What is the precorneal tear film and why is it so important?
The precorneal tear film (PTF) is crucial for preserving ocular surface health. It provides the avascular cornea with nutrition (oxygen, glucose, electrolytes), lubricates the lids and ocular surface, provides protective antimicrobial proteins, immunoglobulins and growth factors, and removes debris and exfoliated cells.

The PTF is made up of three primary components: lipid, mucin and aqueous fluid. These components are intricately intermingled over the corneal and conjunctival surfaces. The lipid layer is secreted by the meibomian glands which line the upper and lower eyelid margins. Its main job is to prevent evaporation of tears and provide the stable and even dispersion of tears. Normal blinking and compression of the eyelids is important for release of lipid from the meibomian gland opening. The mucin layer is secreted by goblet cells within the conjunctiva, corneal and conjunctival epithelial cells, and the lacrimal gland. It decreases bacterial adherence, anchors the tear film to the corneal epithelium, lubricates and facilitates normal refraction. The aqueous layer is secreted by the orbital lacrimal glands and gland of the third eyelid. The aqueous portion of the PTF provides the cornea with nutrition, lubricates, and removes waste (bacteria, carbon dioxide, lactic acid, debris). Lacrimal gland secretion is controlled by the parasympathetic and sympathetic nerve system, hormones and various proteins (i.e. epidermal growth factor). Neurologic and hormonal control of these secretions is not well understood in dogs.

Ocular surface health requires more than normal tears. The eyelids work with the PTF to preserve the normal refractive quality of the cornea (i.e. vision) and protect the globe from injury. Many common ocular problems in some breeds, such as the pug, can be blamed in part for their physiologic exophthalmos preventing normal
stroke, and this can cause KCS.

What are the consequences and clinical signs of poor tear health?

The ultimate outcome of tear film disease is often dry eye syndrome, keratitis, and conjunctivitis. In severe cases, this can lead to corneal ulceration and loss of vision. Clinical signs of KCS include:

- Reduced tear production
- Inflammation of the conjunctiva
- Redness of the eye
- Swelling of the eyelids
- Dry and sticky eyes
- Difficulty in opening and closing the eyes
- Watery eyes
- Bluish coloration of the cornea
- Reduced vision

What are the causes of KCS?

Many causes can lead to KCS, including:

- Immune-mediated: This can be caused by a variety of immune disorders, including autoimmune diseases and allergic reactions.
- Drug-induced: Certain medications can cause a reduction in tear production, such as antibiotics and antihypertensive drugs.
- Neurogenic: This can be caused by damage to the nerves that control tear production.
- Iatrogenic: This can be caused by surgical procedures or the use of topical medications.
- General and Topical Anesthesia: Anesthesia can cause a temporary reduction in tear production.
- Systemic and Metabolic Disease: Conditions such as diabetes, hyperthyroidism, and hypothyroidism can lead to KCS.
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are more likely to become infected in the face of tear deficiency. Accumulation of mucoid discharge can lead to blepharitis and periocular dermatitis.

**How is KCS diagnosed and how are the Schirmer Tear Test results evaluated?**

Any patient presenting with an ocular complaint should have their tear production measured with a Schirmer tear test. The following is a general guideline for interpreting the STT:

- \( \geq 15 \text{ mm/min} = \text{normal} \)
- 11-14 mm/min = early or subclinical KCS
- 6-10 mm/min = moderate to mild KCS
- \( \leq 5 \text{ mm/min} = \text{severe KCS} \)

The STT needs to be evaluated in light of the clinical findings. For example, if a blepharospastic eye has a Schirmer tear test of 15 mm/min and stains positive for corneal ulceration, this would be considered abnormal. Although the STT value is within the normal range, one would expect epiphora, or excessive tearing (STT > 20 mm/min), in an eye with corneal ulceration. Without treatment of the tear deficiency, healing is expected to be prolonged and recurrence of corneal ulceration is likely.

The use of Atropine in a patient with KCS creates a dilemma due to the fact that it is an anticholinergic drug and can reduce tear production. In eyes with KCS in addition to corneal ulceration or uveitis, atropine should be used judiciously or possibly not at all. This again highlights the importance of measuring tear production in any patient presenting with an ocular problem.

Tear production and Schirmer tear test values vary daily and weekly in canines. Therefore, in a patient with low normal tear production (i.e. STT of 15-16 mm/min), one must consider that tear production is likely to dip below normal at times. These patients may initially improve with tear replacement therapy (lubrication), however, specific treatment of tear deficiency is often necessary.

**What is the therapy for KCS?**

Treatment of KCS is specific to the individual patient and varies significantly on the underlying cause of tear deficiency, severity, ability to treat the patient, and client compliance. In general, most cases of KCS are treated with lacrostimulants, lacromimetics and anti-inflammatories.

Lacrostimulants increase the aqueous portion of the tear film. They can be divided into cholinergic agents, or, more commonly used, immunomodulating drugs. Pilocarpine is the cholinergic agent that can be used in cases of neurogenic KCS to stimulate tear production through the parasympathetic pathway.

Immunomodulating agents are commonly used and can be extremely effective in treating and controlling KCS. Cyclosporine A inhibits T-helper and T-cytotoxic cells. This allows T-suppressor cells, which sustain normal lacrimal function, to predominate. Cyclosporine A is frequently used to treat dry eye in people and its immunomodulating and tear stimulating properties have been well documented in dogs. Substantial increases in STT are most commonly observed within 3 weeks. Measuring STT three hours after administration of topical cyclosporine will give the most accurate assessment of response. Dogs with pre-therapy STT values of 2 mm/min or more have an 80% chance of improvement. Those with pre-therapy STT values of 0-1 mm/min have a 50% chance of responding. Systemic absorption of long-term topically applied cyclosporine (at appropriate concentrations) has not been shown to have a clinically evident alteration of peripheral cellular immunity.

Tacrolimus is an immunomodulating drug with a similar mechanism of action to cyclosporine. In vitro, it is 10-100 times more potent than cyclosporine. In dogs that do not have the desired response to cyclosporine, tacrolimus may provide superior tear stimulation.

Lacromimetics are most often used in conjunction with lacrostimulants. Lacromimetics can be used to replace deficiencies in all three tear components (aqueous, mucin, lipid). There is an overwhelming number of tear substitutes commercially available. The majority of these products are polymer combinations. Other products may be polyvinyl alcohol solutions, cellulose-based solutions, or viscoelastic containing solutions. Ointment formulations enhance ocular surface hydration and prolong contact time, however, these products may be challenging to apply. There are an increasing number of gel formulations which are preferable in the sense that they are easier to administer and contact time is improved over a drop. One of the most important things to consider when choosing a topical lubricant is that preservatives used in many of these products, such as benzalkonium chloride and chlorobutanol, cause epithelial toxicity and should not be used more than 6 times daily.

With today’s arsenal of immune modulating drugs and lacromimetics, surgery for KCS is infrequently necessary. Parotid duct transposition (PDT) remains the most common surgical therapy for KCS. In this procedure, the oral papilla of the parotid duct is transposed and attached to the lower conjunctival fornix. Unfortunately, saliva can be extremely irritating to the ocular surface leading to mineral deposition, periocular dermatitis and persistent irritation. Topical medication is needed to control these side effects and at times the duct requires partial or complete ligation (i.e. reversal of the PDT). Another possible complication is ductal occlusion. A less complicated surgical therapy that may be beneficial for dogs with KCS, especially brachycephalic breeds, is partial permanent tarsorrhaphy. The goal is to provide greater protection of the ocular surface and conserve existing tears.

**Indolent superficial corneal ulcer with corneal neovascularization in a dog with untreated KCS.**

Deep infected central corneal ulcer in a dog with acute severe onset of KCS.
**FRIDAY**
4.10.15
by Denise Wyse, CVT and Nicole Thomas, BLS certified

Registration at 6:00PM

“INTRODUCTION TO THE RECOVER INITIATIVE: New CPR Guidelines for Veterinary Technicians”
2 PVMA credits for veterinary technicians

For questions or to R.S.V.P. for any of these events please contact Sarah Spurgeon at events@metro-vet.com or 610.666.1050

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**NEWS & EVENTS**

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**WEDNESDAY**
5.13.15
By Amanda Corr, VMD, DACVO

Registration at 6:00PM

“Tear Disorders and Ocular Surface Disease in Dogs and Cats”
PVMA District 7 Meeting

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**Paws of Promise Foundation**
A 501(c)3 charitable organization

Join us on Thursday, May 21st for a happy hour benefitting the Paws of Promise Foundation!

**DATE:** Thursday, May 21st
**TIME:** 5:00pm – 7:00pm
**LOCATION:** Great American Pub, 123 Fayette Street, Conshohocken, PA 19428
**ENTRY:** $20 entry, includes two drink tickets and light appetizers
**FOR MORE INFORMATION:** https://www.facebook.com/events/726946444070417/

The Paws of Promise Foundation is a 501(c)3 charitable organization focused on helping good owners afford emergency and critical care for their pets in times of financial need.

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**Welcome Dr. Robert Gaunt**

Metropolitan is happy to welcome Dr. Robert Gaunt to our Emergency Services team!

Dr. Gaunt attended University of Pittsburgh where he received his Bachelor of Science degree in Biology in 2009. After Pittsburgh he proceeded on to the University of Pennsylvania receiving his veterinary degree in 2013. Dr. Gaunt was accepted into a rotating medicine and surgical internship from Red Bank Veterinary Hospital in NJ. Upon completion in July 2014, he worked in a general practice until February 2015, when he joined Metropolitan Veterinary Associates. His special interests are Emergency Medicine.

In his spare time he enjoys Philadelphia sports, running, hiking, traveling, soccer and drawing. He resides at home with his four year old shepherd Skye, whom he rescued from North Philadelphia.

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To learn more about Metropolitan Veterinary Associates’ Paws of Promise Foundation, visit: Metro-Vet.com/PawsofPromise