Ocular Toxicology and Pharmacology

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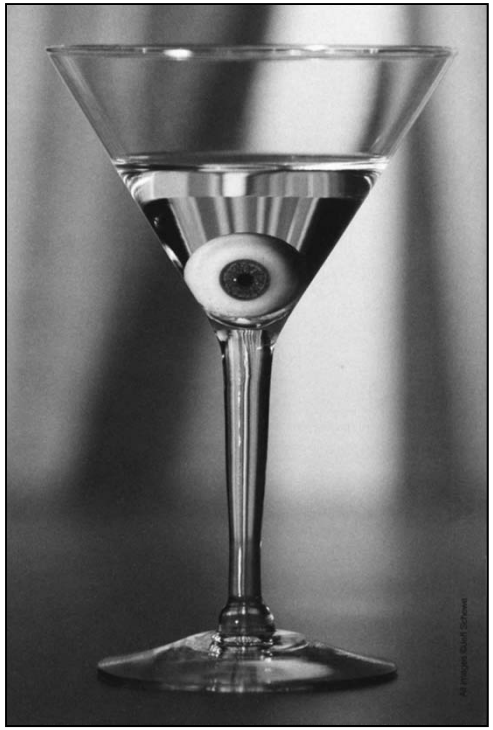
Ocular Toxicology

"The remedy often times proves worse than the disease" - William Penn



Ocular Toxicology

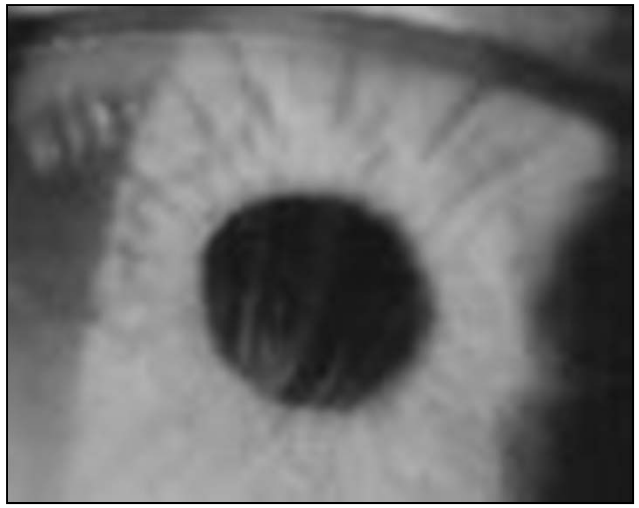
Site Affected

Ocular Toxicology: Corneal and Lenticular

- Chloroquine & hydroxychloroquine
- Indomethacin
- Amiodarone
- Tamoxifen
- Suramin
- Chlorpromazine (corneal endothelium)
- Gold salts (chrysiasis)

Causes of Corneal “Swirl” Keratopathy

- Chloroquine
- Suramin (used in AIDS patients)
- Tamoxifen
- Amiodarone



Ocular Toxicology: Transient Myopia

- Sulfonamides
- Tetracycline
- Perchlorperazine (Compazine)
- Steroids
- Carbonic anhydrase inhibitors

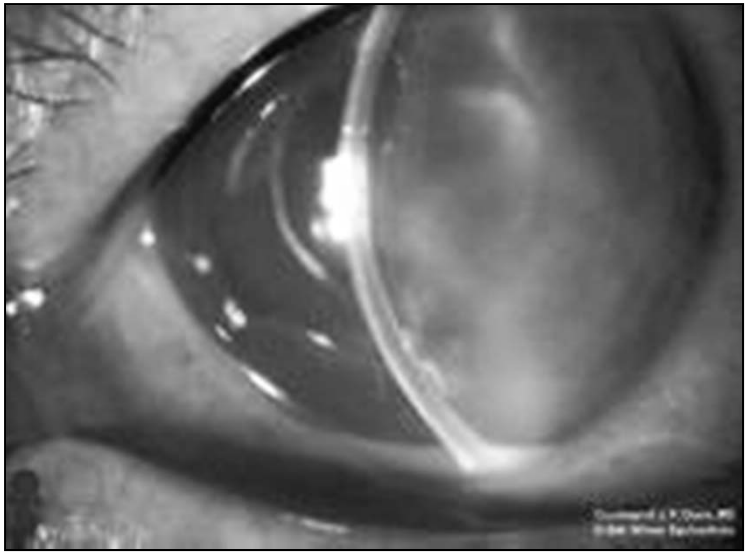
Ocular Toxicology: Conjunctival, Eyelid, Scleral

- Isoretinoin: DES, blepharoconjunctivitis
- Chlorpromazine: Slate-blue discoloration
- Niacin: Lid edema
- Gold salts: Conjunctiva
- Tetracycline: Conjunctival inclusion cysts
- Minocycline: Bluish discoloration of sclera

Ocular Toxicology: Uveal

Rifabutin:

- Anterior uveitis +/- vitritis, associated with hypopyon
- Resolves after discontinuation of medication



Ocular Toxicology: Lacrimal system

Decreased tearing:

- Anticholinergics
- Antihistamines
- Vitamin A analogs
- Phenothiazines
- Antianxiety agents
- Tricyclic antidepressants

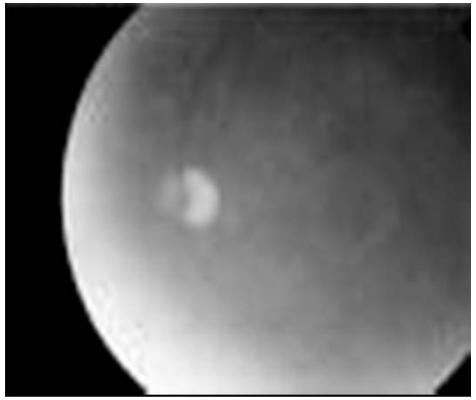
Increased tearing:

- Adrenergic agonists
- Antihypertensives
- Cholinergic agonists

Ocular Toxicology: Retinal

- Chloroquine (Aralen) & Hydroxychloroquine (Plaquenil): Bull's eye maculopathy
- Thioridazine (Mellaril): +/-decreased central vision, pigment stippling, circumscribed RPE dropout
- Quinine: Varies
- Talc (IVDA): Arterial embolizations
- Cardiac glycosides: Disturbance in color vision
- Tamoxifen: Crystalline deposits in retina
- Vigabatrin: Visual field constriction
- Isotretinoin: Impairment of dark adaptation

Bull's Eye Macula



- Chloroquine retinopathy
- Plaquenil retinopathy
- Cone dystrophy
- Stargardt's flavimaculatus
- Speilmeyer-Vogt-Batten-Mayou
- Age-related Macular Degeneration (AMD)
- Nieman Pick Type B

Ocular Toxicology : Neurologic

Nystagmus:

- Barbiturates
- Tranquilizers
- Anticonvulsants

Ocular Toxicology: Neurologic

Optic Neuropathy:

- Ethambutol
- Chloroquine
- Chloramphenicol
- Methanol
- Isoniazid
- Digitalis
- Amiodarone
- Metronidazole
- Carbon monoxide
- Ethylene glycol (antifreeze)
- Corticosteroids
- Streptomycin
- Oral contraceptives
- Tamoxifen
- Isoretinoin
- Sulfonamides
- Naproxen
- Interferon
- Lead
- Mercury

Ocular Toxicology: Neurologic

Retrobulbar neuritis:

Ethambutol

Isoniazid

Suramin

Disulfiram

Busulfan

Cisplatin

Vincristine

Sulfonamides

Chloramphenicol

Ocular Toxicology: Neurologic

Pseudotumor cerebri:

- Hypervitaminosis A (Retin-A)
- Steroids
- Minocycline (Dynacin, Minocin), tetracycline, penicillin
- Oral contraceptives and other hormone-related drugs
- Naproxen (Anaprox, Aleve)
- Nalidixic acid, nitrofurantoin
- Lithium
- Amiodarone

All of the following drugs may be associated with increased intracranial pressure except:

A. Tetracycline
B. Nalidixic acid
C. Isotretinoin (Accutane)
D. Rifampin

D. RIFAMPIN

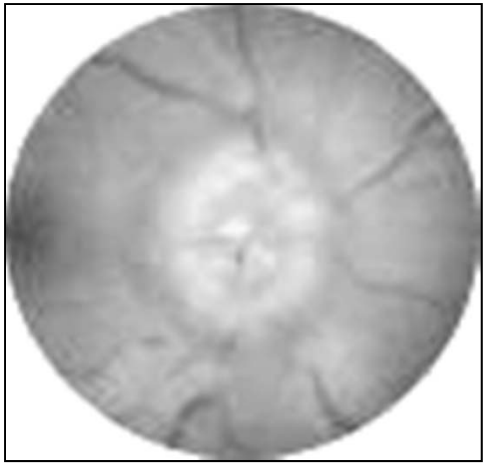
Rifampin: Used with other medicines to treat tuberculosis and can cause a yellowish appearance to the skin and eyes

Tretinoin (Retin-A) is a topical preparation.

Isotretinoin (Accutane) is for internal use.

True or False

Corticosteroids can be a cause and a treatment of Pseudotumor cerebri



TRUE

Causes of PTC:

- Vitamin A
- Corticosteroids (Use & withdrawal)
- Tetracycline (Including semisynthetics)
- Nalidixic acid
- Venous sinus thrombosis
- Radical neck surgery

Treatments of PTC:

- Weight loss
- Diuretics (Diamox)
- Repeat LP's (To be discouraged)
- Corticosteroids
- Surgery (Optic nerve sheath fenestration, lumbo-peritoneal shunt)

Ocular Toxicology: Neurologic

Myasthenia Gravis:

- Antibiotics
- Cardiovascular drugs
- Antirheumatic drugs
- Tranquilizers/Anticonvulsants
- Drugs used during anesthesia

Which of the following drugs is not known to aggravate Myasthenia Gravis?

A. Lidocaine
B. Tobramycin
C. β-blockers
D. Anticholinesterases
E. Corticosteroids

D. Anticholinesterases

Aggravate MG:

- Antibiotics (Neomycin, clindamycin, tobramycin)
- Cardiovascular drugs (B-blockers,lidocaine,pro-cainamide)
- Antirheumatic drugs (Chloroquine, D-Penicillamine)
- Tranquilizers/anticonvulsants (Chlorpromazine, lithium)
- Drugs during anesthesia (Ether, lidocaine, procaine)
- Others (ACTH and corticosteroids, respiratory depressants)

Treat MG:

- Anticholinesterases
- Corticosteroids
- Cytotoxic agents
- Plasmapheresis
- Thymectomy

Ocular Toxicology: Intraocular Pressue

Some Medications Reported to Have Caused IOP Elevations:

- Antidepressants: Fluoxetine (Prozac), Amitryptilline (Elavil)
- Monoamine Oxidase (MAO) Inhibitors: Phenylzine sulfate (Nardil)
- Phosphodiesterase Type-5 (PDE5) Inhibitors: Vardenafil (Levitra), Tadafil (Cialis), Sildenafil (Viagra)
- Antihistamines: Orphenadrine citrate (Norgesic)
- Antibiotics: Sulfa, Quinine
- Cardiac Agents: Disopyramide phosphate (Norpace)
- Surgical Agents: Viscoelastic agents, Silicone oil
- Sympathomimetic Agents: Epinephrine, Phenylephrine
- Mydriatic Agents: All

Ocular Toxicology

Drug-specific Effects

Important Drug-related Adverse Effects for the Ophthalmologist

World Health Organization (WHO)

Classification Scheme:

- For clinical events that might be related to drug administration
- Certain (plausible), Probable/Likely (reasonable), Possible (unclear or lacking information), Unlikely (improbable), Conditional/Unclassified (additional data under examination), Unassessible/Unclassifiable (not supplemented or verified)

Important Drug-related Adverse Effects for the Ophthalmologist

Topiramate (Topamax):

- Primary use: Epilepsy, migraine headaches
- Off label use: Weight reduction, bipolar disorder, clinical depression
- Clinical concerns: Acute angle closure glaucoma (Ophthalmology 111(1):109-111, 2004)
- WHO classif./Certain: Acute glaucoma (mainly bilateral), anterior chamber shallowing, ocular hyperemia, increased intraocular pressure, mydriasis, suprachoroidal effusions, ocular pain, decreased vision, acute myopia (up to 6-8 diopters)

Important Drug-related Adverse Effects for the Ophthalmologist

Bisphosphonates (Fosamax, Aredia, Zometa, Actonel, Bonefos, Didrocal):

- Primary use: Hypercalcemia of malignancy, osteolytic bone metastases of breast and multiple myeloma, Paget's disease of the bone
- Clinical concerns: anterior uveitis, nonspecific conjunctivitis
- WHO classif./Certain: Blurred vision, ocular irritation, nonspecific conjunctivitis, pain, epiphora, photophobia, anterior uveitis (rare-posterior), anterior scleritis (rare-posterior), episcleritis

Important Drug-related Adverse Effects for the Ophthalmologist

Ethambutol (Myambutol):

- Primary use: Pulmonary TB
- Clinical concerns: Optic neuropathy (Ethambutol has an affinity for the optic chiasm causing bitemporal visual field defects)

Important Drug-related Adverse Effects for the Ophthalmologist

Sildenafil (Viagra), Tadalafil (Cialis), Vardenafil (Levitra):

- Primary use: Erectile dysfunction
- Clinical concerns: Changes in color perception, increased perception of brightness
- WHO classif./Certain: Changes in color perception (usually blue or blue-green), blurred vision, changes in light perception, ERG changes, conjunctival hyperemia, ocular pain, photophobia
- Case reports of nonarteritic ischemic optic neuropathy (NAION) with Sildenafil

Important Drug-related Adverse Effects for the Ophthalmologist

Amiodarone (Cordarone):

- Primary Use: Various cardiac arrhythmias
- Clinical concerns: Possible amiodarone-induced optic neuropathy
- WHO classif./Certain: Corneal deposits, periocular skin pigmentation, thyroid eye disease, photosensitivity, colored halos around lights, glare, aggravated sicca (drug in tears), blepharoconjunctivitis
- Multi-million dollar settlement in US for possible amiodarone-induced optic neuropathy. Patient population with risk factors for NAION. No reported cases of Amiodarone neuropathy causing NLP

Important Drug-related Adverse Effects for the Ophthalmologist

Marijuana:

- Primary use: Recreational. Legal in some states for medicinal purposes (IOP lowering, appetite stimulant)
- Clinical concerns: The same cannabinols that lower IOP also cause CNS high. Other products are better at lowering IOP (Marijuana effect only lasts 3-4 hours)
- US government commission formed to study research data (Secondary to strong patient advocacy groups)

Important Drug-related Adverse Effects for the Ophthalmologist

Herbal Medicines and Nutritional Supplements:

- Primary use: Variety of systemic and ocular conditions
- Fall under purview of Dietary Supplement and Health Education Act of 1994 (not FDA): Are not marketed to treat specific diseases
- WHO classif.:
- Certain: Canthaxanthine/Crystalline retinopathy, Chamomile/Allergic conjunctivitis, Datura/Mydriasis, Vitamin A/Intracranial HTN from large doses
- Probable: Echinacea purpurea/Conjunctivitis, Niacin/CME
- Possible: Ginkgo biloba/Spontaneous hyphema, retinal hemorrhage, Niacin/Dry eyes, decreased vision, proptosis, eyelid edema, SPK, loss of lashes and brows, lid discoloration

Important Drug-related Adverse Effects for the Ophthalmologist

Hydroxychloroquine/Chloroquine (Plaquenil):

- Primary use: Rheumatoid arthritis, lupus erythematosis, and various inflammatory disorders (Chloroquine only for malaria treatment, primarily for military use)
- Clinical concerns: Retinal toxicity/Maculopathy (Shroyer, et al: ABCR mutation/Stargardt's disease may be predisposed to retinal toxicity with these drugs)

Important Drug-related Adverse Effects for the Ophthalmologist

Quetiapine (Seroquel):

- Primary use: Schizophrenia
- Clinical concerns: Cataract (Single case report)
- WHO classification: Unlikely

Important Drug-related Adverse Effects for the Ophthalmologist

Tamoxifen (Nolvadex):

- Primary use: Metastatic breast cancer
- Clinical concerns (Based on Gorin, et al): Intraretinal crystals, posterior subcapsular cataracts, color vision loss, minimal effects on retinal small vessel occlusive disease

Important Drug-related Adverse Effects for the Ophthalmologist

Isoretinoin (Accutane) and other retinoids:

- Primary use: Cystic acne, psoriasis, various skin disorders. Retinoids also used to induce leukemia remission
- Clinical concerns: Decreased dark adaptation, permanent evaporative form of sicca
- WHO classif,/Certain: Blepharoconjunctivitis, corneal opacities, keratitis, pseudotumor cerebri (retinoids also), ocular sicca, meibomian gland atrophy, decreased dark adaptation, decreased tolerance for CL wear, myopia, photophobia, decreased vision

Important Drug-related Adverse Effects for the Ophthalmologist

COX-2 Inhibitors (Selective: rofecoxib (Vioxx), celecoxib (Celebrex), valdecoxib (Bextra), etc):

- Primary use: Osteoarthritis, rheumatoid arthritis, acute pain and dysmenorrhea
- Clinical concerns: Case reports (8) of visual disturbance including: orange spots, temporary blindness, “jelly-bean-like” central vision loss, blurred vision
- WHO classif./Certain: Conjunctivitis, blurred vision

Drug-related Adverse Effects of Clinical Importance to the Ophthalmologist

AAO course October 16, 2005. Frederick W. Fraunfelder, MD, Frederick T. Freunfelder, MD.
www.eyedrugregistry.com

Ocular Toxicology

Popular Drugs

Potential Problems of Popular Drugs

Antibiotics:

Cefaclor (Ceclor): Ocular surface inflammation (rare), eyelid problems, nystagmus, visual hallucinations

Cefuroxime axetil (Ceftin): Ocular surface inflammation (rare)

Ciprofloxacin (Cipro): Eyelid problems, exacerbation of myasthenia, visual sensations

Minocycline (Dynacin, Minocin): Papilledema from pseudotumor cerebri, transient myopia, blue-gray or brownish scleral pigmentation, eyelid or conj, hyperpigmentation, diplopia

Rifampin (Rifadin): Conj. hyperemia, exudative conjunctivitis, increased lacrimation

Potential Problems of Popular Drugs

Antidepressants/Anxiolytics:

Alprazolam (Xanax): Diplopia, decreased or blurred vision, decreased accomodation, abnormal extraocular muscle movements, allergic conjunctivitis

Fluoxetine (Prozac): Blurred vision, photophobia, mydriasis, dry eye, conjunctivitis, diplopia

Imipramine (Tofranil): Decreased vision, decreased accomodation, slight mydriasis, photosensitivity

Potential Problems of Popular Drugs

Analgesics, Anti-inflammatory agents:

Aspirin: Transient blurred vision, transient myopia, hypersensitivity reactions

Ibuprofen (Advil): Blurred vision, decreased vision, diplopia, photosensitivity, dry eyes, decrease in color vision, optic or retrobulbar neuritis

Naproxen (Anaprox, Aleve): Decreased vision, color vision changes, optic or retrobulbar neuritis, papilledema due to pseudotumor cerebri, photosensitivity, corneal opacities

Piroxicam (Feldene): Decreased vision, photosensitivity

Potential Problems of Popular Drugs

Asthma, Allergy drugs:

Corticosteroids (general): Decreased vision, posterior subcapsular cataracts, increased IOP

Antihistamines (general): Decreased vision, may induce or aggravate dry eyes, pupillary changes, decreased accomodation, blurred vision, decreased mucoid or lacrimal secretions, diplopia

Potential Problems of Popular Drugs

Cardiovascular drugs:

Amiodarone (Cordarone, Pacerone): Photophobia, blurred vision, corneal opacities, subcapsular lens opacities, optic neuropathy

Beta-blockers (general): Decreased vision, visual hallucinations, decreased IOP, decreased lacrimation

Calcium channel blockers: Decreased or blurred vision, periorbital edema, ocular irritation

Potential Problems of Popular Drugs

Cardiovascular drugs (cont.):

Captopril/Enalapril (Vaseretic): Angioedema of eye and orbit, conjunctivitis, decreased vision

Digitalis glycosides: Decreased vision, color vision defects, glare phenomenon, flickering vision

Diuretics (Thiazide-type): Decreased vision, myopia, abnormal color vision, retinal edema

Flecainide (Tambocor): Blurred vision, decreased vision, decreased accomodation, abnormal visual sensations, decreased depth perception, nystagmus

Warfarin (Coumadin): Retinal hemorrhages in susceptible people, hyphema, allergic reactions, conjunctivitis, lacrimation, decreased vision

Potential Problems of Popular Drugs

Hormones, Hormone-related drugs:

Clomiphene (Clomid and others): Visual sensations, decreased vision, mydriasis, visual field constriction, photophobia, diplopia

Danazol (Danocrine): Decreased vision, diplopia, papilledema due to pseudotumor cerebri, visual field defects

Estradiol (general): Decreased vision, retinal vascular disorders, papilledema due to pseudotumor cerebri, fluctuations of corneal curvature and corneal steepening, color vision abnormalities

Potential Problems of Popular Drugs

Hormones, Hormone-related drugs (cont.):

Leuprolide (Lupron): Blurred vision, papilledema due to pseudotumor cerebri, retinal hemorrhage and branch vein occlusion, eye pain, lid edema

Oral contraceptives (general): Decreased vision, retinal vascular disorders, papilledema due to pseudotumor cerebri, color vision abnormalities

Tamoxifen (Nolvadex): Decreased vision, corneal opacities, retinal edema or hemorrhage, optic disc swelling, retinopathy, decreased color vision, possible optic neuritis or neuropathy

Potential Problems of Popular Drugs

Drug-Induced Ocular Side Effects (5th edition). Frederick T. Fraunfelder, MD, Frederick W. Freunfelder, MD, Joan A. Randall, MPH

Ocular Toxicity of Systemic Anti-cancer Chemotherapy

Omoti AE, Omoti CE. Ocular toxicity of systemic anticancer chemotherapy. Pharmacy Practice 2006; 4(2):55 – 59

Background

- Systemic drug-induced ocular side effects are increasing due to the large number of new drugs now available
- Increased use of chemotherapeutic agents has resulted in longer patient survival potentially resulting in the ophthalmologist seeing more patients with ocular side effects from these agents
- Ocular toxicity due to these agents is broad spectrum
- Awareness is key
  - Early recognition
  - Intervention strategies

Potential Ocular Sights Affected by Cancer Chemotherapy

- Ocular adnexa
- Anterior segment
- Posterior segment
- Neuro-ophthalmic

Potential Ocular Sights Affected by Cancer Chemotherapy

- Ocular adnexa (i.e. face,eyelids, eyebrows)
  - Common: Hyperpigmentation
  - Not common: Photosensitivity, Raynaud's phenomenon, hypersensitivity
  - Therapy specific:
    - Hydroxyurea: Ulceration, pseudodermatomyositis
    - Systemic 5-fluorouracil: Blepharitis, eyelid dermatitis, cicatricial ectropion, tearing (may resolve with cessation of Rx), punctal-canalicular stenosis
    - Interferon: Hypertrichosis

Potential Ocular Sights Affected by Cancer Chemotherapy

- Anterior segment
  - Mucus membranes may be affected due to direct cytotoxicity, infection, decreased PMN or platelet counts):
    - Systemic 5-fluorouracil (detected in tears): ocular irritation, conjunctivitis, keratitis, tearing, blurred vision
    - Tamoxifen: Corneal opacities (sub-epithelial deposits)
  - Cataract (PSC): Busulphan, methotrexate, tamoxifen
  - Glaucoma: Interferon alpha (MoA unclear)

Potential Ocular Sights Affected by Cancer Chemotherapy

- Posterior segment (can be associated with marked vision loss. Rec: dilated exams at baseline and every 3 mos)
  - Cisplatin: Retinopathy, retinal ischemia and neovascularization (comboRx with bleomycin and etoposide)
  - Tamoxifen: Retinopathy (Bilateral pigmentary changes, can be marked), macular crystals/ macular drusen/yellow spots in the macula
  - Interferon: Retinopathy (hemorrhages and CWS' without decreased vision and/or ischemia without symptoms), macular edema (with vision loss). May resolve with cessation of Rx

Potential Ocular Sights Affected by Cancer Chemotherapy

- Neuro-ophthalmic (Side effects from most cytostatic agents)
  - Carmustine, vinblastine, vincristine: Damage to optic and oculomotor nerves
  - Cislatin: Disc edema, retinal edema, optic neuritis
    - Toxicity may be due to CNS accumulation of drug
  - Tamoxifen: Bilateral optic neuritis followed by atrophy (dose related)
  - Interferon: Ischemic optic neuropathy (may be bilateral) followed by atrophy, may be associated with AION

Ocular Pharmacology

General Pharmacologic Principles

Pharmacodynamics

- The biological and therapeutic effect of a drug (i.e. mechanism of action)
- Most drugs work via binding (i.e. to hormone receptors, enzymes, etc)
- Terminology:
  - Agonist/antagonist. Drug is working at the receptor level
  - Activator/inhibitor. Drug is working at the enzyme level

Pharmacokinetics

- The absorption, distribution, metabolism and excretion of a drug
  - More ocular penetration with higher lipid solubility
  - More effect with low protein binding
- Ocular drug delivery routes:
  - Locally/topically:
    - Eye drops (solution/suspension): currently most common ocular delivery route. One drop=50ul (Volume of conjunctival cul de sac 7 - 10ul)
    - Ointment: Increased contact time but side effect of blurred vision
    - Injection (periocular, intracameral, intravitreal)
    - Sustained-release delivery: deliver an adequate supply of medication at steady state level (Timoptic XE, pilocarpine Ocusert, collagen shield, gancyclovir implant
  - Systemically:
    - Oral
    - Intravenous

Factors Influencing Local Ocular Tissue Penetration

- Drug concentration and solubility:
  - The higher the concentration, the better the penetration (limited by reflex tearing)
- Viscosity:
  - Increased contact time with the cornea and alteration of corneal epithelium (i.e. methylcellulose, polyvinyl alcohol)
- Lipid solubility:
  - The higher the lipid solubility the better the penetration secondary to lipid environment of epithelial cell membranes
- pH:
  - Normal tear pH is 7.4. Reflex tearing can result secondary to large difference between drug and tear pH
- Surfactant:
  - Ocular preparation preservatives (i.e. benzylkonium and thimersal) alter cell membranes in the cornea leading to increased permeability of a drug

Local Anesthetics

- Lidocaine: Amide, onset 1 min, lasts 45 min to 1 hr
- Procaine: Ester, onset 2-5 min, lasts 30 min
- Mepivacaine: Amide, more rapid onset, lasts longer than lidocaine, as safe as procaine and lidocaine
- Bupivacaine: Amide, prolonged anesthesia (8 hrs), 4x as toxic as lidocaine

True or False

Local anesthetics are less effective in inflamed tissues where pH is more acidic

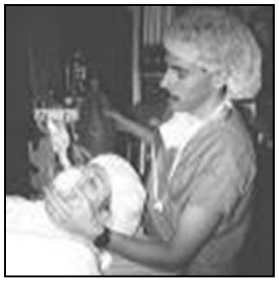
TRUE

- Anesthesia is often pH dependent-works best in alkalinity
- Local anesthetics are less effective in inflamed tissues where pH is more acidic

General anesthesia

- All general anesthetics lower IOP **except KETAMINE**

- Succinylcholine used to induce paralysis; **action is potentiated in patients taking phospholine iodide**



True or False

General anesthesia may increase accommodation

TRUE

- General anesthesia may increase accommodation
- IOP is lower with all except KETAMINE
- Average IOP under general anesthesia is 10-12 mmHg
- When using INTRAOCULAR GAS, anesthesia gas can equilibrate causing IOP to rise

Malignant hyperthermia

- Autosomal dominant
- 1:6000 children, 1:14000-40000 adults
- Muscular disorder characterized by decoupling of oxidative phosphorylation when exposed to succinylchloine
- Resp/meta acidosis, hyperkalemia, hypercalcemia, tachypnea, tachycardia, hyperthermia
- Dantrolene sodium; ice baths, correct acidosis

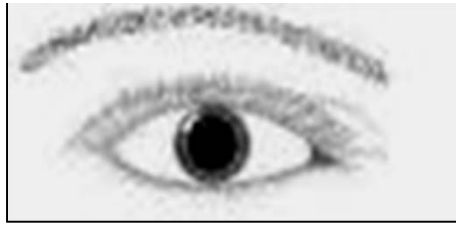
All of the following are true about malignant hyperthermia except:

A. Occurs with exposure to succinylcholine or inhalation anesthetics
B. Oxidative phosphorylation becomes coupled
C. Treatment includes dantrolene sodium, ice baths, stopping anesthesia, and correcting acidosis
D. Can result in hyperkalemia, tachycardia, hypercalcemia, hypercarbia, tachypnea, and increased myoglobin
E. Results from hypermetabolism

B. Oxidative phosphorylation becomes coupled

- During malignant hyperthermia (MH) oxidative phosphorylation (ADP-ATP) becomes **UNCOUPLED** leading to respiratory & metabolic acidosis, hyperkalemia, tachycardia, hypercalcemia, hypercarbia, tachypnea, and increased myoglobin
- MH is rare in children, 1:14,000-40,000 adults
- During MH muscles become rigid and hyperthermic because of hypermetabolism

Dilating drops



Cycloplegics:

- Atropine
- Homatropine
- Scopolamine (Hyoscine)
- Cyclopentolate (Cyclogel)
- Tropicamide (Mydriacyl)

Parasympatholytic Drugs

	MYDRIASIS	CYCLOPLEGIA	DURATION
ATROPINE	30 min	1 hr	14 days
HOM-ATROPINE	10-30 min	30-90 min	2-4 days
SCOPOLAMINE	40 min	40 min	6 days
CYCLO-PENTOLATE	15-30 min	15-45 min	24 hrs
TROPICAMIDE	20-30 min	20-25 min	4-6 hrs

Which series is in correct order of decreasing mydriatic duration?

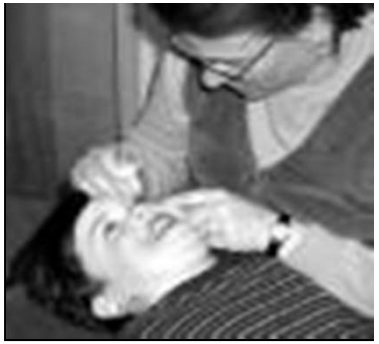
A. Homatropine, scopolamine, cyclopentolate, tropicamide
B. Atropine, homatropine, tropicamide, cyclopentolate
C. Tropicamide, homatropine, cyclogyl, scopolamine
D. Atropine, scopolamine, homatropine, tropicamide

D. Atropine, scopolamine, homatropine, tropicamide

Mydriatic recovery in normal eyes is as follows:

Atropine (7-10 days), scopolamine (3-7 days), homatropine (1-3 days), cyclopentolate (1 day), and tropicamide (6 hours)

Dilating drops



- Cholinergic antagonists
- Dependent on iris pigmentation (tropicamide least)
- Mechanism: inhibition of iris constrictor and ciliary muscles
- Indication: dilation, refraction, uveitis
- Side effects: allergic reaction, angle closure, dry mouth (first sign), facial flushing, inhibit sweating, convulsions, delirium

True or False

Treatment of anticholinergic poisoning includes i.v. physostigmine salicylate repeating every 15 minutes until symptomatic relief or salivation

TRUE

- Treatment of anticholinergic poisoning is with physostigmine salicylate 1-4 mg. IV (0.5-1 mg in kids). Repeat 0.5-1 mg doses Q15 MIN until symptomatic relief or salivation

- Systemic side effects of the anticholinergics include: Dry mucus membranes, bronchial dilation, tachycardia (by vagus nerve block), confusion, decreased sweating, urinary retention, & decreased GI motility with increased gastric secretions

Signs of Atropine Poisoning

- HOT AS A HARE
- RED AS A BEET
- DRY AS A BONE
- BLIND AS A BAT
- MAD AS A HATTER

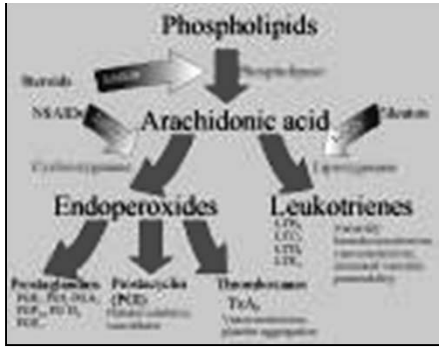
True or False

The fatal dose of atropine is 100 mg for children and 1000 mg for adults

FALSE

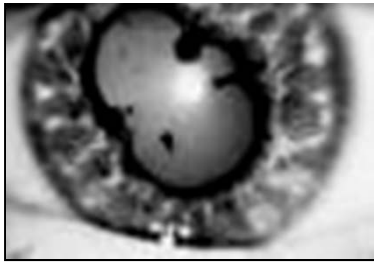
- The fatal dose of atropine is 100 mg for ADULTS and 10 mg for CHILDREN
- Thoughtless use of routine eye drops to examine premature babies for ROP will routinely poison a child 100% of the time

Corticosteroids



Mechanism of action: I**nhibits phospholipase A2** (conversion of phospholipids to arachidonic acid) leading to decreased prostaglandins & leukotrienes

Corticosteroids



Cellular effects:

- Inhibit migration of neutrophils
- Inhibit macrophage access to site of inflammation
- Interfere with lymphocyte activity
- Decrease lymphocyte production
- Inhibit histamine release

Corticosteroids

Tissue effects:

- **Decreased** capillary permeability
- **Decreased** edema
- **Decreased** fibroblast proliferation
- **Decreased** collagen production

Ocular Steroidal Anti-Inflammatory Drugs

- Wide variety to treat ocular inflammation
- Many available in combination with antibiotics and/or other medications
- May be administered by different routes
- Can elevate IOP and cause cataract formation

Steroidal Anti-Inflammatory Drugs

- Topical:
  - Dexamethasone sodium phosphate (Maxidex 0.1%, Ocu-Dex 0,1% & 0.5%)
  - Fluoromethalone (FML 0.1%, FML Forte 0.25%, Fluor-Op 0.1%, Flarex 0.1%)
  - Loteprednol etabonate (Alrex 0.2%, Lotemax 0.5%)
  - Prednisolone acetate (Pred Forte 1%, Econopred Plus 1%, Pred Mild 0.12%)
  - Prednisolone, phosphate (Inflamase Forte 1%, AK-Pred 1%, Inflamase Mild 0.125%)
  - Rimexalone (Vexol 1%)
- Intravitreal:
  - Fluocinolone acetonide. 0.59 mg (Retisert)

All of the following are true about acetate vs alcohol vs phosphate except:

A. Cornea is main barrier to penetration

B. Biphasic compounds penetrate better

C. Acetate and alcohol are biphasic

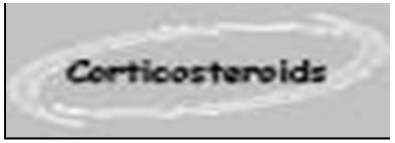
D. Phosphates are hydrophobic so they are better in solution

D. Phosphates are hydrophobic so they are better in solution

- Phosphates are HYDROPHILIC (better in solution)
- Acetate and alcohol are biphasic, penetrate better
- Cornea is main barrier to penetration

Steroidal Anti-Inflammatory Drugs

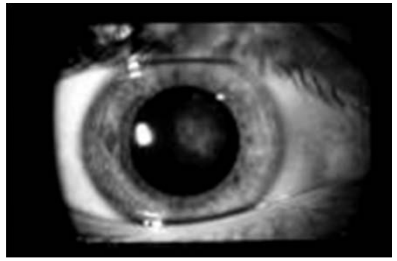
- Usual Route of Administration in Ocular Inflammation:
  - Anterior Uveitis: Topical and/or periocular
  - Blepharitis: Topical
  - Conjunctivitis: Topical
  - Cranial Arteritis: Systemic
  - Endophthalmitis: Systemic-Periocular and/or intravitreal
  - Episcleritis: Topical
  - Keratitis: Topical
  - Optic Neuritis: Systemic or periocular
  - Posterior Uveitis: Systemic and/or periocular and/or intravitreal
  - Scleritis: Topical and/or systemic
  - Sympathetic Ophthalmia: Systemic and topical



Steroidal Anti-Inflammatory Drugs

- Some corticosteroids cause less IOP elevation:
  - Fluorometholone (Structural analog of progesterone)
  - Loteprednol (“Soft drug”/inactivation shortly after release at site of action)

Corticosteroids: Side effects



Cataract:

- Typically PSC
- Dose and duration dependant
- Mechanism unknown

Glaucoma:

- Certain individuals at risk
- Mechanism: accumulation of glycosaminoglycans in trabecular meshwork may play a role

Corticosteroids: Side effects

- Infection/Enhanced microbial proliferation
- Retard epithelial healing
- Mydriasis
- Ptosis
- Ischemia
- Punctate keratopathy

Corticosteroids: Side effects

- Weight gain/Hirsutism
- Euphoria/Psychosis
- Pseudotumor cerebri
- Gastritis/Peptic ulcer
- Bone resorption/Calcium loss
- Growth suppression/Muscle atrophy
- Aggravates diabetes, high blood pressure
- Immunosuppression
- Aseptic necrosis of the hip

Contraindications to steroids include all of the following except:

A. Acute superficial herpes
B. Fungal eye disease
C. Vaccinia but not varicella
D. After removal of superficial corneal foreign body
E. Acute untreated eye infections

C. Vaccinia but not varicella

Contraindications to steroids include:

Acute superficial Herpes, fungal eye disease, most viral diseases of the cornea including **VACCINIA AND VARICELLA**, ocular TB, after removal superficial corneal foreign body, and acute untreated eye infections

Nonsteroidal Anti-Inflammatory Drugs

Mechanism:

Bind to cyclooxygenase, preventing conversion of arachidonic acid to prostaglandins

True or False

The mechanism of NSAIDS involves altering prostaglandin formation with inhibition of phospholipase A

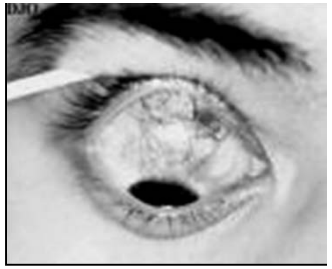
FALSE

The mechanism of NSAIDS involves inhibition of cyclooxygenase so prostaglandin formation is altered and there is **NO INHIBITION OF PHOSPHOLIPASE A** (which generate leukotrienes and are involved in the inflammatory response)

Ocular Nonsteroidal Anti-Inflammatory Drugs

- Bromfenac (Xibrom 0.09%)
- Diclofenac (Voltaren 0.1%)
- Flurbiprofen (Ocufen 0.03%)
- Ketorolac (Acular 0.5%, Acular PF 0.5%, Acular LS 0.4%)
- Nepafenac (Nevanac 0.1%)

Nonsteroidal anti-Inflammatory drugs



Indications:

- Postoperative inflammation (Diclofenac; voltaren, Ketorolac; acular)
- Allergic disease/ocular itching (Ketorolac)
- Prevent intraoperative miosis (Only indication for Flurbiprofen; ocufen)

Nonsteroidal anti-Inflammatory drugs

Side Effects:

- Associated with corneal melts and perforations in rare instances
- Increased IOP?: Little if any

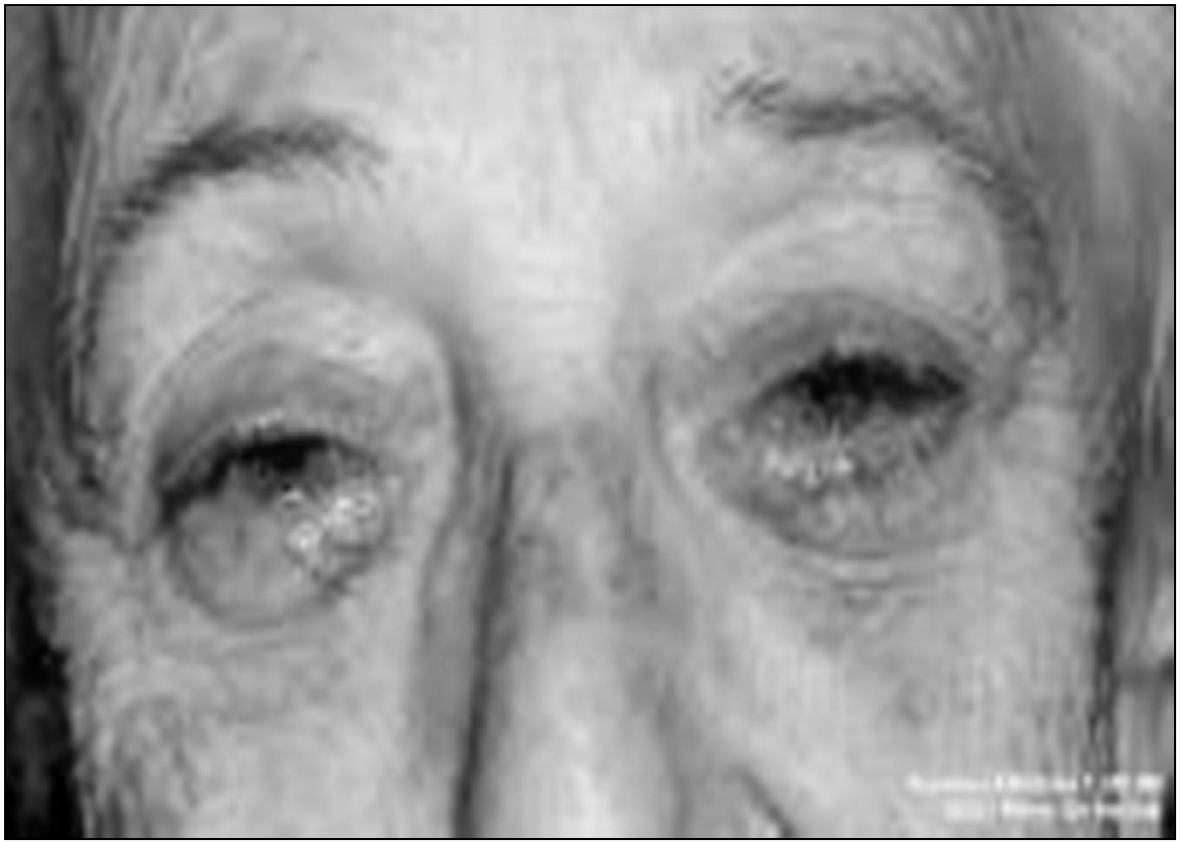
Diclofenac sodium is commonly known as:

A. Voltaren 0.1%
B. Voltaren 1%
C. Acular 0.5%
D. Alomide 0.1%

A. Voltaren 0.1%

- Diclofenac sodium is Voltaren
- Ketorolac tromethamine is Acular
- Cromolyn sodium is Crolom
- Olapatadine is Patanol
- Levocabastine HCL is Livostin
- Ketotifen fumarate is Zaditor
- Azelastine hydrochloride is Optivar
- Emedastine difumarate is Emadine
- Epinastine HCL is Elestat
- Lodoxamide tromethamine is Alomide
- Loteprednol etabonate is Lotemax, Alrex
- Naphazoline/antazoline is Vasocon-A
- Naphazoline/phenirimine is Naphcon-A, Opcon-A, Visine-A
- Nedocromil sodium is Alocril
- Pemirolast potassium is Alamast

20% U.S. POPULATION SUFFER FROM ALLERGY



Agents for Relief of Seasonal Allergic Conjunctivitis:

- Ketorolac tromethamine is Acular: QID (NSAID)
- Cromolyn sodium is Crolom: 4-6x/day
- Olapatadine is Patanol: BID (Pataday: QD)
- Levocabastine HCL is Livostin: QID
- Ketotifen fumarate is Zaditor: BID
- Azelastine hydrochloride is Optivar: BID
- Emedastine difumarate is Emadine: QID
- Epinastine HCL is Elestat: BID
- Lodoxamide tromethamine is Alomide: QID
- Loteprednol etabonate is Lotemax, Alrex: QID (corticosteroid)
- Naphazoline/antazoline is Vasocon-A: QID (antihistamine)
- Naphazoline/phenirimine is Naphcon-A, Opcon-A, Visine-A: QID (antihistamine)
- Nedocromil sodium is Alocril: BID
- Pemirolast potassium is Alamast: QID

Allergy medications

Mast cell stabilizers/inhibitor:

- Mechanism: stabilize mast cell membranes by blocking calcium influx (prevents degranulation)

  Cromolyn sodium 4% (Crolom)

  Lodoxamide thromethamide (Alomide

  Pemirolast (Alamast)

- Indications: Vernal,seasonal,atopic kerato/conjunctivitis

True or False

Cromolyn sodium has almost no side effects and is a safe drug with no direct anti-inflammatory or antihistaminic activity

TRUE

- Crolom has **NO DIRECT** anti-inflammatory or anti-histaminic activity
- Crolom blocks cellular influx of calcium thereby stabilizing mast cell membrane
- Crolom has almost no side effects
- Indications for Crolom use include: Vernal, seasonal, & atopic keratoconjunctivitis

Allergy medications

H1 Antagonists:

- Mechanism: H1 receptor blocker/antagonist

  Emedastine (Emadine)

  Levocabastine (Livostin)

- Side effects: Ocular discomfort on instillation

Allergy medications

H1 Antagonists & Mast Cell Stabilizers:

- Mechanism: H1 receptor blocker/antagonist and mast cell stabilizer/inhibitor

  Olopatadine HCL (Patanol)

  Azelastine HCL (Optivar)

  Nedocromil sodium (Alocril)

  Ketotifen fumarate (Zaditor)

- Indications: Allergic conjunctivitis

Allergy medications

H1 receptors

Tissue:

- Bronchial SM
- Heart
- CNS
- Eye

Antagonists:

- Diphenhydramine
- Loratidine

H2 receptors

Tissue:

- Gastric parietal cells
- Heart
- Blood vessels
- Eyes (blood vessels)

Antagonists:

- Cimetidine
- Ranitidine

Which of the following ophthalmic drugs is an H-1 receptor antagonist only and is used for allergic conjunctivitis?

A. Levocabastine
B. Ketotifen
C. Ketorolac
D. Cromolyn sodium

A. Levocabastine (Livostin)

- Levocabastine (Livostin) is an H-1 antagonist
- Ketotifen (Zaditor) is a mast cell stabilizer AND H-1 receptor antagonist
- Ketorolac (Acular) is an NSAID
- Cromolyn sodium (Crolom, Opticrom) is a mast cell stabilizer

Antibiotics

Penicillins:

- Mechanism: interfere with cell wall synthesis (β-lactam ring)
- Side rings can confer penicillinase-resistance
- Side effects: allergy

Cephalosporins:

- Mechanism: interfere with cell wall synthesis
- Side effects: allergy (cross-react with penicillins)

What percentage of patients that have sensitivity to penicillin will have cross-reactivity to cephalosporins?

A. 10%

B. 20%

C. 30%

D. 40%

A. 10%

- About 10% of patients with penicillin allergy will cross-react, making the use of cephalosporins potentially dangerous

- Allergic reactions include: Itching, rash, hives, and anaphylactic reaction that can be fatal

Antibiotics

Bacitracin:

- Mechanism: interfere with cell wall synthesis (β-lactam ring)
- Side effects: allergy (contact dermatitis)

Vancomycin:

- Mechanism: interfere with cell wall synthesis
- Side effects: Ototoxicity, nephrotoxicity

Antibiotics

Bacitracin:

- Ophthalmic ointment; 500 units/g
- In mixture: Polymixin B/Neomycin/Bacitracin (Neosporin): Ophthalmic ointment
- In combination w/ anti-inflammatory: Hydrocortisone/Neomycin/Polymixin B/Bacitracin (Cortisporin): Ophthalmic ointment

Antibiotics

Aminoglycosides:

- Mechanism: inhibit protein synthesis - 30s
- Side effects: nephrotoxicity, ototoxicity

Tetracycline:

- Mechanism: inhibit protein synthesis - 30s
- Side effects: GI upset, photosensitivity, teeth staining

Antibiotics

Macrolides (Erythromycin, Clarithromycin, Azithromycin):

- Mechanism: inhibit protein synthesis - 50s
- Side effects: GI upset

Lincosamines (Clindamycin):

- Mechanism: inhibit protein synthesis - 50s
- Side effects: pseudomembranous colitis

Antibiotics

Sulfonamides:

- Mechanism: inhibit DNA synthesis - P-amino benzoic acid (PABA) - for folic acid synthesis
- Side effects: allergy, Stevens-Johnson syndrome

Antibiotics

Quinolones:

- Mechanism: inhibits DNA synthesis - DNA gyrase
- Side effects: nausea, headache, rash

Ophthalmic Antibacterial Agents

Quinolones:

- Levofloxacin (Quixin): 0.5% ophthalmic solution
- Moxifloxacin (Vigamox): 0.5% ophthalmic solution
- Ofloxacin (Ocuflox): 0.3% ophthalmic solution
- Ciprofloxacin hydrochloride (Ciloxan): 0.3% ophthalmic solution & ophthalmic ointment
- Gatifloxacin (Zymar): 0.3% ophthalmic solution
- Besifloxacin (Besivance): 0.6% ophthalmic suspension

Oral Fluorquinolones and Risk of Retinal Detachment (RD)

Case-control study from British Colombia presented during ASRS 2012; David Maberley, MD

- Fluoroquinolones interfere with collagen synthesis
- Cohort comprised 989,591 patients of which 4,384 cases of RD identified; 43,840 controls
- Ciprofloxacin contributed the most cases of RD
- Average time between Rx and RD was 4.8 days
- After controlling for known confounders (cataract surgery, etc), concluded positive association between oral fluoroquinolone use and RD

Antifungal agents

Polyenes (Amphotericin B):

- Mechanism: Pore-former in cell membrane
- Spectrum: Blastomyces, Candida, Coccidioides, Histoplasma

Polyenes (Natamycin):

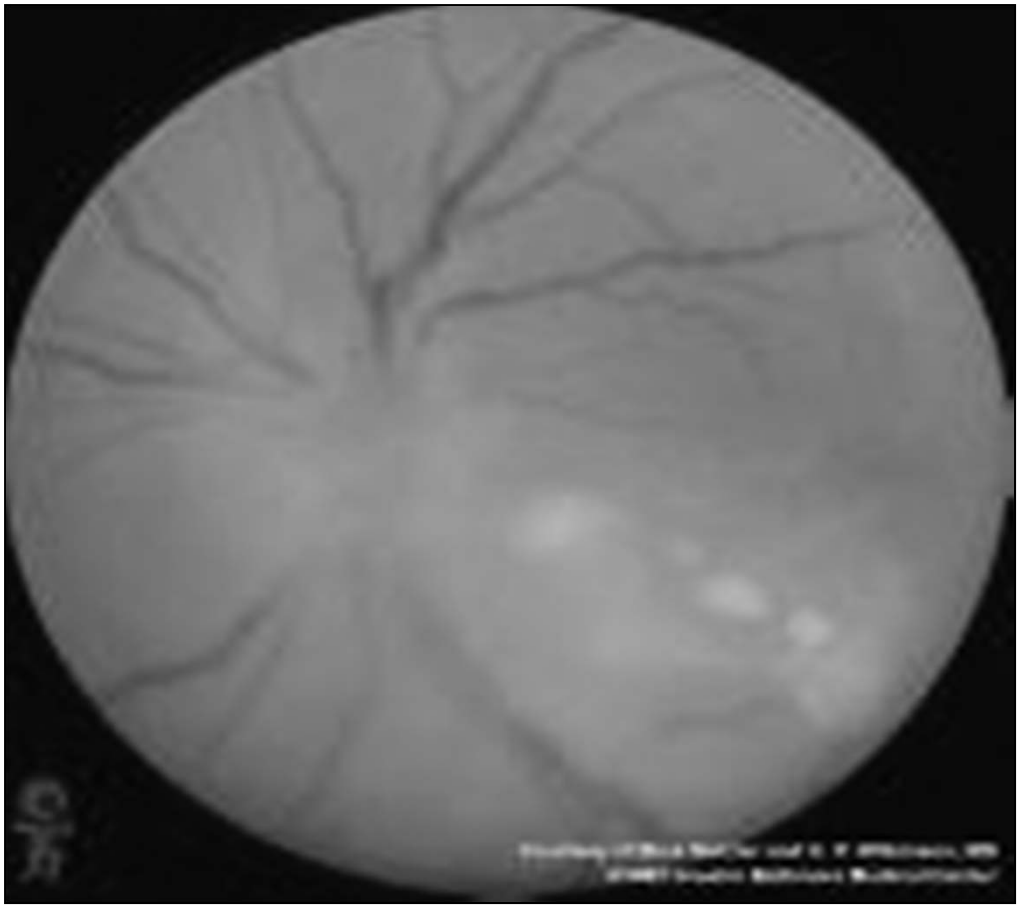
- Mechanism: Pore-former in cell membrane
- Spectrum: Candida, Aspergillus, Cephalosporium, Fusarium, Penicillium

Imidazoles (Ketoconazole):

- Mechanism: inhibit fungal lipid synthesis
- Spectrum: Candida, Cryptococcus, Histoplasma

Flucytosine:

- Mechanism: inhibit DNA synthesis (converted to fluorouracil)
- Spectrum: Candida, Cryptococcus



Non-septate filamentous fungi include all of the following except:

A. Mucor
B. Absidia
C. Aspergillus
D. Phycomycetes

C. ASPERGILLUS

Filamentous Fungi:

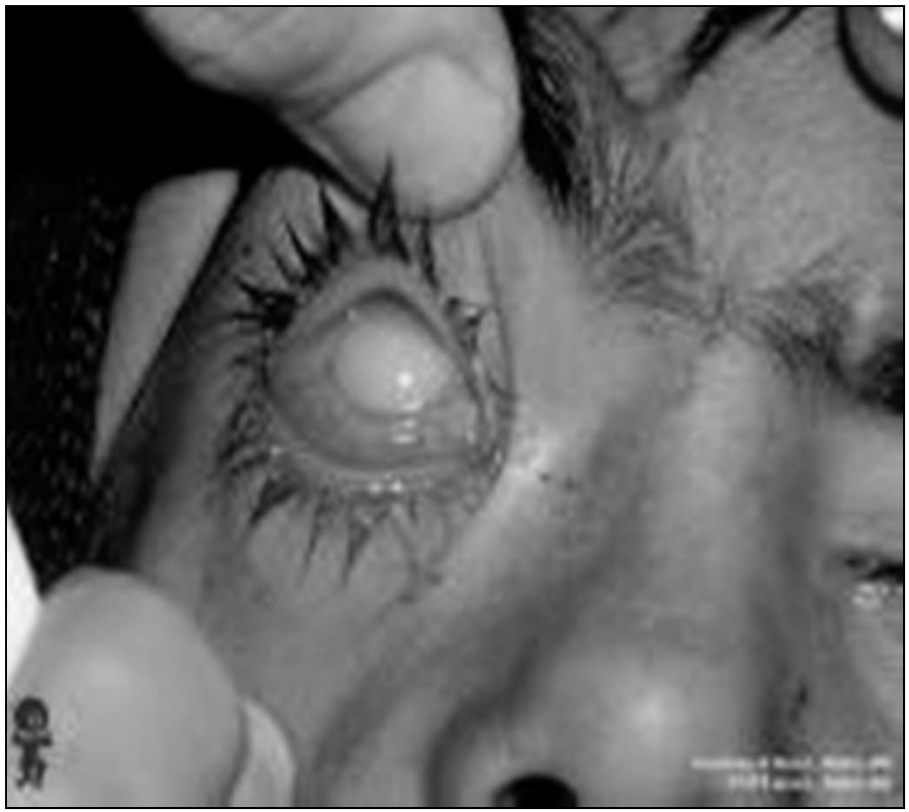
- SEPTATE:

Fusarium, Aspergillus, Penicillium

- NONSEPTATE:

Phycomycetes, Rhyzopus, Mucor, Absidia

Yeasts

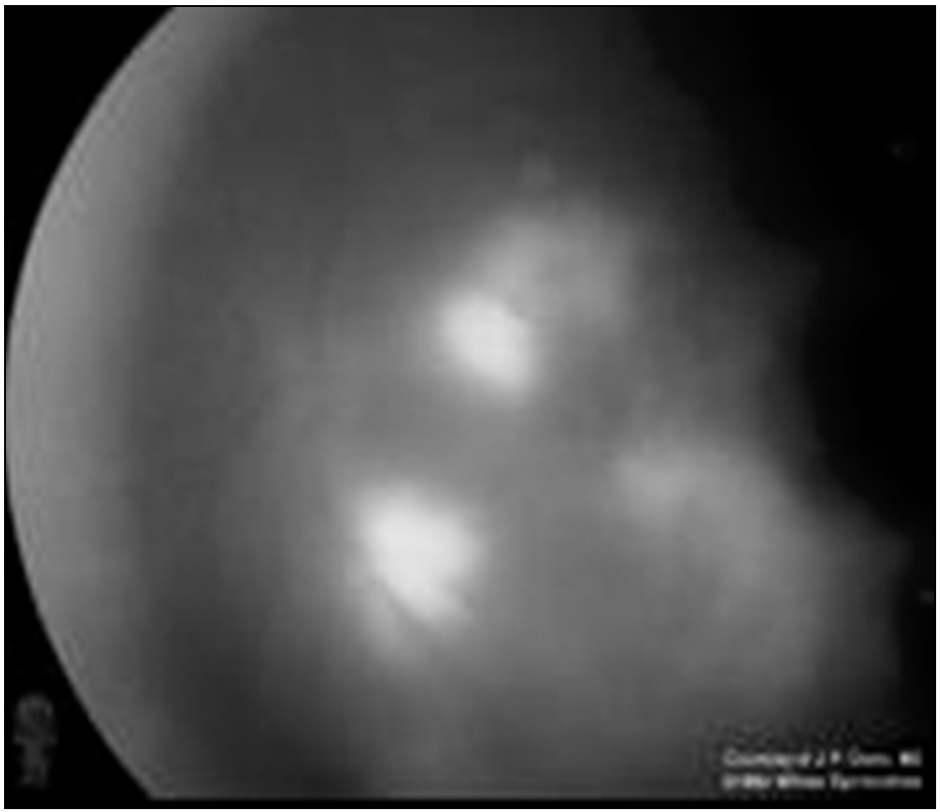


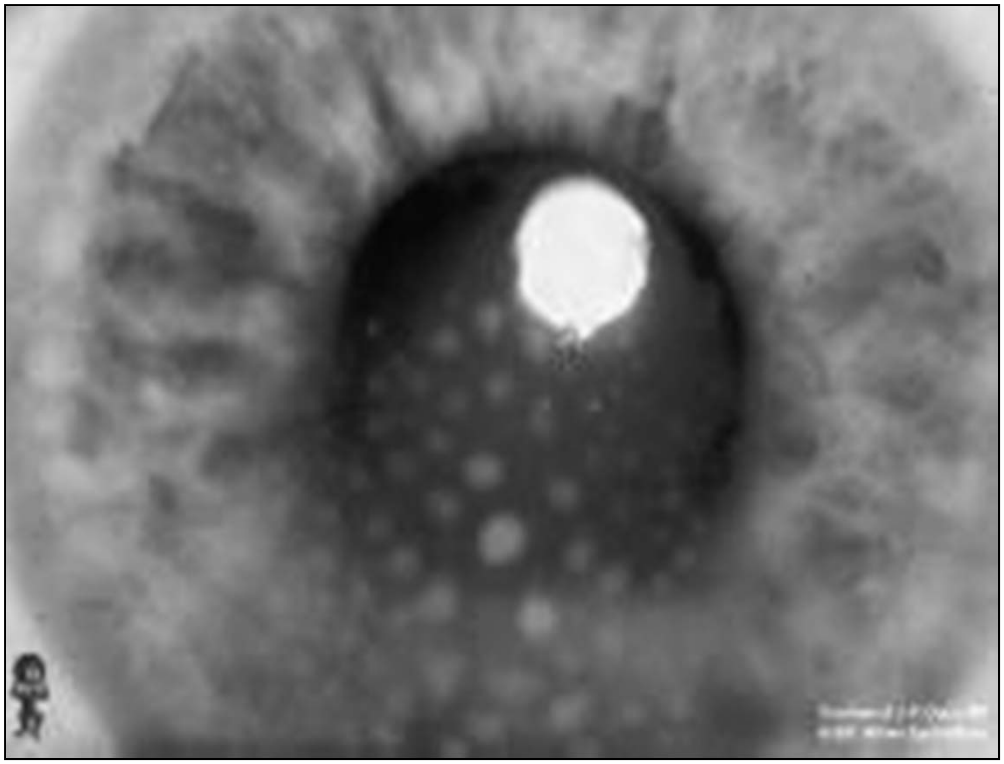
The most common pathogen in fungal endophthalmitis is:

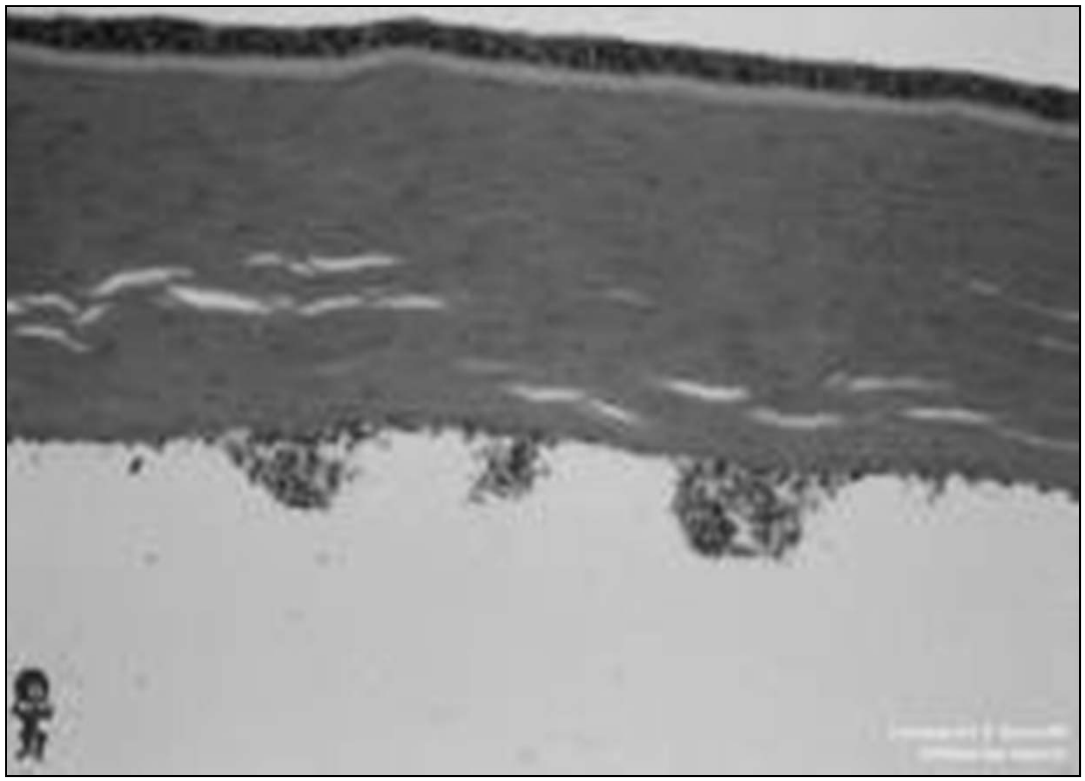
A. C. albicans
B. Fusarium
C. Aspergillus
D. Penicillium

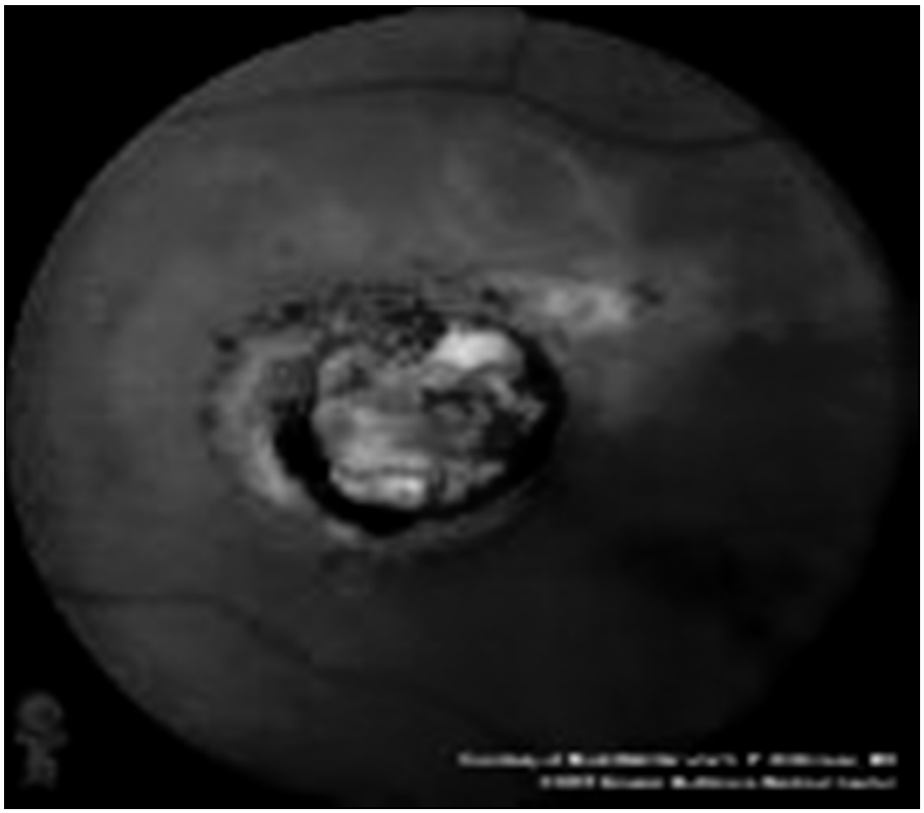
A. C. ALBICANS

- C. Albicans is the most common pathogen in fungal endophthalmitis (70-80% of cases)
- Next most common is: Aspergillus (IVDA, BMT patients)
- Fungal endophthalmitis accounts for 3-13% cases of endophthalmitis
- Steroids worsen fungal infection
- Fungal endophthalmitis is common in hemodialysis patients









Treatment of toxoplasma gondii includes:

A. Pyrimethamine 75 mg qd then 25 mg qd 4-6 weeks plus sulfadiazine 4g load then 1 g qid, 4-6 wks
B. Clindamycin 900 mg orally qid 4-6 wks and folic acid 5-10 mg daily
C. Always use corticosteroids
D. Never use corticosteroids

A. Pyrimethamine 75 mg qd then 25 mg qd 4-6 weeks plus sulfadiazine 4g load then 1 g qid, 4-6 wks

Treatment of Toxoplasma gondii includes:

- Pyrimethamine 75 mg qd load then 25 mg qd 4-6 weeks **PLUS** Sulfadiazine 4g load then one gram qid 4-6 weeks OR
- Clindamycin 900 mg orally qid 4-6 weeks **AND FOLINIC ACID (LEVOVORIN)** 5-10 mg daily
- Corticosteroids as needed

Antivirals

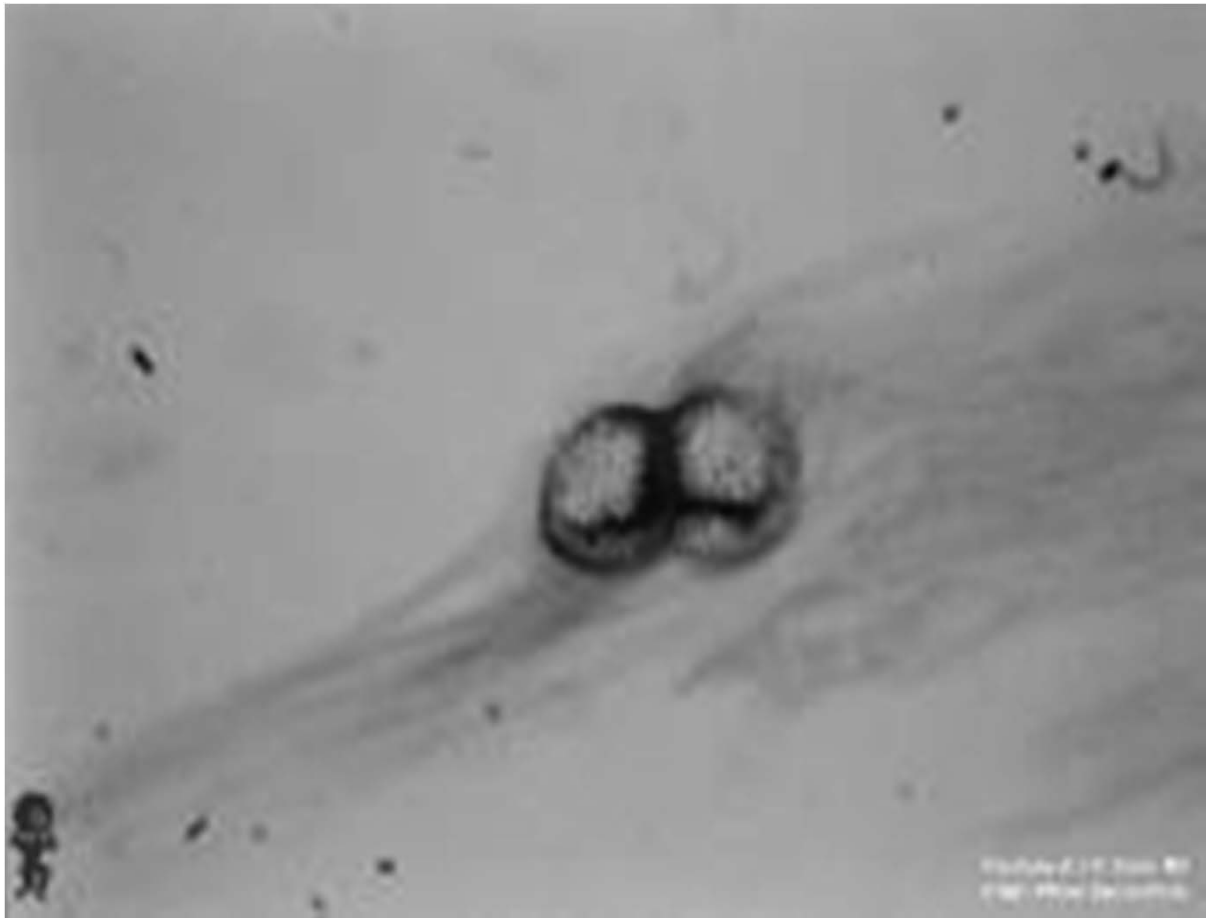
Basic concepts:

- Purine or pyrimidine nucleosides
- Halting virus replication affects host cell function
- Indications include prophylaxis against recurrence as well as treating active disease

Antivirals

Agents:

- Trifluridine (Viroptic): 1% ophthalmic solution
- Acyclovir sodium (Zovirax): Systemic (Oral)
- Cidofovir (Vistide): Systemic (IV)
- Famciclovir (Famvir): Systemic (Oral)
- Foscarnet sodium (Foscavir): Systemic (IV)
- Gancyclovir (Vitrasert): 4.5 mg IVT
- Valacyclovir (Valtrex): Systemic (Oral)



Acanthamoeba:

A. Is not a free living pathogenic amoeba
B. Exists as either a resistant trophozoite or an active cyst
C. Is treated with brolene, neomycin sulfate, and/or clotrimazole
D. Is a minor risk factor in patients who wear contact lenses and/or have contact with contaminated water

C. Is treated with brolene, neomycin sulfate, and/or clotrimazole

- Acanthamoeba is a FREE LIVING pathogenic amoeba in either an ACTIVE trophozoite or RESISTANT cyst
- A MAJOR risk factor is contact lenses and contact with contaminated water, dirty contact lens solutions and cases
- **Treatment may include:** Debridement, cryotherapy, corneal transplant, propamidine isethionate 0.1% (BROLENE), oral itraconazole, neomycin sulfate, polymixin-B, polyhexamethylene biguanide (PHMB 0.02%), clotrimazole or micanozole (imidazoles)

Glaucoma medications

β-adrenergic antagonists:

- **Timolol**
- **Carteolol**
- **Levobunolol**
- **Betaxolol**
- **Metipranolol**

Cholinergic agonists: (Miotics)

- **Pilocarpine**
- **Carbachol**

Adrenergic agonists (Alpha2):

- **Apraclonidine (Iopidine)**
- **Brimonidine(Alphagan P)**

Carbonic anhydrase inhibitors:

- **Acetazolamide (Diamox)**
- **Methazolamide**
- **Dorzolamide (Trusopt)**
- **Brinzolamide (Azopt)**

Prostaglandins:

- **Bimatoprost (Lumigan)**
- **Latanaprost (Xalatan)**
- **Travoprost (Travatan)**

Hyperosmotics:

- **Mannitol, Glycerin, Urea**

Combination agent:

- **Dorzolamide & Timolol (Cosopt)**

β-adrenergic antagonists

Non-selective:

Timolol (Timoptic, Timoptic-XE, Betimol)

Levobunolol (Betagan)

Metipranolol (OptiPranolol)

Intrinsic sympathomimetic activity:

Carteolol (Generic). Non-selective

β1-selective:

Betaxolol (Betoptic-S)

β-adrenergic antagonists

Mechanism: decreased aqueous humor production by the ciliary body (β2-adrenoceptor at the ciliary body)

Which of the following beta-blockers would be the most effective for someone with mild bronchoconstrictive disease?

A. Timolol

B. Betaxolol

C. Metipranolol

D. Levobunolol

B. BETAXOLOL

- Betaxolol is β1-selective, a better choice in cases with pulmonary disorders (less bronchospasm)

- Timolol, metipranolol, and levobunolol are β-adrenergic receptor antagonists that are β1/β2-nonselective

Which of the following is not a typical side effect of topical beta-adrenergic antagonists?

A. Dry eye
B. Corneal anesthesia
C. Alopecia
D. Tachycardia

D. TACHYCARDIA

Side effects from topical beta blockers include:

- **Ocular:** Corneal anesthesia, ptosis, hypotony, burning, superficial punctate keratitis, dry eye
- **Systemic:** Fatigue, psychosis, **BRADYCARDIA**, syncope, alopecia, nausea, impotence, altered response to hypoglycemia, asthma, heart failure, tinnitus, depression, anxiety, hallucinations, dysarthria, abnormal taste sensation, cerebrovascular accident

Cholinergic agonists

Direct acting cholinergic agonists:

- Direct stimulation of cholinergic receptor
  - Pilocarpine (Isopto Carpine, Pilopine-HS gel)
  - Carbachol (Isopto Carbachol)
- Miotics
  - Contraction of the iris sphincter muscle
- Increases aqueous outflow through the trabecular meshwork by longitudinal muscle contraction
- Accomodation by circular ciliary muscle contraction

Indirect acting cholinergic agonists:

- More potent and longer duration of action
  - Physostigmine

Which of the following agents may be implicated in causing black deposits in the conjunctiva?

A. Pilocarpine

B. Epinephrine

C. Carbachol

D. Methazolamide

B. EPINEPHRINE

- Adrenochrome deposits/black deposits can result from oxidative products of epinephrine (a non-selective adrenergic agonist)
- Adrenochrome deposits from epinephrine can be mistaken for malignant melanoma
- Propine is a conjugated epinephrine compound (broken down by corneal esterases to active forms) infrequently associated with black deposits in the conjunctiva

Cholinergic agonists

Side effects of direct cholinergic agonists:

Miosis, myopic shift, accommodative spasm, headache, cataract, pupillary block, retinal detachment, asthma (pilocarpine), perspiration, urinary urgency, nausea

Side effects of indirect cholinergic agonists:

Anterior subcapsular cataract, diarrhea, nausea, vomiting, apnea if used with succinylcholine or procaine, iris cysts (children)

All of the following effects are seen when a direct-acting cholinergic agonist is used except:

A. Miosis

B. Increase in zonular tension

C. Increased outflow facility

D. Traction on peripheral retina

B. Increase in zonular tension

- Direct-acting cholinergics include: Pilocarpine, acetylcholine, and carbachol

- Direct-acting cholinergics cause: Contraction of the iris sphincter, contraction of the circular fibres of the ciliary muscle with **RELAXATION** of the zonular tension, contraction of the longitudinal fibres of the ciliary muscle with pull on the scleral spur to open the meshwork, and contraction of the ciliary muscles which may cause a retinal tear

Glaucoma medications

Adrenergic α-2 selective agonists:

- Apraclonidine (Iopidine)
- Brimonidine (Alphagan P)

Glaucoma medications

- Mechanism: $\alpha 2$ stimulation at the ciliary body inhibits norepinephrine release, leading to decrease aqueous production
  - Decreases aqueous production and increases uveoscleral outflow
- Side effects: Conjunctival blanching, eyelid retraction, mydriasis, allergy, dry mouth, fatigue, headache, potentiate MAO inhibitors

All of the following side effects may be seen when using apraclonidine except:

A. Dry mouth

B. Lid drooping

C. Conjunctival blanching

D. Lethargy

B. Lid drooping

- Apraclonidine is an α2-adrenergic agonist
- Side effects of Apraclonidine include: **LID RETRACTION**, dry mouth, lethargy, conjunctival blanching, and local allergy

Glaucoma medications

Carbonic anhydrase inhibitors:

- Acetazolamide (Diamox): Oral
- Methazolamide (Generic): Oral
- Dorzolamide (Trusopt): Ophthalmic suspension
- Brinzolamide (Azopt): Ophthalmic solution

Glaucoma medications

- Mechanism: Inhibition of carbonic anhydrase reduces bicarbonate formation in ciliary processes (non-pigmented ciliary epithelium), and hence decrease aqueous humor production
- **More than 99% of the enzyme** in the ciliary body must be inhibited to achieve decrease aqueous production
- Contraindicated in sulpha allergy, digitalis users, pregnancy

All of the following effects may be seen with the use of dorzolamide except:

A. Metallic taste
B. Tingling in the hands and feet
C. Skin rash
D. Optic neuritis

D. OPTIC NEURITIS

Side effects of Dorzolamide include:

Numbness in the hands, feet, or lips, a metallic taste to carbonated beverages, malaise, anorexia, weight loss, nausea, somnolence, depression, & local skin allergy

Glaucoma medications

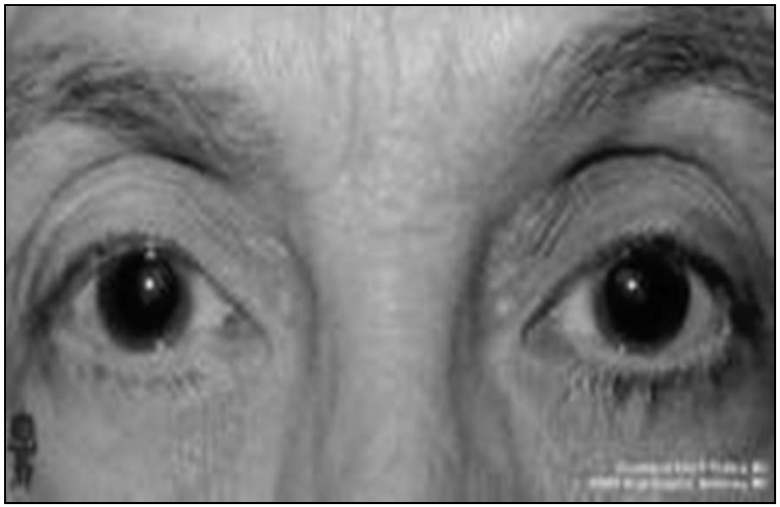
Prostaglandin analogues:

- Latanaprost (Xalatan)
- Bimatoprost (Lumigan)
- Travoprost (Travatan)

Glaucoma medications

Mechanism: Activation of prostaglandin F2α receptor, leading to remodeling of extracellular matrix adjacent to the ciliary muscle cells, leading to **increased uveoscleral outflow**

Side effects: Iris color darkening, eyelid pigmentation, hypertrichosis, conjunctival hyperemia, allergy, CME, uveitis, pseudodendrites



Glaucoma medications

Hyperosmotics:

- IV: Mannitol (Osmitrol), Urea (Ureaphil)
- Oral: Glycerin (Osmoglyn)

Hyperosmotics

- Mechanism: Induction of osmotic gradient (increase osmolarity of serum compared to intraocular). Dehydrate vitreous body which reduces IOP significantly
- Possible secondary mechanism may be effect on osmoreceptors in the hypothalamus
- Side effects: Nausea (Glycerol 50% syrup), hyperglycemia (Glycerol 50% syrup), vomiting, headache, confusion, fluid overload and exacerbation of CHF (Mannitol 20% IV) or renal disease


25
Annual Meeting

Thank you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