



NIDCD Fact Sheet

# Usher Syndrome

U.S. DEPARTMENT OF HEALTH & HUMAN SERVICES · NATIONAL INSTITUTES OF HEALTH · NATIONAL INSTITUTE ON DEAFNESS AND OTHER COMMUNICATION DISORDERS

## What is Usher syndrome?

Usher syndrome is the most common condition that affects both hearing and vision. A syndrome is a disease or disorder that has more than one feature or symptom. The major symptoms of Usher syndrome are hearing loss and an eye disorder called retinitis pigmentosa, or RP. RP causes night-blindness and a loss of peripheral vision (side vision) through the progressive degeneration of the retina. The retina is a light-sensitive tissue at the back of the eye and is crucial for vision (see photograph). As RP progresses, the field of vision narrows—a condition known as "tunnel vision"—until only central vision (the ability to see straight ahead) remains. Many people with Usher syndrome also have severe balance problems.

There are three clinical types of Usher syndrome: type 1, type 2, and type 3. In the United States, types 1 and 2 are the most common types. Together, they account for approximately 90 to 95 percent of all cases of children who have Usher syndrome.

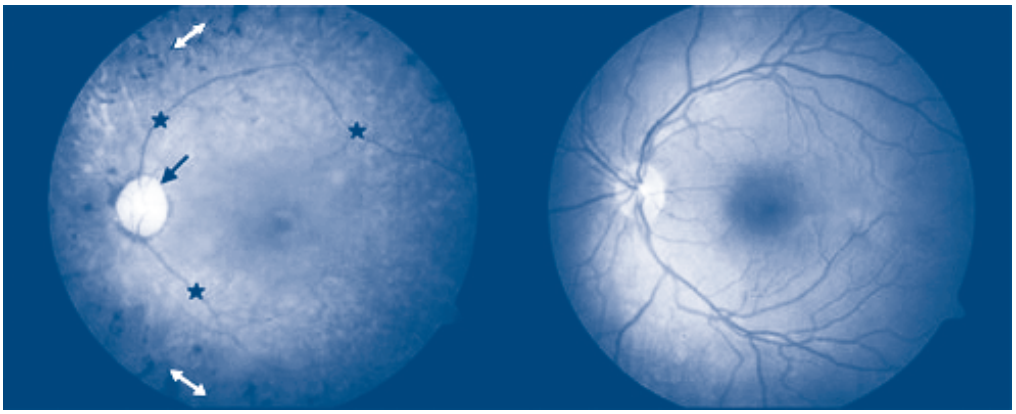
## Who is affected by Usher syndrome?

Approximately 3 to 6 percent of all children who are deaf and another 3 to 6 percent of children who are hard-of-hearing have Usher syndrome. In developed countries such as the United States, about four babies in every 100,000 births have Usher syndrome.

## What causes Usher syndrome?

Usher syndrome is inherited, which means that it is passed from parents to their children through genes. Genes are located in almost every cell of the body. Genes contain instructions that tell cells what to do. Every person inherits two copies of each gene, one from each parent. Sometimes genes are altered, or mutated. Mutated genes may cause cells to act differently than expected.

Usher syndrome is inherited as an autosomal recessive trait. The term autosomal means that the mutated gene is not located on either of the chromosomes



Photograph of the retina of a patient with Usher syndrome (left) compared to a normal retina (right). The optic nerve (arrow) looks very pale, the vessels (stars) are very thin, and there is characteristic pigment, called bone spicules (double arrows).

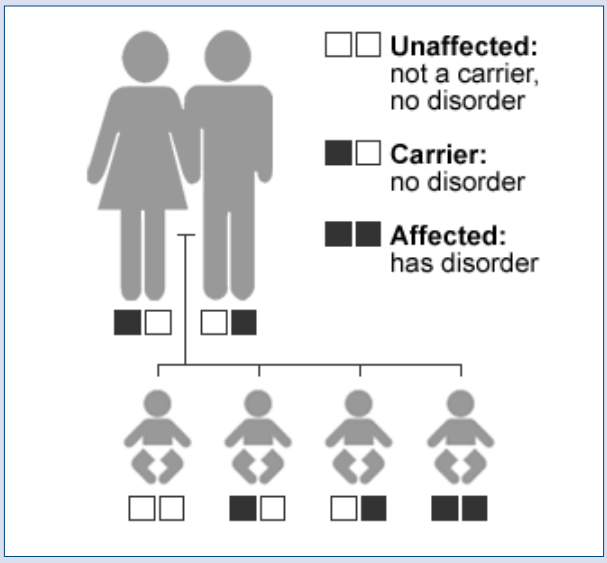
NIDCD National Institute on Deafness and Other Communication Disorders
*Improving the lives of people who have communication disorders*



NIDCD Fact Sheet

# Usher Syndrome

## Chances of Inheriting a Recessive Disorder




Genetic disorders can be caused by one or more changes in a gene. Every individual has two copies of the same gene. Genetic disorders are inherited in different ways. Usher syndrome is a recessive disorder.

Recessive means:

- A person must inherit a change in the same gene from each parent in order to have the disorder.
- A person with one changed gene does not have the disorder, but can pass either the changed or the unchanged gene on to his or her child.

An individual with Usher syndrome usually has inherited a change in the same gene from each parent.

An individual who has one changed Usher syndrome gene is called a carrier. When two carriers of the same Usher syndrome gene have a child together, with each birth there is a:

- 1-in-4 chance of having a child with Usher syndrome.
- 2-in-4 chance of having a child who is a carrier.
- 1-in-4 chance of having a child who neither has Usher syndrome nor is a carrier.

that determine a person's sex; in other words, both males and females can have the disorder and can pass it along to a child. The word recessive means that, to have Usher syndrome, a person must receive a mutated form of the Usher syndrome gene from each parent. If a child has a mutation in one Usher syndrome gene but the other gene is normal, he or she is predicted to have normal vision and hearing. People with a mutation in a gene that can cause an autosomal recessive disorder are called carriers because they "carry" the gene with a mutation, but show no symptoms of the disorder. If both parents are carriers of a mutated gene for Usher syndrome, they will have a one-in-four chance of having a child with Usher syndrome with each birth. (See sidebar on "Chances of Inheriting a Recessive Disorder.")

Usually, parents who have normal hearing and vision do not know if they are carriers of an Usher syndrome gene mutation. Currently, it is not possible to determine whether a person who does not have a family history of Usher syndrome is a carrier. Scientists at the National Institute on Deafness and Other Communication Disorders are hoping to change this, however, as they learn more about the genes responsible for Usher syndrome.

## What are the characteristics of the three types of Usher syndrome?

### Type 1

Children with type 1 Usher syndrome are profoundly deaf at birth and have severe balance problems. Many of these children obtain little or no benefit from hearing aids. Parents should consult their doctor and other hearing health professionals as early as possible to determine the best communication method for their child. Intervention should be introduced early, during the first few years of life, so that the child can take advantage of the unique window of time during

which the brain is most receptive to learning language, whether spoken or signed. If a child is diagnosed with type 1 Usher syndrome early on, before he or she loses the ability to see, that child is more likely to benefit from the full spectrum of intervention strategies that can help him or her participate more fully in life's activities.

Because of the balance problems associated with type 1 Usher syndrome, children with this disorder are slow to sit without support and typically don't walk independently before they are 18 months old. These children usually begin to develop vision problems in early childhood, almost always by the time they reach age 10. Vision problems most often begin with difficulty seeing at night, but tend to progress rapidly until the person is completely blind.

### Type 2

Children with type 2 Usher syndrome are born with moderate to severe hearing loss and normal balance. Although the severity of hearing loss varies, most of these children can benefit from hearing aids and can communicate orally. The vision problems in type 2 Usher syndrome tend to progress more slowly than those in type 1, with the onset of RP often not apparent until the teens.

### Type 3

Children with type 3 Usher syndrome have normal hearing at birth. Although most children with the disorder have normal to near-normal balance, some may develop balance problems later on. Hearing and sight worsen over time, but the rate at which they decline can vary from person to person, even within the same family. A person with type 3 Usher syndrome may develop hearing loss by the teens, and he or she will usually require hearing aids by mid- to late adulthood. Night blindness usually begins sometime during puberty. Blind spots appear by the late teens to early adulthood, and, by mid-adulthood, the person is usually legally blind.

The table at the bottom of the page is a summary of the characteristics of each type of Usher syndrome.

## Characteristics of Usher Syndrome, by Type

| | Type 1 | Type 1 | Type 3 |
|---|---|---|---|
| **Hearing** | Profound deafness in both ears from birth | Moderate to severe hearing loss from birth | Normal at birth; progressive loss in childhood or early teens |
| **Vision** | Decreased night vision before age 10 | Decreased night vision begins in late childhood or teens | Varies in severity; night vision problems often begin in teens |
| **Vestibular function (balance)** | Balance problems from birth | Normal | Normal to near-normal, chance of later problems |

## How is Usher syndrome diagnosed?

Because Usher syndrome affects hearing, balance, and vision, diagnosis of the disorder usually includes the evaluation of all three senses. Evaluation of the eyes may include a visual field test to measure a person's peripheral vision, an electroretinogram (ERG) to measure the electrical response of the eye's light-sensitive cells, and a retinal examination to observe the retina and other structures in the back of the eye. A hearing (audiologic) evaluation measures how loud sounds at a range of frequencies need to be before a person can hear them. An electronystagmogram (ENG) measures involuntary eye movements that could signify a balance problem.

Early diagnosis of Usher syndrome is very important. The earlier that parents know whether their child has Usher syndrome, the sooner that child can begin special educational training programs to manage the loss of hearing and vision.

## Is genetic testing for Usher syndrome available?

So far, 11 genetic loci (a segment of chromosome on which a certain gene is located) have been found to cause Usher syndrome, and nine genes have been pinpointed that cause the disorder. They are:

- Type 1 Usher syndrome: *MY07A, USH1C, CDH23, PCDH15, SANS*
- Type 2 Usher syndrome: *USH2A, VLGR1, WHRN*
- Type 3 Usher syndrome: *USH3As*

With so many possible genes involved in Usher syndrome, genetic tests for the disorder are not conducted on a widespread basis. Diagnosis of Usher syndrome is usually performed through hearing, balance, and vision tests. Genetic testing for a few of the identified genes is clinically available. To learn about laboratories that conduct clinical testing, visit the Web site *www.GeneTests.org* and search the laboratory directory by typing in the term "Usher syndrome." Genetic testing for additional Usher syndrome genes may be available through clinical research studies. To learn about clinical trials that include genetic testing for Usher syndrome, visit the Web site *www.clinicaltrials.gov* and type in the search term "Usher syndrome" or "Usher genetic testing."

## How is Usher syndrome treated?

Currently, there is no cure for Usher syndrome. The best treatment involves early identification so that educational programs can begin as soon as possible. The exact nature of these programs will depend on the severity of the hearing and vision loss as well as the age and abilities of the person. Typically, treatment will include hearing aids, assistive listening devices, cochlear implants, or other communication methods such as American Sign Language; orientation and mobility training; and communication services and independent-living training that may include Braille instruction, low-vision services, or auditory training.

Some ophthalmologists believe that a high dose of vitamin A palmitate may slow, but not halt, the progression of retinitis pigmentosa.This belief stems from the results of a long-term clinical trial supported by the National Eye Institute and the Foundation for Fighting Blindness. Based on these findings, the researchers recommend that most adult patients with the common forms of RP take a daily supplement of 15,000 IU (international units) of vitamin A in the palmitate form under the supervision of their eye care professional. (Because people with type 1 Usher syndrome did not take part in the study, high-dose vitamin A is not recommended for these patients.)

People who are considering taking vitamin A should discuss this treatment option with their health care provider before proceeding. Other guidelines regarding this treatment option include:

- Do not substitute vitamin A palmitate with a beta-carotene supplement.
- Do not take vitamin A supplements greater than the recommended dose of 15,000 IU or modify your diet to select foods with high levels of vitamin A.
- Women who are considering pregnancy should stop taking the high-dose supplement of vitamin A three months before trying to conceive due to the increased risk of birth defects.
- Women who are pregnant should stop taking the high-dose supplement of vitamin A due to the increased risk of birth defects.

In addition, according to the same study, people with RP should avoid using supplements of more than 400 IU of vitamin E per day.

## What research is being conducted on Usher syndrome?

Researchers are currently trying to identify all of the genes that cause Usher syndrome and determine the function of those genes. This research will lead to improved genetic counseling and early diagnosis, and may eventually expand treatment options.

Scientists also are developing mouse models that have the same characteristics as the human types of Usher syndrome. Mouse models will make it easier to determine the function of the genes involved in Usher syndrome. Other areas of study include the early identification of children with Usher syndrome, treatment strategies such as the use of cochlear implants for hearing loss, and intervention strategies to help slow or stop the progression of RP.

## What are some of the latest research findings?

NIDCD researchers, along with collaborators from universities in New York and Israel, pinpointed a mutation, named R245X, of the PCDH15 gene that accounts for a large percentage of type 1 Usher syndrome in today's Ashkenazi Jewish population. (The term "Ashkenazi" describes Jewish people who originate from Eastern Europe.) Based on this finding, the researchers conclude that Ashkenazi Jewish infants with bilateral, profound hearing loss who lack another known mutation that causes hearing loss should be screened for the R245X mutation.

## Where can I find more information?

NIDCD maintains a directory of organizations that can answer questions and provide printed or electronic information on Usher syndrome. Please see the list of organizations at *www.nidcd.nih.gov/directory*.

Use any of the following keywords to help you search for organizations that are relevant to Usher syndrome:

- Usher syndrome
- Hereditary hearing loss
- Genetic diseases/disorders
- Deaf-blindness

For more information, additional addresses and phone numbers, or a printed list of organizations, contact:

NIDCD Information Clearinghouse
1 Communication Avenue
Bethesda, MD 20892-3456
Toll-free Voice: (800) 241-1044
Toll-free TTY: (800) 241-1055
Fax: (301) 770-8977
E-mail: nidcdinfo@nidcd.nih.gov

NIDCD Fact Sheet: Usher Syndrome
Publication No. 98-4291
Updated February 2008

For more information, contact:
NIDCD Information Clearinghouse
1 Communication Avenue
Bethesda, MD 20892-3456
Toll-free Voice: (800) 241–1044
Toll-free TTY: (800) 241–1055
Fax: (301) 770–8977
E-mail: nidcdinfo@nidcd.nih.gov
Internet: www.nidcd.nih.gov

The NIDCD Information Clearinghouse is a service of the National Institute on Deafness and Other Communication Disorders, National Institutes of Health, U.S. Department of Health and Human Services.