

Pharmacology Management of Pediatric Ocular Conditions: From Drops to Systemics

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Disclosures

- None

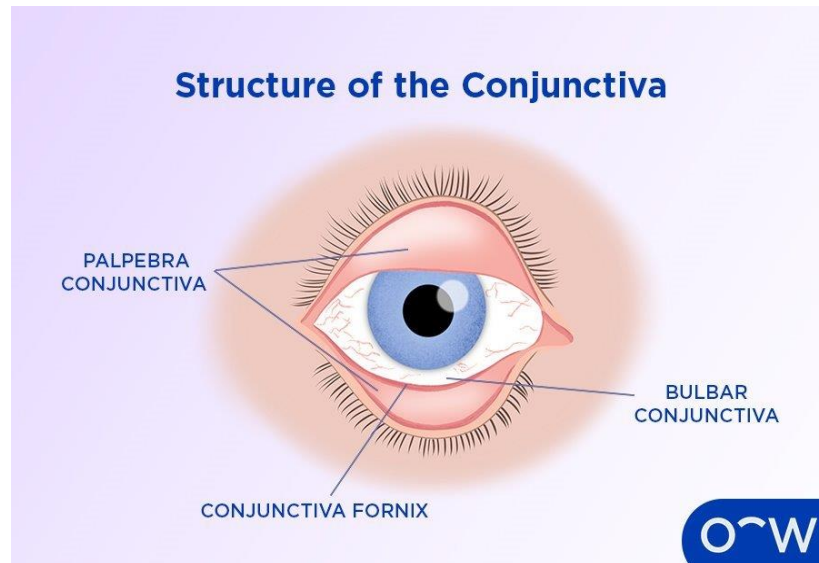
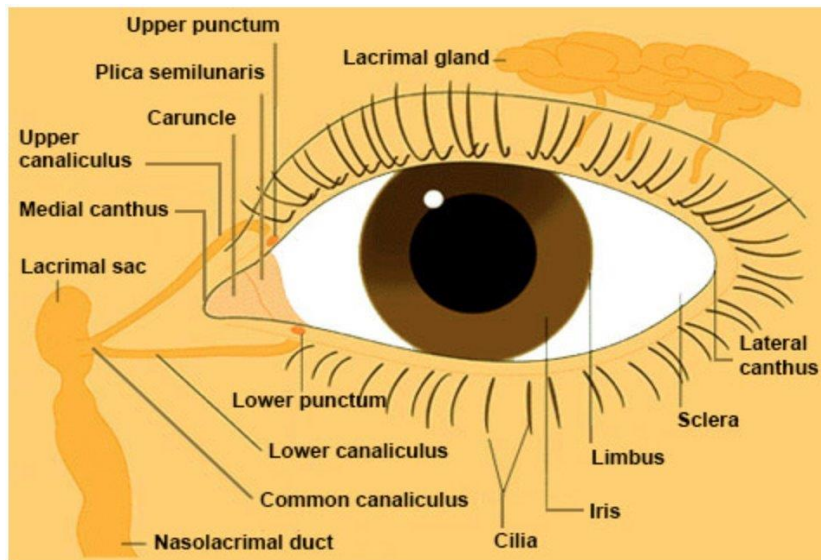


Learning Objectives

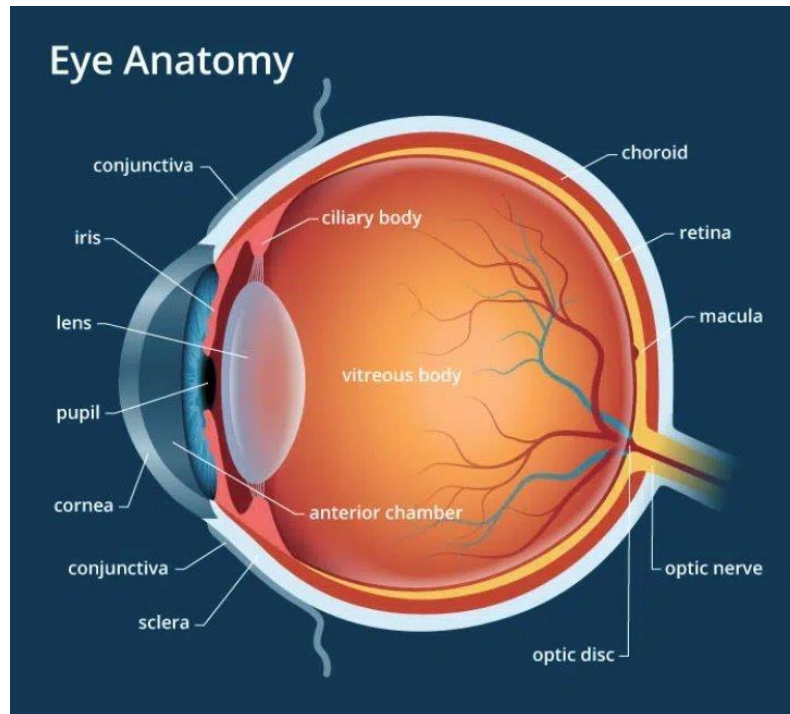
- Review indications, contraindications and side effects of common ophthalmic medications such as antibiotics, anti-inflammatory agents, mydriatics, and glaucoma treatment
- Explain best practices for diagnosing and managing pediatric ophthalmic conditions, such as conjunctivitis, uveitis and amblyopia
- Discuss the Pharmacokinetics and pharmacodynamics of pediatric ophthalmic medications



Anterior Segment Eye Anatomy



Posterior Segment Eye Anatomy



Class	Examples	Uses	Key Cautions
Antibiotics	Erythromycin, Polytrim, Moxifloxacin	Bacterial Conjunctivitis, corneal ulcers	Resistance, allergy
Anti-inflammatory	Loteprednol, Prednisolone acetate	Uveitis, post-op inflammation	IOP increase, cataract, infection
Mydriatics/ Cycloplegics	Tropicamide, Cyclopentolate, Atropine	Exams, refraction, amblyopia therapy	Glaucoma risk, systemic effects
Glaucoma Meds	Latanoprost, Timolol, Brinzolamide	Pediatric Glaucoma	Systemic, bronchospasm (beta blockers)



Conjunctivitis

- Neonatal
 - Bacterial
 - Viral
 - Allergic
-
- Appropriate antibiotic usage
 - Avoiding unnecessary treatment



Conjunctivitis- Neonatal

- **Definition:** Conjunctival infection in newborns, ~ first 4 weeks
- **Etiology:**
 - **Gonococcal:** *Neisseria gonorrhoeae*
 - **Chlamydial:** *Chlamydia trachomatis*
 - **Chemical:** Prophylactic eye drops (e.g., silver nitrate)
- **Clinical Features:** Redness, swelling, discharge (purulent in bacterial, watery in viral/chemical)
- **Treatment:**
 - Gonococcal → IV/IM ceftriaxone
 - Chlamydial → Oral erythromycin
 - Supportive for chemical



Conjunctivitis- Allergic

- **Definition:** Immune-mediated inflammation of the conjunctiva.
- **Common Triggers:** Pollen, dust mites, animal dander
- **Clinical Features:** Itching, redness, watery discharge, chemosis
- **Management:**
 - Avoid allergen exposure
 - Topical antihistamines/mast cell stabilizers
 - Severe → topical steroids (short-term)



Antihistamines/Mast Cell Stabilizers

- **Examples:** Olopatadine, Ketotifen
- **MOA:**
 - Block H1 receptors $\pm$ stabilize mast cells $\rightarrow$ $\downarrow$ histamine release
- **Uses:** Allergic conjunctivitis, seasonal allergic flares
- **Side Effects:** Burning, stinging, headache (rare systemic)
- **Contraindications:** Hypersensitivity; caution in dry eye



Conjunctivitis- Viral

- **Etiology:** Adenovirus most common; can follow upper respiratory infection.
- **Clinical Features:** Red eye, watery discharge, follicular conjunctival reaction, preauricular lymphadenopathy
- **Transmission:** Highly contagious
- **Management:** Supportive care (cold compresses, artificial tears); hygiene to prevent spread



Viral- HSV

- **Definition:** Ocular infection caused by HSV-1 (mostly) or HSV-2 (often neonatal).
- **Epidemiology:**
 - Neonatal HSV: vertical transmission during birth
 - Older children: usually HSV-1 via direct contact
- **Clinical Features:**
 - **Neonates:** Conjunctivitis, vesicular skin lesions, possible keratitis
 - **Children:** Dendritic corneal ulcers, conjunctivitis, lid vesicles
 - Pain, redness, tearing, photophobia



Viral- HSV

- **Diagnosis:**
 - Clinical exam (dendritic lesion on slit lamp)
 - PCR or viral culture if needed
- **Management:**
 - **Topical antiviral:** Ganciclovir gel
 - **Systemic antiviral:** Acyclovir for neonatal or severe cases
 - Avoid steroids unless under ophthalmology supervision



Antivirals

- **Examples:** Trifluridine drops, Ganciclovir gel, Oral Acyclovir
- **MOA:** Nucleoside analogs → inhibit viral DNA polymerase
- **Uses:** HSV keratitis, VZV ocular infections
- **Side Effects:** Ocular irritation, systemic renal toxicity (oral acyclovir)
- **Contraindications:** Hypersensitivity; adjust dose in renal impairment



Conjunctivitis- Bacterial

- **Common Pathogens:** *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Haemophilus influenzae*
- **Clinical Features:** Purulent discharge, lid matting, conjunctival injection
- **Management:** Topical antibiotics (e.g., erythromycin ointment, fluoroquinolone drops)



Antibiotics- Macrolides

- **Examples:** Erythromycin, Azithromycin
- **MOA:** Inhibit bacterial protein synthesis (50S ribosome)
- **Side Effects:** Local irritation, hypersensitivity, rare hepatotoxicity (systemic)
- **Contraindications:** Macrolide allergy, use with caution in hepatic impairment



Antibiotics- Fluoroquinolones

- **Examples:** Moxifloxacin, Ciprofloxacin, Ofloxacin
- **MOA:** Inhibit DNA gyrase & topoisomerase IV → block DNA replication
- **Uses:** Corneal ulcers, contact lens-related keratitis, severe conjunctivitis
- **Side Effects:** Irritation, bitter taste, rare tendon/cartilage toxicity (systemic)
- **Contraindications:** Fluoroquinolone allergy; avoid indiscriminate pediatric use



Antibiotics- Trimethoprim- Polymyxin (Polytrim)

- **Examples:** Polymyxin B/Trimethoprim (Polytrim), Bacitracin/Polymyxin
- **MOA:** Polymyxin disrupts bacterial membranes; Trimethoprim inhibits folate synthesis
- **Uses:** First-line bacterial conjunctivitis in children (>2 months)
- **Side Effects:** Mild irritation, rare hypersensitivity/lid edema
- **Contraindications:** Sulfa allergy (for trimethoprim), hypersensitivity



Antibiotics- Aminoglycosides

- **Examples:** Tobramycin, Gentamicin
- **MOA:** Bind 30S ribosome → inhibit protein synthesis
- **Uses:** Gram– coverage (esp. Pseudomonas); corneal ulcers (fortified drops)
- **Side Effects:** Corneal epithelial toxicity, hypersensitivity, rare systemic absorption
- **Contraindications:** Aminoglycoside allergy



Class	Examples	MOA	Uses	Risks/Contraindications
Macrolides	Erythromycin, Azithromycin	50S ribosome inhibition	Neonates, conjunctivitis	Allergy, hepatic impairment
Fluoroquinolones	Moxifloxacin, Ciprofloxacin	DNA gyrase inhibition	Ulcers, keratitis	Allergy, avoid overuse
Polymyxin combos	Polytrim, Bacitracin/ PolyB	Membrane disruption + folate block	Conjunctivitis	Sulfa allergy, irritation
Aminoglycosides	Tobramycin, Gentamicin	30S ribosome inhibition	Pseudomonas, ulcers	Corneal toxicity, allergy

Uveitis

- **Definition:** Intraocular inflammation (anterior, intermediate, posterior, or pan-uveitis)
- **Etiology:**
 - Idiopathic
 - Associated with systemic disease (e.g., JIA – Juvenile Idiopathic Arthritis)
- **Clinical Features:** Photophobia, redness, pain, decreased vision, posterior synechiae
- **Management:**
 - Topical corticosteroids, cycloplegics
 - Systemic therapy if associated with systemic disease



Topical Corticosteroids

- **Examples:** Prednisolone acetate, Loteprednol, Dexamethasone
- **MOA:** Block phospholipase A2 → ↓prostaglandins & leukotrienes
- **Uses:** Uveitis, post-op inflammation, severe allergy
- **Risks:** ↑IOP, cataracts, secondary infection, delayed wound healing
- **Contraindications:** Glaucoma, HSV keratitis, fungal keratitis
- **Dosing:** Taper



Anti-inflammatories- NSAIDS

- **Examples:** Ketorolac, Diclofenac, Nepafenac
- **MOA:** Inhibit COX → ↓prostaglandins
- **Uses:** Post-op pain, CME prevention, allergic conjunctivitis
- **Risks:** Burning, delayed healing, rare corneal melt
- **Contraindications:** NSAID allergy, epithelial defects



Amblyopia

- **Definition:** Reduced visual acuity not correctable by glasses, due to abnormal visual development.
- **Types:**
 - Strabismic
 - Refractive (anisometropic)
 - Deprivation (e.g., congenital cataract)
- **Management:**
 - Correct underlying cause (glasses, surgery)
 - Occlusion therapy (patching the good eye)
 - Penalization therapy



Amblyopia Treatment- Patching

- **MOA:** Occludes stronger eye → forces weaker eye to work → stimulates visual development
- **Duration / Protocol:** Mild: 2–4 hr/day, Moderate: 4–6 hr/day, Severe: 6–8 hr/day
 - Weeks to months; taper as vision improves
- **Uses:** Strabismic, anisometropic, or deprivation amblyopia
- **Risks / Adverse Effects:** Skin irritation, social/emotional distress, rare reverse amblyopia
- **Precautions:** Ensure adherence, monitor vision regularly, avoid patching if ocular disease in weaker eye



Amblyopia Treatment- Atropine 1%

- **MOA:** Potent muscarinic antagonist → prolonged blockade of sphincter & ciliary body → strong mydriasis + cycloplegia
- **Duration:** Onset 1 hr, lasts 7–10 days
- **Uses:** Amblyopia penalization, myopia control
- **Risks:** Photophobia, systemic anticholinergic toxicity
- **Contraindications:** Narrow-angle glaucoma, caution in very young children



Mydriatics VS Cycloplegia

- **Mydriasis**- dilation of the pupil caused by relaxation of the sphincter muscle
- **Cycloplegia**- Paralysis of the ciliary muscle, inactivates accommodation- convergence



Mydriatics- Phenylephrine

- **MOA:** Selective α_1 -adrenergic receptor agonist
- **Duration:** Onset: 15–30 minutes, Peak: 1 hour, Duration: 3–6 hours
- **Clinical Uses:**
 - **Diagnostic:** Fundus examination, ophthalmic imaging
 - **Therapeutic:** Break posterior synechiae, Reduce conjunctival redness (topical 0.12–0.25%)



Mydriatics- Phenylephrine

- **Risks:**

- **Local:** Eye irritation, stinging, blurred vision
- **Systemic:** Hypertension, reflex bradycardia, headache (especially in infants or with higher concentrations)
- **Rare:** Cardiac arrhythmias

- **Contraindications:**

- Severe **hypertension or cardiovascular disease**
- Infants < 1 year (risk of systemic absorption)
- Narrow-angle glaucoma (may precipitate acute attack)



Cycloplegia- Tropicamide

- **MOA:** Muscarinic antagonist → blocks acetylcholine at iris sphincter & ciliary body → mydriasis with mild cycloplegia
- **Duration:** Onset 20 min, lasts 4–6 hrs
- **Uses:** Routine eye exam
- **Risks:** Photophobia, ↑IOP
- **Contraindications:** Narrow-angle glaucoma



Cycloplegia- Cyclopentolate

- **MOA:** Muscarinic antagonist → blocks acetylcholine at iris sphincter & ciliary body → mydriasis + strong cycloplegia
- **Duration:** Onset 30–60 min, lasts ~24 hrs
- **Uses:** Cycloplegic refraction
- **Risks:** Irritability, hallucinations (rare CNS effects)
- **Contraindications:** Narrow-angle glaucoma, caution in infants



Cycloplegia- Atropine

- **MOA:** Potent muscarinic antagonist → prolonged blockade of sphincter & ciliary body → strong mydriasis + cycloplegia
- **Duration:** Onset 1 hr, lasts 7–10 days
- **Uses:** Amblyopia penalization, myopia control
- **Risks:** Photophobia, systemic anticholinergic toxicity
- **Contraindications:** Narrow-angle glaucoma, caution in very young children



Glaucoma

- **Definition:** Increased intraocular pressure leading to optic nerve damage in children.
- **Types:** Congenital/primary, Secondary (associated with syndromes, trauma, or surgery)
- **Clinical Features:** Corneal enlargement, photophobia, tearing, cloudy cornea, buphthalmic
- **Management:**
 - Medical → topical beta-blockers, prostaglandin analogues, carbonic anhydrase inhibitors
 - Surgical → goniotomy, trabeculotomy



Glaucoma- Beta- Blockers

- **Examples:** Timolol, Betaxolol
- **MOA:** Block beta-receptors → ↓aqueous humor production
- **Uses:** Pediatric glaucoma (temporary measure)
- **Risks:** Bradycardia, bronchospasm, hypotension
- **Contraindications:** Asthma, heart block, bradycardia



Glaucoma- Prostaglandin Analogs

- **Examples:** Latanoprost, Bimatoprost
- **MOA:** Increase uveoscleral outflow
- **Uses:** Pediatric glaucoma (adjunct)
- **Risks:** Iris pigmentation, eyelash growth, conjunctival hyperemia
- **Contraindications:** Hypersensitivity, Uveitis



Glaucoma- Carbonic Anhydrase Inhibitors (CAIs)

- **Examples:** Brinzolamide, Dorzolamide (topical); Acetazolamide (oral)
- **MOA:** Inhibit carbonic anhydrase → ↓aqueous production
- **Uses:** Pediatric glaucoma, IOP lowering in acute settings
- **Risks:** Stinging, metallic taste, systemic acidosis (oral)
- **Contraindications:** Sulfa allergy, renal/hepatic disease (oral)



Diagnostic Tools

- Used mostly in the ER/Urgent Care
- Following injury



Tetracaine- Topical Ophthalmic Anesthetic

- **MOA:** Blocks sodium channels → prevents nerve impulse conduction
- **Uses:** Short-term corneal anesthesia for procedures (tonometry, foreign body removal)
- **Duration:** Onset seconds; lasts 10–20 min
- **Side Effects:** Burning, stinging, delayed healing, epithelial toxicity if abused
- **Contraindications:** Do not prescribe for home use



Ointment vs Drops

- If on several drops- wait 5 minutes between drops to avoid washing out the first one
- Apply drops before ointment if on both
- Ointment- increased time in the eye
- Ointment- causes blurry vision
- No therapeutic advantage of one or the other



Fluorescein- Diagnostic Dye

- **MOA:** Hydrophilic dye absorbed by damaged epithelium; fluoresces under cobalt blue light
- **Uses:** Corneal abrasion/ulcer detection, tear film evaluation, Seidel test (leakage)
- **Forms:** Strips, drops, injectable (for angiography)
- **Side Effects:** Mild stinging, transient discoloration of skin/soft contact lenses, rare hypersensitivity
- **Contraindications:** Hypersensitivity to fluorescein



Pharmacokinetics and Pharmacodynamics in Pediatrics

- Smaller tear volume and immature barriers -> higher systemic absorption
- Increased susceptibility to side effects



Case 1:

- 3-year-old boy, daycare attendance
- Red, watery eye with mild discharge, started after URI
- No pain, no vision changes
- Mom requests antibiotics

- **Discussion:**

- What is the likely diagnosis?
- Do we prescribe antibiotics?
- What caregiver education is most important?



Case 2

- 7-year-old girl, failed school vision test
- VA: OD 20/20, OS 20/60 with glasses
- No pain, no redness, normal ocular exam otherwise
- **Discussion:**
 - What is the diagnosis?
 - What is the next step in management?
 - What treatment options are available?



Case 3

- 10-year-old girl with known juvenile idiopathic arthritis (JIA)
- Complains of light sensitivity, occasional blurry vision
- Exam: no discharge, mild ciliary flush
- **Discussion:**
 - What is the concern?
 - What is the initial treatment?
 - Who should be consulted urgently?



Key- Take Aways

- Most conjunctivitis is viral/allergic → antibiotics are often unnecessary
 - Can have a secondary bacterial infection due to compromised ocular surface barrier
- Steroids are powerful but high-risk in kids — use cautiously and with ophthalmology guidance
- Mydriatics differ mainly by duration: tropicamide (short), cyclopentolate (medium), atropine (long).
- Pediatric glaucoma meds are bridges, not cures — surgery is the mainstay



Category	Examples	MOA	Uses	Key Risks
Antibiotics	Erythromycin, Azithromycin, Moxifloxacin, Polytrim, Tobramycin	50S inhibition; DNA gyrase inhibition; membrane disruption; 30S inhibition	Conjunctivitis, keratitis, ulcers, neonatal prophylaxis	Irritation, allergy, resistance, corneal toxicity
Antivirals	Trifluridine, Ganciclovir, Acyclovir	Nucleoside analogs → inhibit viral DNA polymerase	HSV, VZV ocular infections	Corneal toxicity, renal effects (systemic)
Allergy meds	Olopatadine, Ketotifen	H1 blockade ± mast cell stabilization	Allergic conjunctivitis	Stinging, dry eye

Category	Examples	MOA	Uses	Key Risks
Mydriatics	Tropicamide, Cyclopentolate, Atropine, Phenylephrine	Muscarinic antagonists; α -1 agonist (phenylephrine)	Exam dilation, cycloplegia, amblyopia penalization	Exam dilation, cycloplegia, amblyopia penalization
Anti-inflammatory	Prednisolone, Loteprednol, Ketorolac, Nepafenac	PLA2 blockade; COX inhibition	Uveitis, post-op pain, CME prevention	$\uparrow$ IOP, cataracts, delayed healing, rare corneal melt



Category	Examples	MOA	Uses	Key Risks
Glaucoma meds	Timolol, Latanoprost, Dorzolamide	↓Aqueous humor production; ↑Uveoscleral outflow	Pediatric glaucoma, acute IOP	Bradycardia, bronchospasm, iris pigmentation, sulfa allergy
Diagnostics	Tetracaine, Fluorescein	Na ⁺ channel blockade; dye fluoresces under cobalt blue	Corneal anesthesia, abrasion detection, Seidel test	Corneal toxicity, stains contact lenses, allergy



Questions?

- Thank you!
- Vrussell@akronchildrens.org



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