

# The Pressure is on: An In-Depth Discussion About Glaucoma



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## Objectives for Glaucoma

- Understand how aqueous humor is formed, its pathway of flow and applied anatomy of the filtration angle
- Identify the clinical signs of glaucoma
  - Recognize the difference between dogs and cats
- Understand how to diagnose and treat glaucoma
  - Secondary versus primary glaucoma
- Understand most common forms of glaucoma in dogs and cats

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## Anatomy of the Ocular Outflow

- Primary drain for the eye
  - Iridocorneal angle via pectinate ligaments
- Alternative drain from the eye
  - Uveoscleral outflow pathway



Ophthalmic Diseases in Veterinary Medicine, CL Martin, 2010

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### Fine Balance to Maintain Intraocular Pressures (IOP)

- Delicate Equilibrium
  - Aqueous humor production by the ciliary body epithelium
  - Outflow from the globe
- Intraocular pressure maintained
  - 10-20 mmHg in dogs & cats
  - 15-30 mmHg in horses

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### Aqueous Humor (AH) Dynamics

- Aqueous humor production = Aqueous humor drainage
  - Think Faucet-Drain analogy!
- Glaucoma → due to impaired outflow!
  - Hair clog within the drain → prevents AH outflow → ↑ IOP!

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### Glaucoma

- Elevated intraocular pressure (IOP)
  - >20 mmHg
    - Exceptions → presence of uveitis
  - Causes
    - Obstruction outflow at the iridocorneal angle
    - Obstruction outflow at the pupil

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### Clinical Signs of Glaucoma

- Pupil dilation (mydriasis)
  - Affect iris sphincter muscle → suspect underlying ischemia



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### Clinical Signs of Glaucoma

- Episcleral injection
  - Increased venous congestion



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### Clinical Signs of Glaucoma

- Diffuse corneal edema
  - Increased IOP → endothelial cell dysfunction



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## Clinical Signs of Glaucoma

- Pain/Blepharospam
  - >30 mmHg in human reports → migraine headache
  - Presumption that dogs and cats have similar discomfort



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## Clinical Signs of Glaucoma

- Aqueous flare
  - Secondary to chronic high IOP
  - Present due to underlying uveitis



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## Clinical Signs of Glaucoma

- Chronic glaucoma
  - Buphthalmos (enlarged globe)
    - Secondary to chronic high IOP → scleral stretch



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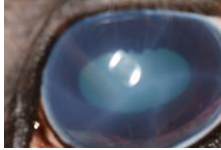
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### Clinical Signs of Glaucoma

- Chronic glaucoma
  - Haab's striae
    - Corneal stretch marks → breaks in Descemet's membrane



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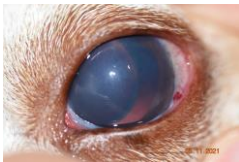
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### Clinical Signs of Glaucoma

- Chronic glaucoma
  - Lens subluxation
    - Secondary to globe stretching
    - Secondary to chronic uveitis



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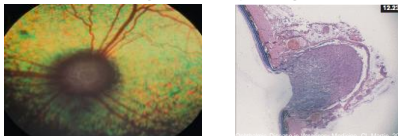
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### Clinical Signs of Glaucoma

- Chronic glaucoma
  - Cupped optic nerve
    - Atrophy of ON due to chronic high IOP
  - Retinal degeneration
    - Retinal thinning secondary to high IOP



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## Clinical Signs of Glaucoma

- Chronic glaucoma
  - Blindness
    - Ischemia to retina
    - Blockage of axoplasmic flow of retinal ganglion cells → Optic nerve ceases to work!

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## Clinical Signs of Glaucoma

- Chronic glaucoma
  - Phthisis bulbi (less common)
    - Shrunken globe → ciliary body atrophy and underlying fibrosis



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## Clinical Signs of Glaucoma

- Clinical signs in cats
  - More subtle than dogs
    - Not much episcleral injection
    - Minimal diffuse corneal edema
    - Overt signs: Mydriasis and progressive buphthalmos

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## Diagnostics for Glaucoma

- Assess Visual status
  - Present or absent
- Assess PLRs
  - Present or absent
- Assess pupil size
  - Normal or mydriatic

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## Diagnostics for Glaucoma

- Tonometry
  - Tonopen
    - Applanation tonometer
      - Requires topical proparacaine
  - Tonovet
    - Rebound tonometer
      - No topical anesthetic required
      - Must be at 90 degrees



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## Diagnostics for Glaucoma

- Common Errors in IOP measurement technique
  - Compressing globe by retracting the lids at lid margin → falsely elevated IOP
    - Need to pull up over the bony orbital rim!
  - Occluding jugular vein during restraint → falsely elevated IOP
    - Ophtho death grip!

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## Anti-Glaucoma Medications

- Hyperosmotic diuretic agents
  - Reduces high IOP → dehydrates vitreous (98% water)
    - Rapid decrease in 10-15 min.
    - Duration for 12-24 hours
    - Side effects: Dehydration
      - Contraindications → renal failure or heart disease

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## Anti-Glaucoma Medications

- Hyperosmotic diuretic agents
  - Mannitol
    - Most effective → acute glaucoma
    - Use: 20% mannitol → 1 gram/kg slow IV over 20 minutes
      - Repeat in 4 hours if needed
      - Use with filtered needle
  - Glycerin
    - Not reliable
    - Use: 1-2 mL/kg PO
      - Repeat in 8 hours PRN
    - Side effects: vomiting
      - DO NOT USE IN DIABETICS!!



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## Anti-Glaucoma Medications

- Prostaglandin Analogs
  - Decrease IOP → increases uveoscleral outflow
    - Rapid decrease in 10-15 min
    - Side effects: topical irritation, exacerbation of uveitis, miosis
  - Latanoprost 0.005% [Xalatan]\*, Travoprost 0.004%, Bimatoprost 0.03%
  - Contraindication: Secondary glaucoma



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## Anti-Glaucoma Medications

- Parasympathomimetic (Miotics)
  - Decrease IOP → increase aqueous humor outflow
    - Side effects: ocular irritation, uveitis; systemic: salivation, vomiting, diarrhea, sweating
  - Direct Parasympathomimetic
    - Pilocarpine 2% BID-QID
      - Good for acute primary glaucoma cases
  - Indirect Parasympathomimetic
    - Demecarium Bromide 0.125-0.25% q24 hr- BID



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## Anti-Glaucoma Medications

- Carbonic Anhydrase Inhibitors (CAIs)
  - Decreases IOP → decrease aqueous humor production (turns faucet off)
    - Reduce IOP by 20-30%
    - Side effects with oral CAIs: hypokalemia, metabolic acidosis, panting, anorexia, fatigue, depression, confusion, PU/PD, vomiting, diarrhea, thrombocytopenia, blood dyscrasias, nephroliths

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## Anti-Glaucoma Medications

- Carbonic Anhydrase Inhibitors (CAIs)
  - Oral CAIs
    - Methazolamide [Neptazane]
      - 2.2-4.4 mg/kg PO q 8-12 hrs [Dogs]
      - 1-2 mg/kg PO q 8-12 hrs [Cats]
    - Acetazolamide → very toxic!!
  - Topical CAIs
    - Dorzolamide 2% [Trusopt]
    - Brinzolamide 1% [Azopt]
    - Dorzolamide 2% with Timolol 0.5% [Cosopt]
      - Minimal to no systemic side effects
      - May have slight periocular irritation!
  - \*\*Good for primary or secondary glaucoma cases!!



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## Anti-Glaucoma Medications

- Beta blockers
  - Decrease IOP → decrease aqueous humor production, potentially increase outflow
    - Side effects: Bradycardia
  - Timolol maleate 0.5%\*
  - Betaxolol HCL 0.5%



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## Classifications of Glaucoma

- Primary Glaucoma
- Secondary Glaucoma

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## Primary glaucoma

- What are the two forms?
- Open angle (POAG)
  - Bilateral, slowly progressive
  - Beagles, humans
- Closed angle (PACG)
  - **Most common in dogs!**
  - Initially unilateral, but progresses bilateral (5-10 months)
  - Basset hounds, Cocker spaniels, Shiba Inu, Chows, Northern breeds (Husky, Samoyed), Labs

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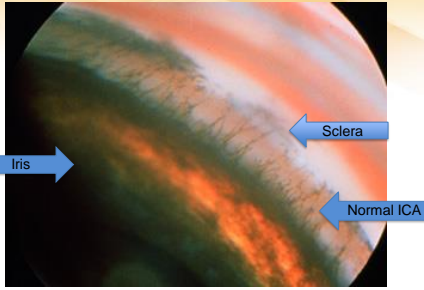
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### Open angle



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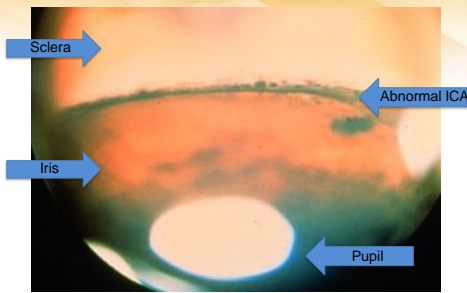
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### Closed angle



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### Primary glaucoma

- How does primary glaucoma (PACG) present?
  - Diffuse corneal edema, mydriatic pupil, minimal to no flare, episcleral injection, blepharospasm, +/- menace, elevated IOP (usually between 50-70 mmHg)
  - Contralateral eye is completely normal

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### Primary glaucoma



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### Primary Glaucoma: Treatment

- Affected eye
  - Instill alternating drops of Latanoprost and Dorzolamide q 5 minutes for 30 minutes
  - Recheck IOP → if still > 30 mmHg, then repeat alternating drops for another 30 minutes
    - If IOP <30 mmHg, can consider continuing combination latanoprost/dorzolamide -> response to medical management
    - If IOP >30 mmHg after 1 hr alternating drops → consider end stage surgical salvage procedure

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### Primary Glaucoma: Treatment

- Contralateral eye
  - Prophylactic therapy with Dorzolamide 2% BID
    - Studies shown delayed onset of glaucoma on average about 26-30 months with prophylactic tx

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### Primary Glaucoma: Surgical Treatment

- Surgical Options for a Visual Eye
  - Surgery to create a ‘new’ drain for the eye
    - **Gonioimplants**
  - Surgery to ‘turn off the faucet’ = decrease aqueous production
    - **Cyclocryosurgery**
    - **Cyclophotocoagulation**
      - Transscleral
      - Endoscopic

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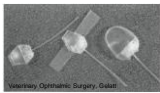
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### Primary Glaucoma: Surgical Treatment

- Gonioimplant
  - Ahmed gonioimplant (pressure sensitive valve)
    - Silicone tube placed in anterior chamber
      - Aqueous humor drains into subconjunctival space
    - Complications: closure of tube opening, fibrosis in subconjunctival space, tube migration



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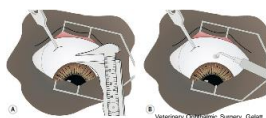
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### Primary Glaucoma: Surgical Treatment

- Cyclocryosurgery
  - Ciliary body is frozen through sclera
    - Complications: fibrosis, regeneration of ciliary body (increase IOP), significant uveitis
    - ~40% cases need repeat



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### Primary Glaucoma: Surgical Treatment

- Cyclophotocoagulation
  - Diode laser → destroy ciliary body processes through sclera
    - Benefit: less uveitis created than cryotherapy



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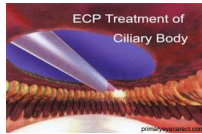
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### Primary Glaucoma: Surgical Treatment

- Endoscopic Cyclophotocoagulation
  - Diode laser → destroy ciliary body processes via intraocular visualization
    - Extensive post operative monitoring
      - 7 days in hospital
    - Benefit: less uveitis created
      - Targeted laser of ciliary body epithelium



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### Surgical Options for a Non-Visual Eye

- **Enucleation +/- orbital prosthesis**
- Evisceration with prosthesis
- Chemical Ciliary Body Ablation
  - Intravitreal Cidofovir injection
  - Intravitreal Gentamicin injection

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### Enucleation +/- orbital prosthesis

- Strongly recommended if owner not interested in cosmesis
- Submit globe for histopath → info for fellow eye
  - Complications: minimal, rare: secondary infection or prosthetic rejection



Veterinary Ophthalmic Surgery, Galati

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### Surgical Options for a Non-Visual Eye

- Enucleation +/- orbital prosthesis
- **Evisceration with prosthesis**
- Chemical Ciliary Body Ablation
  - Intravitreal Cidofovir injection
  - Intravitreal Gentamicin injection

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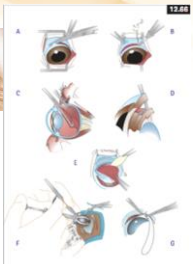
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### Evisceration with prosthesis

- Most cosmetic option
- Avoid in cases of secondary glaucoma (infection/neoplasia)
  - Complications: corneal ulceration, prosthetic rejection, develop KCS



Ophthalmic Diseases in Veterinary Medicine, CL Martin, 2010

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### Surgical Options for a Non-Visual Eye

- Enucleation +/- orbital prosthesis
- Evisceration with prosthesis
- **Chemical Ciliary Body Ablation**
  - **Intravitreal Cidofovir injection**
  - **Intravitreal Gentamicin injection**

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### Chemical Ciliary Body Ablation

#### Intravitreal Injection of Cidofovir (3.75 mg/mL)

- Inject 0.15 mL of Cidofovir
  - Chemically destroys ciliary body → decrease IOP
  - 85% success rate
    - Less cosmetic → shriveled raisinette
  - Recheck IOP in 2 weeks and 1 month

#### Intravitreal Injection of Gentamicin (100 mg/mL)

- Inject 25-40 mg (based on body wt.)
  - **Do not inject >4.4 mg/kg!**
  - Chemically destroys ciliary body → decrease IOP
  - 60-70% success rate
    - Less cosmetic → shriveled raisinette
  - Side effect: Do not perform with kidney disease
  - Recheck IOP in 2 weeks and 1 month

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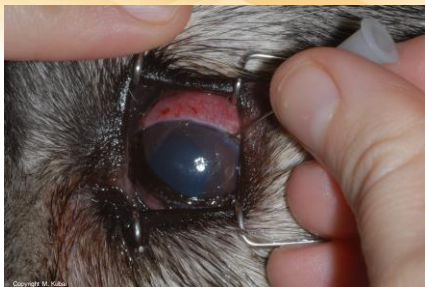
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### Centesis Pre Intravitreal Injection




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### Intravitreal Injection



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### Secondary Glaucoma

- Elevated IOP secondary to other ocular disease/injury
  - Lens associated
  - Traumatic
  - Uveitis
  - Intraocular tumors
  - Vitreal prolapse

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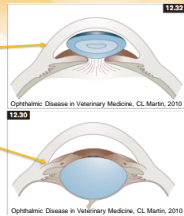
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### Secondary Glaucoma

- Lens associated trauma
  - Lens luxation
    - Vitreous blocks aqueous humor
  - Intumescent lenses
    - Swollen lens → push iris forward → narrow ICA
  - Phacolytic glaucoma
    - Chronic low grade lens induced uveitis → PIFM formation



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## Secondary Glaucoma

- Traumatic glaucoma
  - Hemorrhage
  - Corneal perforation and subsequent uveitis
  - ICA recession secondary post trauma



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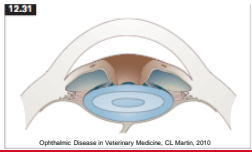
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## Secondary Glaucoma

- Secondary to uveitis
  - Anterior peripheral synechia
  - Iris bombe' (360 posterior synechia)
  - Angle obstruction with cells, debris and fibrin



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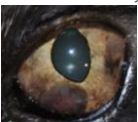
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## Secondary Glaucoma

- Intraocular tumors
  - Primary
    - Melanoma or Adenoma/carcinoma
      - Iris and ciliary body
  - Secondary
    - Lymphosarcoma, but could be anything else



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## Secondary Glaucoma

- Vitreal prolapse
  - Occluding the pupil → increased IOP
    - Secondary to lens luxation or post cataract surgery (aphakia)

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## Secondary Glaucoma: Treatment

- Treat the underlying uveitis
  - Remember uveitis → low IOP
    - If mid range IOP with uveitis → control uveitis and IOP increases (secondary glaucoma)!!
    - Treat the underlying glaucoma (Dorzolamide and/or Timolol)

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## Secondary Glaucoma: Treatment

- Medical Management:
  - Carbonic anhydrase inhibitors with beta blockers
    - Safe for use in these cases
  - Avoid miotic agents or those that create uveitis
    - Avoid latanoprost, pilocarpine, demecarium bromide
      - May make glaucoma worse!
      - Exceptions to the rule always!

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## Secondary Glaucoma

- Surgical Options for Visual Eyes
    - Iris bombe with glaucoma
      - Iridectomies to bypass the pupil
        - Complication: re-seal post op
    - Lens luxation
      - Remove lens
    - Vitreal prolapse
      - Vitrectomy
- \*\*No real good surgical option for most secondary glaucoma\*\***

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## Secondary Glaucoma

- Surgical Options for Blind Eye
  - Enucleation
    - Best option for these cases
      - Submit globe for histopath!
  - Evisceration with prosthesis
    - Only in non-infectious or non-neoplastic cases
      - Lens luxations (primary → terriers)
  - Cyclocryosurgery or laser cyclophotoablation
    - If outflow exists, selected cases only!

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## Glaucoma in Cats & Horses

- Primary glaucoma
  - RARE!!!
- Secondary glaucoma
  - Most common cause in cats & horses
    - Secondary to chronic uveitis
    - Intraocular neoplasia
    - Trauma
    - Aqueous misdirection syndrome (cats!)

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## Successful Glaucoma Treatment

- Early diagnosis and prophylactic therapy
- Accurate IOP measurements
- Aggressive treatment
  - Medical & Surgical

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The bottom line...



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Questions?!



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## ISU Ophthalmology Team

- Dr. Rachel Allbaugh (DACVO)
- Dr. Melissa Kubai (DACVO)



- Residents

- Dr. Lauren Page
- Dr. Leila Bedos
- Dr. Bactelius (Bacty) Turicea



- Technicians

- Chimene Peterson
- Laura White



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## ISU Referral Online Consultation Information

Getting started is easy!

1. Navigate to the CVIS login page (<https://clinic-db.cvm.iastate.edu/cvis/>)
2. **Sign in** using your clinic's CVIS user credentials (OR request a new account by completing a CVIS Pre-Registration Form)
3. Choose "VMC Consultations" from the main menu and follow prompts to initiate a new consultation
4. A [step-by-step instruction sheet](#) is available to guide you through the Consultation Portal process!

Questions about Online Consult Portal → [vmc-services@iastate.edu](mailto:vmc-services@iastate.edu)

\*\*\*OPHTHALMOLOGY ER → JUST CALL US!\*\*\*

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