not found but patients with FBN-1 mutations need periodic screening for aortic root aneurysms	*FBN1* *LTBP2* *ADAMTSL4*
• Craniosynostosis • Hypertelorism • Delayed motor and cognitive milestones • Mental retardation • Aortic root dilatation is uncommon • C1-C2 abnormality	*FBN1* and other
Vascular type: • Arterial, intestinal, uterine fragility and rupture • Characteristic facial appearance (thin lips and philtrum, small chin, thin nose, and large eyes) • Thin translucent skin with easy bruising • Dystropic scars • Facial characteristics Hypermobility type: • Joint Subluxation common • Skin soft or velvety, may be mildly hyperextensible Kyphoscoliotic Type: • Progressive scoliosis present at birth or within first year of life • Scleral fragility and rupture of the globe • Severe muscle hyptonia at birth • Friable, hyperextensible skin • Generalized joint laxity Classic Type: • Skin fragility and hyperextensibility • Widened atrophic scars • Joint hypermobility • Aortic root dilation can occur	*COL3A1* *COL1A2* *PLOD1*

CONDITION	SYMPTOM OVERLAP WITH MARFAN SYNDROME
Homocystinuria	• Mitral Valve Prolapse • Eye lens dislocation and myopia • Skeletal findings
Weill-Marchesani Syndrome	None
Congenital Contractural Arachnodactyly (CCA) or Beals Syndrome	• Mitral valve prolapse and aortic enlargement can occur • Variable skeletal findings
Stickler Syndrome	• Myopia Retinal detachment • Joint hypermobility or contracture • Scoliosis • Mitral Valve Prolapse
MASS Phenotype	• Aorta remains at the upper limits of normal • Skin (stretch marks) and skeletal findings • Mitral valve prolapse • Myopia • Marfanoid skeletal findings
Marfanoid Habitus (Marfan Body Type)	• Skeletal findings
Mitral Valve Prolapse Syndrome	• Mitral valve prolapse • Variable skeletal findings

DISCRIMINATING FEATURES	GENE
• Arterial and venous thrombosis • Mental retardation • Seizures common	*CBS*
• Microspherophakia • Short stature • Brachydactyly • joint stiffness • No aneurysms	*FBN1* and *ADAMTS10*
• Crumpled appearance to the top of the ear • Inability to fully extend multiple joints such as fingers, elbows, knees, toes and hip contractures • Delay in motor development often occurs (due to congenital contractures) • Eyes are not affected • Dissections very rare	*FBN2*
• Hearing loss • Chorioretinal and vitreous degeneration are the hallmark of the syndrome • Orofacial involvement such as cleft palate • Premature osteoarthritis	*COL2A1* *COL9A* *COL11A1* *COL11A2*
• Aorta does not progress in enlargement • Dislocated lenses not found	*FBN1* (Rarely)
• No heart/aortic and ocular involvement	*FBN1* (Rarely)
• Relatively common disorder • Aortic enlargement and ocular involvement of MFS are not findings	*FBN1* (Rarely)

Conclusion

If you or a loved one suspect or have Marfan syndrome or a related disorder, the most important thing you can do is to educate yourself about it—know the facts, the risks and how to minimize them, and what to do in the event of an emergency.

Reading this book is a first step, but it is only a primer. We urge you to continue your education by speaking with your physician and appropriate medical specialists, taking advantage of the many resources available through The Marfan Foundation and other organizations dedicated to related disorders*, and learning everything you can from others who share your experience.

Sometimes you will need to be the one to educate others. Should an emergency arise and you find yourself in an ER, you should be prepared to explain your condition, or that of your loved one, even to seasoned medical professionals. If you are a parent of a child with Marfan syndrome, you will need to teach their teachers (and babysitters, camp counselors, their friends' parents, et al.) about it, and how it does—and doesn't—affect what they can do. And if you are a parent who has Marfan syndrome, you may need to teach your child about it one day.

Down the road, hopefully you will want to share your knowledge with others who are newly affected by Marfan syndrome or a related disorder. Doctors and scientists play vital roles in helping people manage these conditions, but so do those who have lived with them as patients and parents, spouses and siblings.

Whatever stage you are at in this journey, The Marfan Foundation is here for you. Call us at 800-8-MARFAN, email support@marfan.org, or visit www.marfan.org to learn more.

** Our website has a section on related disorders which includes links to organizations dedicated to Loeys-Dietz syndrome, Familial Aortic Aneurysm (FAA), Scoliosis, Stickler syndrome, Bicuspid Aortic Valve, and Ehlers-Danlos syndrome.*

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THE MARFAN FOUNDATION

The Marfan Foundation, founded in 1981, is a non-profit voluntary health organization that creates a brighter future for everyone affected by Marfan syndrome and related disorders.

- We pursue the most innovative research and make sure that it receives proper funding.
- We create an informed public and educated patient community to increase early diagnosis and ensure life-saving treatment.
- We provide relentless support to families, caregivers, and healthcare providers.

We will not rest until we've achieved victory—a world in which everyone with Marfan syndrome or a related disorder receives a proper diagnosis, gets the necessary treatment, and lives a long and full life.

22 Manhasset Avenue, Port Washington, NY 11050
516 883 8712 800 8 MARFAN
Marfan.org

Is Marfan syndrome inherited?

How do they test for it?

What type of doctor should I see?

Will I need surgery?

What can I do to protect myself?

How can I help my child?

If it's not Marfan syndrome, what is it?

A Guide to Marfan Syndrome and Related Disorders answers these and other questions people face in the event or possibility of a Marfan syndrome or related connective tissue disorder diagnosis. It also provides information about other resources created by The Marfan Foundation and others to help you manage medical care for yourself or your family members and cope with psychological, social and lifestyle challenges posed by the diagnosis.

A Guide to Marfan Syndrome and Related Disorders is published by The Marfan Foundation. Learn more at www.marfan.org.