

# Glaucoma

## Why is Glaucoma an emerging public health issue?

Glaucoma is an eye disease that can cause blindness. Also known as the "sneak thief of sight", it is one of the leading causes of blindness in the world affecting approximately 3 million Americans and 67 million people worldwide. African-Americans over age 40 and anyone over age 60 are at greater risk than others for developing glaucoma. Because there are not any obvious symptoms presenting early in the disease, half of the people with glaucoma are undiagnosed. Once damage to the eye has occurred, it is irreversible.

If glaucoma is diagnosed, treatments are available, including eye drops, laser and traditional surgery. Early detection and treatment can usually stop further damage and prevent blindness. Yearly, comprehensive eye examinations with dilated pupils performed by eye care professionals are necessary.

There are various forms of glaucoma, some of which are inherited, and others that are independent of genetics. Current research concentrating on the various forms of glaucoma will hopefully yield information that will allow us to better understand the disease, including how it can be passed through families. People should find out if anyone in their family has glaucoma. New knowledge may enable us to develop tests that aid in the identification of individuals at risk for the disease and improved therapies to treat affected individuals.

Suggested reading: West, SK (2000) Looking forward to 20/20: a focus on the epidemiology of eye diseases. [Epidemiol Rev 22\(1\):64-70](#)

## What is Glaucoma?

Glaucoma is characterized by damage to the [optic nerve](#) and loss of vision caused by increased pressure in the eye. Fluid is constantly produced by a tiny gland in the eye called the [ciliary body](#), which is located behind the [iris](#) (the colored part of the eye). This fluid nourishes the [cornea](#) and lens and then flows out of the eye via the [trabecular meshwork](#), which is essentially the drainage system of the eye. When this drainage system becomes clogged, the fluid does not leave the eye as fast as it is produced. Therefore, the fluid gets backed up and causes increased pressure within the eye, known as [intraocular pressure](#). The increase in pressure damages, and eventually kills, the cells of the optic nerve. The optic nerve is responsible for carrying visual information to the brain. The death of cells comprising the optic nerve essentially destroys the line of communication between the eye and the brain, therefore, causing permanent loss of vision.

## What are the symptoms of Glaucoma?

Unfortunately, there are no obvious symptoms or pain associated with the early stages of glaucoma. Side vision, known as peripheral vision, slowly begins to diminish. However, many people ignore this because they believe that they simply need new glasses. Therefore, most people are not aware that the disease affects them until severe damage to the eye and permanent vision loss has occurred. Therefore, frequent and regular eye exams are essential to prevent, diagnose, and minimize the effects of the disease.

## What are the hereditary types and causes of Glaucoma?

- Primary open-angle glaucoma (POAG)
- Juvenile-onset open angle glaucoma (JOAG)
- Chronic open angle glaucoma (COAG)
- Glaucoma associated with pigment dispersion syndrome
- Glaucoma associated with pseudoexfoliation
- Congenital glaucoma
- Low or normal tension glaucoma
- Post-traumatic glaucoma
- Narrow angle glaucoma

Glaucoma is caused by increased pressure in the eye that causes damage to the system responsible for relaying visual information to the brain. The average pressure in the eye, known as intraocular pressure, is between 14 and 16 mm of mercury. However, pressures up to 20 mm of mercury are considered to be within the normal range. When a pressure of 22 mm of mercury or above is reached, concern is warranted. There are numerous different types of glaucoma that can be defined by their characteristics and age of onset.

This is the most common form of glaucoma, which affects approximately 7 to 8 million Americans. Pressure within the eye rises slowly causing the individual to gradually lose vision. Because this disease is painless and without obvious symptoms, most patients will not realize they are affected until the later stages of the disease when damage is irreversible. This disease predominantly occurs in people over the age of 40 and is known as adult onset. The disease is inherited in an [autosomal dominant](#) fashion. In an [autosomal dominant](#) disorder a person must only possess one copy of the gene to express a trait. Therefore, if a person with the trait were to have children, each child would have a 50% chance of [inheriting](#) the disease. There is also a subset of POAG, known as juvenile-onset open angle glaucoma.

### Juvenile-onset open angle glaucoma (JOAG)

This subset of POAG affects children, adolescents, and young adults. The disorder can be inherited as either an [autosomal dominant](#) or an [autosomal recessive](#) disorder in families. The most common form is [autosomal dominant](#). In an [autosomal recessive](#) disorder, a person who possesses one copy of the gene is known as a [carrier](#), or [heterozygote](#), and does not exhibit the trait. A person carrying two copies of the gene is known as a [homozygote](#) and will express characteristics of the disease. If two carriers were to have children, each child has a 25 percent chance of being affected ([homozygote](#)), a 50 percent chance of being a [carrier](#) ([heterozygote](#)), and a 25 percent chance of not possessing the [gene](#) at all. Researchers have linked JOAG to [chromosome](#) 1 and more specifically to the TIGR (trabecular meshwork induced glucocorticoid response) gene, which is involved with the trabecular meshwork (drainage system of the eye) and the ciliary body (tiny gland that produces fluid in the eye).

### Chronic open angle glaucoma (COAG)

This type of glaucoma is typically seen after the age of 35 and is most commonly inherited as an [autosomal dominant](#) disease or a [multifactorial](#) disease. A multifactorial disease is caused by a combination of [genes](#) and environmental factors. However, inheritance patterns of [autosomal recessive](#) and [X-linked](#) have also been observed. In an X-linked disorder the genes for the trait are

carried on the [X chromosome](#) (sex chromosome). A father with an [X-linked](#) disorder will pass the genes onto all of his daughters (XX) and none of his sons (XY) because they receive their single [X chromosome](#) from their mother. A mother with an [X-linked](#) disorder will pass the genes onto half of her children.

### **Glaucoma associated with pigment dispersion syndrome**

This form of glaucoma occurs more frequently in men than women and has an age of onset in the twenties and thirties. Nearsighted people are at an increased risk for this disease due to the concave shape of their [ciliary body](#), which is located behind the [iris](#). [Pigmentary](#) glaucoma occurs when pigment granules flake off of the [ciliary body](#), which is located behind the [iris](#) and clog the eye's drainage system.

### **Congenital Glaucoma**

This disease occurs when infants are born with defects of the eye that inhibit it from properly draining fluids. This disease is predominantly inherited as an [autosomal recessive](#) disorder, but cases of [autosomal dominant](#) and [multifactorial](#) inheritance have been observed. There are also other forms of glaucoma that are not inherited.

### **How is glaucoma detected?**

Eye care professionals possess a variety of diagnostic tools that can aid in the detection of glaucoma. Regular testing, depending upon risk factors, can lead to the diagnosis of glaucoma before symptoms exist. Individuals considered at high risk for glaucoma should be tested at least every two years.

Screening for glaucoma is not a trivial process, nor can it be done with a single test like the measurement of blood pressure for hypertension. Individuals can have glaucoma and damage to their vision even if their intraocular pressure measurements are normal. Variations in the appearances of people's optic nerves can make it difficult to tell if early glaucoma-related damage is present. Visual field testing (described below) requires the cooperation and concentration of the subject and can be affected by inexperience, impatience, or distractions. These difficulties and costs in screening are largely why it is necessary to focus screening efforts on high risk groups rather than conducting nonselected population-based screening.

### **Characteristics of High Risk Individuals:**

- Age over 45 years
- A family history of glaucoma
- An abnormally high [intraocular pressure](#)
- African American ancestry
- Diabetes
- Nearsightedness
- History of a previous eye injury
- History of extended use of steroids/cortisone

## Tests used for the diagnosis of glaucoma:

### Tonometry

In this technique, a device called a tonometer directly measures the pressure in the eye. There are three possible methods of tonometry that can be used. Applanation tonometry applies direct pressure to the eye with a plastic prism that can take a pressure reading. This method requires that anesthetic drops be put in both eyes. While this is the most accurate method, there are new, handheld devices that can also rapidly measure the eye pressure by momentary contact with the cornea. Air tonometry does not require direct contact with the eye and takes a measurement by sending a puff of air onto the eyeball. Though less accurate than the other methods and somewhat more disconcerting for the subject, air tonometry has the advantage of not using any eye drops or directly contacting the eye.

### **Visual Field Testing**

This test measures an individual's ability to detect a target or light that is outside of their central vision. Glaucoma initially affects a person's side or peripheral vision and this test can detect damage to these areas of sight. Lights of varying brightness and dimness are flashed and the individual is asked to respond by pressing a button each time he/she sees a light.

### Pupil Dilation

Special drops are applied to the eyes that temporarily enlarge the pupil to allow the doctor to better view inside the eye.

### Ophthalmoscopy

An instrument called an ophthalmoscope is used, which allows the doctor to look through the pupil at the optic nerve. The color and appearance of the optic nerve can tell the doctor whether or not there is damage from glaucoma.

There are new instruments to digitally measure the features of the optic nerve and allow for a record to be made of the nerve for future comparisons. This instrument can be used with either dilated or undilated eyes.

## How is Glaucoma treated?

### **Eyedrops**

There are different classes of eyedrops that can be prescribed according to the specific needs of an individual. All eyedrops may cause a burning or stinging sensation upon application that will last only a few seconds. Be sure to ask your doctor or pharmacist about possible side effects associated with eyedrops and to verify the safety of mixing them with other medications.

<b>Eyedrops and their Respective Functions</b>	
<b>Eyedrop Type</b>	<b>Function</b>
Miotics	Open the eye's drain to facilitate and increase the flow of fluid out of the eye
Beta-Blockers	Decrease the flow rate of fluid into the eye
Latanoprost	Increase the flow rate of fluid out of the eye
Apraclonidine	Prevent sudden increases in intraocular pressure during laser surgery; also used long term

## **Oral Medications**

Medications are usually prescribed in addition to eyedrops when eyedrops alone cannot sufficiently control the intraocular pressure. These agents can decrease the amount of fluid produced in the eye. Many have additional side effects associated with them, so it is very important to consult your doctor before taking them.

## **Carbonic Anhydrase Inhibitors**

This medication may reduce the flow of fluid into the eye.

## **Surgery ([trabeculectomy](#))**

A small piece of the eye's drain, the [trabecular meshwork](#), is removed to allow fluid to drain easier. This will decrease the pressure in the eye. After surgery, vision may not revert back to normal for several weeks, but most patients are able to stop taking all other anti-glaucoma medications. Although relatively safe, approximately one-third of all patients will develop cataracts within five years of the procedure.

## **Laser Surgery**

During this ten to twenty minute procedure a high energy light beam, known as a [laser](#) beam, is focused on the eye's drain (trabecular meshwork). The heat from the laser beam shrinks particular areas of the drain allowing adjacent areas to stretch open. This facilitates drainage of eye fluid, which will decrease intraocular pressure within a few weeks of the surgery. As an intermediate step between medication and surgery, this procedure is becoming increasingly popular because it is painless, has minimal complications, and does not induce cataract development.

## **Information and Support Resources**

- [The Glaucoma Foundation](#)
- [Glaucoma Research Foundation](#)
- [Youth and Under Pressure \(YUP\)](#)
- **Additional References**
- Eid, Tarek M & Spaeth, George L (2000) The Glaucomas: Concepts and Fundamentals. Lippincott Williams & Wilkins, Philadelphia.
- Traboulsi, Elias, I. (1998) Genetic Diseases of the Eye. Oxford University Press, New York