Presents:

OPTHALMOLOGY

With:

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**KEEP CALM WHEN THE PRESSURE RISES: MANAGEMENT OF GLAUCOMA**

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Elevated intraocular pressure (IOP) is a frequent cause of irreversible blindness in dogs and cats. The only unifying theme in this diverse group of disorders is that IOP is too high to permit the optic nerve to function normally. To effectively treat glaucoma, the clinician must constantly be aware of the circumstances in which alterations in IOP occur, use a tonometer to measure IOP, and have a working understanding of both the pharmacologic agents and surgical modalities which are currently available. Vision is more likely to be preserved by prophylactically treating high risk eyes, and by combining medical and surgical therapy to aggressively treat overtly glaucomatous eyes early in the course of the disease.

Glaucoma should be ruled out in all eyes that are red, have corneal edema, pupil abnormalities, chronic anterior uveitis, lens luxations or when vision is impaired. Many breeds are predisposed; the most common breeds in our practice are the American cocker spaniel, Bassett hound, Chow and Shar-pei. It is less common in cats, and usually secondary to other ocular problems. They usually have more subtle clinical signs, often consisting of only mydriasis and progressive buphthalmia.

**PRIMARY ANGLE CLOSURE GLAUCOMA IN DOGS: DIAGNOSIS**

Signs of glaucoma include pain, redness (episcleral injection), mydriasis, corneal edema, and varying degrees of vision loss in the acute stages. Signs of chronic glaucoma include buphthalmia, lens luxation, optic disk cupping, corneal edema, and retinal degeneration. A chronically buphthalmic eye can often lead to exposure keratitis, which is further complicated by corneal edema, leading to a diagnostically challenging case.

**Tonometry:** Tonometry must be performed to accurately diagnose glaucoma. Normal readings for dogs are 10-26 mm Hg and cats are 12-32 mm Hg. Common errors are globe compression by retracting the lids (IOP too high); occluding the jugular veins during restraint (IOP too high); non-vertical tonometer (Schiotz) application or applying to the sclera or third eyelid; not resting the footplate completely on the cornea (IOP too low); and prolonged application (subsequent IOPs will be lower and corneal ulceration is possible-mostly with Schiotz). Corneal scarring, infiltrates, or thinning may also render the readings inaccurate, particularly with the Schiotz tonometer. Most errors artificially increase the IOP, so when taking a series of measurements, a good general rule is that the lowest reading is the most accurate. Probably the most common error, particularly among new Tono-Pen users, is to hold the lids too close to the margin, resulting in elevated IOP readings. This mistake is particularly common in brachycephalic breeds, in which primary glaucoma is rare. If an animal, particularly a brachycephalic dog, has a completely normal ophthalmic examination but the IOP reading is elevated (usually in the 30’s), carefully reassess your technique and check it again.

**Schiotz tonometry:** The Schiotitz tonometry uses indentation tonometry, which measures the amount of corneal indentation by a known weight. Be sure the instrument is clean and you use good technique. Apply topical anesthesia. IOP must be measured with the animal either sitting or in dorsal recumbency. Vertically apply the instrument (with the 5.5 gm weight) to the center of the cornea, and average 3 readings. Each reading should take 1-2 seconds, and all 3 readings should be within 1-1.5 scale units of each other. If IOP is elevated, or one wishes to verify the accuracy of the
5.5 gm weight readings, the 7.5 or 10.0 gm weights are added individually to the 5.5 gm base weight. IOP estimates with the 7.5 gm weight should be within 6 mm Hg of those with the 5.5 gm weight. Use the human conversion table that comes with the tonometer to convert readings.

**Applanation tonometry**: The Tono-Pen is accurate, fast, easy to use, less traumatic, and unaffected by many corneal abnormalities. Three to six readings are averaged and the mean IOP is shown on a liquid crystal display. The coefficient of variance is also indicated as 5, 10, 20 or >20%. Only results with ≤10% are valid. The Tono-Pen does require some practice to use, and the same common errors as described above can occur. Its expense limits its use in private practice, although it is cost effective if used to screen dogs and cats for glaucoma. Screening the general population of dogs for glaucoma is not cost effective as IOP has been shown to be a very poor predictor of glaucoma, but IOP should be measured on any animal with a red eye. The incidence of glaucoma (aqueous humor misdirection) in cats does increase with age, making screening potentially useful.

**Rebound tonometry**: The TonoVet uses an electromagnetically propelled probe to come into contact with the cornea and then rebound. The characteristics of this rebound motion are used to provide an estimate of the IOP. The TonoVet must be calibrated by the manufacturer for each species, but these calibration curves have been done for dogs, cats, and horses. Studies in enucleated eyes and in vivo suggest that the rebound tonometer measures IOP accurately in dogs and horses (and likely in cats as well). To take a measurement with the TonoVet, the probe must be parallel to the ground and the animal must be looking forward while standing or resting on its sternum. Topical anesthesia is not required. There is no research thus far on the accuracy of rebound tonometry in diseased corneas.

**Ancillary tests**: Gonioscopy is a method to examine the iridocorneal angle to determine the underlying cause of glaucoma. Most animals with primary glaucoma have goniodygenesis, a malformation of the drainage angle that leads to gradual closure and increase of IOP. As it requires considerable practice to perform gonioscopy and to interpret the findings, this procedure is usually performed by veterinary ophthalmologists. High resolution ultrasound is a way to examine the ciliary cleft, the inner part of the drainage angle, and can often be useful in monitoring changes in the eye as well as determining underlying mechanisms.

**THERAPY**
Several things should be considered for determining the best therapy and/or referral for glaucoma on an emergency basis. These include whether the animal is visual; if blind, whether the eye is potentially sighted (best chance of vision if blind < 24 hours) or irreversibly blind (buphthalmia, luxated lens etc); and whether the glaucoma is primary or secondary. Primary glaucoma has 2 forms: (a) primary open angle glaucoma (POAG) and (b) primary closed angle glaucoma (PCAG). POAG is the best studied form, and has a slow, insidious onset with mild IOP elevations that may, at least initially, respond to medical therapy but is uncommon in dogs. PCAG is 8 times more common than POAG and usually produces unilateral, sometimes episodic, acute elevations in IOP that may spontaneously resolve or persist at very high levels (50-80 mm Hg), and almost always requires surgery. Due to the acute elevations in IOP, PCAG is the form seen more commonly on an emergency basis. Secondary glaucoma occurs secondary to other intraocular diseases, and is twice as common as primary glaucoma in dogs, and 7 times in cats. Treatment of secondary glaucoma will be discussed in the next section.

Therapy will vary depending on how you answered the above questions. For primary glaucoma, if the eye is visual or there is a chance of vision, and the owner wants the best possible treatment to preserve vision as long as possible, they should either be referred immediately to an ophthalmologist to be considered for surgical treatment or the pressure should be lowered until they can get to an
ophthalmologist (preferably within a few days). The reasoning behind referral for surgery is that anti-glaucoma drugs alone, or in combination, rarely can maintain more than a 10-15 mm Hg IOP reduction and often their efficacy diminishes over a few weeks to months. They are generally used as a bridge to surgery, as a surgical adjunct when additional minor IOP reductions are needed postoperatively, and to control minor IOP increases in secondary glaucoma. There are two general thrusts behind surgery: reducing aqueous production, or improving aqueous outflow. Because the role of aqueous humor is to maintain ocular health, procedures that decrease aqueous production either by freezing the ciliary body (cyclocryosurgery) or lasering with a diode or Nd:YAG laser (cyclophotocoagulation) may ultimately result in cataract and/or corneal degeneration. Cyclodestructive procedures also result in an immediate post-operative pressure rise which can destroy any remaining normal ganglion cells. Theoretically, procedures that improve outflow and allow production to continue would be preferable.

Gonioimplants are drainage devices that allow outflow by placing a tube in the anterior chamber than allows aqueous drainage to the subconjunctival space, however, intense fibrosis in dogs usually leads to failure within 2-6 months. Therefore, a combination of procedures is usually recommended, as the implant will provide short term control and the cycloablation will provide long term control. The most frequently used combination includes placement of a gonioimplant, a pressure-sensitive valve (Ahmed glaucoma valve, New World Medical Inc.), in combination with limited cyclocryosurgery or cyclophotocoagulation. Topical adrenergics, beta-blockers, or oral carbonic anhydrase inhibitors (all discussed below) are added if further IOP reduction is needed to achieve target pressures. Combination therapy is the most effective method of controlling IOP and maintaining vision for extended periods of time; and is more effective than either medical therapy alone or a single surgical procedure alone. Retrospective studies show, however, that only slightly more than 50% of dogs are visual at one year following surgery, although a larger percentage have controlled IOPs.

Emergency therapy should be administered prior to referral if there is a long driving distance, if the patient cannot be referred for a period of time, or referral is not an option. Each case is different, but the principal goal is to reduce IOP to a “safe” level at which progressive visual impairment and optic nerve damage no longer occurs. An arbitrary target of <20 mm Hg can be used for most animals. The most effective combinations of medications are prostaglandin analogs, hyperosmotics, carbonic anhydrase inhibitors, and miotics, and in the usual situation, drugs from all three categories are given at once in acute glaucoma if there is the potential for vision.

Hyperosmotics should be used if IOP is >45 mm Hg. Hyperosmotics work by increasing blood osmolarity, resulting in removal of water from the aqueous humor and vitreous. Mannitol should be heated or filtered (5 micron filters) to remove crystals prior to giving slow IV over 20 minutes. It has a short-lived (24-48 hrs), but very potent effect. The 1 gm/kg dose can be repeated once. Death may occur if crystals are given IV. Oral glycerin can also be used at 1 ml (mixed 50:50 with water) per pound. It is easier to administer and store. Disadvantages of oral glycerin include vomiting (making it ineffective) and problems with absorption. Hyperosmotics should be used with caution or not at all in animals with congestive heart failure or diabetes.

Methazolamide is the oral carbonic anhydrase inhibitor most commonly prescribed for glaucoma in veterinary medicine. Carbonic anhydrase inhibitors decrease production of aqueous humor. Dichlorphenamide is only intermittently available, but is also appropriate for use in dogs. The dosage is 2-4 mg/kg BID to TID PO. A lower dose should be prescribed and increased as needed. Adverse side effects include hypokalemia, metabolic acidosis, panting, anorexia, fatigue, depression, confusion, polyuria/polydypsia, vomiting and diarrhea, thrombocytopenia, blood dyscrasias, and nephrolithiasis. Some of these side effects are dosage dependent. Several topical carbonic anhydrase inhibitors (dorzolamide and brinzolamide) are also available but oral carbonic anhydrase inhibitors appear to be
more effective for reducing IOP more quickly on an acute basis. Often, both topical and oral carbonic anyhydrase inhibitors are given for acute glaucoma.

Miotics are more effective when the IOP is under 40, so they should be used in combination with the above medications. 2% pilocarpine is effective in lowering IOP and should be prescribed QID. Side effects include irritation from a low grade uveitis induced by the pilocarpine and ciliary body spasms that may be painful. Concurrent use of topical steroids (neomycin/polymyxin/dexamethasone or 1% prednisone acetate) is recommended.

A single agent therapy for the acute management of glaucoma is topical prostaglandin derivatives. Latanoprost 0.005% (Xalatan) is the drug we use most frequently in the emergency management of glaucoma. This drug is an extremely potent miotic in dogs, and can sometimes break the IOP pressure spike as the sole agent in 1-2 hours. This drug also can cause a mild uveitis, and concurrent steroids are recommended for that reason. Often, this is an appropriate drug to administer as soon as the diagnosis of glaucoma is made, as it may result in IOP lowering without the need for administration of systemic medications. Its long-term efficacy is poor—in a review of our cases at UW, all dogs on latanoprost for PCAG had IOP increases within 6 months. Latanoprost quickly loses its efficacy 30 days after being opened, however, so bottles kept on hand for emergency situations need to be replaced frequently. It is also a quite expensive drug, even with the generic version now available. Latanoprost may be given up to three times daily, but is usually most effective once to twice daily.

Follow-up goals are to maintain IOP at ≤18-20 mm Hg. If the IOP is close (2-3 mm Hg) to the target IOP, add in 1.0% epinephrine or dipivefrin, or a topical beta-blocker (timolol or betaxolol). Both sympathomimetic agents and beta-adrenergic antagonists decrease production of aqueous humor. Beta-blockers may be more effective in cats than dogs, although timolol may cause bradycardia in small dogs and cats. Otherwise, one of the drugs listed above can be added. A combination of timolol and dorzolamide (Cosopt) is also available, which may improve owner compliance when administering multiple medications. If the owner is unable to be referred, contact a veterinary ophthalmologist who will be able to help you with a long-term medication protocol. It can be challenging since medications provide limited long-term control and may need to be altered frequently.

If the eye is blind and painful, then options for treatment include enucleation, evisceration and prosthesis, cyclocryosurgery, or cyclophotoablation. Intravitreal gentamicin is often unsatisfactory as it causes excessive intraocular inflammation, intraocular bleeding, cataracts, and often causes a phthisical eye. The goal of treatment in blind, painful eyes is to make the animal comfortable as quickly as possible, so treatments that have an extended recovery due to inflammatory side effects, such as cyclocryosurgery, cyclophotoablation or gentamicin injections, may be less than ideal.

Although CAG typically presents as a unilateral disease, the initially normotensive fellow eye becomes overtly glaucomatous a median of 8 months after the first eye is affected, if no therapy is administered. Prophylactic therapy delays the risk to a median time of 33 months. To delay the onset of overt glaucoma in the fellow eye, prophylactic therapy with demarcarium bromide 0.125% once daily or betaxolol 0.5% twice daily may be used. Demarcarium bromide is an indirect acting parasympathomimetic drug, but is no longer commercially available but is compounded by several pharmacies. Demarcarium is can cause a low grade uveitis, so concurrent treatment with 1% prednisolone acetate once daily is also recommended. Betaxolol is a β-blocker, which decreases aqueous production. Betaxolol is associated with an increased incidence of keratoconjunctivitis sicca, so Schirmer tear tests should be routinely measured on these patients. Measure IOP monthly for 3 months and then at 3 month intervals thereafter. Progressively rising IOPs, IOPs exceeding 20 mm Hg,
changes in the appearance of the retina or optic nerve head, or an episode of acute glaucoma warrant more aggressive therapy.

SECONDARY GLAUCOMAS

Glaucoma secondary to uveitis:
Severe uveitis leads to secondary glaucoma through obstruction of the outflow pathways by inflammatory debris, cells or by the development of a pre-iridal fibrovascular membrane that covers the drainage angle. If the animal has secondary glaucoma from uveitis, the primary underlying cause needs to be aggressively treated to best control IOP. Topical steroids, topical NSAIDs, and potentially systemic steroids if no systemic disease is present are indicated to treat the uveitis. However, do not ignore the IOP elevation while treating the primary cause. For treating glaucoma secondary to uveitis, in addition to the uveitis workup and treatment, topical dorzolamide, epinephrine, dipivefrin, or timolol q 6-12 hrs, are good choices in mildly (5-10 mm Hg increase) glaucomatous inflamed eyes. In my hands, topical treatment with dorzolamide appears to have the best efficacy. Oral carbonic anhydrase inhibitors are useful if the IOP elevation is greater, but hyperosmotic agents should be reserved for last-ditch efforts as they may cross an incompetent blood-aqueous barrier and further raise IOP. Miotics should be avoided as they will cause further ciliary spasm and more pain. Atropine should be avoided as well, as it may cause further IOP elevation. If the eye is normotensive but inflamed, follow IOP carefully as the outflow capacity is likely to be impaired, and glaucoma may occur when the inflammation is controlled. Dogs with abnormal drainage angles (Cockers, Bassets, Chows, etc) may develop glaucoma more rapidly as their drainage angles are more easily occluded.

For glaucoma secondary to hyphema, carefully monitor IOP and consider intraocular neoplasia as a cause of the hyphema, particularly if unilateral. If a coagulopathy is the cause of the hyphema and inflammation is minimal consider topical epinephrine or dipivefrin to constrict the vessels. If inflammation is suspected to be the cause, and the IOP elevation is mild, use topical and/or systemic corticosteroids and topical 1% epinephrine. Carbonic anhydrase inhibitors are useful for more substantial rises but try to avoid hyperosmotic agents as they may actually raise IOP.

Anterior Lens Luxation:
Anterior lens luxations are most commonly secondary to a zonular problem especially in particular breeds such as terriers. Traumatic lens luxations are infrequent and usually carry a poor prognosis due to other intraocular damage. Signs of lens luxation include a quiet or inflamed eye (especially if secondary glaucoma is present), the appearance of a shallow anterior chamber due to the presence of the lens in the anterior chamber, and corneal edema from contact of the lens to the corneal endothelial surface. Acute anterior lens luxation with glaucoma in a potentially sighted eye is an emergency and best treated by immediate lensectomy (lens removal). Prior to surgery, or prior to referral if long distances need to be traveled, the IOP should be reduced. Mannitol, carbonic anhydrase inhibitors (both oral and topical) and beta blockers are indicated. No miotics should be used as they can actually increase IOP by pupillary constriction around the lens or anteriorly placed vitreous. Constricting the pupil around the lens may also make surgical removal more difficult. Due to vitreal loss and secondary retinal detachments luxated lens removal is more difficult than standard cataract surgery, and success rates reflect this. Only around 50% of dogs are visual at a year post operatively, with vision loss due to either glaucoma or retinal detachment. Trapping a loose lens behind the pupil with miotics often fails in the long-term. If primary lens luxation occurs in one eye, it will occur in the remaining eye, and there is no prophylactic therapy available. Prophylactic lens removal by phacoemulsification when the lens is subluxated may offer a higher success rate, but there are no definitive studies at this point.
GLAUCOMA IN CATS:
Glaucoma in cats is most often secondary to uveitis. Unfortunately, clinical signs are often subtle in cats as they do not develop the red eye (vascular injection) as dogs do and they typically have no or very mild corneal edema. Cats will often develop subtle buphthalmia and lens luxations in secondary glaucoma, and owners may not notice clinical signs until far along in the course of the disease. Many cats with glaucoma are blind at their initial evaluation. Aggressive treatment of the inflammation should be immediately instituted, and a systemic work up to determine the underlying cause of uveitis should be performed. Oral carbonic anhydrase inhibitors are not well tolerated by cats, so most glaucoma treatment involves topical therapy. Beta-blockers and topical carbonic anhydrase inhibitors are the most effective drugs; topical prostaglandin derivatives have been shown to be ineffective in glaucomatous cats after a few days.

Feline aqueous humor misdirection syndrome:
Several studies have documented a form of glaucoma in cats known as aqueous misdirection syndrome. In this disease, an abnormality in the anterior vitreous face allows aqueous humor to travel into the vitreous rather than into the anterior chamber. The iris-lens diaphragm then shifts anteriorly, resulting in a block of aqueous flow into the anterior chamber by increase iris-lens contact, and displacement of the iris anteriorly, resulting in a narrow and ultimately compromised iridocorneal angle. Most cats present with anisocoria, due to dilation of the pupil in the affected eye. Examination reveals a very shallow anterior chamber compared to the contralateral eye. This is most easily observed by looking at the cat from the side and by comparing the distance between a slit or small beam of light on the cornea and the lens. Other clinical signs include decreased pupillary light reflex, decreased menace response, blindness, incipient cataracts, and optic nerve cupping with retinal degeneration. IOP is usually over 20 and often higher, although it can occasionally be in the normal range. Females are predisposed, and the disease is more common in older cats (average age of 11.7 years). The diagnosis is made by the observation of a shallow anterior chamber with intact lens zonules (in other words, a non-luxated lens). Treatment is directed at decreasing aqueous humor production, usually by topical carbonic anhydrase inhibitors. Miotics should be avoided, as they can exacerbate the pupillary block of aqueous and result in increased IOP. Cycloplegics are recommended in humans with this disease to inactivate ciliary constriction, resulting in a tightening of the lens zonules to pull it back into a more normal position. The efficacy of mydriatics in this disease in cats is unknown.
COMMON FELINE OCULAR DISORDERS
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Overview: Feline ocular disorders can be frustrating to diagnose and to treat.

Feline conjunctivitis
Conjunctivitis is perhaps the most commonly diagnosed feline ocular problem and also perhaps the most frustrating. In contrast to canine conjunctivitis, feline conjunctivitis is usually infectious, although it is not generally a bacterial conjunctivitis. The most common etiologic agents are feline herpes virus-1, chlamydia psittaci (Chlamydophilia), and mycoplasma. In response to disease, conjunctiva develops hyperemia, chemosis (edema), follicles, or a cellular exudate. Conjunctival or subconjunctival hemorrhage is typically due to trauma (particularly globe rupture), systemic inflammation, vasculitis, and coagulopathies.

Feline herpes virus
The feline herpes virus is ubiquitous, and is the most common cause of feline conjunctivitis (indeed, it is probably involved with many feline ocular diseases). In primary infection, there is often an upper respiratory infection with conjunctivitis. The cornea may also be affected. The conjunctivitis caused by initial infection is characterized by bilaterality, hyperemia, serous then mucopurulent discharge, and chemosis. Some infections may resolve with no long term effects; however, others do not. Herpes virus in cats is associated with not only conjunctivitis, but KCS, sequestrums, keratitis, eosinophilic keratitis, uveitis, dermatitis, and respiratory disease.

Adult cats with recrudescent herpes viral disease often present with recurrent hyperemia, chemosis, and discharge, with a wide range of severity. Clinical signs are typically unilateral but may be bilateral in some cases. Most cats will have waxing and waning courses of disease as they have periodic periods of viral recrudescence. Remember that cats tend to have a dark red ocular discharge that many owners will mistakenly call bloody.

One somewhat unique manifestation of herpes virus is symblepharon. In these cases, loss of conjunctival and corneal epithelium from cytolysis due to viral replication leads to inappropriate adherence of conjunctiva to the lids and cornea. Symblepharon is difficult to repair, and often recurs after excision. Symblepharon may also occlude the nasolacrimal puncta, leading to chronic epiphora.

80% cats are latently infected with herpes virus after primary infection. The virus is thought to survive in the trigeminal ganglia of cats. At least half of these cats have spontaneous reactivation with symptomatic or asymptomatic shedding. Often with re-activation, there is no URI. Reactivation occurs with and without obvious causes such as stress or concurrent disease.

Diagnosis: Since so many cats are exposed to herpes virus either from other cats or the vaccine, serology is positive in a majority of cats and therefore of little aid in diagnosis. Unfortunately, in chronic disease, there is typically a lower virus load, and so other diagnostic tests are often falsely negative. The diagnosis often depends on clinical signs and response to treatment trials. Specific diagnostic tests are PCR for herpes viral DNA, virus culture, IFA, and cytology. Many of these tests, particularly cytology, are non-diagnostic in chronic disease, making it difficult to get specific
diagnosis. This author typically discusses herpes with the client, but typically does not do specific testing for herpes virus.

_Treatment:_ There is a wide variation in the efficacy of many anti-virals commercially available. Additionally, many have poor bioavailability and are toxic to cats. To date, topical trifluridine (usually reserved for corneal disease) is probably the most efficacious but requires frequent (4-8 times/day) treatment and can be irritating, as it can target normal cells as well as affected cells. Trifluridine is expensive as well ($80-120). Idoxuridine is also efficacious against the feline herpes virus and is inexpensive; however, it also requires frequent application and must be compounded. Cidofovir is slightly less effective in vitro, but requires only twice daily administration, must be compounded, and is also expensive. Topical ganciclovir was recently approved for use in humans. In vitro data suggests it would be equivalent to Idoxuridine and trifluridine, however its use has not been reported in cats yet, and it is very expensive.

Although there are a large number of oral antivirals available for use in humans, many of them have shown to be of limited efficacy against the feline herpes virus and/or have toxic systemic effects on cats. Famcyclovir is an oral drug that has been tested in cats and shown to be both safe and effective; however, due to complex pharmacokinetics, the appropriate dose is unclear, ranging from 125mg/cat BID PO to 90mg/kg TID PO. Further research should elucidate an appropriate dose. Famciclovir is expensive, but a less expensive compounded version is available. Acyclovir is has poor efficacy and valacyclovir is very toxic to cats and should not be used.

Oral lysine (250mg-500mg/day) has been shown to decrease viral replication in experimentally infected animals, and may be helpful in some cases. Lysine has been shown to be useful in experimental infections but not useful in shelter situations. Typically, I ask owners to document how many outbreaks their cat had the previous 6 months, then give lysine for 6 months and document how many outbreaks occur. If there are less episodes and/or the episodes are less severe, the lysine can be continued. Topical antibiotics are for used prophylactically or for secondary infection in herpetic conjunctivitis.

**Chlamydial (Chlamydophila felis) conjunctivitis**

Chlamydial disease in cats is usually not associated with upper respiratory infections, although mild rhinitis, fever, and lymphadenopathy may occur initially. Clinical signs usually start unilaterally and progress to bilateral within 7-10 days. Chemosis is often a primary feature, along with hyperemia and discharge. Often, chlamydial conjunctivitis occurs in a young cat or after intro of new cat into the household.

_Diagnosis:_ Diagnosis is through conjunctival cytology early in the infection (intracytoplasmic inclusions), IFA or PCR.

_Treatment:_ topical tetracycline TID, erythromycin BID-TID, or ciprofloxacin. Tetracycline topically can be irritating. Oral doxycycline should also be considered, particularly in cases that seem responsive to topical therapy but recur when topical therapy is discontinued (beware esophageal stricture). All cats in the household may need to be treated if problems occur after introduction of a new cat.

**Mycoplasma**

Mycoplasma is typically considered as a possible cause of conjunctivitis in cats, however, 90% of cats have mycoplasma in their normal flora, so its role in conjunctivitis is under debate.
Mycoplasma conjunctivitis is described as unilateral or bilateral, with epiphora, hyperemia, and chemosis.

*Diagnosis:* inclusions at cell membrane, isolation of organism

*Treatment* of mycoplasma is similar to treatment for Chlamydia: tetracycline, erythromycin, ciprofloxacin.

**Approach to feline conjunctivitis**
Definitive diagnosis in feline conjunctivitis can be difficult, particularly in an adult cat with chronic signs. One study (Nasissse, 1993, JAVMA, 834-837) found that no agent was identified in ~60% of cases. FeLV and FIV were more prevalent than in the reference population. When diagnosis was achieved, it was either herpes or Chlamydia. Therefore, the approach to feline conjunctivitis often involves a treatment trial with or without diagnostics, depending on the owner’s level of concern and financial constraints.

Cytology is likely more useful than culture and sensitivity, but if excessive mucopurulent discharge is present, a culture may be indicated. Diagnostics for herpes/Chlamydia may be performed, but often have a low diagnostic yield. Often, treatment trial is done for both diagnostic and therapeutic purposes. Treatment should include tetracycline or erythromycin or ciprofloxacin topically, and oral doxycycline should be considered. If clinical signs recur after topical therapy alone, consider a trial of oral doxycycline. Otherwise, a trial of oral lysine should be considered. There is little to no indication to use steroids in feline conjunctivitis. Topical steroids may exacerbate disease due to feline herpes virus and can lead to stromal keratitis.

**Eosinophilic Keratitis**
This is a distinct entity in the cat and less often in horses. The exact cause is unknown, but thought to be immune-mediated. However, 76% of cats with eosinophilic keratitis are PCR positive for herpes. It may occur in one eye initially, but eyes can become involved with time. The lesions develop at the limbal margins and extend into the cornea. They appear clinically as reddish, raised focal plaques that may be covered with white flecks. Cytologic examination of corneal scrapings reveals predominately eosinophils and mast cells, although even one eosinophil is diagnostic. These are very responsive to topical corticosteroids as well as systemic treatment with megestrol acetate (Ovaban). Topical steroid therapy often starts at 4-6 times daily depending on the severity of the lesion, and is tapered. Often completely resolution can be seen; otherwise, faint scars may remain. Blood vessels and infiltrates should resolve. These lesions may recur over time. Due to the potential for underlying herpes infections, concurrent antivirals such as trifluridine or cidofovir may be considered. If an epithelial break is present, concurrent antibiotics should also be considered. Always warn owners that if their cat is looking worse and not better on the steroids, then they should immediately stop the steroids and bring the cat back for re-examination. Recently, topical cyclosporine has been reported to be efficacious for the treatment of eosinophilic keratitis in cats.

**Feline corneal sequestrums:**
Sequestrums are unique to cats, and are characterized by collagen degeneration and brown pigmentation. Sequestrums occur in all breeds, but Himalayans, Persians, and Burmese are predisposed. Likely causes are chronic exposure (brachycephalic cats, entropion, etc), and feline herpes virus infection. The clinical appearance is usually diagnostic, and consists of a brownish to black circular to oval lesion in the axial or paraxial cornea. The sequestrum can be incorporated into the cornea or can appear raised. Often there is an associated epithelial erosion around the sequestrum that is fluorescein positive, but the sequestrum itself usually does not take up stain. The
lesions can be superficial, or can extend to Descemet’s membrane, but it is difficult to assess depth due to the opaque nature of the lesion. Vascularization, stromal edema, inflammation and secondary infection can all occur.

Treatment consists of observation with prophylactic antibiotic therapy or surgery. Observation can be elected if the lesion is known to be superficial and the cat is non-painful. Many sequestra will slough with no further therapy. If they do slough, there is typically less scarring, less expense, and no need for general anesthesia. However, if the lesion extends deep into the stroma, then corneal perforation is a risk with spontaneous sloughing. Surgical therapy consists of removing the sequestrum via keratectomy. If all of the discoloration is removed with less than 50% of the superficial stroma, then no further therapy (other than prophylactic antibiotics) is necessary. If the lesion extends deeper than 50% into the stroma, then some kind of graft is necessary to strengthen the weakened cornea. Options include lamellar keratoplasty (partial thickness corneal graft), corneoscleral transposition, conjunctival flaps/grafts, or full thickness corneal transplants. With all of these procedures, there is a risk of sequestrum recurrence.

**Herpes Drugs, and Dosages**

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<tr>
<th>Drug</th>
<th>Drug Class</th>
<th>Dose Range</th>
<th>Frequency</th>
<th>Route</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Trifluridine</td>
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<td>Topical</td>
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<td>Nucleoside analogue</td>
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<tr>
<td>Ganciclovir</td>
<td>Nucleoside analogue</td>
<td>5x/day</td>
<td>Topical</td>
<td>$185, no reported use in cats</td>
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<tr>
<td>Cidofovir</td>
<td>Cystine analogue</td>
<td>BID</td>
<td>Topical</td>
<td>$80-180, compounded</td>
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<tr>
<td>Famciclovir</td>
<td>Deoxyguanosine analogue</td>
<td>125mg/cat BID to 90mg/kg TID</td>
<td>BID/TID</td>
<td>Oral</td>
<td>Try 40mg/kg BID; $200/30 tablets; 300mg/ml paste $45 compounded (Wedgewood)</td>
</tr>
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**Feline retinal diseases:**

*Enrofloxacin retinal degeneration:* Enrofloxacin was originally approved at a dose of 2.5mg/kg in cats. Further testing revealed that a dose range of 5-20mg/kg PO could be used, and this was approved in 1997. Shortly after introduction of this dosing regimen, reports of cats with blindness, partial blindness, and mydriasis began to appear. One unpublished study found dose related ocular effects (primarily retinal degeneration) in cats starting at doses greater than 5mg/kg/day. A toxicity study using 50mg/kg/day revealed severe retinal degeneration, as well as neurologic changes including incoordination, stiff gaits, tremors, convulsions, blindness, ataxia, circling, seizures and nystagmus. Neurologic signs may be due to GABA inhibition. One review of reported cases of retinal degeneration in cats suggested that older cats, particularly cats with renal disease, were more susceptible to toxic effects of enrofloxacin. Other fluoroquinolones have been shown to be retinotoxic in other species. Use caution with fluoroquinolones in cats, particularly older cats or cats with renal disease.
Hypertensive retinopathy: Hypertensive retinopathy usually occurs in older cats, and is associated with acute vision loss. Clinical signs are due to precapillary vasoconstriction of retinal arterioles (due to autoregulation of retina) leading to smooth muscle necrosis, vascular dilation and leakage. Clinically, this causes retinal hemorrhage and retinal edema. These changes may occur in choroid as well leading to retinal detachments (leading to acute vision loss).

Clinical signs include hyphema, intravitreal hemorrhage, retinal vessel tortuosity, retinal hemorrhages, and varying degrees of retinal detachment.

Diagnostics include blood pressure measurement and a systemic work-up, since high blood pressure in cats is often associated with cardiac abnormalities, renal abnormalities, and/or hyperthyroidism.

Treatment consists of treating the primary disease and lowering the blood pressure.

Quick retinal reattachment may result in regaining vision, but the retina may slowly degenerate over time.

All cats with acute vision loss need to have a blood pressure measurement performed!
IT’S STILL THERE! WHAT TO DO WITH NON-HEALING CORNEAS
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Overview: The most common causes of erosions/ulcers seen on an emergency basis are secondary to foreign bodies and trauma. Other causes of corneal problems are adnexal disease or poor conformation leading to exposure or mechanical injury to the cornea, both quantitative and qualitative tear film abnormalities, corneal edema leading to bullous keratopathy, abnormalities in globe position leading to lagophthalmia and facial nerve paralysis causing lagophthalmia. Appropriate management of corneal disease includes a thorough ophthalmic exam to ensure that lid function is normal, tear function is normal, and that no other ocular abnormalities are present which could contribute to the formation or persistence of a corneal erosion.

Treatment: The most important aspect of treatment is to determine and correct the underlying cause, if present. Many superficial erosions caused by trauma will heal rapidly and uneventfully, however, if there is an underlying cause (such as KCS, entropion, etc) then the erosion will not heal without addressing that underlying cause. Treatment of superficial erosions (urgent non-emergencies) includes debridement if epithelial lipping (see section on SCCED below), and topical antibiotics prophylactically. A broad spectrum antibiotic such as neomycin/polymyxin/gramicidin is suitable with a BID to TID frequency for a non-infected erosion. It is important not to over-treat the erosion and impair wound healing. Consider atropine only if secondary uveitis present, however, it is often not necessary. Remember, atropine is contraindicated with concurrent KCS as it will further lower tear production and delay wound healing. E-collars are recommended.

Spontaneous chronic corneal epithelial defects: Spontaneous chronic corneal epithelial defects (SCCEDs) in dogs are chronic erosions with no apparently underlying cause that fail to resolve through normal epithelial wound healing. Various names have been applied to this condition, including boxer erosions, indolent erosions or ulcers, canine recurrent erosions, recurrent epithelial erosions, persistent corneal erosions, refractory corneal ulcers, nonhealing erosions, and idiopathic persistent corneal erosions. The typical clinical appearance of a SCCED is that of a superficial, non-infected erosion surrounded by a sheet of non-adherent or loose epithelium. The epithelium sometimes appears thickened, and fluorescein stain often leaks beneath the abnormal, nonattached epithelium. Left untreated or if improperly treated, these erosions can persist for weeks to months and sometimes for even over a year. These erosions usually occur in middle-aged dogs (i.e., 7 to 9 years) and in all breeds of dogs, although Boxers are often overrepresented.

Diagnosis: A spontaneous, chronic, corneal epithelial defect should be suspected in any middle-aged dog with a nonhealing corneal erosion (i.e., an uncomplicated erosion that has not healed within 1 to 2 weeks). Careful examination must be performed to eliminate any possible underlying causes for delayed wound healing, such as mechanical trauma from lid abnormalities (e.g., lid mass, entropion, lagophthalmos) or foreign bodies, infection, tear film abnormalities, exposure (e.g., conformational, neurogenic, secondary to globe abnormalities such as exophthalmos or buphthalmos), or corneal edema causing secondary bullous keratopathy. If any underlying causes are found, addressing those issues generally results in resolution of the corneal erosion.
Diagnosis is also aided by the typical clinical appearance. A rim of loose epithelium around the erosion is characteristic in SCCEDs. The erosion is highlighted by diffuse staining with fluorescein, and a less intense ring of fluorescein staining surrounds the defect. The lesion is superficial, with no loss of stromal substance. Any corneal edema is confined to the area of the erosion. Diffuse stromal edema implies that endothelial disease, with secondary corneal edema and bullous keratopathy, is the more likely underlying cause of the erosion. The amount of blepharospasm, epiphora, and corneal vascularization varies tremendously. A central corneal lesion may commonly exist weeks to months without any vascular response at all. Peripheral lesions are more likely to vascularize.

**Treatment:** Multiple treatment modalities have been recommended for the management of SCCEDs. It is important to remember that because SCCEDs are by definition nonseptic, frequent application of antibiotics is not necessary and may delay corneal wound healing. Topical antibiotics are administered prophylactically only, and application is needed only q 12 to 8 hours. Changing antibiotics seldom results in healing, unless the animal is suffering a toxic response to the antibiotic. After all the procedures described below, animals should be maintained on antibiotics until epithelial closure occurs. It is also important to communicate to the owners that these erosions often require multiple treatments and often recur in one or both eyes. For dogs with multiple recurrences, sometimes limiting access to bushes and tall dry grass decreases the frequency of recurrences, as superficial trauma likely initiates SCCEDs.

Epithelial debridement has long been a mainstay of therapy for SCCEDs. After application of a topical anesthetic, dry, sterile, cotton-tipped applicators are used to gently remove the loose epithelium, starting in the center of the erosion and working outward in a radial motion. Normal corneal epithelium is very firmly attached to the underlying stroma and is not easily removed with a cotton-tipped applicator, so debridement is continued until all loose epithelium is removed (without fear of unnecessary removal of normal epithelium). Often, a much larger area of epithelium is removed than originally indicated by fluorescein staining. Combining the outcomes of the various studies in the literature results in an overall success rate of approximately 50%.

Another therapy for SCCEDs involves making either small punctures or linear scratches in the superficial stroma, which likely creates channels for epithelial cells to penetrate the abnormal superficial stromal hyalinized zone noted on histopathology of these samples. Various names have been given to these procedures, including punctate keratotomy, anterior stromal puncture, multiple punctate keratotomy, multifocal superficial punctate keratotomy, and grid keratotomy. To perform an anterior stromal puncture, a 25-gauge needle is clamped in a hemostat so that the tip of the needle is barely exposed. This allows the hemostat to be used as a handle and controls the depth of the puncture. Alternatively, a commercially available anterior stromal puncture needle can be used. After application of topical anesthesia and debridement of loose epithelium, multiple small punctures are made 0.5 to 1 mm apart across the surface of the exposed stroma and extending 1 mm into the normal, surrounding attached epithelium. To perform a grid keratotomy, small lines are made in a crosshatched pattern extending from normal cornea across the epithelial defect. Combining the outcomes in the various studies in the literature results in a success rate of approximately 80%. A contact lens or third eyelid flap may also be used after these procedures; one study found that 100% (n=12) of eyes healed after treatment with grid keratotomy followed by a third eyelid flap.

A more invasive procedure for the treatment of SCCEDs is superficial keratectomy. This procedure, unlike the two described above, requires general anesthesia and is best performed under an operating microscope. As a result, veterinary ophthalmologists generally perform this procedure. To perform a superficial keratectomy, the loose epithelium may or may not be debrided. If it is not
debrided, careful examination of the cornea must be done to ensure that the entire area of non-adherent epithelium is removed with the keratectomy. The area is either outlined with a corneal trephine of appropriate size or with a 64 Beaver blade, and then it is undermined with a corneal dissector. The flap of cornea, usually 150 to 200 μm thick, is then removed, and any attachments are trimmed as necessary. Following the keratectomy, either a contact lens or third eyelid flap may be placed. Superficial keratectomy probably works by completely removing the abnormal superficial zone of stroma, allowing epithelial adhesion. The success rate with this surgery has been reported to be 100%. Although this procedure results in rapid healing, it is often not recommended as an initial therapy because of the need for referral, its higher cost, the risks inherent with general anesthesia, and the increased likelihood of corneal scarring.

**Erosions due to bullous keratopathy:**

Bullous keratopathy is typically due to endothelial degeneration. Endothelial degeneration may be due to old age, dystrophies, or some previous insult that decreased the number of endothelial cells (uveitis, glaucoma). In this process, stromal edema leads to alterations in epithelial attachment, and small bulla (epithelial water blisters) form. These small bulla easily rupture, leading to corneal erosions that do not heal easily. Corneal erosions due to edema are often multifocal, and the associated edema is more generalized and more severe than the mild edema associated with epithelial loss alone. Differentiating a long-standing SCCED from bullous keratopathy can sometimes be difficult, but erosions due to bullous keratopathy have an even more protracted course of healing.

Medical therapy of bullous keratopathy is often unrewarding. Topical hypertonics may provide palliative therapy for epithelial edema. Hypertonic agents increase the tonicity of the tear film, which draws excess fluid from the epithelium. Topical hypertonics, however, have no significant effect on stromal edema. The most commonly used hypertonic is 5% sodium chloride drops or ointments. Ointments used 4 times daily appear to have the best efficacy in canine patients with bullous keratopathy. If erosions are present, topical broad-spectrum antibiotics should be used as described for SCCEDs. Contact lenses may relieve pain and discomfort as well as protect corneal epithelium from mechanical trauma. Contact lenses can be left in place for two weeks, and an Elizabethan collar should be placed to facilitate retention.

Surgical therapy provides the most definitive treatment of bullous keratopathy. Goals of therapy are pain relief and visual recovery, if possible. In veterinary medicine, pain relief is often the only easily obtainable goal. Thermal cautery is an easy and practical surgical option for painful bullous keratopathy, but usually requires referral. In this process, the anterior stroma is denatured by heat. This destroys the basement membrane, which is abnormal in bullous keratopathy, along with altering the anterior stroma. Thermal cautery creates a light subepithelial scar that is a barrier to fluid flux. This barrier prevents the formation of bulla, and allows the epithelium to re-attach. Excessive scar formation will often result in decreased vision, but the animals are usually comfortable. If scar formation is minimal, vision can be retained, but owners should be warned that vision may decrease after surgery. The procedure is performed with the animal under general anesthesia using disposable hand-held thermal cautery to make small, superficial burns across the affected area after epithelial debridement. Several hundred burns may have to be placed. In cases of degeneration or dystrophy, often the entire cornea is treated to prevent future problems because the edema typically continues to progress. A blunt tipped diathermy probe on its lowest setting may also be used. A contact lens should be placed, and broad-spectrum topical antibiotics used. Mydriatics should be used if the patient appears painful and if tear production is normal. After the cornea is epithelialized, topical corticosteroids may be used to decrease scar formation. Skill with
microsurgical techniques and a familiarity with working under magnification (preferentially an operating microscope) are required, and therefore, referral to an ophthalmologist is recommended.

Anterior stromal puncture (ASP) has been advocated in human patients with bullous keratopathy as a means to improve their comfort while awaiting penetrating keratoplasty (the definitive treatment for humans). The punctures penetrate the abnormal basement membrane and anterior stroma, allowing focal epithelial adhesions to occur. One advantage of this procedure is that it can usually be performed in conscious animals using topical anesthesia, which can be an important consideration in elderly patients with endothelial degeneration. ASP also causes less scarring than thermal cautery, but may not be as effective long term as it does not significantly alter the anterior stroma.

A thin conjunctival flap may also be placed over the cornea in cases of painful bullous keratopathy. Generally thermal cautery is preferred, as there is a better chance of retaining vision, however, a thin, partial flap may result in decreased edema and retention of vision. Again, this procedure usually requires referral to a veterinary ophthalmologist.
RED EYE

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Red eye typically refers to conjunctival, episcleral/scleral or palpebral hyperemia. The term ‘red eye’ typically does not refer to redness within the anterior chamber (ie, hyphema), but hyphema may be present along with a red eye.

Ocular examination findings may include:

Conjunctival vessel hyperemia, or diffuse conjunctival redness. Conjunctival vessels appear to originate in the conjunctival fornix and branch as they approach the limbus. Conjunctival hyperemia usually indicates ocular surface (ie superficial) disease including conjunctivitis and superficial keratitis (ulcers, pannus etc).

Episcleral/scleral hyperemia: discrete engorgement and tortuosity of episcleral vessels, which appear as larger vessels originating at the limbus and following a deep, straight course toward the conjunctival fornix. These deeper vessels usually indicate intraocular disease such as uveitis, glaucoma, or deep corneal disease, or episcleritis/scleritis.

Both conjunctival and episcleral/scleral vessel injection can occur in the same eye. Non-specific signs that often accompany a red eye are ocular discharge and blepharospasm. Other signs depend on the underlying cause of red eye and include:

- **Blepharitis; hyperemic, swollen eyelids:**
  - ± Mucopurulent ocular discharge.
  - Normal intraocular examination.

- **Conjunctivitis, hyperemic conjunctiva:**
  - Chemosis (conjunctival swelling).
  - Ocular discharge.
  - Normal intraocular examination

- **Keratitis:**
  - Corneal opacities: edema, infiltrate, pigmentation
  - Corneal vascularization.
  - Corneal vessels that cross the limbus and branch suggest superficial corneal disease.
  - Vessels that start at the limbus and form a dense straight pattern on cornea suggest deep corneal disease and/or intraocular disease.
  - ± Fluorescein dye retention.
○ **Uveitis: any or all of the following:**
  - Aqueous cells or flare.
  - Constricted pupil.
  - Abnormal appearance to iris
  - Hyphema
  - Fibrin clot in anterior chamber.
  - Hypopyon
  - Low intraocular pressure.

○ **Glaucoma:**
  - Dilated pupil.
  - Diffuse corneal edema.
  - ± Buphthalmos
  - Fundic exam: optic disk cupping.
  - Lens luxation: suggests primary or secondary glaucoma.

**Differentials of a red eye:**
- Blepharitis
- Conjunctivitis
- Keratitis
- Anterior uveitis
- Hyphema
- Glaucoma
- Episcleritis

**Initial diagnosis:**
Perform a complete ophthalmic examination, including STT (looking for KCS as cause of keratitis/conjunctivitis), fluorescein (if positive-keratitis/ulceration), IOP measurement (greater that 20-25mmHg suggests glaucoma, less than 10 mmHg may suggest uveitis).

**Treatment:**
General principles in the treatment of ophthalmic disease are to decrease inflammation, eliminate infection if present, achieve appropriate intraocular pressure if abnormal, eliminate ocular pain and maintain vision.

Loss of vision acutely is an emergency that requires immediate determination and treatment of the underlying cause. Glaucoma, severe uveitis, severe keratitis should be considered in acute or progressive vision loss associated with a red eye.