OPHTHALMOLOGY
BATTLEFIELD LASERS
THE NIGHT ENVIRONMENT

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INTRODUCTION
This section on Ophthalmology was originally written for the flight surgeon training program by an ophthalmologist in Pensacola, Florida. It is included here because of the practical, non-ophthalmologist approach to treatment of common field ocular problems. At the end, there is also a discussion of battlefield lasers and their risks, along with some of the night environment weapons systems available to air and ground forces.

BASIC APPROACH
Unfortunately, the eye and its associated disorders are all too frequently *terra incognita* to non-ophthalmologists, often producing inordinate amounts of anxiety and feelings of helplessness. The purpose of this chapter is to help reduce these feelings by providing a practical approach to diagnosis and treatment of common ocular disorders in situations where ophthalmic consultation and referral is not readily available and indicating when referral is definitely indicated.

Like other medical problems, the importance of good history and examination in ocular disorders cannot be overemphasized. Many ocular problems are recurrent or chronic, and scanning the patient's health record for a few minutes prior to the examination is frequently very productive. Previous ocular problems, systemic medical problems, functional disorders and evidence of previous attempts to malinger are usually evident on a quick review. Further, prior documentation of visual acuity is frequently very helpful in evaluation the acuteness of the problem. Following chart review and careful delineation of the nature of the present complaint, questioning the patient about previous personal or familial ocular complaints of similar nature is indicated.

BASIC EXAMINATION
The non-ophthalmologist should learn to do a basic eye examination by practicing on normal patients in order to be able to recognize abnormal findings when they occur and to gain expertise in the use of the associated instruments and techniques. This should require very little investment of time and effort with the instruments and techniques listed below and may pay off handsomely in patient care and the minimization of physician anxiety. Examination should be designed to accomplish on orderly evaluation from anterior to posterior as follows:

- **VISUAL ACUITY** - Should always be taken and written in chart prior to examination (very important medico-legally). If at any distance, a notation of "No Light Perception," "Light

Perception Only," "Hand Motion at 3 Feet," "Counts fingers at 1 foot," etc., are appropriate. Corrected visual acuity of less than 20/20 should prompt evaluation for etiology. If a Snellen chart is not available, patient can compare his vision in each eye by reading print on medicine bottles or a calendar.

- **EXTERNAL EXAM -** Careful observation of orbital contours, lids, conjunctivae, cornea, anterior chamber and iris (with magnification where indicated).

- **PUPILS -** Direct and consensual reaction to light and near (Accommodation).

- **MOTILITY -** Gross examination of eye movements and parallelism in all fields of gaze.

- **INTRAOCULAR PRESSURE -** Notation of readings from Schiotz tonometer or tactile tension.

- **FUNDUS EXAM -** Use of mydriatics or cycloplegics is indicated in many cases in order to obtain widest field of vision.

Aside from time required for pupillary dilatation, the above exam requires less than five minutes in a normal patient in the hands of a moderately experienced examiner.

Equipment required for the above evaluation
- Visual acuity charts (20' Snellen, Reading card for near vision at 16").
- Bright light source (Penlight, ophthalmoscope).
- Magnification (Loupes, ordinary magnifying glass, ophthalmoscope).
- Tonometer (Schiotz - must be kept clean to function properly).

Recommended supplies
- Fluorescein strips
- Cotton-tipped applicators
- Eye patches (gauze and cotton)
- 1" paper tape
- Anesthetic drops (Ophthetic/ Proparacaine/Tetracaine)
- Dilating drops

  1% Mydriacyl (Tropicamide) (Use together with 2.5% Neosynephrine for examination). Effects last 4-6 hours.

  0.5% Scopolamine HBr - Use for treating corneal abrasions, etc. - effects last up to 4 days after discontinuing.

- Antibiotic Drops and Ointment; Sulfacetamide, Neosporin, Garamycin

- Antiherpetic Drops and Ointment; Herplex, Stoxil

Notes on drops:

1. Anesthetic drops are a *diagnostic*, not a treatment modality. They retard corneal healing. Analgesia is much better accomplished with cycloplegic drops. *Under no circumstances* should a patient be given a bottle of anesthetic drops to take with him for an ocular injury.

2. Dilating drops are often used therapeutically in corneal abrasions, iritis, etc., but their use must be consonant with their duration of action. That is, don't use atropine for a minor corneal abrasion since dilatation and cycloplegia may last up to 14 days with associated glare and loss of accommodation.

3. Use of antibiotic drops versus ointment is dictated by the fact that ointment effect is of longer duration, but blurs vision.

4. Antiherpetic drops are indicated only in cases of herpes simplex keratitis and have no proven value in other viral infections. Since this entity is infrequent, only small stocks of drugs need be maintained. There are 2 other antiviral drugs, viroptic and vira A available for unresponsive cases.

5. Steroid drops are indicated in very few ocular conditions, since their salutary effects (comfort, decrease in vascular injunction) are outweighed by their complications (exacerbation of herpes simplex keratitis, development of glaucoma). Because of their serious potential complications, their use should be restricted to specific conditions, such as allergic conjunctivitis.

OCULAR DISORDERS

The following is a discussion of ocular disorders which constitute 95-98% of those conditions hich may be expected to confront the practitioner in clinical or emergency room practice. Since this Monograph must of necessity remain relatively brief, a good reference in general ophthalmology is desirable as an ancillary source (such as <u>General Ophthalmology</u>, Lange Publications).

External inflammation and related conditions

LIDS

<u>Blepharitis</u> - Most cases are marginal blepharitis, an inflammation of the lid margins generally due to a combination of staphylococcus and seborrhea, probably the commonest cause of <u>chronic</u> symptomatic red eyes. Occurs mostly in fair-skinned people, in a dry environment.

<u>Symptoms</u> - "Granular lids," burning, stinging, red rimmed eyes.

<u>Exam</u> - crusts or granulations at the bases of the lashes with varying amounts of underlying erythema, edema and, occasionally, even ulceration. There is often an associated secondary conjunctivitis due to frank infection, chemical and/or immunological reaction to breakdown

products of bacterial seborrheic deposits in tear film.

Treatment - This condition can usually be treated with rubbing lid margins with fingertips, wet with hot water, for 10 seconds, t.i.d., while washing one's face; then a drop of sulfacetamide (or in more severe cases, blephamide (sulfa-prednisolone combination)) rubbed into lid margins, in similar fashion. More severe cases respond to warm saline soaks and steroid antibiotic ointment (ophthocort steroid chloromycetin combination) lid scrubs performed with cotton tip applicator. shampooing the scalp with a mild anti-seborrheic shampoo, such as Fostex is often helpful. The medication is usually required for 2 weeks whereas the water lid scrubs should be done on a continuing basis. Failure of treatment is usually secondary to failure of the patient to carry out the above and inspection of the lid margins will usually bear this out.

This condition usually precedes the next two listed.

Chalazion - Small painless bump in lid secondary to meibomian gland blockage. Can begin as painful red bump that eventually resolves completely or leaves residual nodule. Does not usually point externally.

Therapy - Hot soaks for one-half hour B.I.D. followed by antibiotic/steroid ointment or drop lid scrubs. May not resolve completely, in which case have patient see an ophthalmologist. Respond to intralesional injection of deposteroids (Kenalog).

Sty - Painful bump in lid which points externally in lid margin. Usually resolves completely. Recurrent stys should be treated with blepharitis regimen.

Therapy - Same as chalazion. some may require incision and drainage with a #11 Bard Parker blade or a large needle; 18ga has nice sharp edge which can be used as a knife.

CONJUNCTIVA

Conjunctivitis - Inflammation of the conjunctiva with multiple etiologies, including bacterial, viral and chlamydial infections, allergies, chemicals and physical agents. Viral agents are the most common etiology. Usually bilateral with one eye being more involved that the other.

Symptoms - Minor itching or burning. Often eyes will be stuck shut by thick discharge upon awakening in a.m. No significant pain or light-sensitivity unless there is accompanying keratitis. Marked itching is generally good evidence for allergic etiology, particularly when present with ropey mucoid discharge, sneezing and/or strong familial or personal history of allergic disorders.

Exam - Moderate redness. The area surrounding the cornea (limbus) is usually relatively free of injunction and the lower lid conjunctiva is usually bright red. Cornea clear with no fluorescein stain. Pupil round, moves well. May be some lid crusting. Can be bilateral. Giemsa smear of conjunctival scraping reveals mononuclear cells in viral conjunctivitis and PMS's in bacterial conjunctivitis. Conjunctival appearance in viral infections frequently velvety, with minimal discharge.

Treatment - Sulfacetamide or antibiotic ointment or drops Q.I.D. No patch. Most cases resolve in 72 hours, 7-10 days at the longest. If the condition is not responding to treatment by the end of 72 hours several things are possible: the wrong antibiotic is being used, it is caused by a virus or other etiologic agent, or it is not conjunctivitis. The patient should be warned at the outset that there is a good chance that it may not respond to antibiotics and that follow-up is a necessity if they don't respond. See discussion later on the Differential Diagnosis of the Red Eye.

CORNEA

Superficial Keratitis - Inflammation of corneal epithelium secondary to various agents, including sunlight (snow blindness, sunburn) and other ultraviolet sources (ultraviolet lamp, arc welding), dryness (corneal exposure during sleep, Sjogrens syndrome), viral infections (epidemic keratoconjunctivitis, pharyngoconjunctival fever), topical eye medications and recurrent corneal erosions (previous history of corneal abrasion), and contact lens overwear.

Symptoms - Decreased visual acuity, when present, is usually of mild degree. Most common symptoms include scratchiness, foreign body sensation, and photophobia, which may be severe.

Exam - One or more areas of punctate staining of cornea with instillation of fluorescein - often hard to see without slit lamp exam. May have injunction of limbal conjunctiva or greater area or none at all.

Management - Refer if ophthalmologist available. With acute cases such as flash burns, contact overwear, etc., short acting cycloplegics, patching with antibiotic ointment x 24 hours and systemic analgesia often sufficient. Further treatment dependent upon initiating cause. An ice cube in a plastic sack, placed on the lids, and aspirin often bring quick relief.

Corneal Ulcers - Peripheral corneal ulcers are generally not ulcers at all but rather hypersensitivity reactions to staph toxins. Central corneal ulcers may be due to herpes simplex or zoster, bacterial or fungal (in probable order of incidence).

Symptoms - Similar to those of superficial keratitis except visual acuity may be more adversely affected in central ulcers and pain and photophobia is often not quite as pronounced.

Exam - With herpes infections the classical finding is staining of the central cornea in a dendritic (branching) pattern of fluorescein instillation. There is often associated corneal scarring in cases of recurrent infection. With bacterial infections there are areas of pearly to white corneal clouding. If ulceration per se is present they will stain with fluorescein. Endotoxin hypersensitivity produces such areas (usually non-staining) in peripheral cornea adjacent to the limbus and there is often associated marginal blepharitis. Central bacterial corneal ulcers often have antecedent history of foreign bodies or corneal abrasions. Fungal ulcers are rare and generally seen in patients who are debilitated or have been on a long term immunosuppressive or who have had a foreign body of vegetable origin. They generally appear whiter and more shaggy than bacterial ulcers.

Management - Refer to an ophthalmologist when possible, as they are potentially threatening to vision and ocular integrity. Dendritic ulcers should be treated with viroptic Q. 4 H. Central corneal ulcers should be cultured with immediate transfer of the inoculum to culture media and treated with topical antibiotic solution, Garamycin Q. 1 H. and Neosporin Q. 1 H. The best source of material is the base or beneath the leading edge of the ulcer. KOH Prep may reveal hyphae in fungal ulcers.

IRIS AND ANTERIOR CHAMBER

Iritis - Inflammation of the iris with exudation of WBC's and protein into the aqueous humor. Multiple causes (many of which are unknown), including blunt trauma, corneal trauma and inflammations, lues, viral infections, collagen diseases, arthritics, etc.

Symptoms - Mild to severe ocular discomfort, usually of aching nature, and usually with some photophobia. Visual acuity may be normal to significantly diminished but is usually only mildly diminished.

Exam - Circumcorneal conjunctival injunction in the early stages, often progressing to generalized injection. Pupil usually of normal size to somewhat miotic, may be irregular and/or non-reactive in severe or longstanding cases. Iris details may b somewhat fuzzy in severe cases due to exudate on posterior cornea and in aqueous.

Management - Should be referred, but temporizing measures include dilation of the pupil with intermediate or long-acting cycloplegics such as scopolamine, homatropine or atropine drops Q.I.D. and salicylates may be of some value.

Acute Glaucoma - A relatively rare condition (particularly rare in younger patients) usually secondary to occlusion of the trabecular meshwork by iris in individuals who are anatomically predisposed (short eyes, mature cataracts) but may, on occasion, be secondary to other ocular conditions.

Symptoms - May be subacute, but classical acute picture involves brow ache (frequently of severe degree with nausea and vomiting), halos around lights and blurred vision - usually of significant degree.

Exam - With sustained attacks the conjunctiva becomes very injected in a relatively generalized distribution, the cornea is cloudy with some obscuration of iris details, the pupil is in mid-dilation and poorly to non-reactive and visual acuity is reduced. The eyeball is usually rock hard and tonometry reveals pressures around 60-70mm Hg.

Management - Referral to ophthalmologist immediately is indicated, as attacks which are sustained for more than a few hours may result in permanent visual loss. Temporizing measures include Diamox 500mg Stat and Q.6 H. thereafter (IV if patient unable to retain P.O. dose), use of Pilocarpine drops starting 30 minutes after diamox given Q. 15 min. x 4, than Q.6

H., 50% oral glycerine (hyperosmotic agent - "OSMOGLYN") 6 oz.

"RED EYE" DIFFERENTIAL DIAGNOSIS

Many non-ophthalmologists assume a red eye is conjunctivitis: they are wrong about 3% of the time. If any of the following are present, one should call an ophthalmologist, if possible: significant eye pain, photophobia, vision decreased from what it was previously or halos around lights. If your pull down the lower eyelid and observe that the lower eyelid conjunctiva is not especially inflamed compared to that of the normal eye, beware, because this is probably not simply conjunctivitis. If in doubt, treat as a conjunctivitis. If a patient has severe iritis or acute glaucoma it will usually be unilateral and he will usually develop severe eye symptoms in one to three days. In acute glaucoma, the eye can be palpated with the fingertips against the upper lid, with the patient looking down, and it will feel hard as a marble, compared with the normal eye. In severe iritis, the photophobia will be severe. for a more detailed discussion of the differential, consult the standard texts; e.g., the section on eye emergencies in the Lange publication, General Ophthalmology. the following outline may additionally be of value:

TRAUMA

Subconjunctival Hemorrhage - Caused by rupture of tiny vessel, can follow trauma or coughing, but often no history.

Symptoms - Painless red blotch on white of eye.

Exam - Red blotch on white of eye.

Treatment - None. Will clear in 2-3 weeks, often turning yellow or green before complete resolution. If recurrent and accompanied by other evidence of bleeding, hematologic workup is indicated.

Corneal Abrasion - Usually caused by relatively small objects, e.g., a fingernail; can be caused by contact lens overwear.

Symptoms - Extreme pain, light sensitivity and lid spasm, foreign body sensation.

Exam - Instillation of fluorescein into the eye produces a bright green area of staining. Eye is red. Instillation of topical anesthetic will facilitate exam.

Treatment - Instill a small amount of antibiotic ointment into the eye (e.g., Tobramycin, Garamycin). Then apply two eye patches with firm pressure. Reexamine every 24 hours and repeat exam and treatment until no stain is present and patient is asymptomatic. Heals in 1-4 days, depending on size of abrasion.

Foreign Body - Caused by tiny particle of metal, rust, dirt, concrete, etc. Usually superficial and easily removed if seen soon after incident, especially if located on inner surface of upper eyelid.

Examine under surface of upper lid - small foreign bodies often located just posterior to lid margin.

Symptoms - "feels like something in my eye." Not especially painful usually, though it may be.

Exam - Look for small speck on cornea with a strong like and magnification. Most of them can be seen with the plus eight (black) number of an ophthalmoscope. In cases of high energy foreign bodies, dilated fundus exam and, occasionally, x-ray, is warranted.

Treatment - Remove. Attempt first with a moist cotton tipped applicator then try a 20 gauge needle. If the tip of the needle is applied tangent to the cornea, it is very difficult to perforate the tough corneal tissue. Attempt to remove a rust ring, but if removal is too tedious, patch and remove more the next day. A rust ring remover drill is very handy.

Before removing foreign body (F.B.), instill topical anesthetic into the eye ("Ophthaine" or "Ophthetic") and have the patient fixate will on some object with the other eye. Loupe magnification desirable. After removing, instill antibiotic ointment and apply 2 patches. Examine every 24 hours until eye is quiet (usually 1-2 days). Fluorescein instillation may aid in follow up.

Conjunctival Laceration - Various traumatic causes.

Symptoms - Moderate pain.

Exam - Cornea is clear with no stain. Topical anesthetic may facilitate exam, though usually not necessary. Exam shows laceration of the conjunctiva with whitish sclera often visible. If dark pigmentation seen in depths of wound, scleral perforation likely.

Treatment - Antibiotic ointment and mild pressure patch. Check every 24 hours, should heal well in 3-5 days.

NOTE: In cases where small particles of any nature have flown into the eye, careful exam of the fornices is important. Wipe away any particles lodged here with a cotton tip.

Lid Laceration

Symptoms - Moderate pain and bleeding.

Exam - Cleanse area with sterile saline. Don't use Phisohex without topical anesthetic, or patient may clobber you! Check for associated eye injuries. Determine extent of laceration.

Treatment - Lid lacerations not involving the lid margins or medial canthal area may be sutured. If free margin of eyelids or lacrimal canaliculi are lacerated, refer to an ophthalmic surgeon. If unable to refer patient, suture eyelid margin laceration by approximating deep and superficial tissues. The tarsal plate, which is adherent to the conjunctiva, is the most important tissue to approximate. Don't suture conjunctiva.

Corneal or corneoscleral laceration - caused by small, often sharp objects striking eye with great force (e.g., glass, darts, sticks, nail fragments and occasionally with high energy blunt trauma). Eye is penetrated.

Symptoms - Pain, blurred vision, tearing.

Exam - Must be gentle to avoid extrusion of intraocular contents. Pull lids apart gently. Topical anesthetic may help and probably does no harm. Exam usually shows a laceration of the cornea, often with protrusion of dark iris tissue, lens, vitreous or retina (may be subconjunctival). Pupil is often distorted towards the laceration.

Treatment - Instill antibiotic drops, apply bilateral patches lightly. Patient must then be transferred to a facility having ophthalmologist for definitive surgical care. If unable to transfer, approximate the corneal tissues with 7 "O" black silk sutures under general anesthesia. Important to keep patient supine to minimize chance of further extrusion of ocular contents.

Blunt Trauma to Orbit and/or Globe - The sequelae to blunt trauma are many and it is beyond the scope of this monograph to present a comprehensive discussion of all possibilities. A partial list of these sequelae with a few pertinent comments follows in order to emphasize the need for thorough examination and intelligent follow-up.

- Lid laceration, contusion, hematoma.
- Hemorrhage into orbit - usually doesn't require treatment (if an isolated lesion) but if severe enough may require evacuation).
- Iritis (dilation and steroids unless minor).
- Iridodialysis.
- Dislocated Lens - requires evacuation to ophthalmologist - emergency, if dislocated into anterior chamber or producing angle closure glaucoma.
- Cataract.
- Vitreous hemorrhage.
- Retinal Detachment (usually a dialysis just behind the ora serrata).
- Choroidal rupture.
- Occult rupture of the globe.
- Retinal edema and/or hemorrhage (Berlin's edema, commotio retinae).

- **Hyphema** - Blood in the anterior chamber. Often follows blunt trauma, e.g., fist, handball.

  Symptoms - Can be minimal if small hyphema; large hyphema can cause extreme pain if ocular pressure increases.

  Exam - Eye usually red; blood present in anterior chamber; cornea and sclera may be normal (i.e., no laceration or perforation). Visual decrease depends on amount of blood (and also on associated retinal or vitreous findings).

  Management - Small hyphemas with little or no pain and moderately good vision should be admitted. Clearing should take place in 2-3 days. Probably a good idea to keep patient's head elevated and keep him at rest. After clearing, watch for re-bleed (often at 3-4 days; may have associated glaucoma, therefore, monitor pressure if pain ensues with re-bleed). Instill no drops.

  A large hyphema with pain and more visual decrease should be referred to an ophthalmologist. If unable, patch both eyes with head elevated, changing patches every day, for five days. 500mg Diamox p.o. every 12 hours is safe and often alleviates severe pain from increased intraocular pressure. They may keep patient more comfortable while he is being transferred. Aminocaproic acid (AMICAR) 100 mg/Kg q4h up to a maximum of 30 G/d x 5d is fairly routine nowadays.

  Naturally, any hyphema with associated corneoscleral laceration or perforation is to be referred. Also, any blow sufficient to produce a hyphema often produces problems further back (problems that can't be seen without special instruments). Therefore, transfer if any doubt.

- **Orbital Fracture** - A relatively common injury following blunt trauma. Usually takes one of two forms, depending upon the nature of the trauma. One is fracture of the orbital floor as part of a tri-malar (tripod, zygomatico-maxillary complex) fracture, the other sites of fracture being the zygomatic arch and zygomatico-frontal suture. The other is a "blow-out" fracture which usually involves only the orbital floor, though occasionally the medial wall and rarely, the roof may be involved. Significant ocular signs, symptoms and sequelae are much more common with the latter than with the former.

  Symptoms - In the absence of damage to the globe there may be no symptoms other than tenderness from soft tissue trauma. Diplopia in various positions of gaze may result from entrapment of orbital soft tissues in the fracture or orbital hematoma and edema. Enophthalmos may be noted as a late sequel.

  Examination - The globe and ocular adnexa should be carefully examined for damage as in any trauma. Evaluation of ocular motility should be performed with special attention to subjective diplopia and pain in up and downgaze. Hypesthesia in the distribution of the infraorbital nerve, discontinuity of the orbital rim facial dysmmetry and signs of epistaxis should be looked for as they are often present (though not pathognomonic) with orbital fractures. Orbital x-rays should be ordered (particularly an upright Waters view) if there is clinical suspicion that a fracture may exist. Orbital tomograms may be required if scout films equivocal. MRI in especially complex cases.

Management - In the absence of damage to other structures, orbital fractures per se do not constitute true emergencies. While timely evaluation by an ophthalmologist is desirable, it is safe to wait up to two weeks prior to surgical correction when indicated if ophthalmologic evaluation is not readily available. This not only makes surgery technically easier, it may result in disappearance of symptomatology and negate the need for surgery. It must be stressed, however, that damage to other structures must be ruled out, and if doubt exists, timely ophthalmic evaluation is indicated.

Notes on more severe trauma

1. Small objects moving at high velocity (e.g., piece of nail) may penetrate the eye, yet cause very little discernible damage or pain.

2. Sharp objects may penetrate lids and eye, yet cause minor-looking damage.

3. Severe blunt trauma may cause an occult rupture of the eye (e.g., fist). Therefore, with these and similar instances, refer if any doubt exists, especially if the eye is painful or the vision is poor. Monitor pressure - if close to zero, occult rupture is likely. As with any injury resulting in an open globe, it is essential that no pressure be applied.

Chemical Burns (acids, alkali, organic solvents, etc.) Alkali burns such as lye, ammonia are one of the few emergencies in Ophthalmology and treatment must be initiated within minutes, if possible. Acid and other burns are usually much less damaging in the long run. It is, therefore, important to identify the offending chemical.

Exam - Skin about face and lids may be severely abraded, especially with alkali burns. Conjunctiva usually diffusely red, but in severe alkali burn may be ischemic and white. The cornea may be clear or cloudy, depending on the severity and type of chemical. With small amounts of solution (even alkali, in some cases) the cornea may be grossly clear. It may also be clear with more severe non-alkali burns. However, moderate or severe alkali burns usually present with local or diffuse pearly-gray opacification of the cornea. Fluorescein may help in evaluation, especially in a grossly clear cornea.

Treatment - Immediately irrigate each eye involved with 1000cc of normal saline. If this is not immediately available, begin irrigation with tap water. Following irrigation, wipe the fornices with cotton-tips to remove any particulate matter, and also clear the lids well. Monitor pH of tears if possible. Instill cycloplegic and antibiotic drops and patch with moderate pressure. Monitor non-alkali burns with clear corneas can probably be watched with daily follow-up. All but the most trivial alkali burns should be referred because the damage progresses over days and can result in corneal perforation.

Thermal Burns - Flash burns, actinic keratitis (welding, ultra violet, snow blindness), molten metals, scalding water, etc.

Exam - Look for lid burns. Conjunctiva may be hyperemic or, if severe high-temperature burn, may be white and ischemic. Cornea may be clear or cloudy, depending on type and severity of burn. Fluorescein may aid in questionable cases.

Treatment - Treat burns of skin on lids like burns elsewhere. For mild or moderate burns where conjunctiva is moderately red and cornea relatively clear, instill cycloplegic drops and antibiotic ointment. For more severe burns with conjunctival necrosis and corneal clouding, treat as above and refer.

OTHER DISORDERS

Pinguecula and Pterygium - A pinguecula is a small, slightly to moderately elevated, yellow-tan lesion usually found on the medial conjunctiva near the limbus in a high percentage of patients over 25-30. It may be vascular and injected but usually isn't. It is thought to be a connective tissue change secondary to exposure to the elements (low humidity, solar radiation, wind, dust, etc.). In susceptible individuals it is thought to be the precursor of a pterygium, which differs from it in that a pterygium proliferates to the degree that it slowly invades the superficial cornea. it is more likely to be injected, elevated and symptomatic.

Symptoms - As mentioned, pingueculae are usually asymptomatic and usually present because the patient has noted it in the mirror or someone comments upon it. Pterygia, on the other hand, are more likely to be accompanied by burning and irritation.

Exam - Findings on inspection as noted above.

Treatment - Pingueculae usually require no treatment unless symptomatic or progressive. Treatment for both pingueculae or pterygia is largely non-specific, i.e., avoidance of irritants such as sun, dust, etc., wearing sunglasses, and use of astringent drops (Vasocon, Albalon, etc.) which are not usually too effective. If a pterygium has advanced more than 1mm onto the cornea its extent (beyond the limbus) should be measured and recorded and followed periodically. Those which appear to be 1/3 to 1/2 of the distance of the pupillary margin should be referred to an ophthalmologist for possible excision.

Strabismus ("Squint," "Crossed Eyes," "Wall Eyes") is a relatively common condition which may be seen at any age. The ocular deviation may be constant or intermittent. In children above the age of three months and below the age of seven years such patients should be referred ASAP to an ophthalmologist, as there is a possibility of intraocular or intraorbital pathology or, at the least, a possibility that normal visual maturation may be hindered with the development of amblyopia. The likelihood of the child "outgrowing" the condition is statistically poor and medical intervention is often indicated. In any patient, sudden onset of such deviation may well be due to neurologic pathology, including intracranial tumors or aneurysms, demyelinating disease, myasthenia gravis, etc., and prompt evaluation is indicated. Longstanding deviations in adults are generally not as significant and evaluation may usually be delayed until a convenient time if indicated at all. Such deviations are usually surprisingly asymptomatic, as the diplopia one might ordinarily expect is usually eliminated by sensorial adaptations such as suppression of one image, amblyopia, etc. While certain occupations requiring highly developed stereoscopic vision may be denied to such patients, a high percentage of activities are not materially affected by such conditions.

Headache Contrary to prevailing non-ophthalmologic opinion, few headaches have a significant ophthalmologic basis. The large majority, of course, stem from tension, poor physical condition and non-specific causes. Worthy of mention and much more common than usually appreciated are vascular headaches, migraine being the classical example. Family history of medically diagnosed migraine, visual disturbances (scintillating scotoma, "watery" or "heat wave" disturbances) lasting 20-30 minutes in both eyes and followed by cephalgia (often severe, often unilateral, accompanied by nausea, vomiting, photophobia and fatigue and unresponsive to common analgesics) are highly indicative. However, many variations on this theme exist, including cases without visual disturbance, without cephalgia, and with other neurological signs and symptoms. Onset of such symptomatology with no previous history probably warrant a referral to a good internist or neurologist, as migraine is occasionally the result of intracranial lesions.

Neoplasia The most common cancer in the world is basal cell carcinoma; the most common place for it (due to the incidence of the sun's rays and facial contours) is the lower lid. Be very suspicious of any area of the lid that loses its cilia: this is almost diagnostic of malignancy if localized. Fortunately, basal cells don't metastasize, so there is a safety margin. But they do grow, so find them and treat them early.

Squamous cell carcinomas are less common but they do metastasize and look a lot like the less dangerous basal cells: tumors are safer "in the bottle" (i.e. biopsied).

If the lesion is below the lash line, general physicians can safely do trephine biopsies (2 mm trephine) or small punch biopsies. If behind the lash line, you may get a notch in the lid which may spill tears, so refer it out unless you're in a 3rd world situation.

Pseudophakia The practicing clinician is going to be seeing more and more of these: there are now millions of these people in the U.S. What is it! Pseudo (false) phakia (lens) - i.e. the artificial lens implanted into the eye when the cataractous lens is removed. Well, not all of the cataractous lens: 95+% of modern cataract surgery is done leaving the posterior capsule of the lens intact and putting the artificial intraocular lens (I.O.L.) just in front of the capsule, in the site of the natural lens, i.e. in the posterior chamber, behind the iris. These modern posterior chamber I.O.L.s are so slick that the unsophisticated observer may not notice it, even on slit lamp examinations.

Pseudophakes have essentially no accommodation so if one eye only is pseudophakic, they may need different strength bifocal "adds." The lenses can dislocate and pop out from behind the iris. The most frequent problem is a subtle opacification of the posterior capsule which can be quite insidious and cause significant glare disability. This can easily be seen on slit lamp exam of the dilated eye, and an ophthalmologist can bang a hole through it non-invasively with a YAG laser.

"Normals" Kodachromes will be shown of non-disease conditions which can look really scary:

- Myelinated nerve fibers - white splotches, usually adjacent to the disc, easily confused with papilledema.
- Pigment crescents - scleral crescents: dark or white crescents adjacent to optic nerve heads.
- Vortex vein - octopus-looking areas near the equator; spooky if you've never seen them before.
- Mittendorf dot - Anterior remnant of embryonic hyaloid artery, on posterior capsule of lens.
- Cloquets canal - A-P tube in vitreous remnant of hyaloid artery.
- Burgmeisters' papilla - Little extrusion from disc; posterior end remnant of hyaloid artery.
- Arcus "senile", Peripheral girdle of Vogt - benign peripheral corneal "degenerations."
- "Bear tracks" - Congenital grouped hypertrophy of the retinal pigment epithelium.
- Drusen - Hyaloid excrescences of Bruch's (choroidal) membrane. On the disc can look like papilledema or on the retina like age-related macular degeneration. Usually not pathologic.

MANMED NOTES FOR AVIATION

Distant Vision (ManMed 15-65-48)

1. General - Visual defects are one of the major causes of physical disqualification from the Armed Services.

2. Procedure for Testing Acuity:

    - Remove Rx before patient enters room
    - Test VA without unnecessary delay
    - One patient tested at a time
    - Keep other candidates kept out of hearing
    - Occluder held in contact with nose only. Do not repeat VA on same line
    - Tested without and with Rx, both eyes
    - If memorization suspected, read line backwards or use GOOD LITE magnetic letters
    - 1 - 2 seconds per letter is ample time though no precise limit
    - Can encourage but do not coach
    - Examiner should watch patient, not chart

3. Retests
   - Effects of fatigue, alcohol, etc., can influence VA
   - One retest allowed at a minimum of 24 hours later

4. Security - targets should be inaccessible when not in use

5. Charts - at least 3 must be available - GOOD LITES best

Refraction (ManMed 15-65-48)

1. Required on original exam

2. Required when VA falls to or below 20/30

Near Vision Acuity (ManMed 15-65-48)

1. In lieu of a report of accommodation, a report of NVA will be made in #61

2. Service Groups I, II, and III; cannot be worse than 20/200 binocularly, and must wear a correction if worse than 20/40

3. Class II personnel must be correctable to 20/20 binocularly, and must wear a correction if worse than 20/40

Testing Heterophoria (ManMed 15-65-45)

1. Tested with Rx

2. Horizontal and Vertical phorias neutralized with Risley prism and Maddox rod

3. Vertical phorias - refer to the hyper eye

4. Begin with the prism off center

Near Point of Convergence (NPC) (ManMed 15-65-45)

1. Use Prince Rule and a pin with a 2mm white head

2. Rule placed 11.5mm in front of the cornea on the side of the nose

3. Begin at 33cm and move toward nose until one eye swings out

4. Distance read and recorded in millimeters

5. Greater than 100mm is disqualifying for SNA's

Color Vision (ManMed 15-13A, 40-22)

1. Farnsworth Lantern (FALANT)
   - Must use when available
   - Considered final in all questionable cases
   - Detailed instructions on metal plate. This is not a highly sensitive test; nicely measures functional color vision

2. Pseudoisochromatic Plates (PIP)

   - Use when FALANT not available (although FALANT is only accepted color vision test)
   - Detailed instructions inside cover

Depth Perception (Stereopsis) (ManMed 15-65-45)

1. AFVT - must be no misses in groups A thru D for aviation

2. Verhoeff Stereopter

   - If failure on AFVT or if AFVT unavailable
   - Test #2 presented at 40cm to introduce patient to test
   - Move Verhoeff to one meter
   - Must be held centered and steady
   - "Report the nearest or farthest strip"
   - 8/8 in first trials is passing
   - If fails first attempt, must get 16/16 in 2nd and 3rd trial
   - Subject not permitted to move his head
3. Recording
   - AFVT - record highest group passed ie. "Passed F"
   - Verhoeff - required perfect score is 8/8 or 16/16
   - Indicate on right side of #65 whether corrected or uncorrected

Field of Vision (ManMed 15-65-45)

1. Procedure
   - Face examinee at 2 feet
   - Patient closes his left eye and you close your right eye
   - Patient fixates your open eye
   - Bring your moving fingers in from the periphery, midway between you and the examinee
   - Patient should see fingers as soon as you
   - Done in all cardinal directions
   - Repeated for left eye

2. Any contraction requires perimetric study

3. Any contraction of 15 degrees or more is disqualifying

4. Normal fields listed in manual

Intraocular Tension (ManMed 15-65-45)

1. General - Incidence of glaucoma approximately 2% in those over 40

2. Instrument - Schiotz Tonometer is almost universally available and is still an excellent instrument for I.O.P. measurement.

3. Care - Should be kept protected in its case. The standard weight and plunger should be removed after use and cleaned. Ether or "41" solvent solution and a pipe cleaner can be used to clean the plunger column and the plunger. Allow thorough drying!

4. Testing - With the instrument setting vertically on the test foot plate, there should be a scale reading of zero.

5. Technique
   - Anesthesia - 1 to 2 drops of topical anesthetic
   - Patient - relaxed, collar loosened, reclining and fixating straight up OU on a target on the ceiling or looking at his own extended thumb.
   - Examiner - bring tonometer in from the side and place vertically on the center of the cornea (needle should fluctuate with pulse)
   - Performed on those 35 and over at the conclusion of other eye exams
   - Conditions of referral - non-relaxed or uncooperative pt.; known sensitivity to anesthetic; Consistent elevation of IOP greater than 25mm Hg; consistent difference between the 2 eyes of greater than 5mm Hg.

ARMED FORCES VISION TESTER (AFVT)

General
The AFVT has been approved as an alternate method for testing of vision of naval aviation personnel. The standards for the various categories of personnel and various training programs are the same as the standards for the same item tested by any other method.

Description
The AFVT consists of two rotating drums holding illuminated slides for the testing of various facets of vision. A lever operates an occluder so that each eye can be tested separately or together. AFVT comes with scoring key. Acuities and phorias can be checked at both distance and near.

Acuity
For scoring distant and near acuity, four or more errors is a failing score for any line with 10

letters and automatically lowers the visual acuity score.

Stereopsis
Horizontal rows of circles with groups numbering A through F. In each horizontal row one circle stands out closer to the examinee. There must be no misses in groups A through D. Caution: Make sure neither eye is inadvertently left occluded.

Vertical Phorias
OD sees a set of numbered steps and OS sees a dotted line. The examinee is asked which step the dotted line intersects. Detection of malingerers; by pushing the variable prisms outward, a downward shift is induced. The maximum amount of shift provided by each control corresponds to 4 steps.

Horizontal Phorias
OD sees a row of numbered dots and OS sees an arrow. The examinee is asked what is the number of the dot to which the arrow is pointing. Detection of malingerers; when the variable prisms are shifted out as far as they go, the apparent position of the arrow is moved seven dots to the left, giving a score 7 below the true score.

BIOMICROSCOPY

The biomicroscope (slit lamp) is one of the most versatile instruments in our clinical arsenal. It is a highly sophisticated illumination and magnification system which, when used appropriately, enables careful examination of both the internal and external structures of the eyeball.

There are many different brands and varieties of slit lamps presently sold on the open market today. All slit lamps have the same five basic components: 1) Base; 2) Head Support (consisting of a chin rest and forehead support); 3) High Intensity illumination system; 4) Beam Adjustment Knobs (makes slit or spot, as desired); 5) Binocular Microscope system. Adjunctive equipment includes various filters, fundus lenses, etc.

The base of the slit lamp is the portion of the instrument which is bottom most and supports the remaining structures. One part of the base is stationary (the head support is attached to this portion) while another portion of the base is movable. The moveable base supports the illumination system and binocular microscope device. A joy stick is also located on the moveable base which controls both the elevation and horizontal movement of the instrument: some older models have a large screw disc that controls the vertical movement.

The joy stick is responsible for the simultaneous movement of the illumination system and binocular magnification system. The head rest is attached to the front of the stationary base. It consists of a chin rest, forehead rest, and adjustment control for chin height. There is a horizontal black slash mark on the right side of the head support, which MUST be lined up with the patient's outer canthus in order to obtain full vertical range of the instrument. This is easily accomplished by adjusting the patients chin height until the patient's outer canthus lines up with the black slash mark. It will be important to remind your patients to keep their chins down on the chin rest and forehead up against the support bars during the examination. Otherwise you will not be able to maintain adequate focus and range of the instrument: obese patients may need to grasp the knobs on the base or even get additional head support from an aide.

The illumination system is mounted on the movable base and allows rotation of the system approximately 180 degrees around the vertical axis. This axis is coincident with the focal point of the illumination system, so it will never be out of synchronous focus with the magnification system. The illumination system is controlled by a rheostat, located on the bottom of the stationary base. In addition to the rheostat there are several controls on the lamp itself which control the width, height, brightness, and color of the light. In the Haag-Strait type slit lamp (which most of the copies try to duplicate) the knob located at the very bottom of the illumination system controls the width of the beam. The narrower the width, combined with increasing the angular subtense of the beam, the greater degree of optical dissection possible (in other words, it is easier to see the layers of the cornea, lens, or other structures). The height of the beam is controlled by a knob located on the lamp housing. This knob also accesses the Cobalt Blue filter utilized in fluorescein examinations. Other filters, such as a red-free filter (green) and neutral density filters aid in the differential diagnosis of a myriad of ocular conditions. Additionally, if the top of the lamp housing is rotated, the slit beam will be rotated through 180 degrees. The illumination system can also be tilted forward through several stops, allowing for glare control when conducting several specialized examinations.

The Binocular Microscope system is a dual magnification system (actually expandable to several magnifications by changing eye pieces), mounted on the movable base and it rotates around and focuses on the same vertical axis as the illumination system. It is important to remember that both the microscope and illumination systems will focus on the same point in space. Therefore, where ever the light is focused, your eyes will be focused on the same point in the eye. In order to maintain good binocular vision and ultimately, stereopsis during your examination, it is imperative that you adjust the pupillary distance of the two eyepieces to meet your specific requirements. This is easily accomplished by either separating or pushing together the eyepieces until you feel you have the proper visual fusion. In addition to the pupillary distance, the eyepieces are equipped with rotating separate dioptric corrections which can be dialed in to meet your refractive error. You must note and appropriately adjust these settings each time you utilize the instrument, otherwise you will not be able to maintain good binocular vision during your examination. Most examiners simply leave the setting on plano and leave their glasses on when examining patients.

To change magnification levels, simply move the lever located just below the eye pieces to either the left or right side. The setting to the left will give the lower magnification while the setting to the right gives maximum magnification.

The Hruby lens, the Volk 90, 78 and 60 diopter hand held lenses and the goniolens are utilized in the examination of the ocular fundus and anterior chamber angle. The Hruby lens is mounted on the side of the slit lamp and is slid into place when utilized. The lens, which is a high minus lens (about -58 diopters) is positioned in the viewing axis of the microscope with it's plano side facing the examiner. The illumination system must be directly in line with the lens and microscope inn order to maintain a glare free view. Use of the 90, 78 and 60 diopter and goniolens is generally the same, except that both of these instruments are external to the actual slit lamp apparatus and are hand held by the examiner.

How to conduct the exam

With both you and the patient comfortably seated in front of the instrument, have the patient lean his head into the headrest, pressing his forehead against the upper bar. Be sure and remind the patient to maintain pressure against that upper bar. Align the patient's outer canthus with the black hash mark described earlier, insure that all of your microscope settings (pupillary distance, dioptric scale) are correct and begin your examination.

The first step in conducting a slit lamp examination is to get a general overview of the eye. This is accomplished by first setting the slit width at approximately 1.5 mm and slowly scanning the eyelid margins, both upper and lower, and then proceeding to the caruncle, conjunctiva, and cornea. Note any particular matter along lid margins as this may be indicative of marginal or chronic blepharitis; note irregularities of the conjunctiva such as pinguecula (raised yellowish tissue either nasally or temporally, but not on the cornea), nevi, or redness; note any irregularities of the cornea (this could include pterygia, scars, color changes, neovascularization, infiltrates, or variations of normal such as arcus senilis), the sclera underlying the transparent movable conjunctiva, and any other findings you feel are appropriate.

Once you have examined the outer structures in a general manner, you are ready to proceed with a more in-depth examination. If you noted abnormalities of the cornea, you now need to determine if these abnormalities are located in the epithelial layer, Bowman's layer, the stroma, Descemet's membrane, or the endothelium. Additionally, you should measure the diameter of any opacity or abnormality utilizing the millimeter scale located on the lamp housing, just above the vertical height adjustment. Localization within the cornea is easily determined by narrowing the slit beam to about 0.5 mm, swinging the illumination housing to about 30-40 degrees and focusing on the questionable area. You should be able to differentiate the five different layers of the cornea by the different shades of grey represented in your slit beam. The outermost is the epithelium, which has a smooth, whitish appearance, followed by Bowman's, which appears as a solid white line, followed by the stroma, which is the widest area, and appears whitish grey with many linear white lines (actually corneal nerves). Descemet's membrane is next and it also appears as a thin bright white line and then finally, the endothelium, which appears as a whitish surface. You will actually be able to discern what layer your findings are in simply by noting where they fall in relation to the layered light.

To continue your examination, narrow the slit beam to between 0.5 mm to 1.0 mm and slowly move the joy stick forward. You will pass through the anterior chamber (which is normally optically empty and should have nothing floating within it) and focus on the iris. Scan the iris, noting any vascularization, raised lesions or nevi, and be sure to adequately measure the diameter (using the scale located on the lamp housing of the slit lamp) of any abnormality. Once the iris examination is completed, proceed posteriorly by centering the slit in the middle of the pupil and maintaining focus on the iris and anterior capsule of the lens. In elderly people with small pupils, examination of lens may be difficult and require mydriasis. With the lens in focus, swing the entire lamp housing outboard to approximately 40 degrees (we swing it outboard to preserve the patient's nose) and move the joystick towards the patient. At this point you should be able to differentiate the different layers of the lens (it looks almost like an onion, with varying shades of grays and whites). If you cannot differentiate the different layers, you may need to either narrow the slit beam or change the degree of swing of the lamp housing. At any rate, play with the settings at this point to be sure that you can see the layers. While examining the lens, you should also note several important anatomical landmarks. The first landmarks you should find are the lens sutures, of which there are two. The most anterior suture (often called the "Y-Sutures") is shaped like a right-side up "Y". It may be oriented a little off the vertical, but never the less, it does look like a "Y". The posterior suture looks like a Mercedes Benz symbol or upside down "Y". These sutures delineate the borders of the fetal nucleus. The reason this is important is because if you find lens opacities (cataracts) within these boundaries, they are considered congenital, and non-progressive. Opacities found outside the boundaries of the fetal nucleus generally are more suspect and can potentially increase in size. The other landmarks of the lens which you should be able to see are the anterior and posterior capsules. The anterior capsule will be in focus for you the same time the iris is clearly focused. It is not unusual to find small aggregates of pigment, called pigment stars on the anterior lens capsule. These are generally bilateral findings, and are considered perfectly normal. The posterior capsule is a little more difficult to see, but can be visualized by focusing the instrument posteriorly after seeing the posterior "Y" suture. Generally, the lens will look a little yellow (especially in older patients) around the posterior capsule. Once the posterior capsule is in focus, note any opacities or irregularities. Opacities located near the posterior capsule (especially posterior subcapsular) are extremely deleterious to vision. One common finding you may note along the posterior capsule of the lens is a small opacity located at approximately 2 O'clock on the most posterior aspect of the lens. This is called a Mittendorf dot and represents the point where the hyloid artery embryologically connected to the posterior aspect of the lens. This is an incidental finding and does not effect vision.

If you focus the slit lamp posterior to the lens, ask the patient to move his eyes up or down and then straight ahead: you will note a white lacy material. These are collagen fibrils in the gelatinous vitreous.

Another important use of the slit lamp involves the measurement of intraocular pressures with the Goldmann Tonometer. This instrument is mounted on the slit lamp and is swung into place when needed. To use the Goldmann tonometer, first establish the patient has no allergies to anesthetics, and then instill one drop of Fluress (a combination of fluorescein and a topical anesthetic) into each eye. Place the magnification of the slit lamp to either high or low, set the dial on the side of the tonometer to 10 mmHg (reads "1" on the dial), engage the cobalt blue filter (by turning the dial on the lamp housing all the way counterclockwise) and swing the tonometer into place. To measure the right eye first, place the illumination system approximately 40-60 degrees off to the left, and place the tonometer on the cornea (watch from the side as to insure that the tonometer just touches the eye BEFORE you look through the eye piece). The limbus will seem to illuminate when contact is made. Once the tonometer is touching the eye, look in the eye piece, and turn the tonometer dial until the mires are touching during systole (you will actually see the mires move with the pulse: the higher reading represents systole). At that point read the intraocular pressure directly from the dial. Without moving the lamp housing, repeat the procedure for the left eye. When recording your findings, note the eye (OD; OS), intraocular pressures (14 mmhg, etc) and time of day (1400, etc). Any finding above 19 mm Hg would be followed by repeat pressures, a careful disc examination and baseline visual fields.

The slit lamp is also an excellent instrument for examining the posterior pole of the eye. This is accomplished by utilizing either the Hruby lens, Volk 90, 78 or 60 diopter lenses or gonio or contact lens. The Hruby lens is a simple and excellent tool for the examination of the optic disc, while the Volk lenses are exceptionally useful in not only examination of the disc, but 60 degrees around the disc. The gonio or contact lenses are generally considered more cumbersome because they must be placed directly on the eye, while the other two methods do not touch the eye at all. The gonio lens is also utilized for the examination of the anterior chamber angle, as well as the posterior pole.

Practice, patience, and attention to detail is absolutely necessary to master the slit lamp. Once you have seen several patients, develop your own clinical routine with the instrument, you will begin to feel more comfortable and master your technique.

RECOMMENDED BOOKS

1. PDR for Ophthalmology

2. Manual for Eye Examination and Diagnosis

   Leitman, Gartner and Henkind
   Medical Economics Co.
   Book Division
   Oradell, NJ
   $18.95 + $2.00 handling

3. General Ophthalmology

   Vaughan and Ashbury
   Lange Medical Publications
   $12.00

4. Adlers Textbook of Ophthalmology

   Scheie, HG and Albert, DM
   W.B. Saunders, 1977
   $28.50

If any of these items are not available through either your local supply department, pharmacy or Serv-mart, you will be able to "Open Purchase" them from an optical supply company, such as;

House of Vision Instrument Dept.
P. O. Box 29507
Atlanta, GA 30329
(404) 482-9511

West Coast Optical Instrument, Inc.
1338 So. Killian Dr.
Suite 11
Lake Park, FL 33403
800-282-2273

Pennsylvania College of Optometry Bookstore (Texts)
1200 W. Godfrey Avenue
Philadelphia, Pennsylvania 19141
(215) 276-6004

Check with your local "Supply Department" and they will show you how to fill out the necessary forms

SCHIOTZ CLEANING SOLUTION

The address for "Cleaning Solution" solvent for the Schiotz Tonometer:
V. Mueller
6600 West Toury Ave.
Chicago, IL 60648
(312) 774-6800
Order Number: OP-9072, Mueller
$5.00 each

BATTLEFIELD LASERS

Points of Contact

- Unit Intelligence Officer/Safety Officer
- Armed Forces Medical Intelligence Center (AFMIC)
- NAMI Ophthalmology, AV 922-3938/4558

Definition

LASER - Light Amplification by Stimulated Emissions of Radiation

General
Lasers are of military usefulness by all nations for range finding, target designation and tracking. They may be used as weapons also for harassment and physical injury of opposing forces. They may be disruptive of operations by

- Obscuring dim lights, such as a Heads Up DisplayCausing glare and interference with dark adaptation and target acquisition
- Causing damage to canopies, cameras and weapons
- Causing temporary or permanent eye damage

Laser Physics
If energy is applied to a substance causing electrons to jump from the basal to the excited state, the same amount of energy is released as electrons return to the basal state. If that energy is released as light, the light will be of the wavelength (color) characteristic for that substance and the energy required to excite it. Thus, only a single wavelength is produced when an electron in a given molecule returns to its basal state. If that light is collimated by mirrors into a unidirectional beam, it will tend to retain its energy until dissipated by distance through the atmosphere, each wavelength absorbed by the atmosphere at different rates. So, some wavelengths will retain their energy and focus over greater distances than others. How intense the laser beam is depends upon the energy applied to excite the electrons (and therefore that released) and the excitability of the substance used. Therefore, a ruby laser is not necessarily stronger or more energetic than a neodymium laser, but the wavelengths produced have quite different properties. Each LASER will function at a discrete frequency (depending on the substance used), some of which are in the visible range, some not. Some LASER substances have more than one energy level capability on excitation, and therefore may radiate at more than one discrete frequency if different energy levels are applied.

Optical Media
Atmospheric conditions will have an effect on LASER beams by diffusion or absorption by water vapor, smoke, etc., again depending on wavelength. Generally all LASER beams widen at least a small amount with distance. Unfortunately, the human eye has the capability of concentrating the LASER beam by a factor of about 100,000 times and focusing it on the retina. The temperature at the point of focus at the retina may be in the neighborhood of 1000 degrees, causing coagulation and destruction of that small area or, if a blood vessel is involved, a rupture of that vessel and hemorrhage into the vitreous with subsequent loss of vision. Or since there are no pain fibers in the retina, damage may go undetected until it is discovered that there is a loss of some portion of the visual field. It is also worth noting that LASER beams may be reflected off mirror-like surfaces and picked up by the eye, losing some transmissibility, but still dangerous. Skin burns are quite unlikely given the powers used and distances on the battlefield, and since skin does not concentrate the beam as the eye does.

The cornea will not allow all wavelengths to pass through, but acts somewhat like a filter. Wavelengths above 1300 nm (far infrared) are absorbed by the cornea and lens and may produce damage to these structures while the retina is undamaged. Thus, visible and near infrared

LASERs may cause damage to the retina while far infrared LASERs cause damage to the cornea and lens structures ultimately leading to corneal scarring and cataract formation.

LASER Eye Protection

Just as with any other optical media, filters may be employed to absorb LASER light before it reaches the eye to cause damage. Unfortunately, if one were to filter out all the LASER wavelengths available, the result would be a filter which no one would be able to see through. The compromise is to filter out those frequencies most likely to be used in LASER operations, leaving as much usable visible spectrum as possible.

Note that while the EEK-3/P would only block the Neodymium wavelength, the aircraft canopy would block the far infrared and provide some additional protection. The LG-B goggle provides protection against several wavelengths, but would also block out considerable amounts of visible violet and blue-green wavelengths, degrading normal vision and particularly night vision. Unfortunately, there are hundreds of different LASERs with different wavelengths available.

The Practicalities of LASER Protection

When operating in the neighborhood (5 mi) of U.S. deployed neodymium LASERs, eye protection at the 1040 nm wavelength is needed to prevent eye damage from this invisible wavelength device. This does not help much when confronted by opposing forces who may use different wavelength devices as multiple devices. The fact is that there is no good way to predict what might be used. We do know that there have been a number of incidents reported in which the Soviets have practiced their target designation on our aircraft and ships.

At this time the recommendations are to use protection against neodymium when that is the one most likely to be used, and LG-Bs when unknown frequency LASERs are the potential threat. At night, there is greater threat of eye damage due to enlarged pupillary opening, and so LASER protection is recommended when operating within 10 miles of suspected systems.

It is also recommended that people not fixate on a target with LASER use potential, but rather to one side of it. The rational for that is to minimize the possibility of central retinal burn and complete visual loss. Obviously, when LASERs are being used around friendly forces, they cannot be trained on ships, aircraft or uncleared ground.

It is very important that LASER exposure incidents be evaluated and reported in order to gather as much data as possible in an attempt to determine wavelengths being used, allowing use of appropriate protection.

NIGHT VISION DEVICES AND THE NIGHT ENVIRONMENT

Night vision goggles (NVG's) are designed to electronically amplify or intensify ambient light (moonlight and starlight) and display images on small video screens mounted within the apparatus. Presently, there are several models of NVG's utilized within the fleet. Infantryman and personnel on surface ships utilize either the PVS-5/C or PVS-7, while aviators utilize the ANVIS (Aviator's Night Vision Imaging Systems) in rotary wing aircraft and a modification of the ANVIS called "Cat Eyes" in the tactical, fixed wing community.

The PVS-5/C is an improved version of the first generation night vision goggles originally utilized by the Army and Marines back in the 60's. It consists of a full face shield on the infantry version, and a cut-away face shield on the aviation version. The newer PVS-7 incorporates the newest technology (third generation image intensifying tubes) with light weight design and eyecups to shield the outside environment from scatted light created by the goggles. The ANVIS has been specifically developed for use in modern aircraft as well as land based vehicles and some surface ships such as LCACs.

Both models of NVG's are receptive to the visible spectrum and near IR radiation. The PVS-5's response is between 500 nm (blue-green) and 850 nm (IR), while the PVS-7 and ANVIS have a blue-green cut off and a range which extends a little more into the IR range. This allows the instrument to be much more sensitive in the red and near IR end of the spectrum.

Images produced by NVG's are elicited by photons striking a photocathode, which in turn causes a release of electrons within an adjacent microchannel plate. An electric field then guides the electrons to a phosphor screen which produces an amplified light image. The image produced is green, which disallows for any color discrimination of objects. Both the PVS-7 and ANVIS have automatic brightness controls which limit the maximum luminance of the phosphor screen to prevent output surges and minimize the chances of decreasing dark adaptation. A clamp voltage mechanism is also present to protect against excessively bright light sources (search lights, flares, lightning, lasers, etc.).

The PVS-7 and ANVIS have incorporated many improvements, including: compatibility for utilization with eyeglasses; easily mountable to helmets or head gear; "look under" capability, which allows normal peripheral vision to view flight controls, in the case of ANVIS; a fail-safe battery warning system; and less weight and counterbalancing on helmet. The most important technical advantages of the ANVIS and PVS-7 are their greater sensitivity at low light levels and ability to operate with ambient, compatible lighting. There is a notched filter built into the device which allows for lighting below the wavelength of 665 nanometers to be utilized with the goggles. Any light which is below this wavelength will not drive the automatic gain control of the system down, thus enabling maximum performance at all times. There is no lighting color or scheme which is compatible with the electronics of the PVS-5/C. The PVS-7 and ANVIS produce an image with greater contrast and resolution, resulting in longer detection ranges when viewing objects illuminated with starlight. This is not always an advantage, because under certain, unusual lighting conditions (moonlit nights with shadows cast over the terrain), users have reported that third generation image intensifying tubes (PVS-7 or ANVIS) do not create a difference in contrast between adjacent terrain features.

Two points to realize both when teaching about and using NVG's are that with the PVS-5s, the best possible acuity is in the 20/50 range, while the PVS-7 and ANVIS will afford about 20/40 acuity, and the users depth perception will be greatly reduced.