A Patient’s Guide to Glaucoma
“Glaucoma” describes a whole group of diseases affecting the eye. Many different types of glaucoma exist. Treatment depends upon the type of glaucoma. The factor common to all types of glaucoma is damage to the tissues of the eye due to pressure inside the eye too high for that particular eye to withstand.

What Causes the Damage?

Normally, watery fluid (aqueous humor) constantly flows into and out of the eye. This fluid keeps the eye firm and clear so that the eye can function well as an optical instrument. The fluid is made in the ciliary body behind the iris, flows through the pupil and leaves via the Canal of Schlemm (Diagrams 1 and 2). The relative state of inflow and outflow of aqueous humor partially determines how firm the eye is. If the outflow is blocked, pressure inside the eye builds up.

Diagram 1.
The pressure within the eye, the intraocular pressure (IOP), can directly damage the optic nerve. This is the nerve that carries the electrical impulses from the light-sensitive part of the eye to the brain, where the electrical impulses are put together to form a picture. Even when the intraocular pressure is not above average, it may still be high enough in certain susceptible individuals to cause optic nerve damage. The higher the intraocular pressure becomes the more likely is damage to not only the optic nerve but also other tissues as well, such as the cornea and the lens. The outflow of fluid, aqueous humor, can be blocked in different ways:

The hole (the pupil) through which the fluid flows as it passes from the back to the front of the iris (the colored part of the eye) can get blocked by adhesions or by a cataract.

The sieve out of which the fluid exits (the trabecular meshwork) can become blocked by debris caused by inflammation, by deposits that are due to aging, by abnormal material which is sometimes the result of drugs, or by the iris itself.

The veins into which the fluid flows when it leaves the eye can be also be blocked and can raise the eye pressure.

Normal open anterior chamber angle showing the flow of aqueous humor through the pupil and out of the Canal of Schlemm. The fact that the “angle is open,” however, does not mean that the eye cannot have glaucoma. The usual cause for pressure within the eye with an open angle is resistance to flow through the trabecular meshwork into the Canal of Schlemm.

Narrow anterior chamber angle, open but capable of closing.

Closed anterior chamber angle with flow blocked. Treatment to open the “angle” of this eye will allow aqueous to get to the trabecular meshwork and allow the intraocular pressure to fall, unless the meshwork itself does not work normally.
Proper Diagnosis is Key to Corrective Action

The treatment of the various types of glaucoma may be very different. Some patients need surgery, some need medicine for the eye, some need medicine for the body and others need to have certain medicines stopped.

When the optic nerve does not continue to become damaged, the glaucoma is considered “controlled.” When the patient has “uncontrolled” glaucoma, the nerves become more damaged. Once a correct diagnosis is made, control often becomes possible. In fact, if a diagnosis is made when the nerve fibers are only injured but not actually dead, the damage is often reversible. The earlier the diagnosis is made, the less likely it is that damage will occur. The later the diagnosis made, the more likely it is that damage will occur, and the less “room” there is for further damage without the person losing function.

The result of nerve damage is loss of part of the vision, most frequently the part of the visual field toward the nose. At the start of the disease, this usually does not affect central vision or the side vision toward the outside periphery (“peripheral vision”). So, the person with glaucoma rarely notices the injury in its early stages. It can often only be detected by specifically testing for it. With proper treatment, some vision may return in such cases, but only rarely can the full field of vision be restored.

Average Pressure/
The Range of Normal Pressure

Average intraocular pressure in adults is 15mm Hg (mercury). If the pressure is below 7mm Hg, the eye may be too soft to function well.

If the pressure is consistently above 21mm Hg, the chance that the eye will eventually be damaged by the pressure is around 5%. When the pressure inside the eye is above 28mm Hg, the likelihood increases to about 50%. When the intraocular pressure is above 34mm Hg, the chance that damage will eventually develop may be close to 100%, though it may take months to years for damage to be noticed.

What constitutes healthy intraocular pressure varies by individual. For example, some people with an intraocular of 16mm Hg may need surgery to stop progressive glaucoma; however others with a pressure of 26mm Hg may not need any treatment. The relationship between intraocular pressure and glaucoma is easy to understand if one recognizes that even the normal eye has a “high” pressure — a pressure that by itself can cause damage. For unknown reasons, however, most people’s eyes are not damaged by that “average” or “normal” intraocular pressure. But the nerves of some individuals are easily damaged, even by the average pressure; others have nerves that are resistant to damage, even at higher levels such as 26mm Hg.
Table 1: Stages of Glaucoma

1. Is at Risk
- Everybody at any age

2. Is at Greater Risk than Average
- Has a gene associated with glaucoma
- Has a family history of glaucoma
- Is of African extraction
- Is of Chinese extraction
- Has a narrow anterior chamber angle
- Uses cortisone products
- Has been hit in the eye
- Has other ocular diseases or surgery
- Is over 70 years of age
- Has eye pressure greater than 21mm Hg

3. Has Glaucoma
- Characteristic optic nerve damage regardless of the level of pressure in the eye
- Intraocular pressure over 35mm Hg
- Asymmetry difference between the two eyes

4. Glaucoma Confirmed
- Optic disc tissue loss
- Narrowing of the rim tissue of the optic nerve
- Acquired pit of the optic nerve
- Hemorrhage on the disc
- Asymmetry between the nerves
- Visual field loss which starts towards the nose and progresses towards the center
- Loss of function when damage is marked
- Increasing difficulty with activities of living
- Trouble in the dark, reading problems, misty vision, etc.

Types of Glaucoma

Some types of glaucoma are chronic, which means they continue to be present for a long time. Other types of glaucoma are acute; that is, they occur suddenly. In the United States, the most common type of glaucoma is chronic, open-angle glaucoma. Acute angle-closure glaucoma is less common.

Glaucomas following trauma to the eye or in association with the exfoliation syndrome, pigment dispersion syndrome, cataracts, and other changes in the eye are called secondary glaucomas (Table 2).

Table 2: Types of Glaucoma

Rapidity of Onset and Duration of Disease
- Acute = rapid onset (within hours)
- Subacute = onset within days
- Chronic = present for many years

Mechanisms of Pressure Control
- Open-angle
- Closed-angle

Specific Types
- Primary – no known cause
- Secondary – cause known, such as:
  - Trauma
  - Tumor
  - Eye disease
What Symptoms to Look For

The person with one of the chronic glaucomas frequently is unaware that the disease is present in the eye. Like the hands of a clock, it moves so slowly that its progress is not noticed. On the other hand, acute glaucoma, in which the pressure rises rapidly, often causes symptoms which may be severe. Symptoms that suggest that presence of chronic or acute glaucoma include:

- Trouble focusing
- Poor night vision
- Sensation of a blind area
- Headaches associated with exercise
- Headaches in the early morning or after dusk
- Pain in the eye, particularly when associated with smoky vision
- Halos around light
- Trouble reading signs in the distance

When symptoms of glaucoma occur acutely (that is, suddenly) and severely, so there is much pain and/or worsening of sight, then treatment needs to be started within hours—the sooner, the better.

Heredity of Glaucoma

Some glaucomas run in families, but it is important to remember that there are many types of glaucoma. Some types, such as juvenile-onset, primary open-angle glaucoma, are associated with known genetic abnormalities and are frequently passed from parent to child. Others, such as primary open-angle glaucoma in adults, have a variety of patterns of inheritance. Soon it will be possible to test for many of the genetic defects using specific tests.

Where visual loss from glaucoma has occurred in a parent, the offspring are more likely to lose sight themselves. This appears to be true especially for those with angle-closure glaucoma, where almost one-third of the offspring may be affected. Brothers and sisters of the affected person are at even greater risk.

There are now tests to determine whether a gene associated with glaucoma is present. These tests are expensive and not always easy to interpret.
The Treatment for Glaucoma

Many people who are at risk for glaucoma do not need any treatment; however, some do. The need for treatment relates to the likelihood the person will be damaged seriously. Patients with narrow anterior chamber angles, for example, may not have any glaucoma, yet they frequently need laser treatment.

By the time a person has actually developed eye damage, that individual will be in need of glaucoma treatment. The great majority of persons whose glaucoma is discovered early will retain their sight. The proper care of glaucoma demands an ongoing partnership between the patient and the eye physician.

Even for those with considerable loss of sight already, treatment of the far-advanced stages of the disease often can be effective in preventing further deterioration of sight.

A major goal of glaucoma treatment is to keep the intraocular pressure in a range that permits the best functioning of the eye. Treatment may be medicinal (drugs) or surgical, but other considerations are also important, such as blood pressure, nutrition and body weight.

The higher the intraocular pressure is, the more likely the possibility of progressive glaucoma damage. The physician tries to determine just what pressure level is safe for each individual. This usually takes repeated visits and repeated tests, often over a period of months or years.

Pressure may be lowered by drops or pills that decrease the rate at which the watery fluid is made, or drops that assist the outflow of the fluid from the eye, or by laser treatment or surgery.

<table>
<thead>
<tr>
<th>Table 3: Glaucoma Medications</th>
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<tr>
<td><strong>Class</strong></td>
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<tr>
<td>Prostaglandin Analogues</td>
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<td>(helps outflow)</td>
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<td></td>
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<td></td>
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<tr>
<td>Beta-Blockers</td>
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<td>(decreases inflow)</td>
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<tr>
<td>Alpha-Agonist</td>
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<td>(decreases inflow and helps outflow)</td>
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<tr>
<td>Carbonic Anhydrase Inhibitors</td>
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<td>(decreases inflow)</td>
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<tr>
<td>Miotics</td>
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There are several classes of drugs (Table 3). Some drops are now available in which there is no preservative. The absence of a preservative is a great step ahead, because the preservatives gradually harm the surfaces of the eye. There will undoubtedly be more types of drops without preservatives in the future, but at the time of this brochure, drops that are available without preservative include: Tafluprost (Zioptan), Timolol (Timoptic Ocudose), and Dorzolamide/Timolol (Cosopt NP).
The physician tries to find the combination of medications that lowers pressure adequately without producing symptoms from the medications themselves. Usually it is preferable to try to control the glaucoma with the use of drops from one, two or at the most three different classes of drugs.

Where there is progressive damage to the optic nerve or visual field, the glaucoma is uncontrolled. In many cases, treatment is first begun with medicine. In some cases, laser therapy is appropriate as the initial treatment. Laser iridotomy (Diagram 5) is the preferred treatment for most individuals with narrow angles. Laser trabeculoplasty is the preferred treatment for some patients with primary open-angle glaucoma. In some cases, standard surgery may be the most appropriate first step. New surgical procedures for glaucoma have lowered the complication rate. Success depends on factors such as the type and extent of glaucoma, the presence of other conditions (e.g., cataracts), the skill and judgment of the surgeon, and the nature of the patient.

Different types of glaucoma may require different types of surgery. For example, in angle-closure glaucoma, making a hole in the iris (iridotomy) permits the watery fluid to flow from the back to the front of the iris. When this is done early in the course of illness, before the iris adheres to the cornea, the surgery is usually curative. As complications are very rare, iridotomy is often advised in cases where closure or narrowness of the angle of the anterior chamber plays a role. Iridotomy is usually performed with a laser, although in rare cases standard surgery is used. Iridotomy is done as an outpatient procedure.

In another surgical procedure (guarded filtration, Diagram 6), a block of tissue is removed in the area of the trabecular meshwork, thus creating a new channel for the exit of watery fluid. Surgery of this type may require an overnight stay but is typically an outpatient surgical procedure. This type of surgery “works” in approximately 80-90% of patients; however, it can carry with it serious complications requiring further treatment and sometimes lead to loss of vision. Even when successful, the treated eye having had surgery may feel different postoperatively.
New surgical techniques with plastic tubes or metallic stents may be helpful in some types of glaucoma. The use of agents such as mitomycin or 5-fluorouracil increases the success of some selected surgical cases but also increases the rate of complications.

In most cases there are minimal limitations on activity following glaucoma surgery. After discharge from Wills Eye, a patient may return to a normal way of life. Vision will be blurred in the operated eye for a varying period of time, depending upon the state of the eye prior to surgery, the nature of the surgery, and the rate of healing. Recovery usually takes about six weeks following a guarded filtration procedure. When the intraocular pressure is below 6mm Hg, however, activity should usually be limited so that straining is minimized.

Laser surgery has given the eye physician new and remarkably safe ways to control glaucoma. Laser trabeculoplasty is helpful in at least 50% of appropriate cases. It lowers eye pressure by helping the aqueous humor leave the eye. Iridotomy may be successfully performed with the Nd:YAG Q-switched laser in almost all cases.

In some types of glaucoma, such as those associated with the vascular complications of diabetes, treating the eye with a special laser may help. Some of the secondary forms of glaucoma are very hard to treat successfully.

Importantly, there are new surgical procedures. These are less damaging to the eye, but require a highly skilled, well-trained surgeon, such as those at Wills Eye Hospital. These procedures include iStent, canaloplasty, and others. These new surgeries have both advantages and disadvantages.

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**Advice for Patients with Glaucoma**

**Make sure you understand your eye physician’s instructions and follow them.**

Use the medication as often as is advised. If you are bothered by the medication in any way, contact your physician immediately but continue to use it until you have received new instructions. Your physician will then tell you whether to stop the medication or continue it. If you do not understand why you need a medication, or anything else related to your care, ask your physician.

**Be certain to use the medication exactly as ordered.**

Continue to use medication at all times as prescribed even if you are away from home or are ill. If you need to take different types of eye drops, wait at least 5 minutes before applying the next set of drops. Ask for instructions if you are unsure.

**Make sure the drop goes into the eye.**

Hold a tissue at the corner of the eye to prevent the drop from running into the nose. If you are unsure of how to do this, ask. It is important to achieve what is called “punctual occlusion” because it increases the effect of the drops and decreases their side effects. Keep the eye closed for 3 minutes.

**Do not run out of medication.**

Make sure to have it refilled in time. If the pharmacist says it cannot be refilled, call your physician.
Return for your scheduled re-examination.
Most glaucomas are diseases that progress slowly. The correctness of treatment can be decided only by repeated examinations. If it is impossible for you to keep your appointment, be certain to call your physician so that you can arrange another appointment as soon as possible.

Know what type of glaucoma you have.
Some medications that are unrelated to glaucoma may make your glaucoma worse, but this may depend on the type of glaucoma you have. For example, most patients with chronic open-angle glaucoma can safely take any type of medicine except products containing cortisone.

If your eyes bother you in any way that concerns you, consult your physician at once.
This is particularly true if you have blurred vision associated with pain, or if you see halos around lights. If you cannot reach your physician, go to a hospital which provides emergency medical eye care.

Moderation is the key to good health.
People with glaucoma, just like the general population, should live an active, vigorous, full, but reasonably balanced life.

Encourage your relatives to have a medical eye examination.
Glaucoma tends to affect more than one member of a family. This is especially true for primary glaucomas. Therefore, your parents, brothers, sisters, aunts, uncles, cousins and children should be examined.

Carry a medical emergency card that states what type of glaucoma you have and the medications you need.
This would help in the rare chance that you might be involved in an accident or other emergency medical problem which might interrupt your medication schedule or lead the examining physician to misinterpret the size of your pupils.

There are no specific lifestyle limitations.
If you have glaucoma it is probably not necessary for you to change your manner of living in any way. In rare instances, some medicines that are ordered for conditions unrelated to glaucoma can make glaucoma worse. Therefore, tell all of your doctors that you have glaucoma.

In addition, exercise is important. Not only is exercise helpful for preservation of general health, it also can lower intraocular pressure. Being overweight can make glaucoma worse.
Glaucoma Service

The William and Anna Goldberg Glaucoma Service and Research Laboratory of Wills Eye is one of the largest in the country. Providing the finest care available is its primary goal; teaching and research are also vital activities. Patients from all walks of life and virtually all parts of the world come to the Glaucoma Service for consultation or ongoing care.

Sophisticated diagnostic facilities include computerized visual field testers, instruments for measuring blood flow of the optic nerve, and special methods for measuring the optic nerve and anterior chamber angle.

The Glaucoma Service trains students, beginning and experienced physicians, and paramedical persons in the diagnosis and management of glaucoma.

The staff plays a leadership role in teaching around the world and has published numerous articles and books about glaucoma.

The Glaucoma Research Center

The Glaucoma Research Center (GRC) coordinates all of the research performed by the Glaucoma Service. It consists of a highly trained staff of investigators and coordinators.

Research projects currently under way include investigation of:

- Gene therapy
- A new test of actual function
- New and old drugs
- New surgical techniques
- The usefulness of new lasers especially regarding angle closure glaucomas
- The relationship between intraocular pressure and nerve damage and visual field loss
- How to reduce costs of diagnosing and caring for patients with glaucoma
- New systems of delivering care, especially to those having trouble getting care
- The effect of glaucoma on the quality of life
- Socioeconomic aspects of glaucoma
- New diagnostic tests
- New ways to identify those with glaucoma

The Glaucoma Service Foundation to Prevent Blindness

The Glaucoma Service Foundation to Prevent Blindness helps provide some of the funds to support the Glaucoma Research Center.
About Us

Wills Eye Hospital is a global leader in ophthalmology. Established in 1832 as the nation's first hospital specializing in eye care, we now are known worldwide for our clinical expertise. Today, we continue to shape the field of ophthalmology thanks to our talented, skilled physicians and staff who are dedicated to improving and preserving sight.

Wills Eye's core strengths include:

Research: We maintain a close connection between innovative research and advanced care as our physicians pursue research that can be translated quickly into clinical care.

Education: Wills Eye pioneered the development of ophthalmology as a unique branch of medicine in the U.S. and created the nation's first ophthalmology residency program in 1839. Our tradition of innovation and excellence has made Wills Eye a premier training site for all levels of ophthalmic medical education.

Patient Care: Our motto – Skill with Compassion – is central to every aspect of patient care. We remain steadfast in our commitment to improving quality of life for our patients and their loved ones.

Become a valued partner in the work we do. Your gift to Wills Eye Hospital will help us continue providing the best care possible, advance research for innovative treatments, and train new generations of ophthalmologists.

Please call 215-440-3154 or visit www.willseye.org/make-a-gift and make a donation today!
Glaucoma Service

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