Global Blindness and Tropical Ophthalmology

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Overview

- Magnitude of Global Blindness
- Demographics and distribution
- Characteristics and interventions
- Unique ophthalmic findings/conditions

Learning Objectives

At the conclusion of this activity, participants will be able to:

- Describe global burden of visual impairment and blindness.
- List the leading causes of visual impairment and blindness worldwide.
- Recognize conditions with prominent ophthalmic findings.
- Recognize conditions with Force Health Protection and Global Health Engagement implications.

Vision Impairment Definitions

The International Classification of Diseases 11 (2018) classifies vision impairment into two groups.

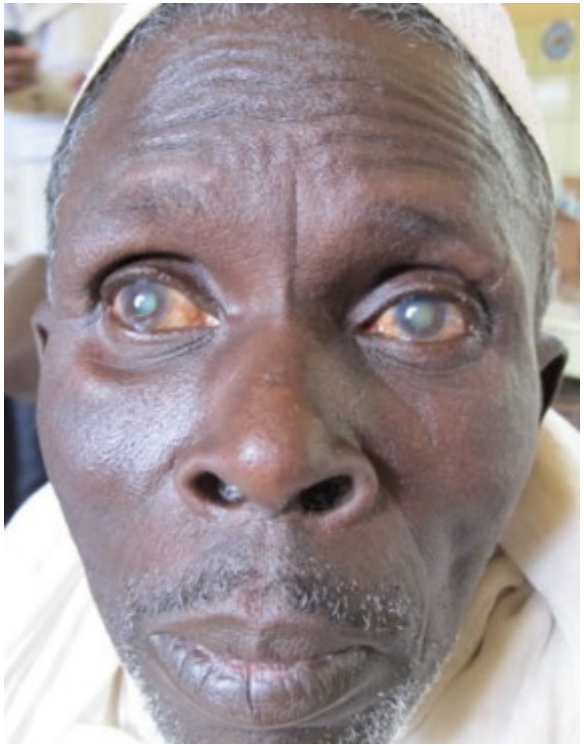
- Distance vision impairment:
  - Mild – presenting visual acuity worse than 20/40 (6/12)
  - Moderate – presenting visual acuity worse than 20/60 (6/18)
  - Severe – presenting visual acuity worse than 20/200 (6/60)
  - Blindness – presenting visual acuity worse than 20/400 (3/60)
- Near vision impairment:
  - Presenting near visual acuity worse than J8 (~20/80) N6 or M.08

Scope of Problem – Global Prevalence

- At least 2.2 billion people have a vision impairment or blindness.
- 1 billion have a preventable or unaddressed vision impairment:
  - Cataract (94 million)
  - Uncorrected Refractive Error (88.4 million)
    - ✓ Moderate or severe distance vision impairment or blindness (88.4 million)
  - Age-related macular degeneration (8 million)
  - Glaucoma (7.7 million)
  - Diabetic retinopathy (3.9 million)
  - Trachoma (1.9 million)
  - Near vision impairment caused by unaddressed presbyopia (826 million)
- Majority with vision impairment are over the age of 50 years.
- Population growth and ageing expected to increase the risk.

Cataract

- Clouding of the crystalline lens leading to degradation of visual acuity
- Risk factors for early development and/or progression:
  - Cigarette smoking
  - Ultraviolet light exposure
  - Diabetes mellitus
  - High BMI
- Leading cause of preventable blindness (51%)



Cataract Surgery

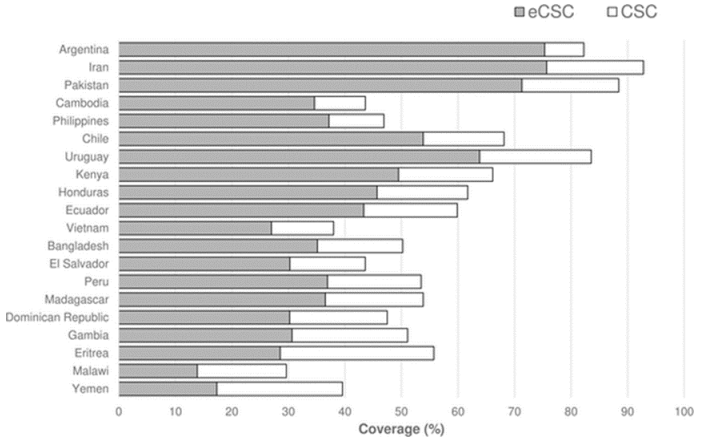
Cataract Challenges

- Requires extensive system for ongoing function
- Training and ongoing development for surgeons, nurses, and administrators
- Equipment purchase, maintenance, and replacement
- Ordering and supply of consumables
- Cost recovery with patient cross-subsidization

Cataract Challenges (continued)

- Effective cataract surgical coverage (eCSC): number of people in defined population with operated cataract and good outcome as a proportion of those having operable plus operated cataract (Cataract surgical coverage, CSC)

Fig 2. Cataract surgical coverage (CSC) and effective cataract surgical coverage (eCSC; persons <6/60, %) in 20 countries, 2005–2013.[1]



[1]Ramke J, Gilbert CE, Lee AC, Ackland P, Limburg H, et al. 2017. "Effective cataract surgical coverage: An indicator for measuring quality-of-care in the context of Universal Health Coverage." *PLOS ONE* 12(3): e0172342. https://doi.org/10.1371/journal.pone.0172342 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0172342

Manual Small Incision Cataract Surgery (MSICS)

- Low-cost, small-incision form of extracapsular cataract extraction (ECCE)
- Operative time significantly shorter
- Cost of surgical supplies significantly lower (US$70 for phacoemulsification and US$15 for MSICS)
- Similar visual outcomes and complication rates
- Increased utilization for developing world applications

Uncorrected Refractive Error - 2020

- Decreased vision due to unaddressed or inadequate optical correction
- 2020 estimates (2020 Vision Loss Expert Group data):
  - 157 million people had significant vision loss
  - 3 million of which are blind
  - 510 million functional presbyopia and no correction

Impact and Barriers

- Correction of refractive error improves work productivity and quality of life indicators
- Presbyopia correction improves quality of life even in countries with low literacy rates
- Lack of recognition of problem at individual, community, and government level
- Inadequate refractive services for testing (trained personnel and equipment).
- Lack of accessible or affordable corrective lenses

WHO SPECS 2030

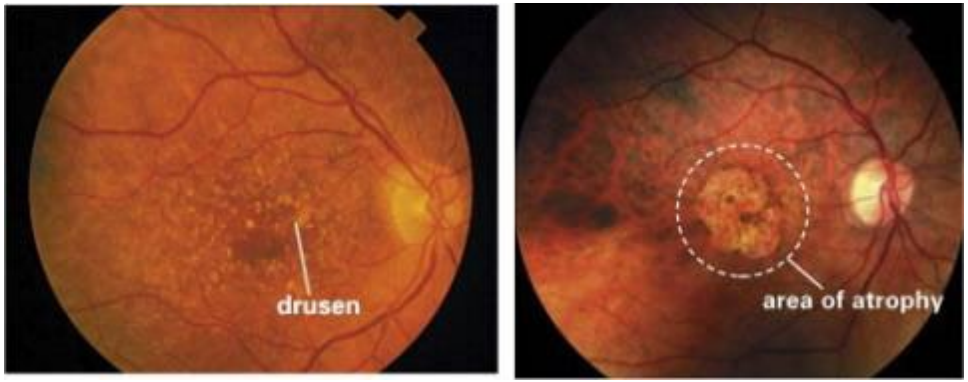
- Coordinated action across five pillars to improve refractive error coverage:
  - Improve access to refractive **S**ervices
  - Build capacity of **P**ersonnel to provide refractive services
  - Improve population **E**ducation
  - Reduce the **C**ost of refractive services
  - Strengthen **S**urveillance and research

Field Refractive Error Correction Kit (FRECK)

- Low-cost, low-tech option for rapid vision correction in austere environments
- Developed and fielded to remote locations in Operation Enduring Freedom
- Effective for 84% distance correction and 97% near correction
- No difference between the percentages of patients achieving 20/40 vision for distance or reading when medics used the technique under direct supervision versus independent use

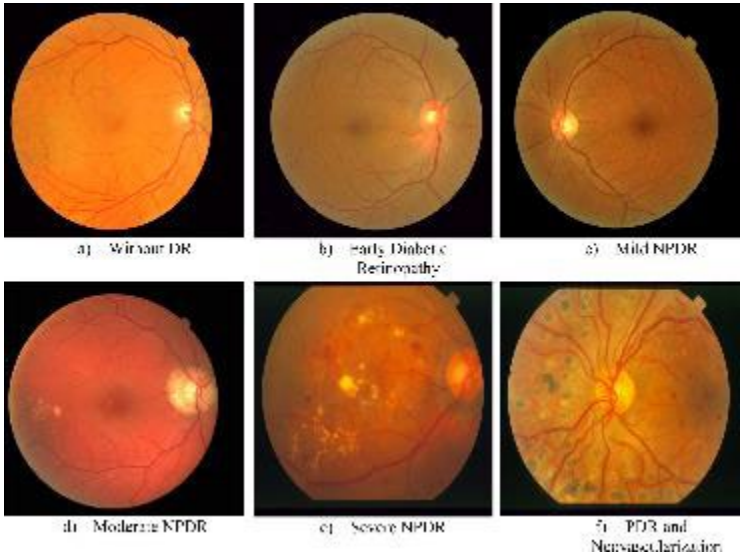
Age-related Macular Degeneration

- Degenerative disease of photoreceptors and retinal pigmented epithelium affecting central vision
- Dry (~75%) and Wet variants
- Incidence and prevalence increases with age
- Global increases expected with increasing age



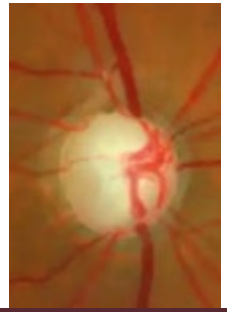
Diabetic Retinopathy

- Individuals diagnosed with diabetes increased from 108 million in 1980 to 422 million in 2014
- Prevalence increasing more rapidly in low- and middle-income countries
- Diabetic Retinopathy (DR) prevalence increases with duration of disease
- DR is categorized as nonproliferative and proliferative
- Treatments options include intravitreal injections, panretinal photocoagulation and vitrectomy



Glaucoma

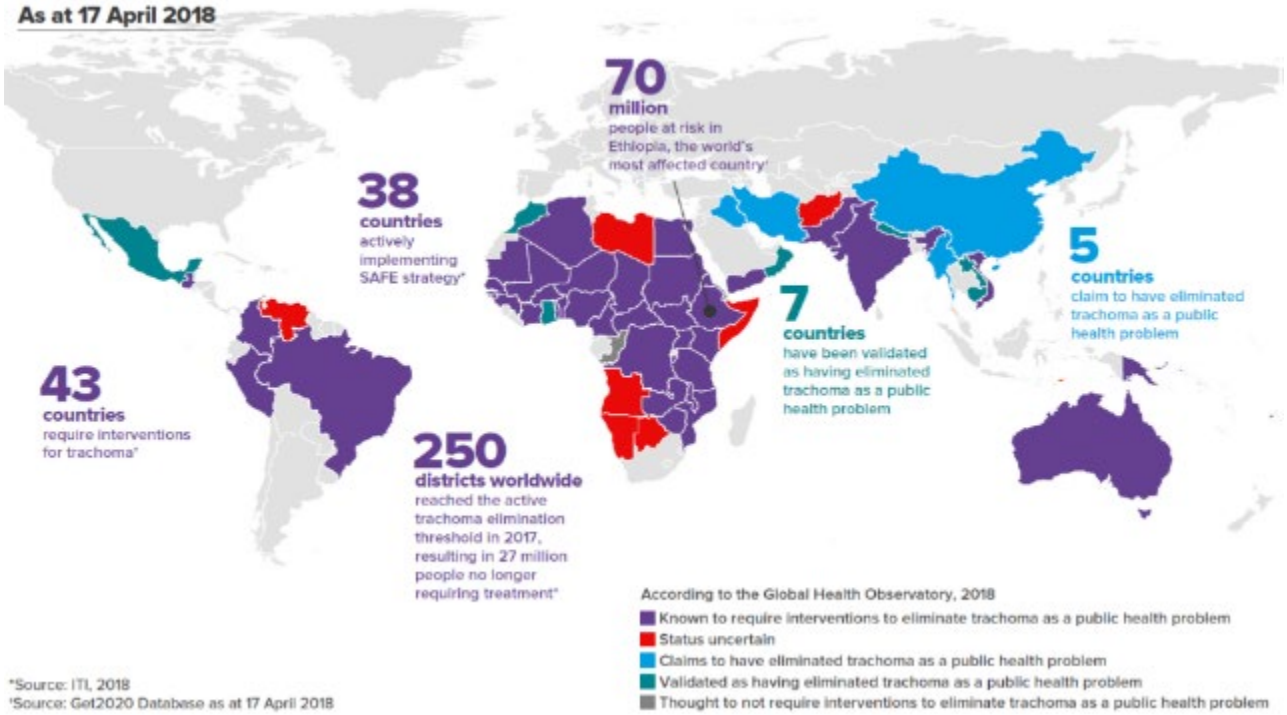
- Most common cause of irreversible blindness
- Open Angle Glaucoma is most common
- Group of disorders with common features
- Cupping and atrophy of optic nerve
- Characteristic visual field loss
- Usually increased intraocular pressure
- No uniform case definition
- Most patients with glaucoma unaware of disease



Trachoma

- Caused by infection with the bacterium Chlamydia trachomatis
- Spreads through personal contact and *Musca sorbens*
- Repeated episodes of infection lead to conjunctival scarring and trichiasis
- Public health problem in 42 countries
- 125 million people live in trachoma endemic areas (June 2022)
- Responsible for the blindness or visual impairment of 1.9 million people
- Blindness from trachoma is irreversible
- Enormous burden on affected individuals and communities
- Lost productivity from blindness and visual impairment estimated at least US$ 2.9–5.3 billion annually, increasing to US$ 8 billion when trichiasis is included

Trachoma Map: Endemicity by Country



https://www.trachomacoalition.org/resources/trachoma-map-endemicity-country

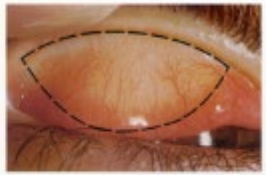
Trachoma Grading

TRACHOMA GRADING CARD

– Each eye must be examined and assessed separately.
– Use binocular loupes (x 2.5) and adequate lighting (either daylight or a torch).
– Signs must be clearly seen in order to be considered present.

The eyelids and cornea are observed first for inturned eyelashes and any corneal opacity. The upper eyelid is then turned over (everted) to examine the conjunctiva over the stiffer part of the upper lid (tarsal conjunctiva).

The normal conjunctiva is pink, smooth, thin and transparent. Over the whole area of the tarsal conjunctiva there are normally large deep-lying blood vessels that run vertically.



Normal tarsal conjunctiva (x 2 magnification). The dotted line shows the area to be examined.

TRACHOMATOUS INFLAMMATION – FOLLICULAR *(TF): the presence of five or more follicles in the upper tarsal conjunctiva.*

Follicles are round swellings that are paler than the surrounding conjunctiva, appearing white, grey or yellow. Follicles must be at least 0.5mm in diameter, i.e., at least as large as the dots shown below, to be considered.

Trachomatous inflammation – follicular (TF).

TRACHOMATOUS INFLAMMATION – INTENSE (TI): *pronounced inflammatory thickening of the tarsal conjunctiva that obscures more than half of the normal deep tarsal vessels.*

The tarsal conjunctiva appears red, rough and thickened. There are usually numerous follicles, which may be partially or totally covered by the thickened conjunctiva.

Trachomatous inflammation – follicular and intense (TF + TI).

TRACHOMATOUS SCARRING *(TS): the presence of scarring in the tarsal conjunctiva.*

Scars are easily visible as white lines, bands, or sheets in the tarsal conjunctiva. They are glistening and fibrous in appearance. Scarring, especially diffuse fibrosis, may obscure the tarsal blood vessels.

Trachomatous scarring (TS)

TRACHOMATOUS TRICHIASIS *(TT): at least one eyelash rubs on the eyeball.*

Evidence of recent removal of inturned eyelashes should also be graded as trichiasis.

Trachomatous trichiasis (TT)

CORNEAL OPACITY (CO): *easily visible corneal opacity over the pupil.*

The pupil margin is blurred viewed through the opacity. Such corneal opacities cause significant visual impairment (less than 6/18 or 0.3 vision), and therefore visual acuity should be measured if possible.

Corneal opacity (CO)

TF:– give topical treatment (e.g. tetracycline 1%).
TI:– give topical and consider systemic treatment.
TT:– refer for eyelid surgery.

WORLD HEALTH ORGANIZATION
PREVENTION OF BLINDNESS AND DEAFNESS

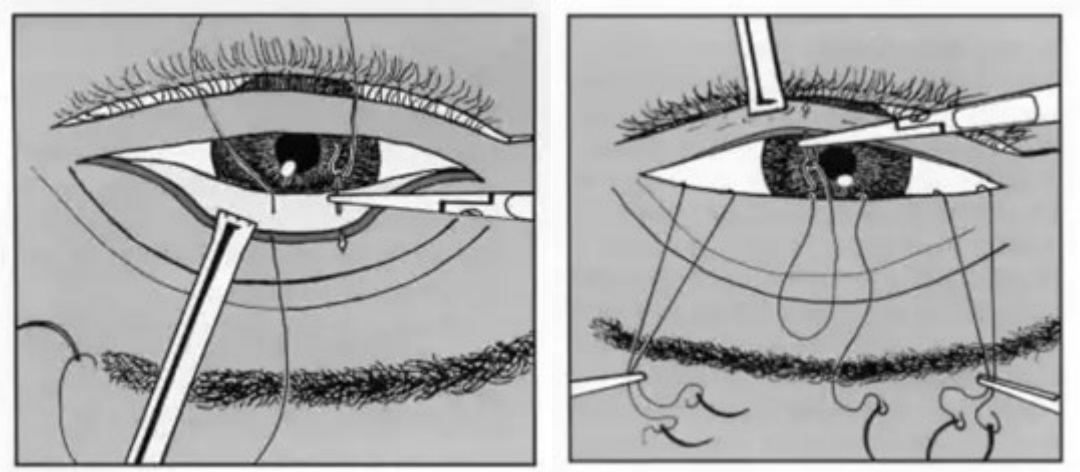
Support from the partners of the WHO Alliance for the Global Elimination of Trachoma is acknowledged.

Trachoma Prevention and Control

- The elimination strategy is summarized by the acronym “SAFE”:
  - Surgery to treat the blinding stage
  - Antibiotics to clear infection
  - Facial cleanliness
  - Environmental improvement to reduce transmission
- In 2020, 42,045 people received surgical treatment for advanced stage of the disease
- 32.8 million treated with antibiotics
- Global-level antibiotic coverage in 2020 was 21%:
  - Program activity was affected by the COVID-19 pandemic

Trichiasis – Surgical Intervention

- Bilamellar Tarsal Rotation (BLTR) surgery



In 2021, 69,266 people received surgical treatment for advanced stage of the disease

WHO Recommended Antibiotic Treatments

- Single dose azithromycin:
  - Children aged <16 years is 20 mg/kg (maximum 1 g)
  - Adult dosage is 1 g
- Topical 1.5% ophthalmic solution:
  - 1 drop per eye, twice a day x 3 days
- Topical 1% tetracycline eye ointment:
  - Pregnant women
  - Children aged below 6 months
  - Allergy to macrolides
- 64.6 million people treated with antibiotics in 2021
- Global antibiotic coverage in 2021 was 44%

Eliminating Trachoma. London School of Hygiene and Tropical Medicine https://www.futurelearn.com/courses/eliminating-trachoma/0/steps/21672

Environmental Improvements

- *Musca sorbens* (face fly) implicated as vector
- Preferentially breeds on human feces
- Unable to breed in latrines
- Improved water supply, latrine construction, fly control decreases trachoma

Onchocerciasis (River Blindness)

- Parasitic worm *(Onchocerca volvulus)* infection transmitted repeated bites of the blackfly genus Simulium
- Second most common cause of infectious blindness worldwide
- Global Burden of Disease Study (2017) estimated 20.9 million prevalent *O. volvulus* infections worldwide: 14.6 million of the infected people had skin disease and 1.15 million had vision loss
- 99% of infected people live in 31 African countries
- Involvement of all ocular tissues possible, multiple etiologies of blindness
- Reaction to migrating microfilariae
- Initial corneal changes are reversible
- Long standing infection leads to sclerosis keratitis (major cause of blindness)
- Uveitis leads to scarring and secondary glaucoma
- Retinal changes possible

Disease Progression - Onchocerciasis

Sclerosing keratitis in onchocerciasis. © Ian Murdoch & Allen Foster Community Eye Health Vol 14 No. 38 2001

Onchocerciasis Treatment

- Single dose Ivermectin every 6 to 12 months
- Ocular microfilariae counts do not begin to be reduced for at least 2 weeks
- Advanced eye disease and existing blindness not reversible

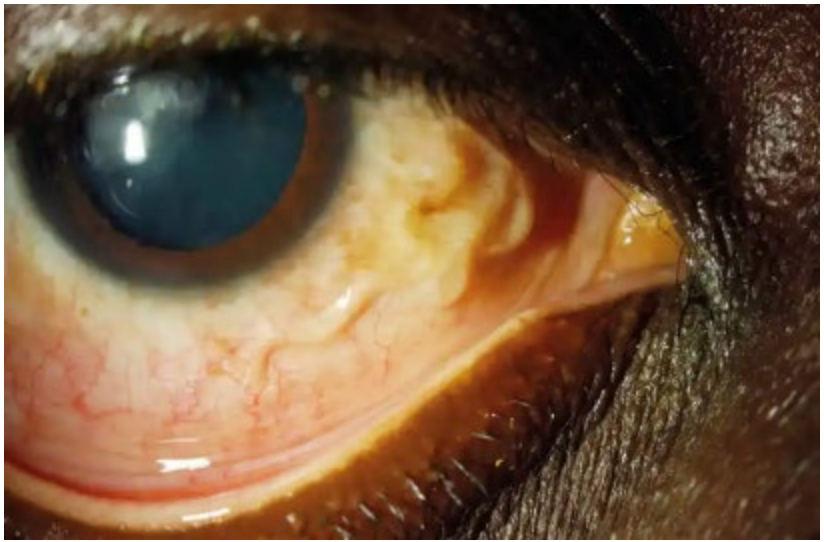
Community Eye Health Journal. Vol 31:(104) 2019

Onchocerciasis Control Programs

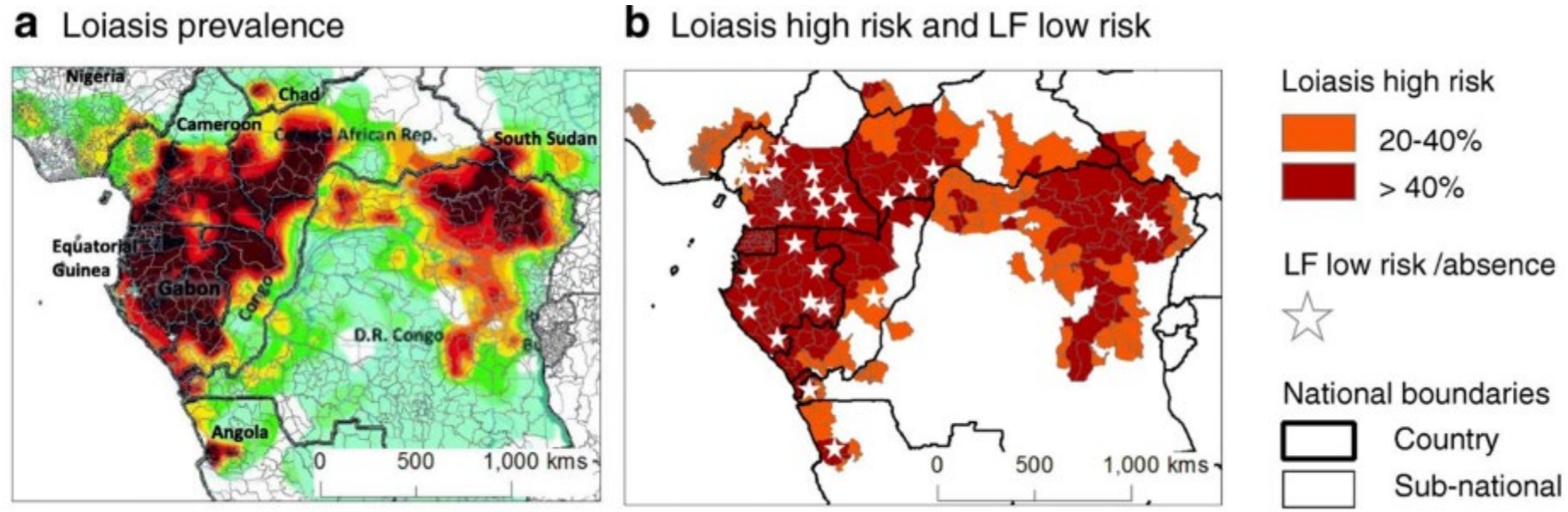
- Africa: Community-directed treatment with ivermectin
- Americas: Biannual large-scale treatment with ivermectin
- Onchocerciasis Control Programme (OCP) West Africa 1974-2002
- African Programme for Onchocerciasis Control (APOC) 1995-2015
- Onchocerciasis Elimination Program for the Americas (OEPA) 1992-current
- Expanded Special Project for Elimination of Neglected Tropical Diseases (ESPEN)

Loa loa

- Found in rain forests in Western and Central Africa
- Vector is *Chrysops* deerfly (day biters during rainy season); common on rubber plantations
- Infective larvae become adults in adult host after about 5 months
- Can live for up to 17 years in humans in connective tissue (Calabar swelling)
- Ocular migrations (subconjunctival) can last from hours to days with little damage
- Diethylcarbamazine kills microfilariae and adult worms



Loa loa Maps



Maps of loiasis prevalence and study areas with low LF risk. **a** Loiasis prevalence. **b** Loiasis high risk and LF low risk

Kelly-Hope, L.A., Hemingway, J., Taylor, M.J. et al. Increasing evidence of low lymphatic filariasis prevalence in high-risk Loa areas in Central and West Africa: a literature review. Parasites Vectors 11, 349 (2018).

Other Eye Worms

Organism/Condition	Locations affected
Alariasis	Intraocular worm, DUSN
Angiostrongyliasis (rat lungworm)	Anterior chamber, vitreous, DUSN
Brugia malayi	Chemosis, lid edema, orbital cellulitis, anterior uveitis, or worm in the anterior chamber
Dirofilariasis (dog heart worm)	Eyelids, orbit, subconjunctival tissue, anterior chamber, and vitreous
Toxocariasis	Ocular larva migrans, DUSN

DUSN = Diffuse unilateral subacute neuroretinitis

Other Eye Worms (continued)

Organism/Condition	Locations affected
Baylisascariasis (raccoon round worm)	Ocular larva migrans, DUSN
Thelaziasis (oriental eye worm)	Conjunctivitis, keratitis, and corneal ulcers, DUSN
Gnathostomiasis	Eyelid, conjunctiva, cornea, anterior chamber, uvea, and vitreous cavity
Sparganosis	Periorbital and conjunctival mass or granuloma, proptosis, iridocyclitis
Coenuriasis	Subconjunctival, orbital, or intraocular cyst

DUSN = Diffuse unilateral subacute neuroretinitis

Vitamin A Deficiency

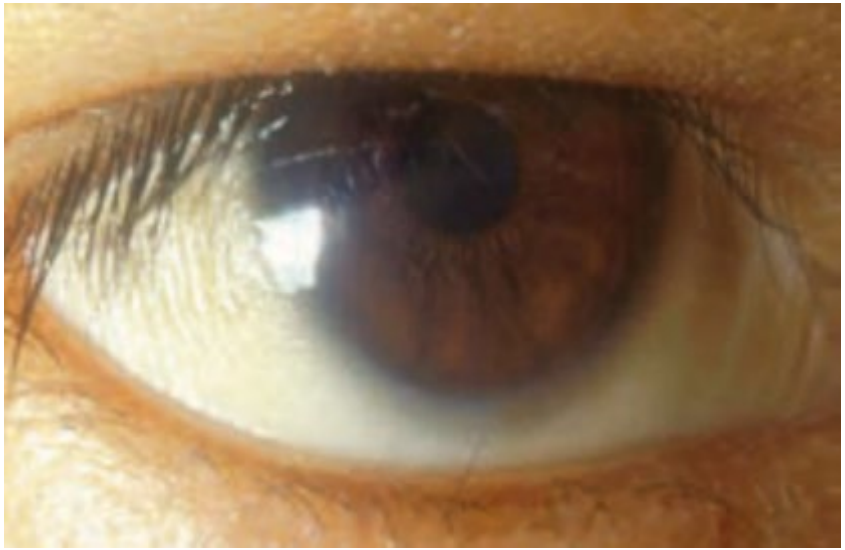
- 30% among children <5, 50% in young children in South Asia and sub-Saharan Africa
- Prominently affects eyes, especially in children
- Xerophthalmia includes all manifestations of disease
- Surface effects from loss of goblet cells
- Night Blindness due to rhodopsin abnormalities
- Measles can markedly depress circulating levels of serum retinol
- Presentation depends on nutritional status:
  - Well nourished: tearing, photophobia, punctate keratitis
  - Malnourished: xerophthalmia signs

Xerophthalmia and Vitamin A

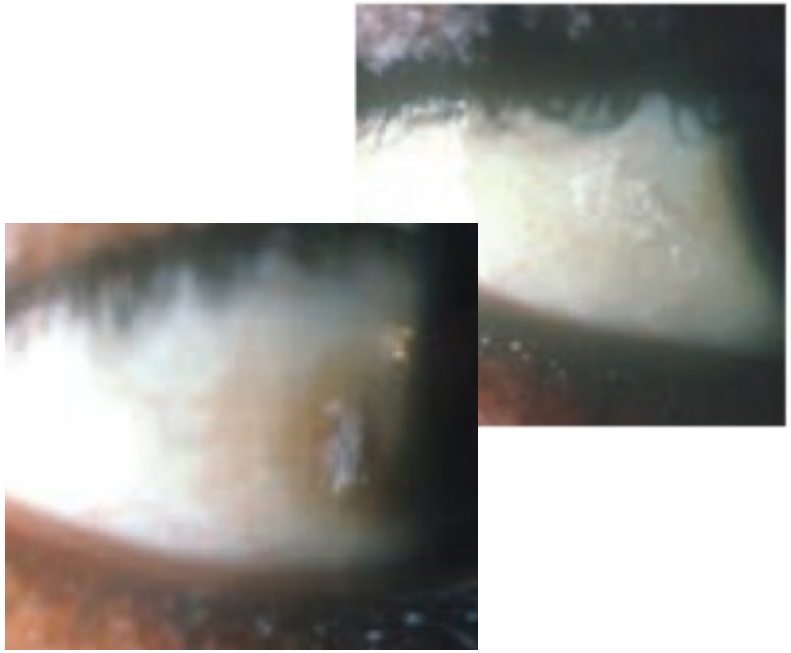
World Health Organization classification of vitamin A deficiency and age group most affected

	Grade of Xeropthalmia	Peak age group (years)	Type of deficiency	Risk of death
XN	Night Blindness	2-6; adult women	Long standing. Not blinding.	+
X1A	Conjunctival xerosis	3-6	Long standing. Not blinding.	+
X1B	Bitot's spot	3-6	Long standing. Not blinding.	+
X2	Corneal xerosis	1-4	Acute deficiency. Can be blinding.	++
X3A	Corneal ulcer/keratomalacia <1/3 stroma	1-4	Severe acute deficiency. Blinding.	+++
X3B	Corneal ulcer/keratomalacia ≥ 1/3 stroma	1-4	Severe acute deficiency. Blinding.	++++
XS	Corneal scarring (from X3)	>2	Consequence of corneal ulceration.	+/-
XF	Xerophthalmia fundus	Adults	Long standing. Not blinding. Rare.	-

WHO Classification



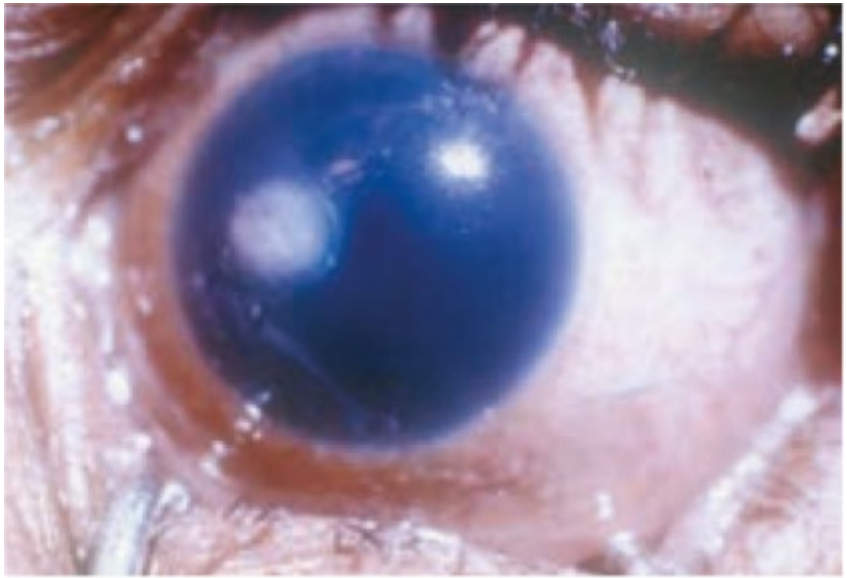
Conjunctival Xerosis (X1A)



Bitot's Spots (X1B)

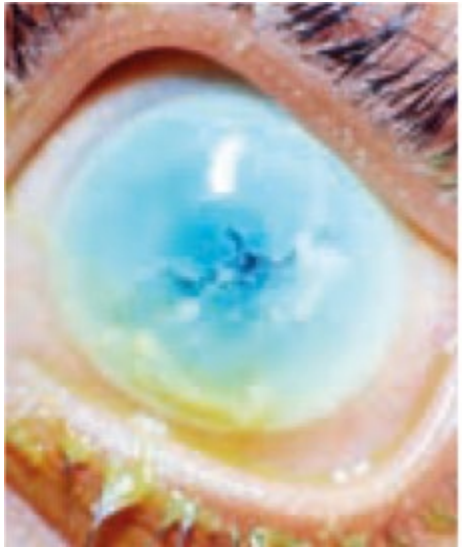
WHO Classification (continued)

Corneal Xerosis (X2)

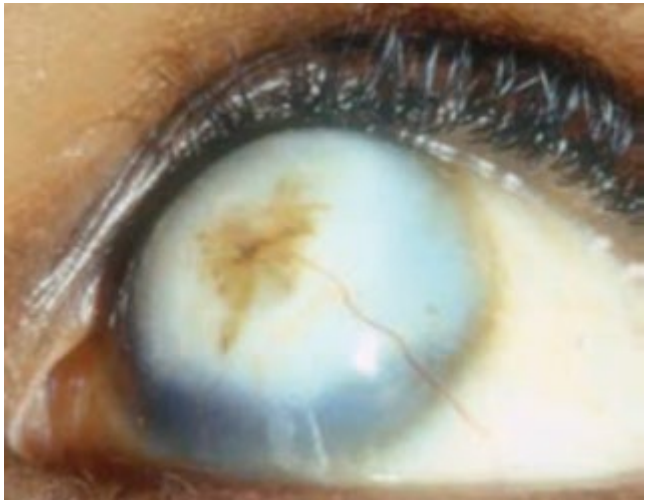


Corneal Ulceration with Xerosis (X3A) < 1/3 of corneal surface

WHO Classification (continued)



Corneal Ulcer/keratomalacia (X3B) ≥ 1/3 of corneal surface



Secondary Classification:

- Night Blindness (XN)
- Xerophthalmia Fundus (XF)
- Corneal Scars (XS)

Vitamin A Replacement

- WHO recommended replacement, universal:
  - Infants 6 to 12 months: 100,000 international units orally (30 mg retinol equivalent) – One dose
  - Children 12 to 59 months: 200,000 international units orally (60 mg retinol equivalent) – Dose repeated every 4 to 6 months
  - Pregnant women in high-risk areas: frequent small doses to prevent night blindness.
- High risk of vitamin A deficiency (measles, diarrhea, respiratory disease, or severe malnutrition):
  - Infants < 6 months: 50,000 international units orally
  - Infants 6 to 12 months: 100,000 international units orally
  - Children >12 months: 200,000 international units orally
- High-risk measles: above on 2 successive days
- Xerophthalmia: above in 3-dose series

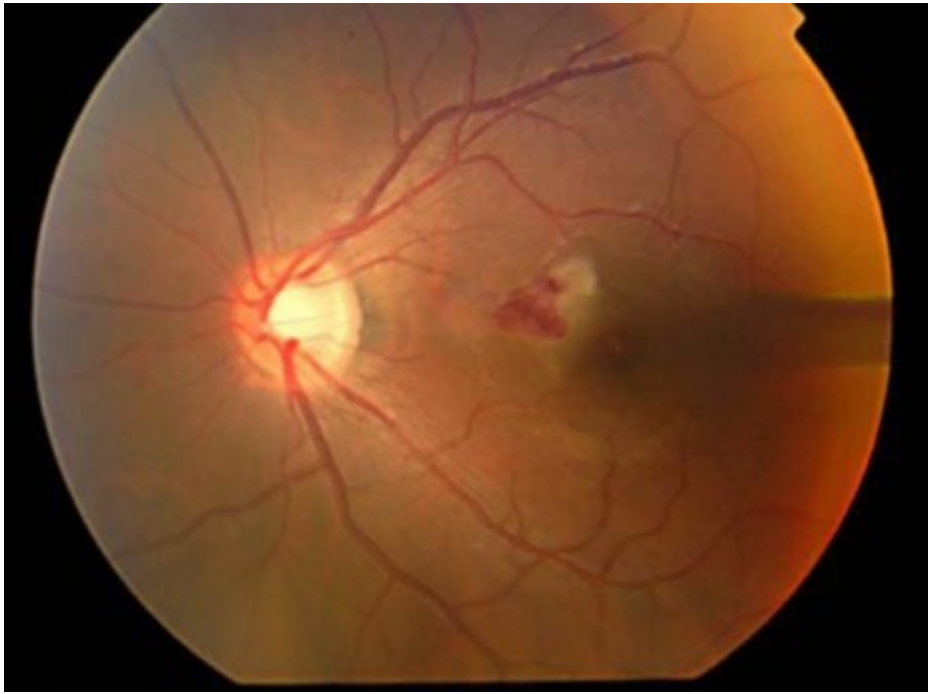
Leprosy (Hansen's Disease)

- Direct ocular involvement from mycobacteria or inflammatory reaction
- More common in lepromatous leprosy
- Ocular pathology 3x more likely to have other disabilities.
- Multiple possible ocular complications:
  - Lids: ectropion, entropion, lagophthalmos, reduced blinking, trichiasis
  - Cornea: thickened nerves, keratitis, anesthesia, pannus, exposure keratopathy, corneal leproma
  - Iris: acute or chronic iritis, iris leproma
  - Ciliary body: loss of accommodation, hypotonia, phthisis
  - Sclera: episcleritis, scleritis, nodules, staphyloma
  - Lens: cataract
  - Fundus: choroidal lesions, vasculitis, papillitis
  - Lacrimal system: acute/chronic dacryocystitis

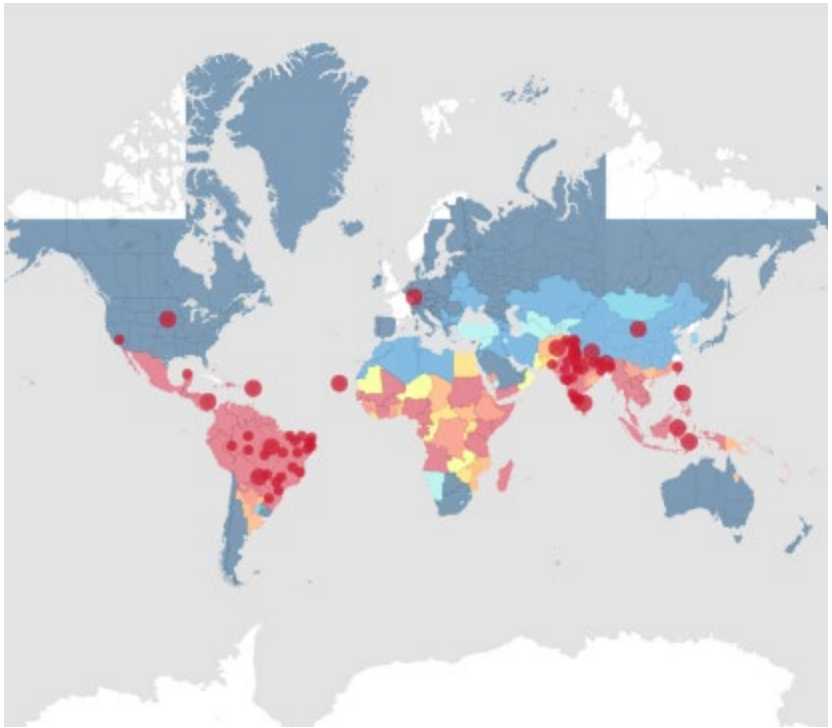
Leprosy Complications

Dengue Eye Disease

- Multiple ocular complications from subconjunctival hemorrhage to posterior complications
- Most significant ocular complications of dengue fever maculopathy and hemorrhage
- Commonly present at the start of convalescence - associated with the nadir of thrombocytopenia



Dengue Map



Map Layers

HealthMap Reports

Recent reports of local or imported dengue cases from official, newspaper, and other media sources. Source.

Country Level Local Level

Global Consensus Map (2013)

Risk areas determined by consensus between sources including: national surveillance systems, published literature, questionnaires and formal and informal news reports. Source.

Absent Unlikely Uncertain Likely Present

CDC Yellow Book Map (2012)

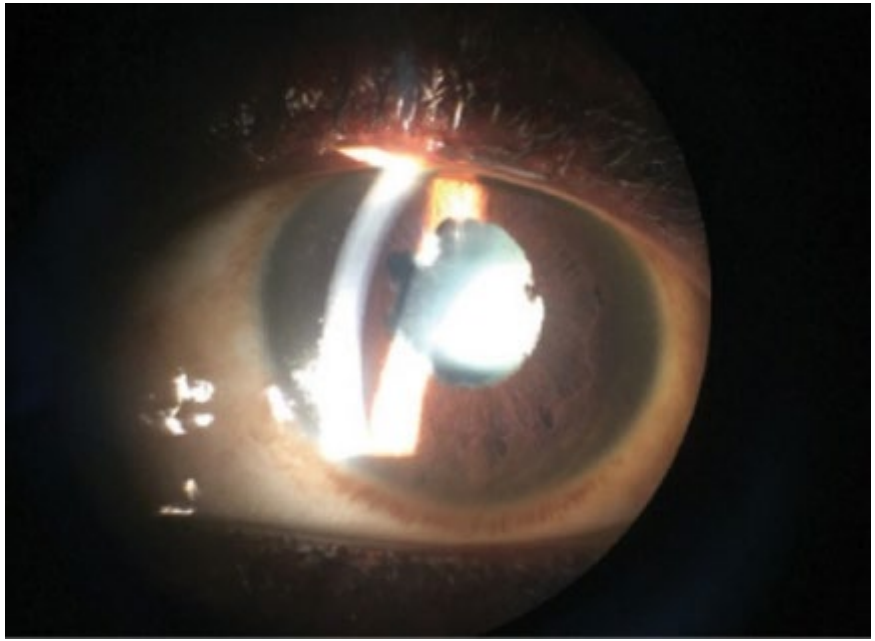
CDC Yellow Book Map (2010)

Endemic risk areas determined using data from Ministries of Health, international health organizations, journals, and knowledgeable experts. Source.

Endemic Area

Ebola Eye Disease

- Estimated 17,000 survivors from 2013-2016 West Africa outbreak
- Post-Ebola virus disease syndrome (PVEDS):
  - Ocular disease, arthritis, hearing loss, abdominal pain, neuropsychiatric disorders
  - Up to 60% survivors report ocular symptoms after acute infection
- Uveitis most common complication (up to 1/3 of survivors)
- Posterior and panuveitis most commonly observed



Retina Today. January/February 2018

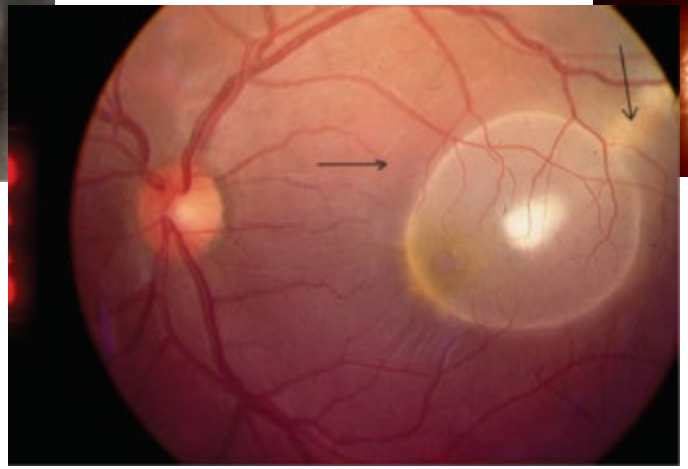
Zika Virus

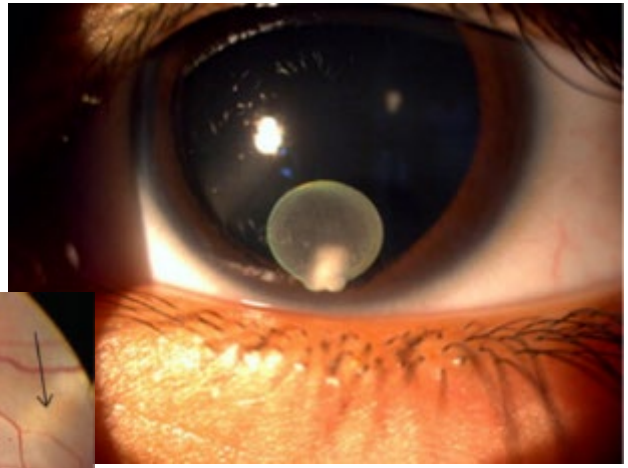
- Adults:
  - Inflammatory disease most likely (uveitis)
  - Usual onset 1 week after the onset of systemic disease
  - Hemorrhagic retinopathy
- Congenital:
  - 50% of infants with microcephaly related have some ocular findings
  - Most effects on posterior structures
  - Chorioretinal atrophy in the macula
  - Torpedo maculopathy

Cysticercosis

- Most common ocular platyhelminth infestation:
  - Southeast Asia, the Indian subcontinent, Latin America, and Africa
- Extraocular or Intraocular – 1 to 3% of cysticercosis cases:
  - Orbit/adnexa more common in India
  - Posterior more common in west (still rare)
- Intraocular can lead to blindness in 3 to 5 years if untreated
- Death of the parasite causes profound inflammatory reaction, destruction of eye
- Antihelminthic drugs for orbital cysticercosis
- Early surgical removal of intraocular parasite is treatment of choice

Cysticercosis Locations





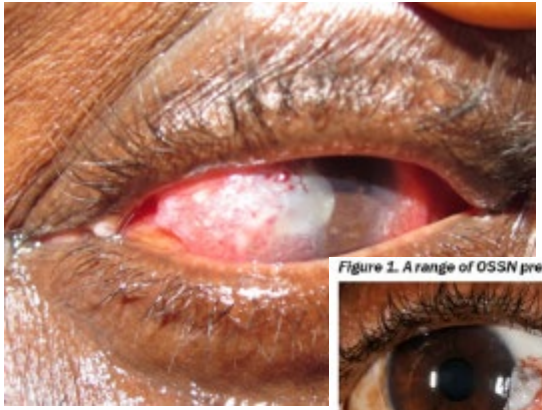
Ophthalmomyiasis

- Larval infestation of ocular tissues
- Superficial (externa) or deep (interna) structures
- Manifestations depend on species and location:
  - Oestrus ovis (sheep botfly) most common; affects conjunctiva and cornea
  - Rodent botfly uncommon; affects internal structures
- Treatment: removal of intact larva or destruction if not surgically accessible

Retina Image Bank #4390

Ocular Surface Squamous Neoplasia

- Increased prevalence in populations within 30° latitude from the equator
- Afflicts younger patients and more clinically aggressive in Africa and certain parts of Asia
- Increased prevalence with HPV and HIV
- Treatment approach depends on location, size and extension
- Recurrence after surgical excision in over 50% of cases and may be delayed many years (up to 1/3 in 10 years)



Neglected Tropical Diseases

Organism/Condition	Locations affected
Buruli ulcer (Mycobacterium ulcerans infection)	No reports of ocular involvement found
Chagas disease (American trypanosomiasis)	Romanna's sign - eyelid edema
Dracunculiasis (guinea-worm disease)	Cystic mass involving the upper lid/periorbital tissue
Echinococcosis	Orbital cyst with proptosis intraocular cyst (subretinal, vitreous, or anterior chamber), and choroidal mass
Foodborne trematode infections	Fascioliasis: Orbital mass, proptosis, ophthalmoplegia, intraocular and intravascular invasion, vitritis and vitreous hemorrhage
Trypanosomiasis, human African (sleeping sickness)	Iritis, keratitis, and conjunctivitis, optic neuritis, double vision, optic atrophy, and papilloedema
Leishmaniasis	Nodular lesion in the eyelids (simulating chalazion), trichiasis, nodular conjunctivitis, interstitial and ulcerative keratitis, dacryocystitis, and episcleritis

Neglected Tropical Diseases (continued)

Organism/Condition	Locations affected
Mycetoma	Eyelid and orbit
Lymphatic filariasis	Brugia malayi: Chemosis, lid edema, orbital cellulitis, anterior uveitis, or worm in the anterior chamber, subconjunctival space, and vitreous cavity Wuchereria bancrofti: Uveitis and subretinal yellow lesions
Rabies	Transmission through corneal transplant
Scabies	Eyelid and conjunctival infestation possible
Schistosomiasis	Conjunctiva, eyelids, orbital or subretinal granuloma, keratouveitis, and vasculitis
Soil-transmitted helminth infections	Ascaris: subconjunctival mass, granulomatous iridocyclitis, choroiditis, recurrent vitreous hemorrhage, chronic dacryocystitis and invasion into the subretinal space
Snakebite envenomation	Exotropia, ptosis, diplopia, ophthalmoplegia, accommodation paralysis, optic neuritis, globe necrosis, keratomalacia, uveitis, and loss of vision
Yaws	No firm evidence of a causal relationship

Questions