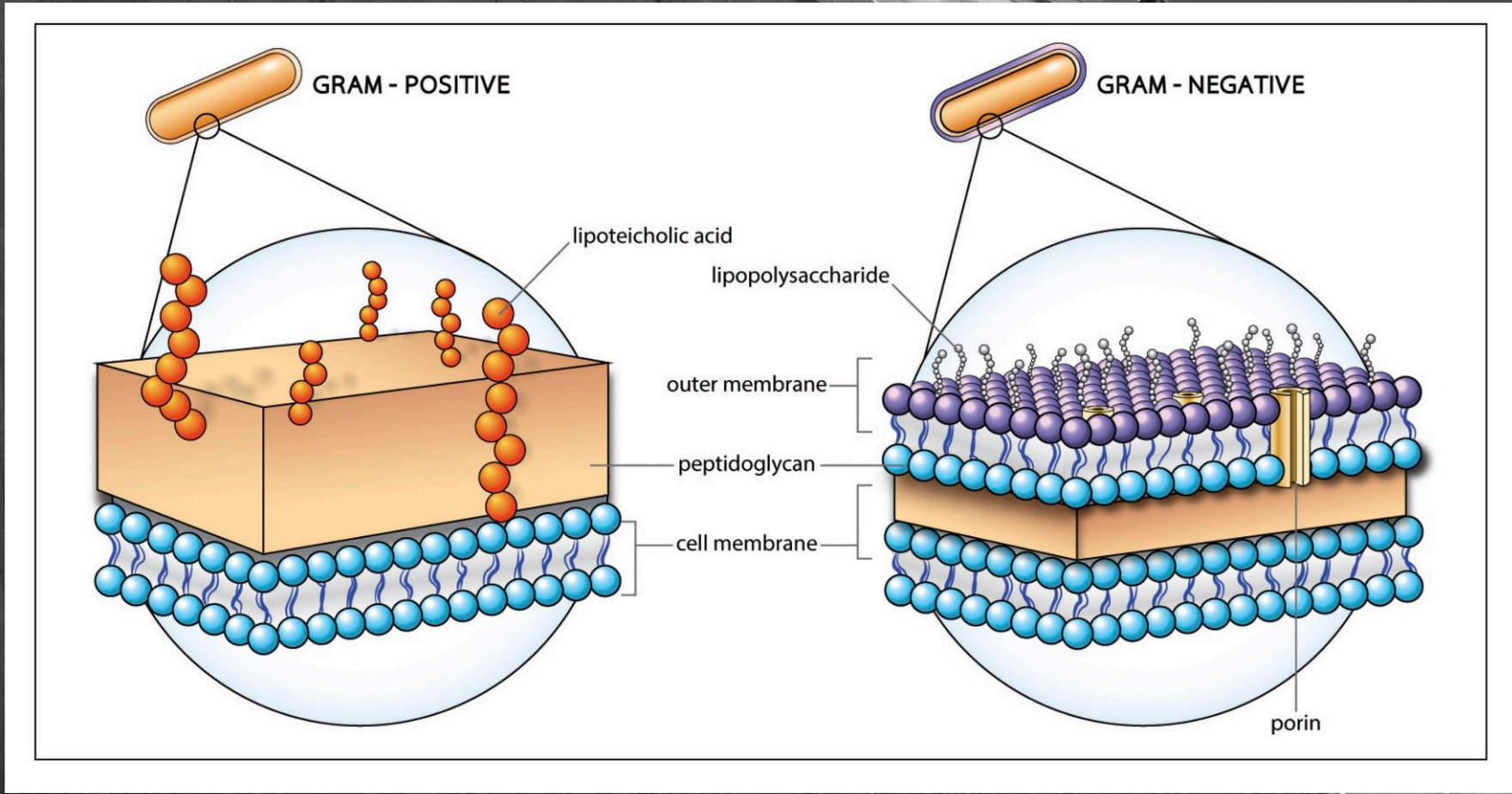
CHRISTOPHER OBERHOLZER MD

PEDIATRIC INFECTIONS AND TREATMENT

PART 1

ANTIBIOTICS IN OUTPATIENT PEDIATRICS

- Clinically Relevant Bacteriology

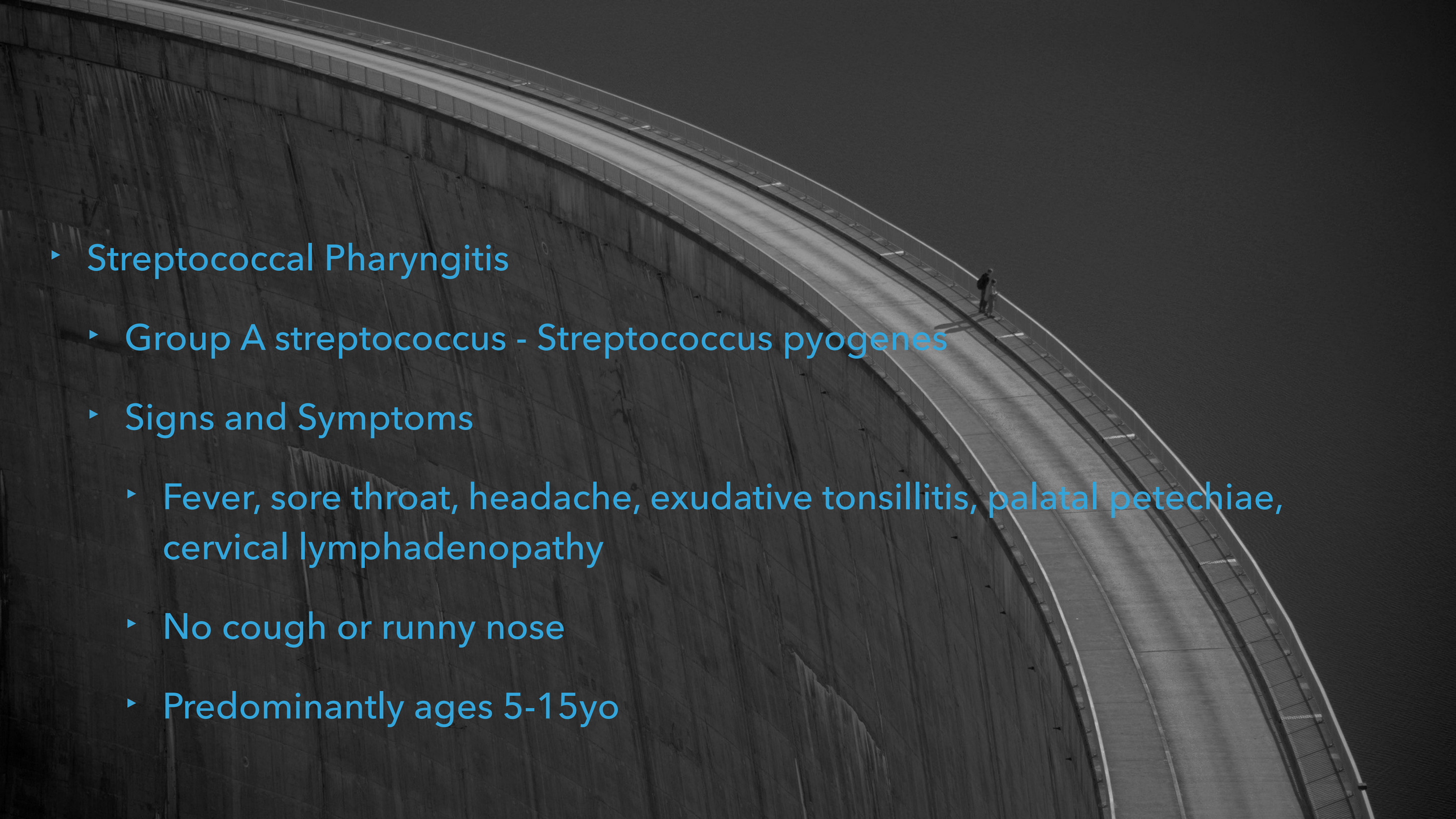


- Gram +
  - Streptococcus
  - Staphylococcus
  - Enterococcus

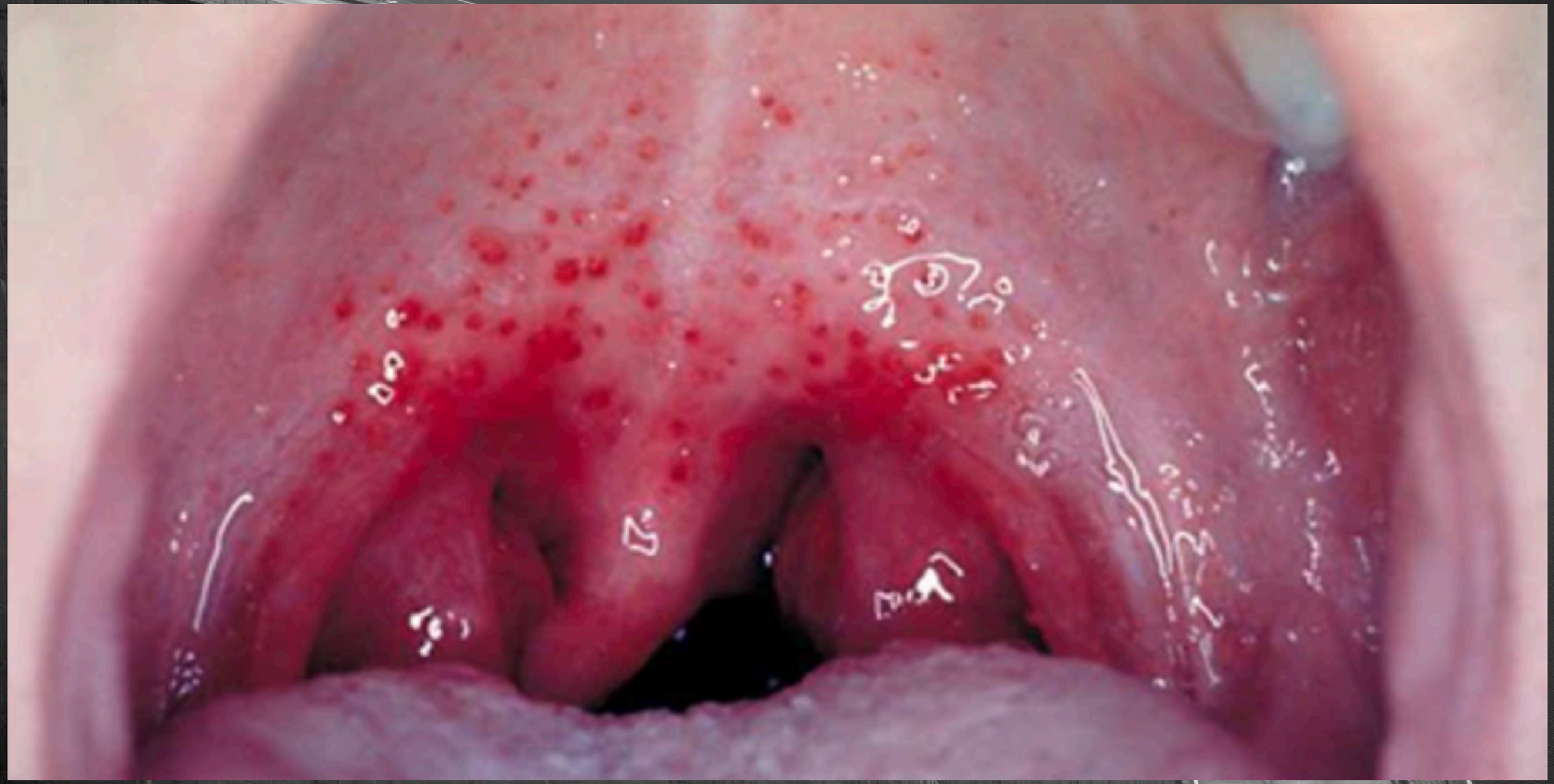
- Gram -
  - E. Coli
  - Salmonella
  - Neisseria meningitidis
  - Klebsiella
  - Pseudomonas

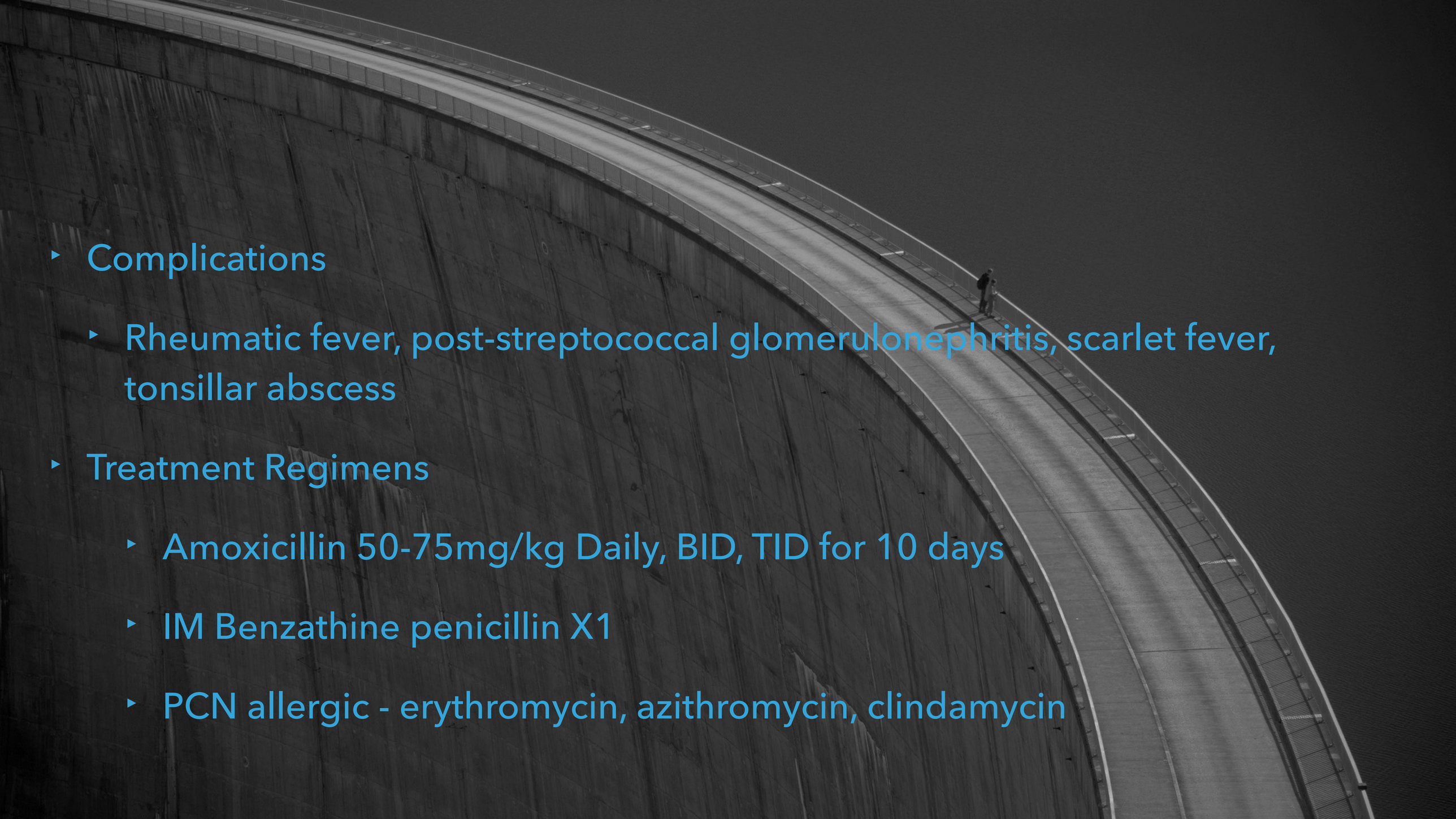
- **Pediatric Dosing and Administration in children**
  - Outpatient Considerations
    - Oral tolerability
    - Length of treatment and compliance
    - Allergies?
  - Inpatient Considerations
    - IV Access
    - Penetration

COMMON OUTPATIENT BACTERIAL INFECTIONS

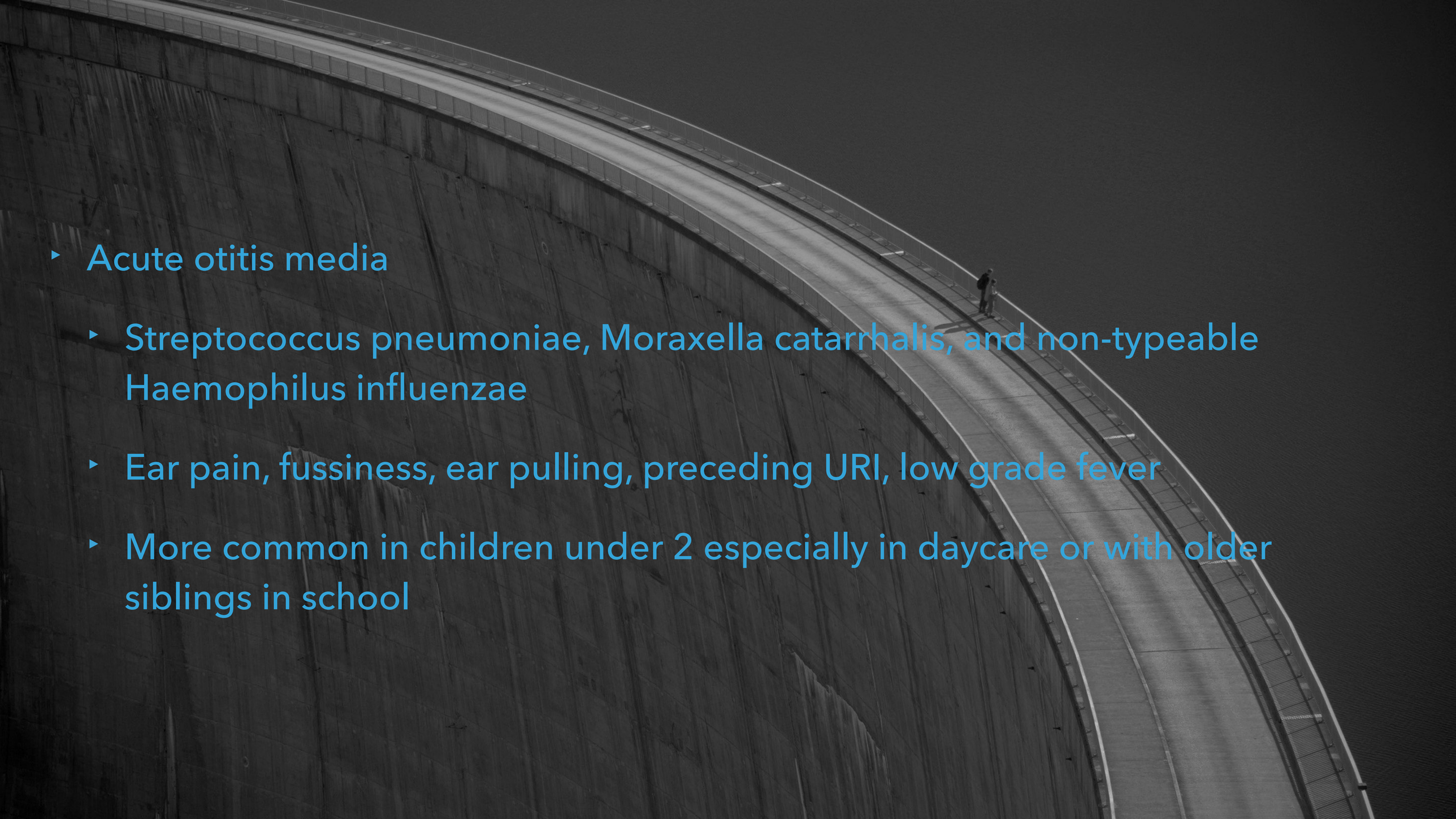


- Streptococcal Pharyngitis
  - Group A streptococcus - Streptococcus pyogenes
  - Signs and Symptoms
    - Fever, sore throat, headache, exudative tonsillitis, palatal petechiae, cervical lymphadenopathy
    - No cough or runny nose
    - Predominantly ages 5-15yo



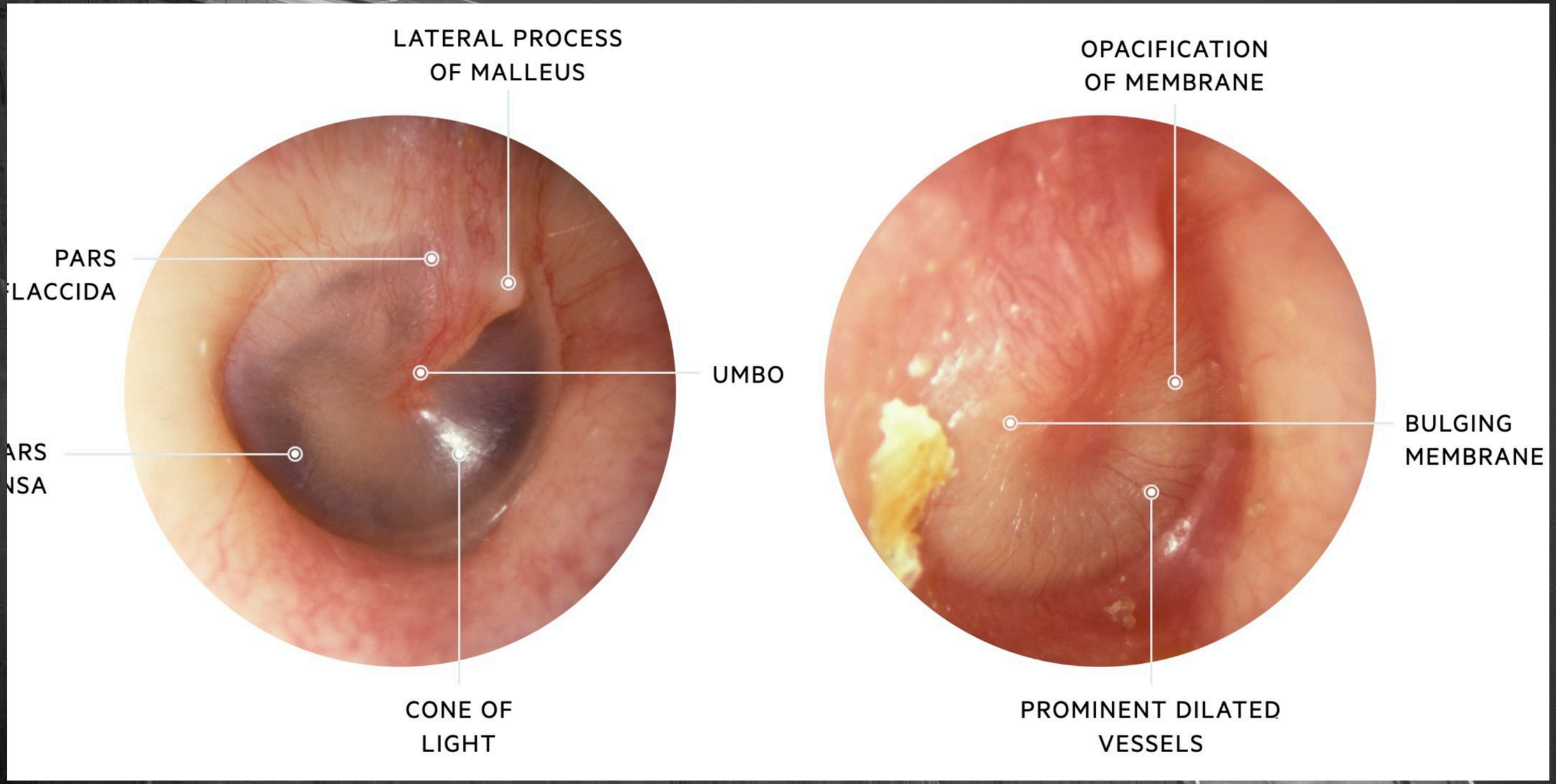


- Complications
  - Rheumatic fever, post-streptococcal glomerulonephritis, scarlet fever, tonsillar abscess
- Treatment Regimens
  - Amoxicillin 50-75mg/kg Daily, BID, TID for 10 days
  - IM Benzathine penicillin X1
  - PCN allergic - erythromycin, azithromycin, clindamycin



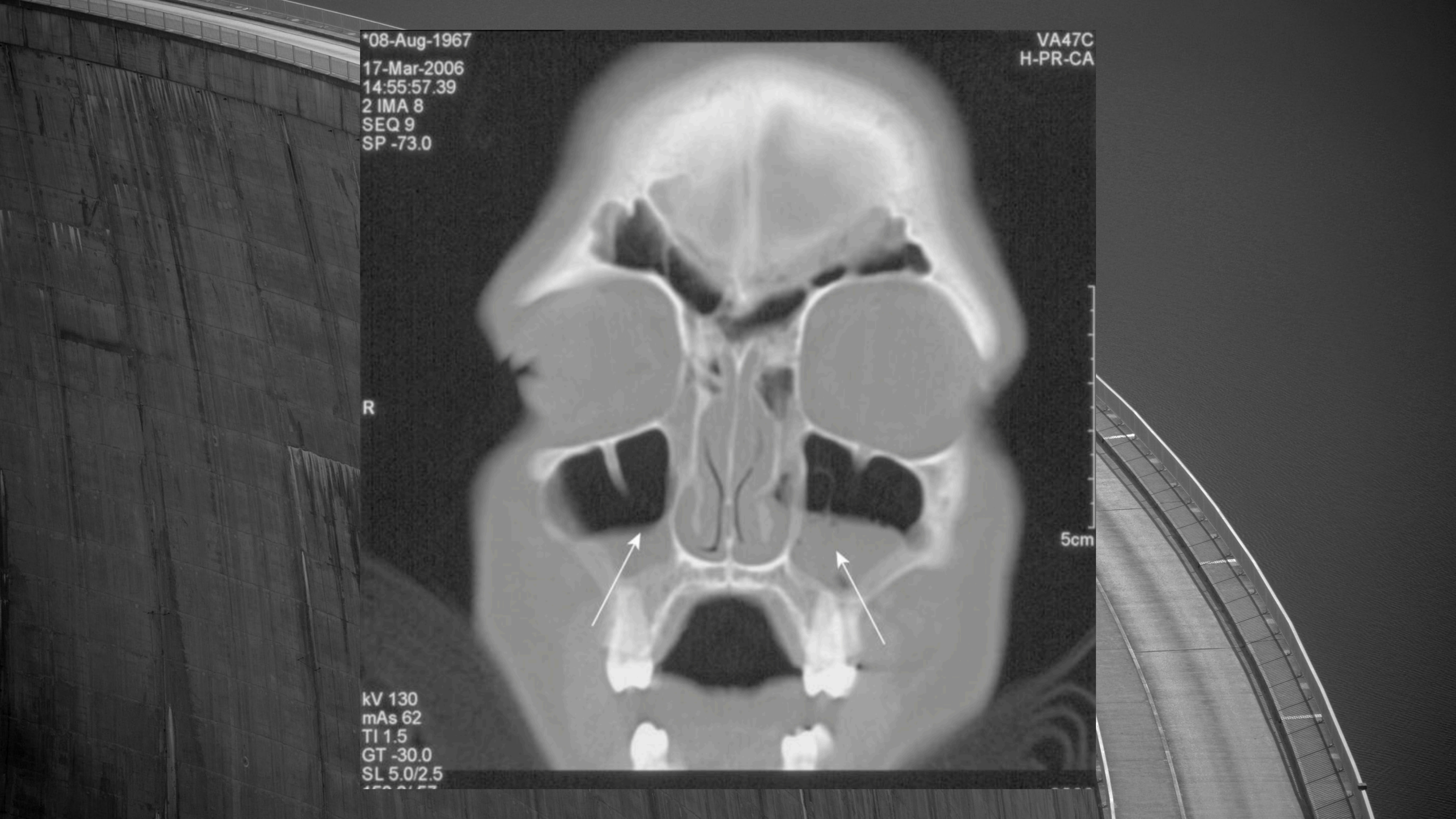
- Acute otitis media
  - Streptococcus pneumoniae, Moraxella catarrhalis, and non-typeable Haemophilus influenzae
  - Ear pain, fussiness, ear pulling, preceding URI, low grade fever
  - More common in children under 2 especially in daycare or with older siblings in school

- Acute otitis media
  - inflammatory process involving the mucosa of the nose, nasopharynx, middle ear mucosa, and Eustachian tubes
  - constricted anatomical space of the middle ear, the edema caused by the inflammatory process obstructs the narrowest part of the Eustachian tube leading to a decrease in ventilation.
  - leads to an increase in negative pressure in the middle ear, increasing exudate from the inflamed mucosa, and buildup of mucosal secretions, which allows for the colonization
  - growth of these microbes in the middle ear then leads to suppuration and, eventually, frank pus

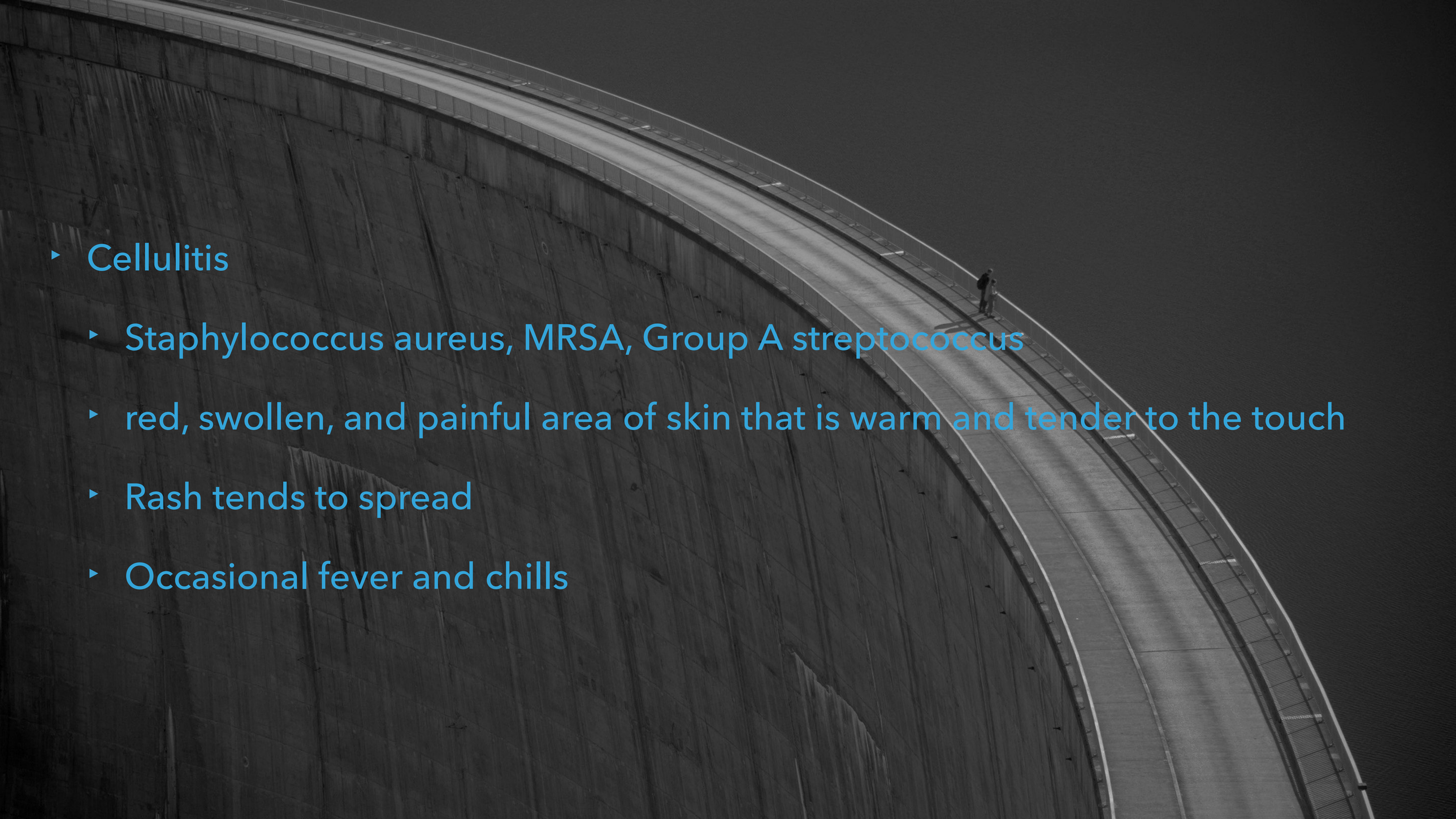

LATERAL PROCESS
OF MALLEUS
PARS
FLACCIDA
UMBO
ARS
NSA
CONE OF
LIGHT
OPACIFICATION
OF MEMBRANE
BULGING
MEMBRANE
PROMINENT DILATED
VESSELS

- Complications - mastoiditis, perforation, cholesteatoma
- Treatment Regimens
  - Amoxicillin high dose
  - Augmentin, Cefdinir
  - Ceftriaxone IM
  - PCN allergy - azithromycin
-

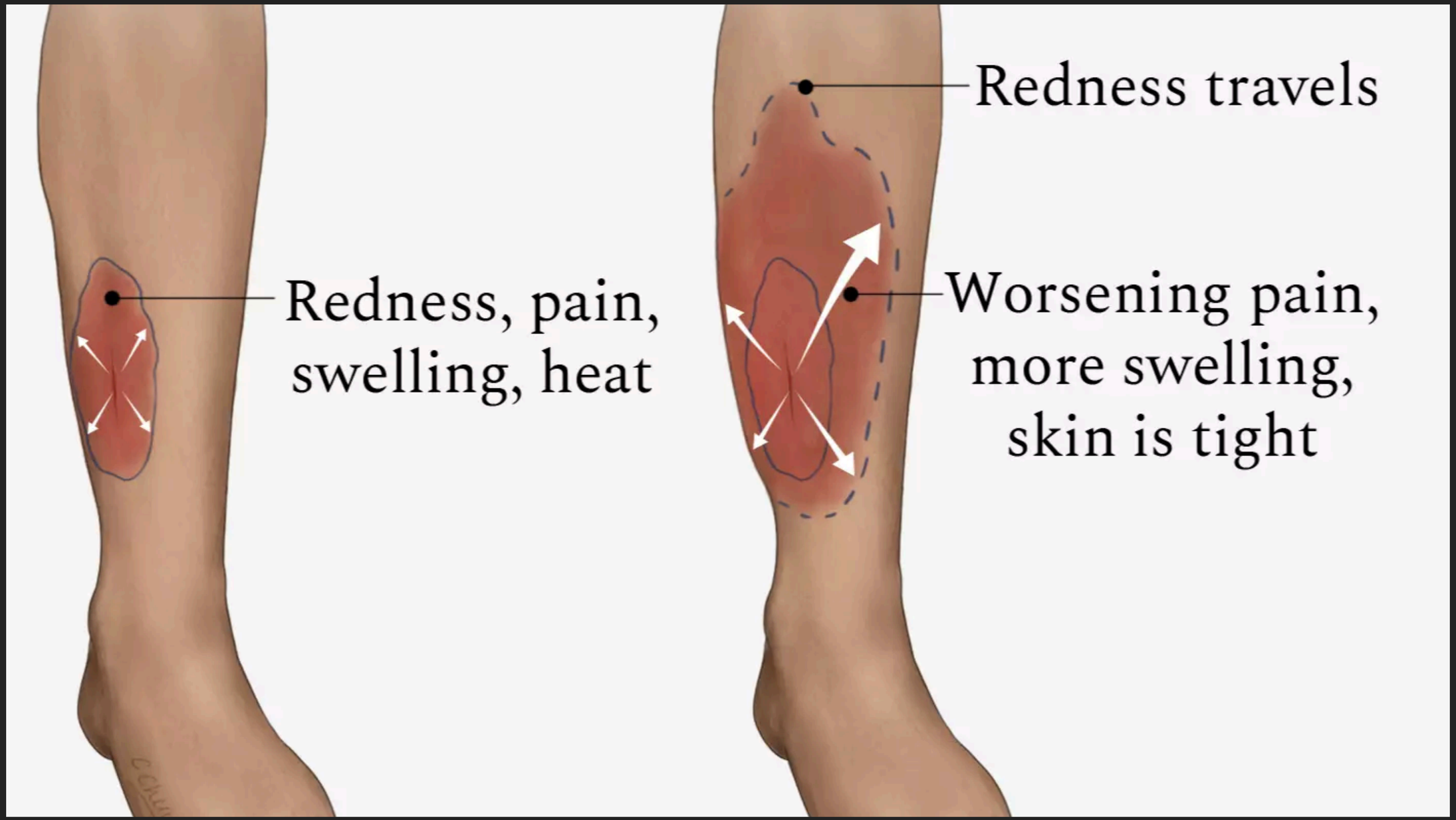
- Acute Sinusitis
  - Streptococcus pneumoniae, Moraxella catarrhalis, and non-typeable Haemophilus influenzae
  - after a viral URI with persistent symptoms for ≥10 days without improvement
  - nasal discharge, daytime cough (worsening at night), an abrupt increase in severity of symptoms of a URI after initial improvement, or symptoms that seem more severe than usual (high fever, copious purulent nasal discharge, periorbital edema, and pain)


*08-Aug-1967
17-Mar-2006
14:55:57.39
2 IMA 8
SEQ 9
SP -73.0
VA47C
H-PR-CA
R
5cm
kV 130
mAs 62
TI 1.5
GT -30.0
SL 5.0/2.5

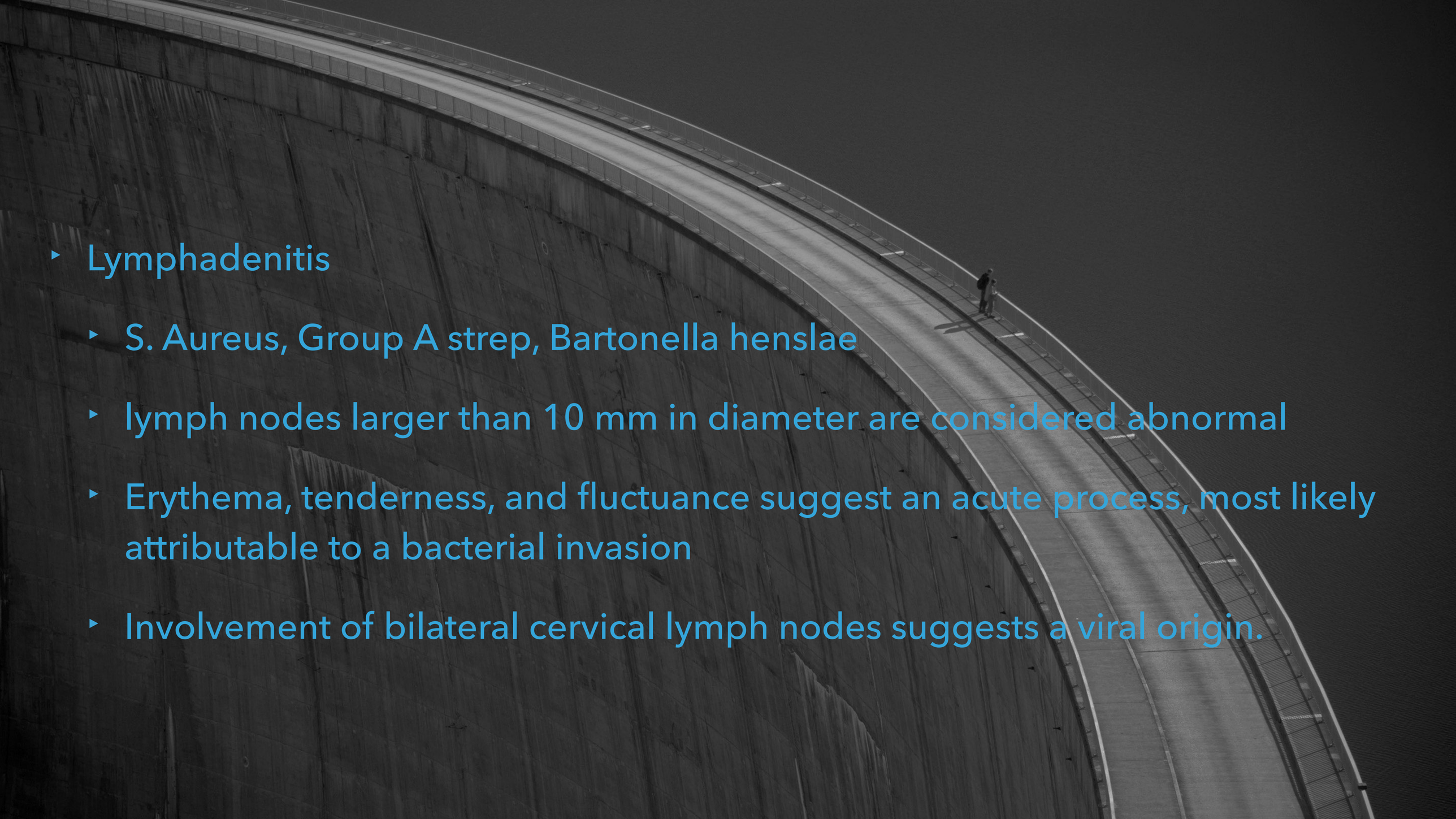
- Complications - subperiostal abscess, orbital cellulitis, cavernous sinus thrombosis, epidural empyema, meningitis
- Treatment
  - Same as AOM but for 14 days
    - First line either amoxil or augmentin
    -



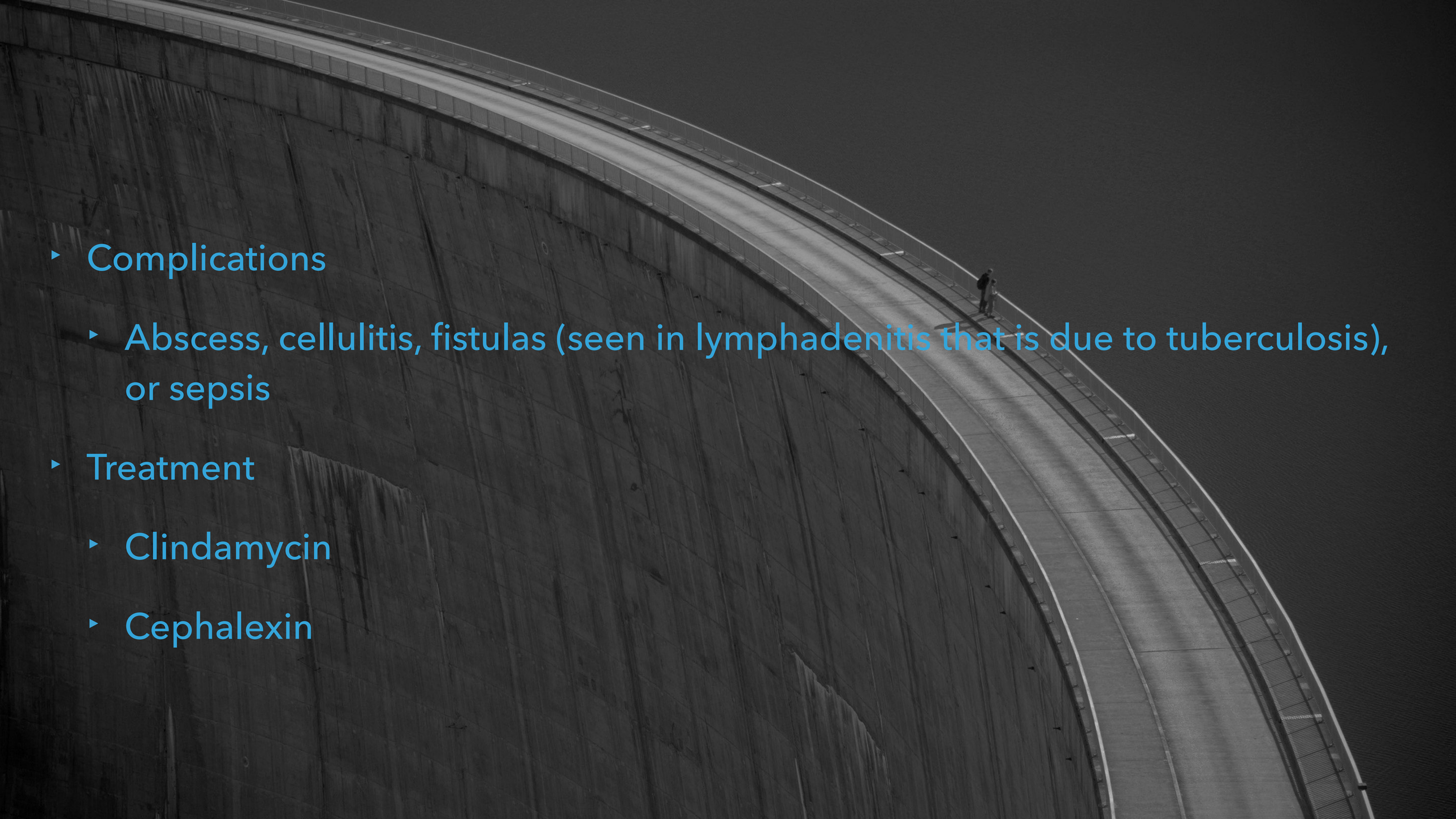
- Cellulitis
  - Staphylococcus aureus, MRSA, Group A streptococcus
  - red, swollen, and painful area of skin that is warm and tender to the touch
  - Rash tends to spread
  - Occasional fever and chills


Redness, pain, swelling, heat
Redness travels
Worsening pain, more swelling, skin is tight

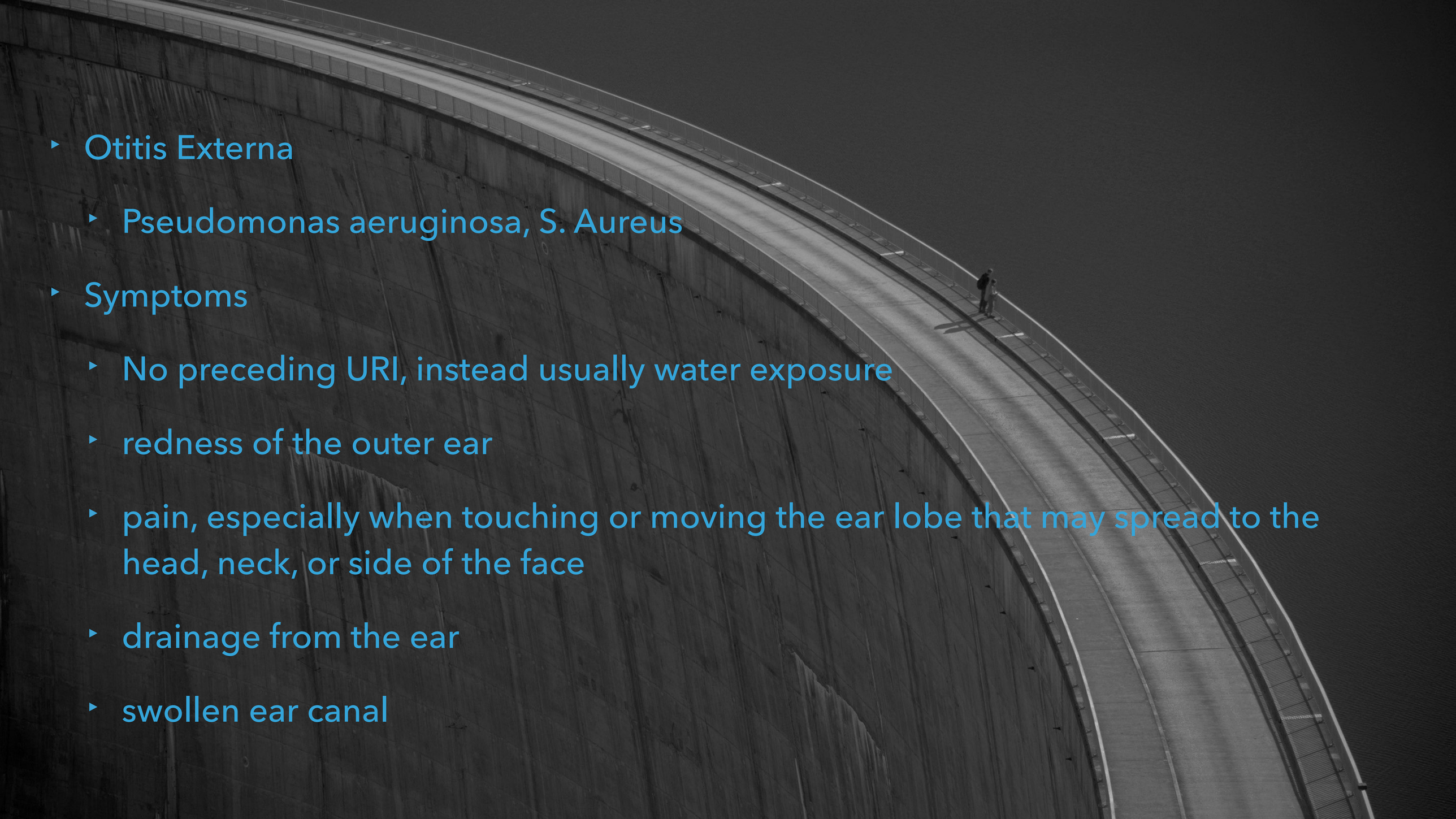
- Complications
  - bacteremia, endocarditis, or osteomyelitis
- Treatment
  - Cephalexin - MSSA, GAS
  - Clindamycin - MRSA



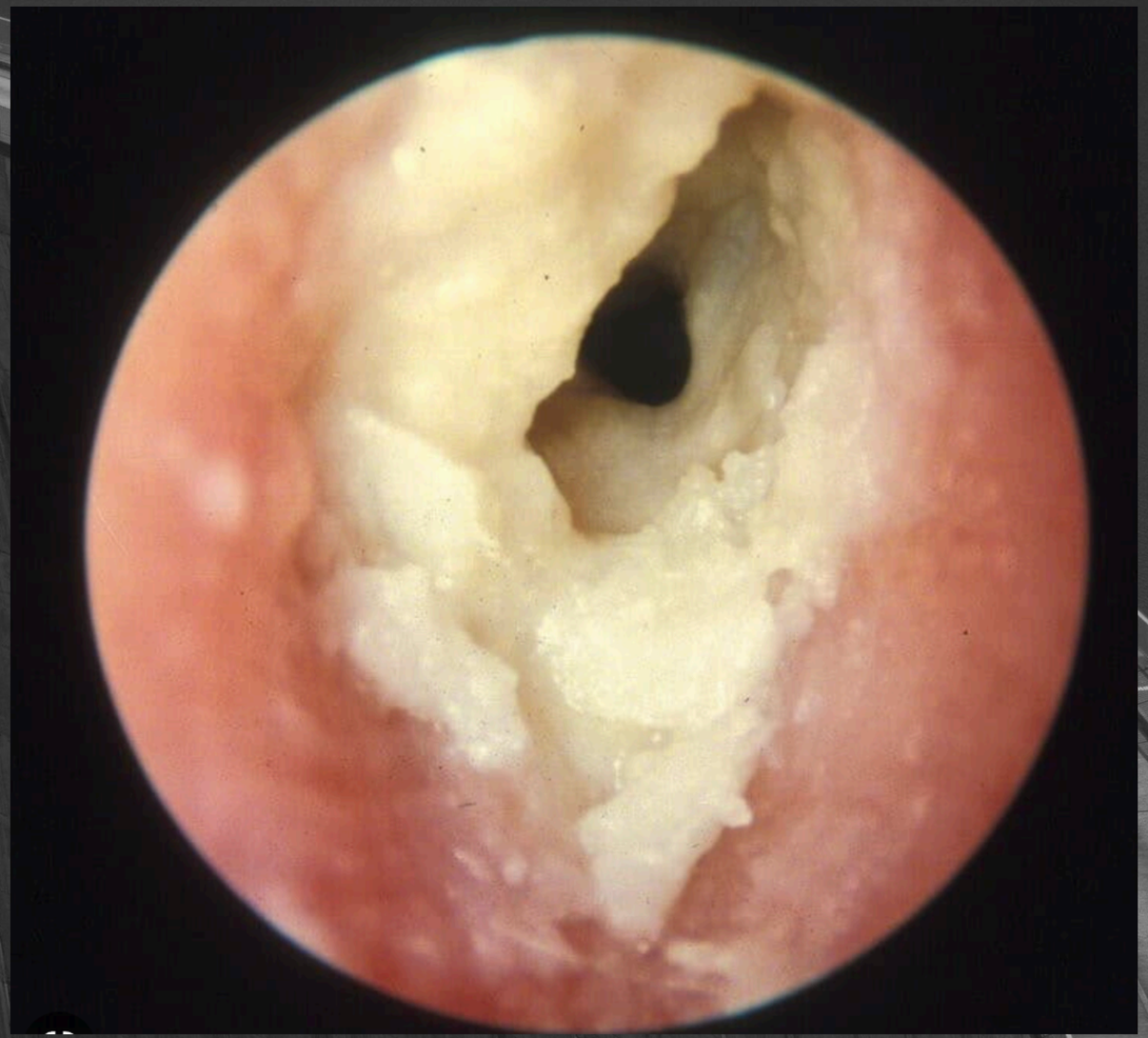
- Lymphadenitis
  - S. Aureus, Group A strep, Bartonella henslae
  - lymph nodes larger than 10 mm in diameter are considered abnormal
  - Erythema, tenderness, and fluctuance suggest an acute process, most likely attributable to a bacterial invasion
  - Involvement of bilateral cervical lymph nodes suggests a viral origin.

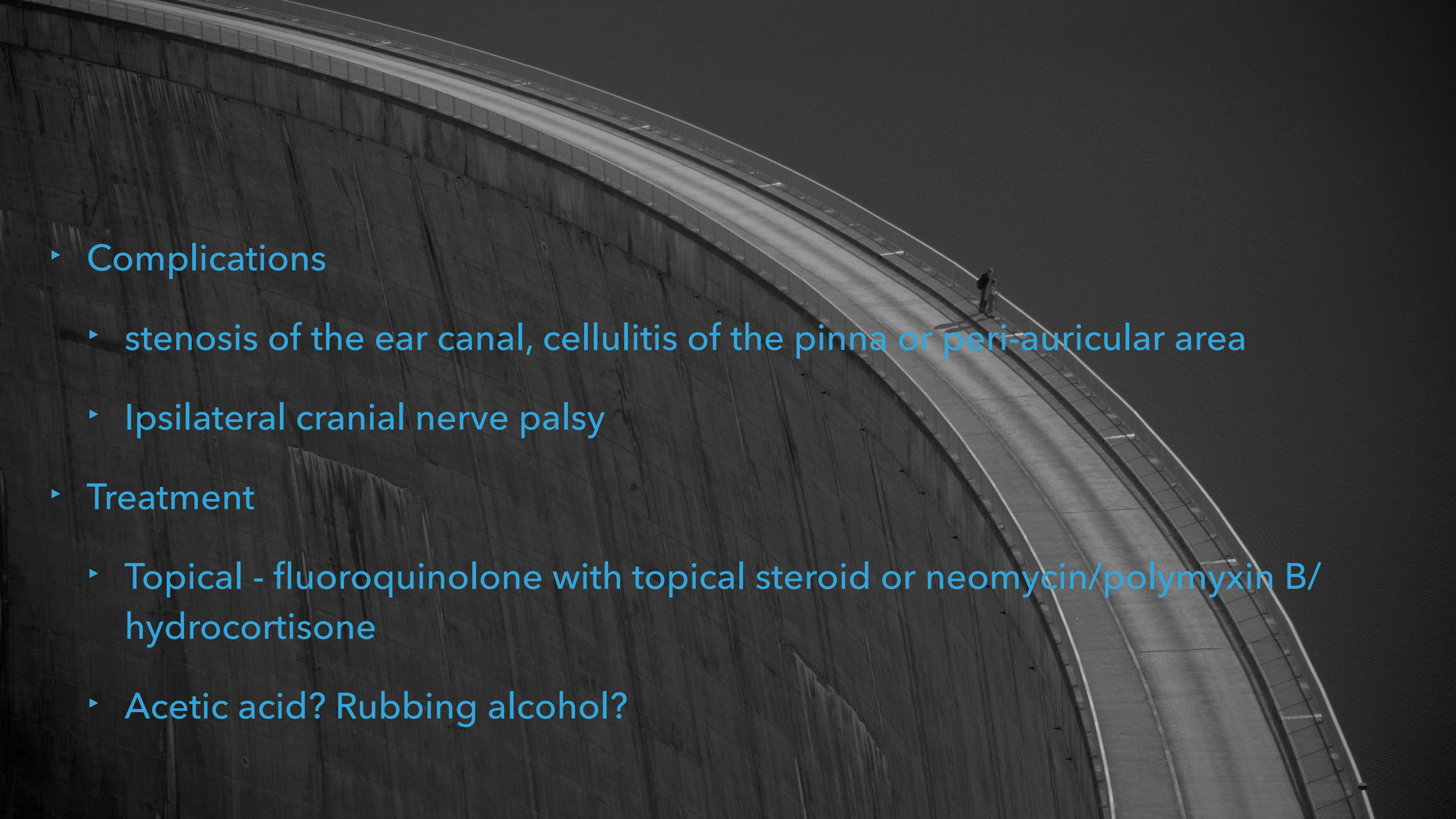


- Complications
  - Abscess, cellulitis, fistulas (seen in lymphadenitis that is due to tuberculosis), or sepsis
- Treatment
  - Clindamycin
  - Cephalexin



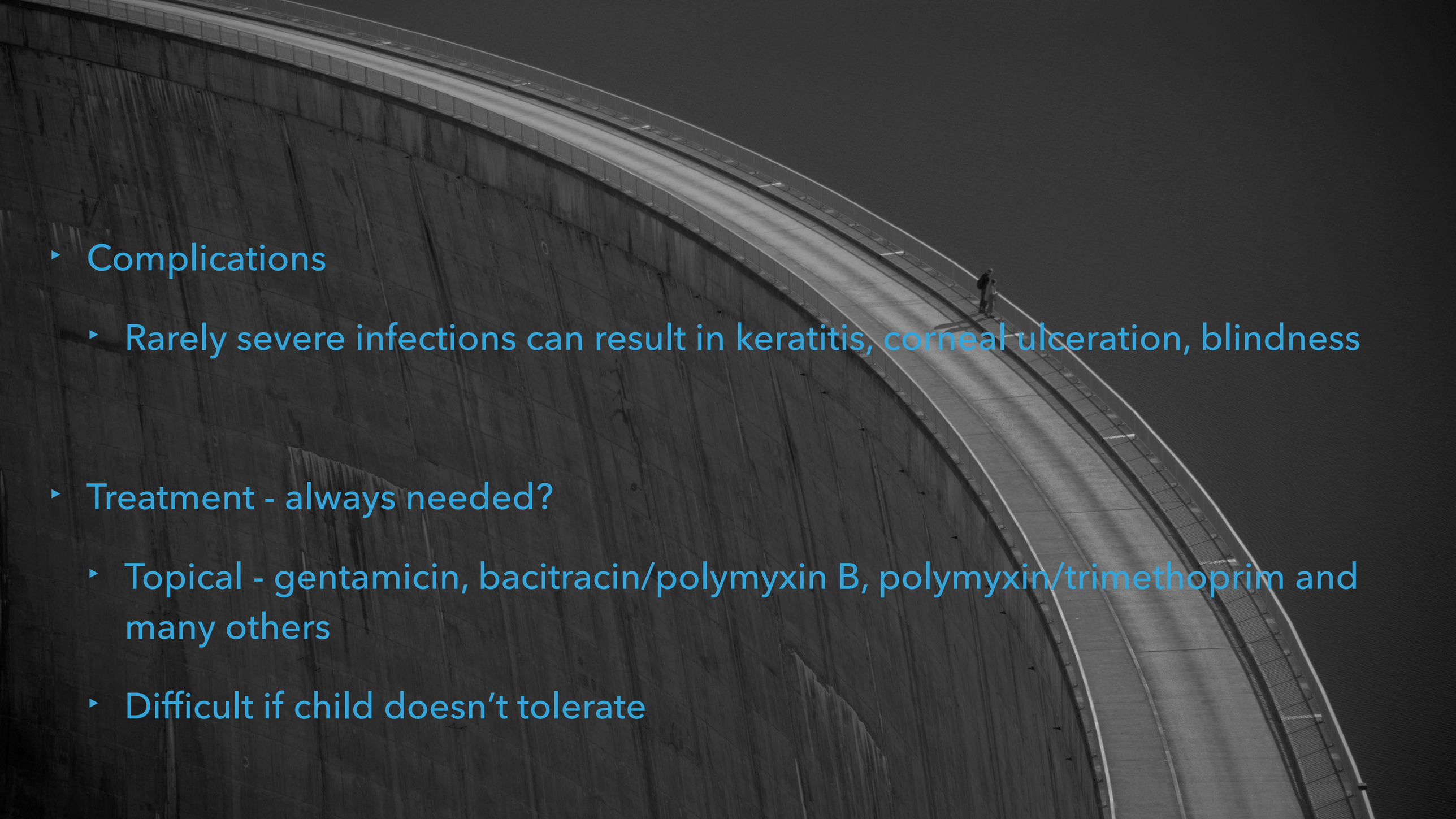
- Otitis Externa
  - Pseudomonas aeruginosa, S. Aureus
- Symptoms
  - No preceding URI, instead usually water exposure
  - redness of the outer ear
  - pain, especially when touching or moving the ear lobe that may spread to the head, neck, or side of the face
  - drainage from the ear
  - swollen ear canal



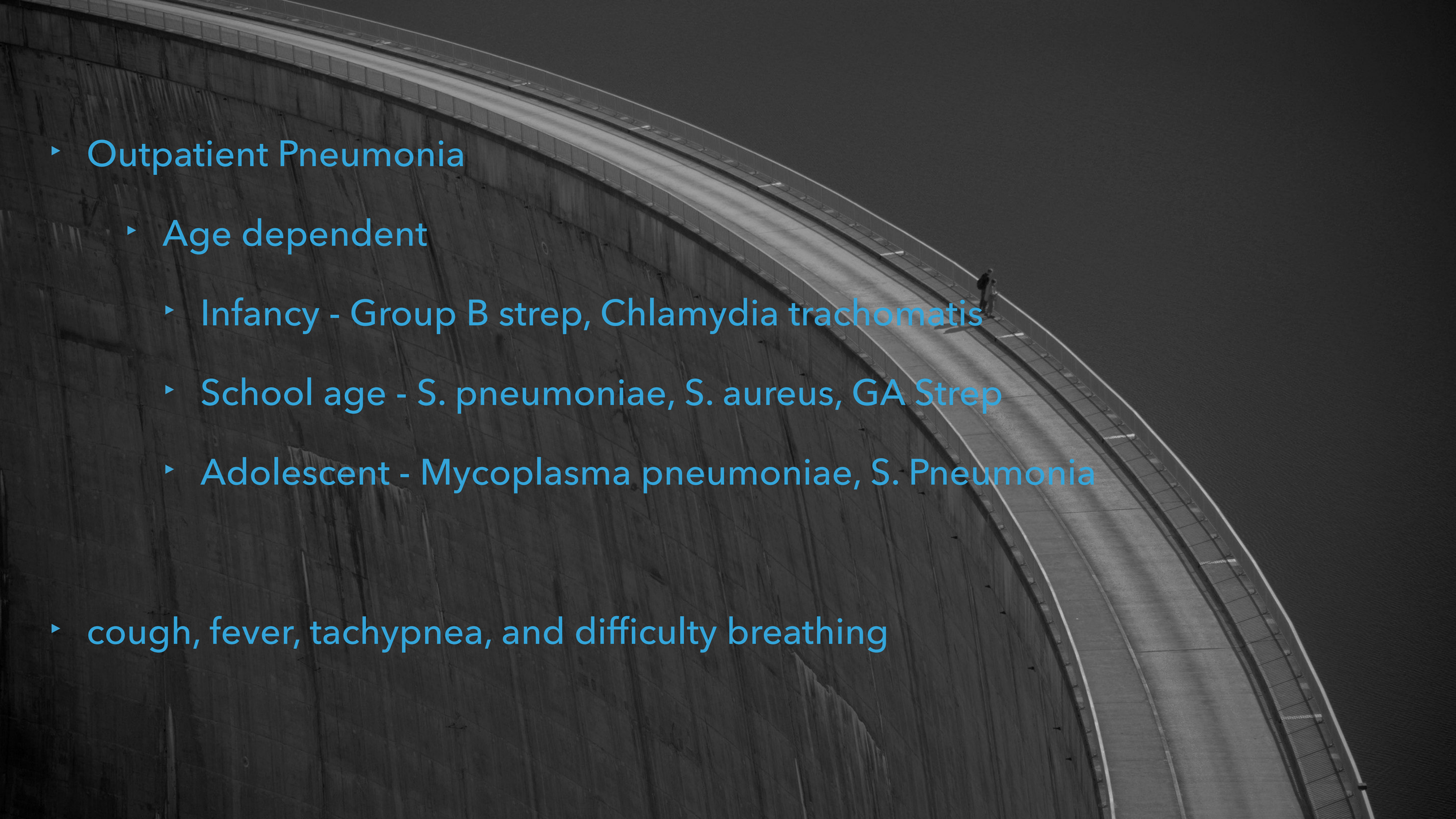


- Complications
  - stenosis of the ear canal, cellulitis of the pinna or peri-auricular area
  - Ipsilateral cranial nerve palsy
- Treatment
  - Topical - fluoroquinolone with topical steroid or neomycin/polymyxin B/ hydrocortisone
  - Acetic acid? Rubbing alcohol?

- Bacterial Conjunctivitis
  - Question if not viral
  - Haemophilus and S. Pneumoniea
- Symptoms
  - redness and eye discomfort
  - discharge
  - crusting of lids

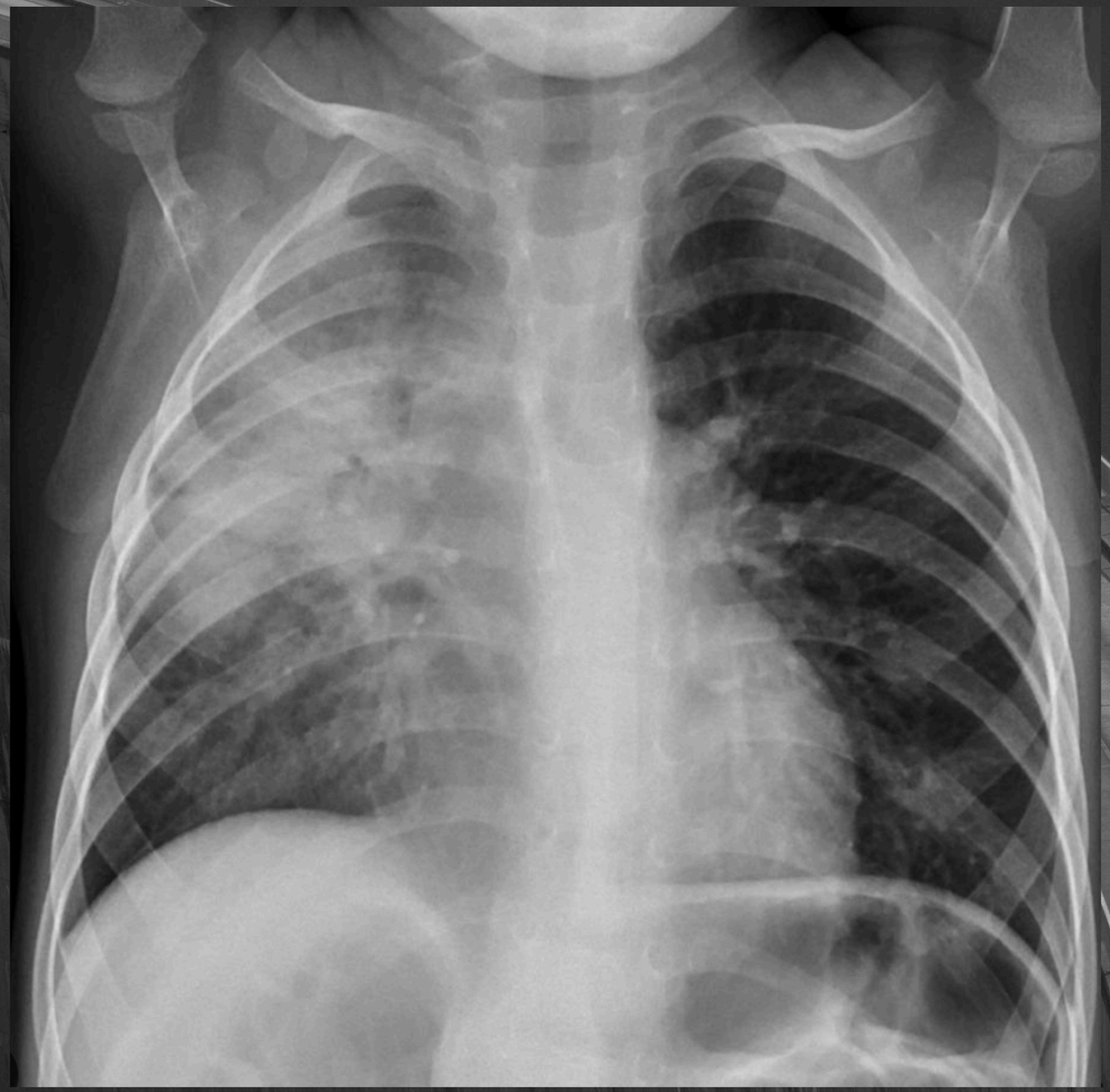


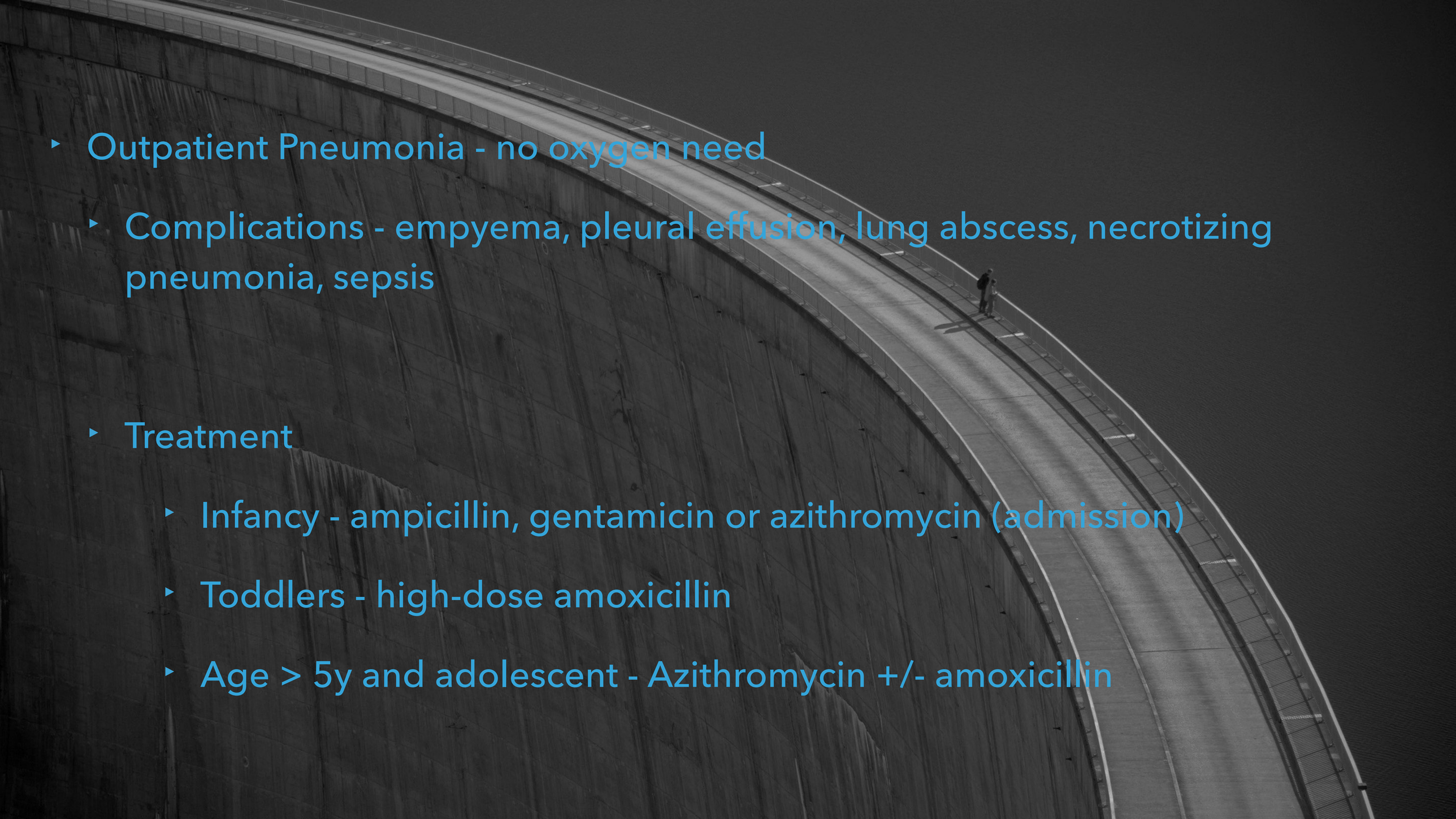
- Complications
  - Rarely severe infections can result in keratitis, corneal ulceration, blindness
- Treatment - always needed?
  - Topical - gentamicin, bacitracin/polymyxin B, polymyxin/trimethoprim and many others
  - Difficult if child doesn’t tolerate



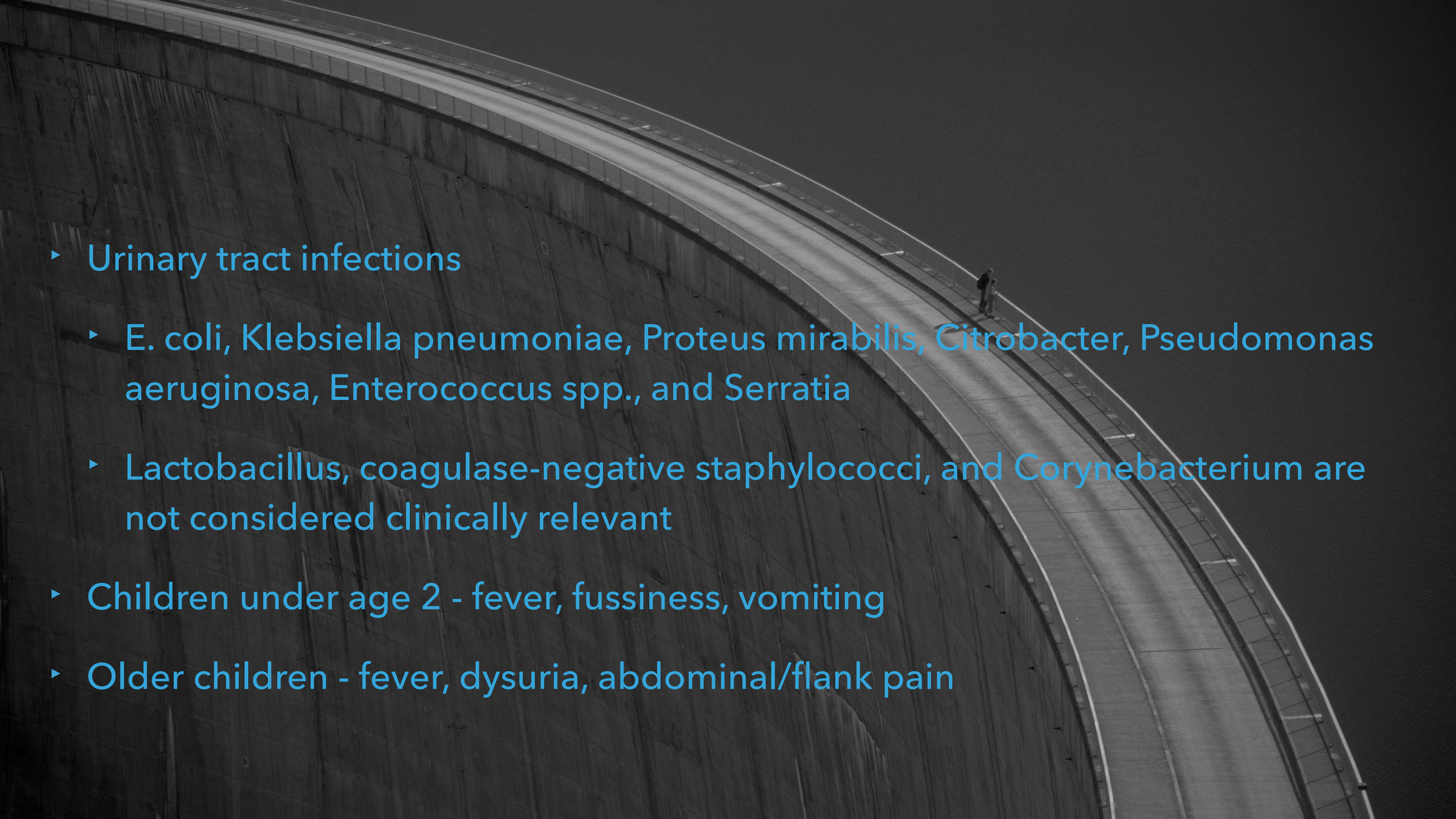
- Outpatient Pneumonia
  - Age dependent
    - Infancy - Group B strep, Chlamydia trachomatis
    - School age - S. pneumoniae, S. aureus, GA Strep
    - Adolescent - Mycoplasma pneumoniae, S. Pneumonia

- cough, fever, tachypnea, and difficulty breathing

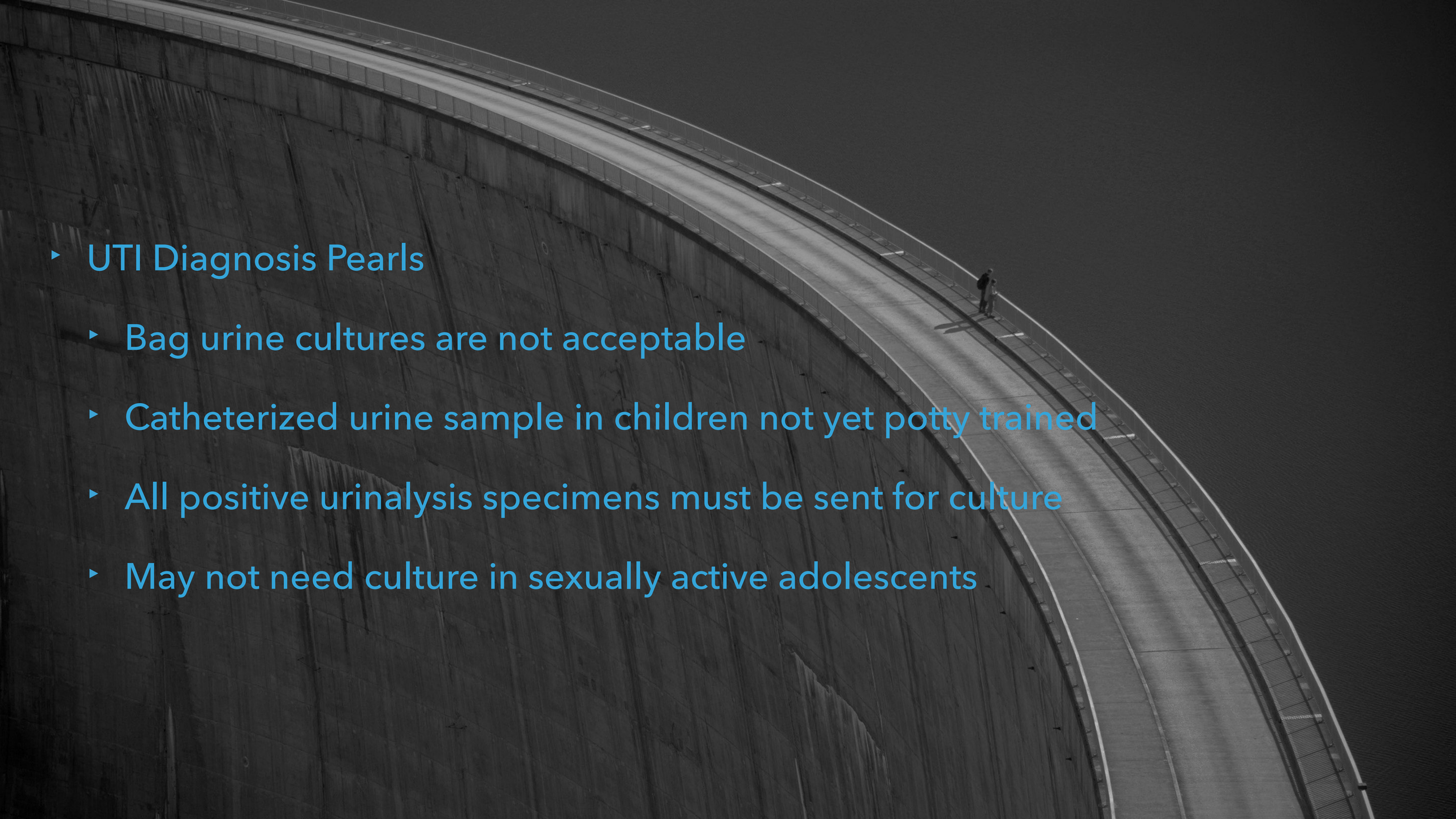




- Outpatient Pneumonia - no oxygen need
  - Complications - empyema, pleural effusion, lung abscess, necrotizing pneumonia, sepsis
  - Treatment
    - Infancy - ampicillin, gentamicin or azithromycin (admission)
    - Toddlers - high-dose amoxicillin
    - Age > 5y and adolescent - Azithromycin +/- amoxicillin

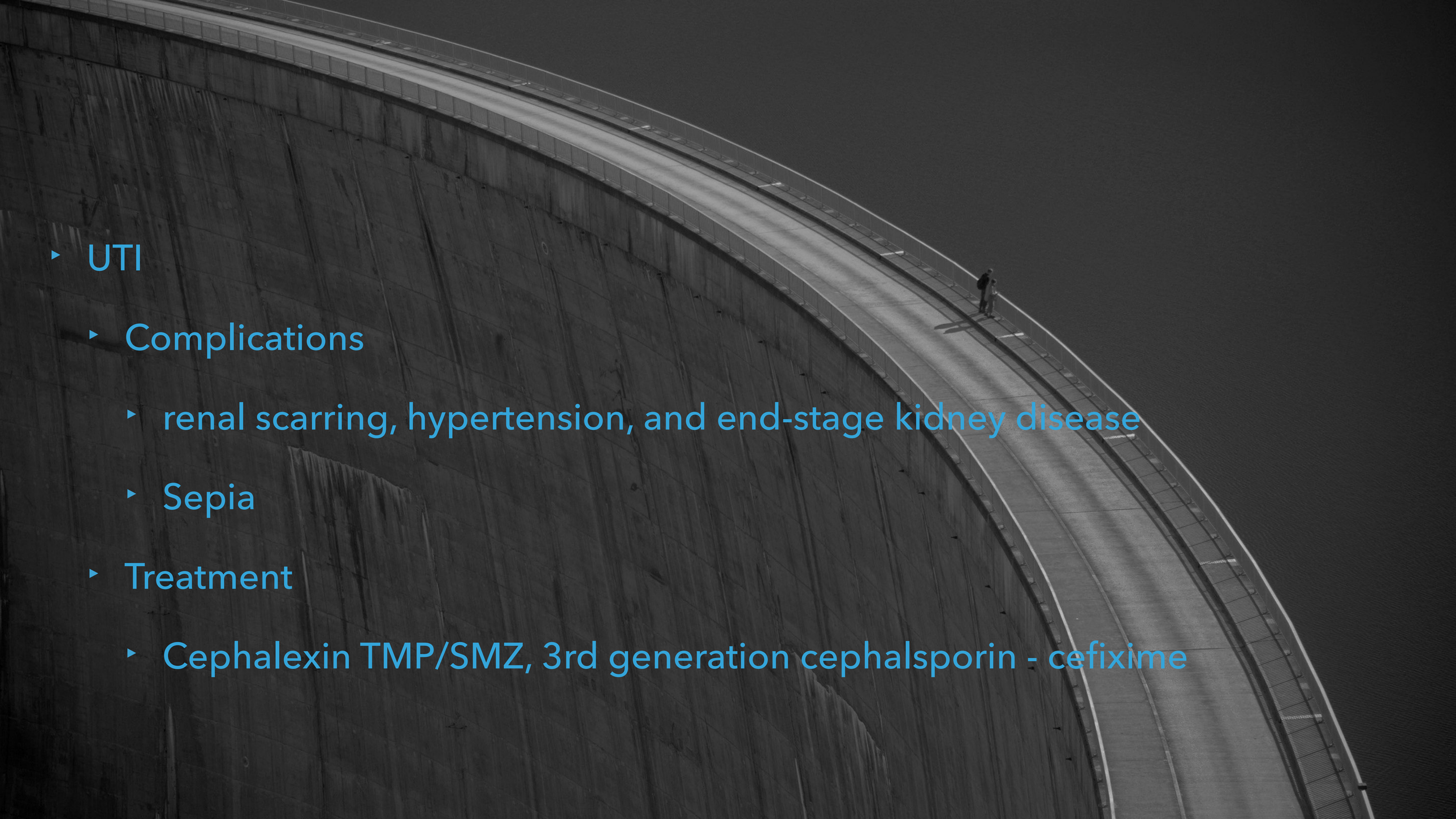


- Urinary tract infections
  - E. coli, Klebsiella pneumoniae, Proteus mirabilis, Citrobacter, Pseudomonas aeruginosa, Enterococcus spp., and Serratia
  - Lactobacillus, coagulase-negative staphylococci, and Corynebacterium are not considered clinically relevant
- Children under age 2 - fever, fussiness, vomiting
- Older children - fever, dysuria, abdominal/flank pain

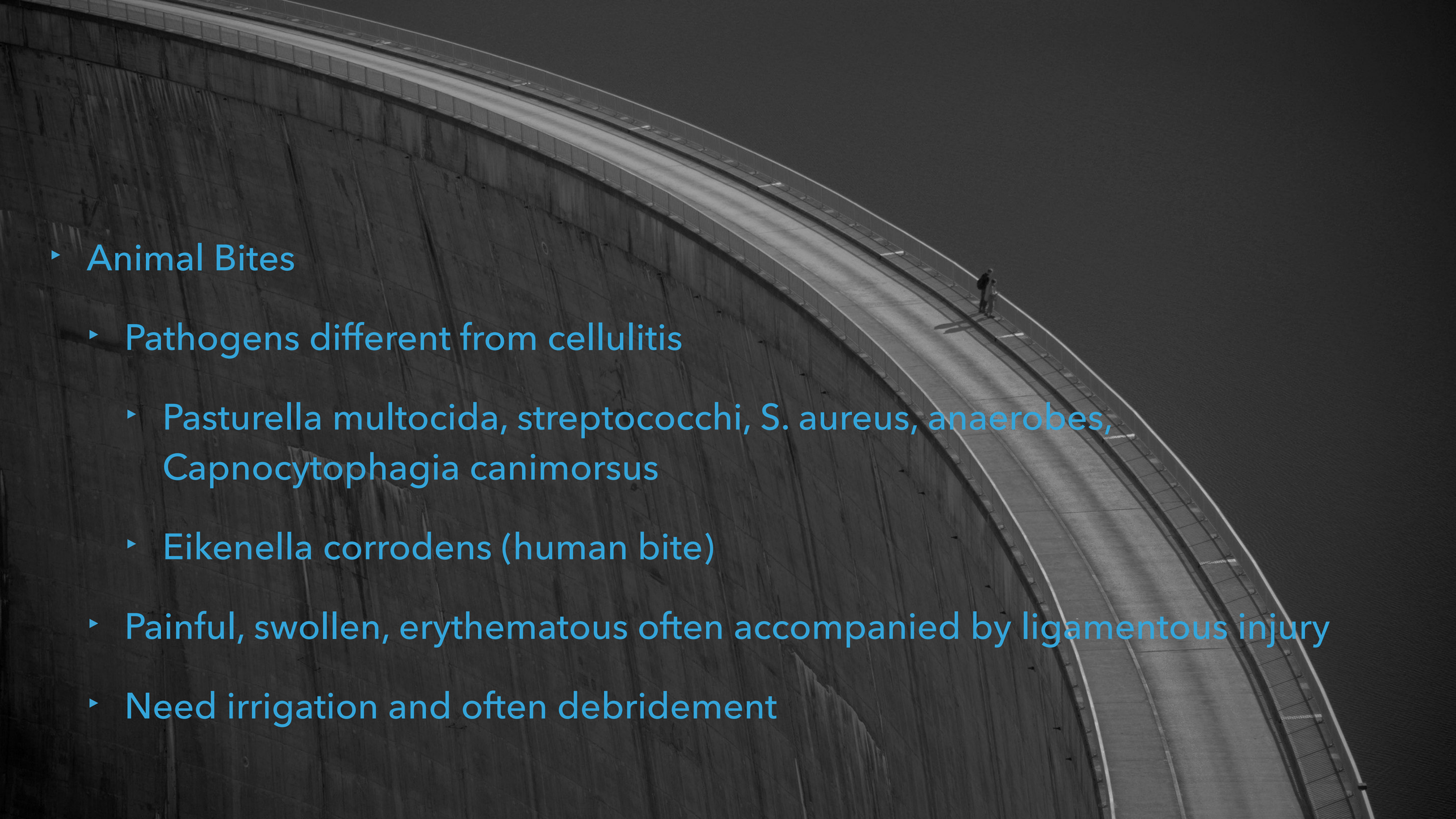


- UTI Diagnosis Pearls
  - Bag urine cultures are not acceptable
  - Catheterized urine sample in children not yet potty trained
  - All positive urinalysis specimens must be sent for culture
  - May not need culture in sexually active adolescents

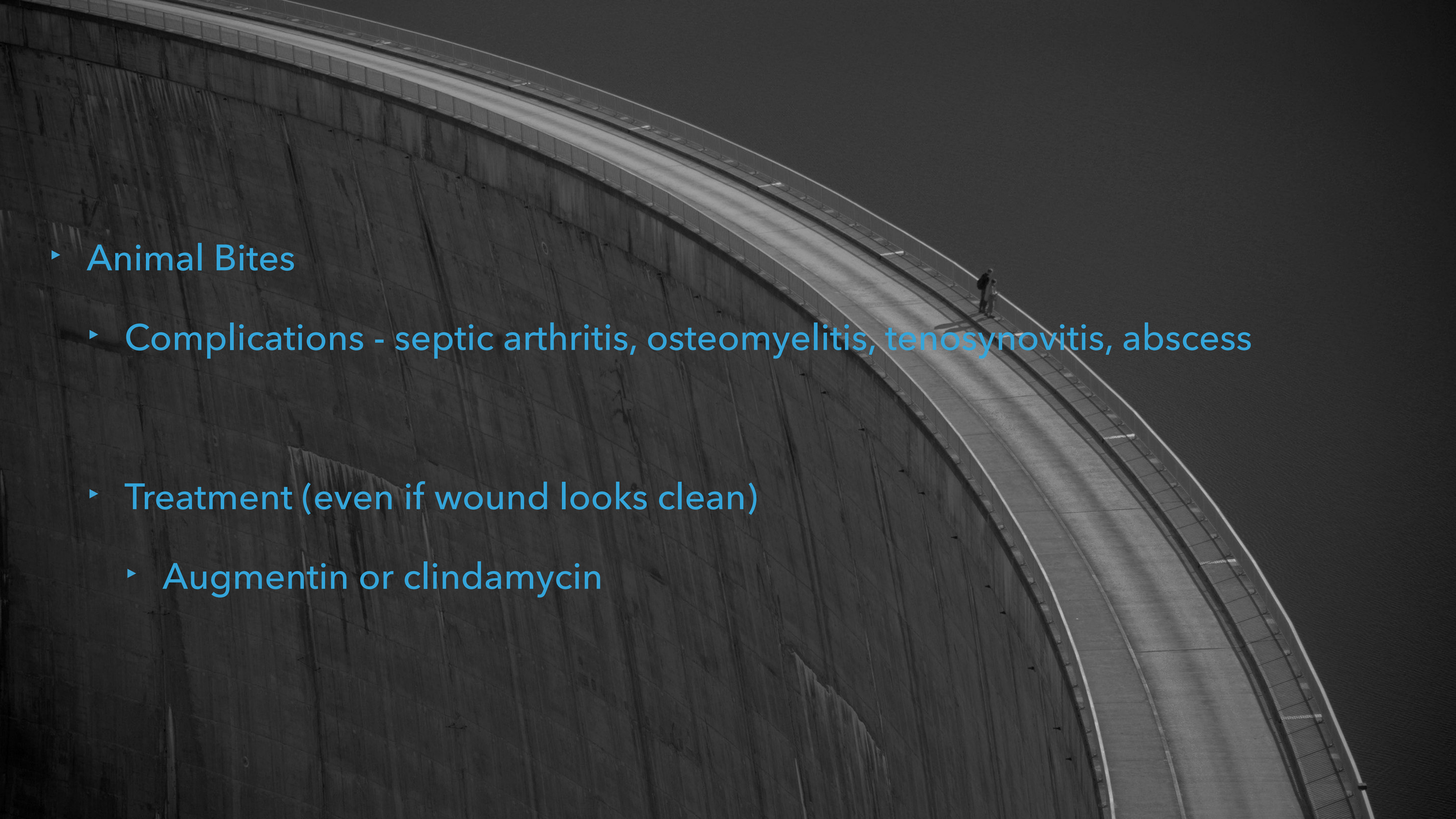
- UTI
  - Childhood risk factors
    - Uncircumcised
    - Poor hygiene
    - Urinary tract abnormalities



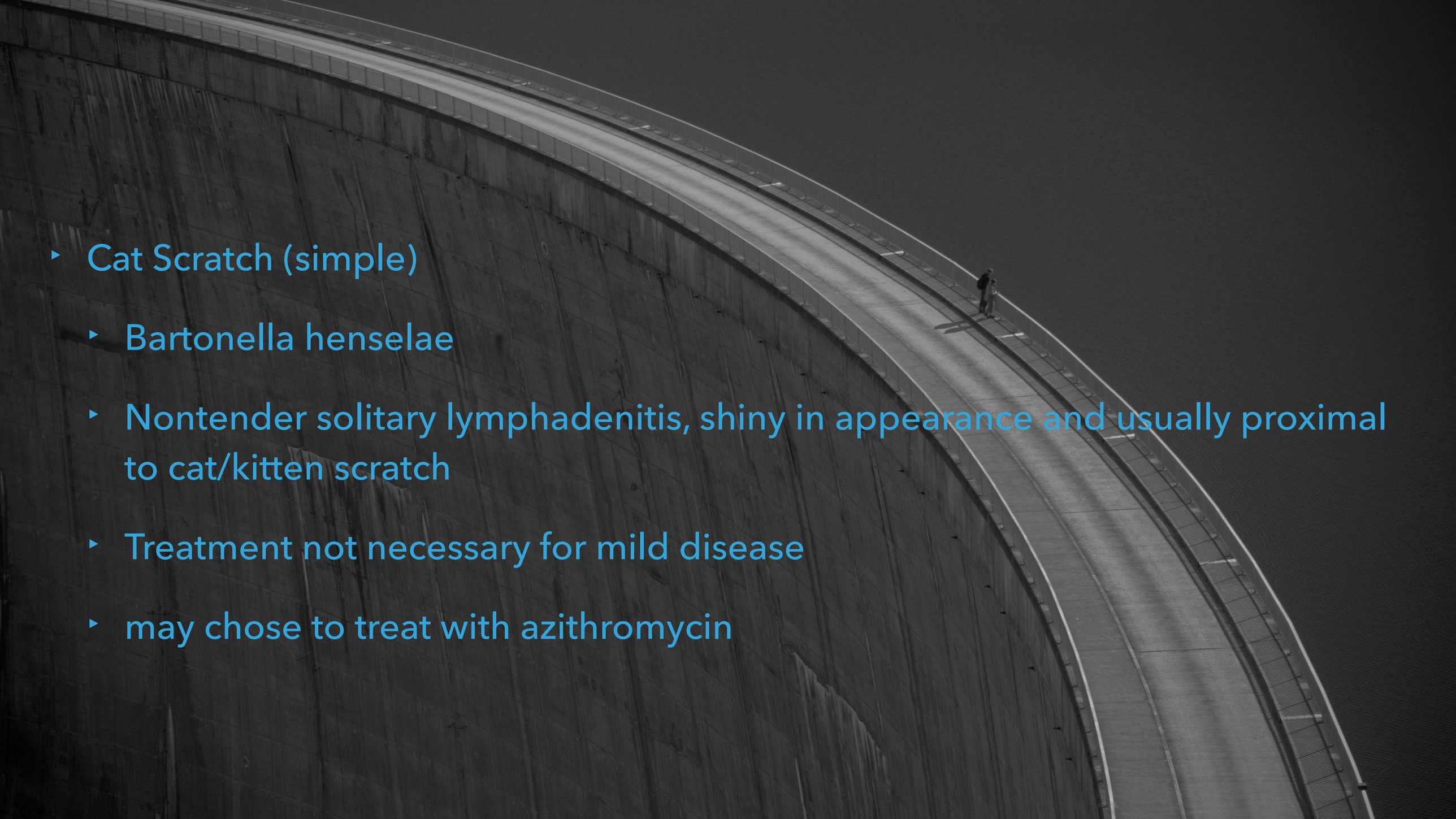
- UTI
  - Complications
    - renal scarring, hypertension, and end-stage kidney disease
    - Sepia
  - Treatment
    - Cephalexin TMP/SMZ, 3rd generation cephalsporin - cefixime



- Animal Bites
  - Pathogens different from cellulitis
    - Pasturella multocida, streptococchi, S. aureus, anaerobes, Capnocytophagia canimorsus
    - Eikenella corrodens (human bite)
  - Painful, swollen, erythematous often accompanied by ligamentous injury
  - Need irrigation and often debridement

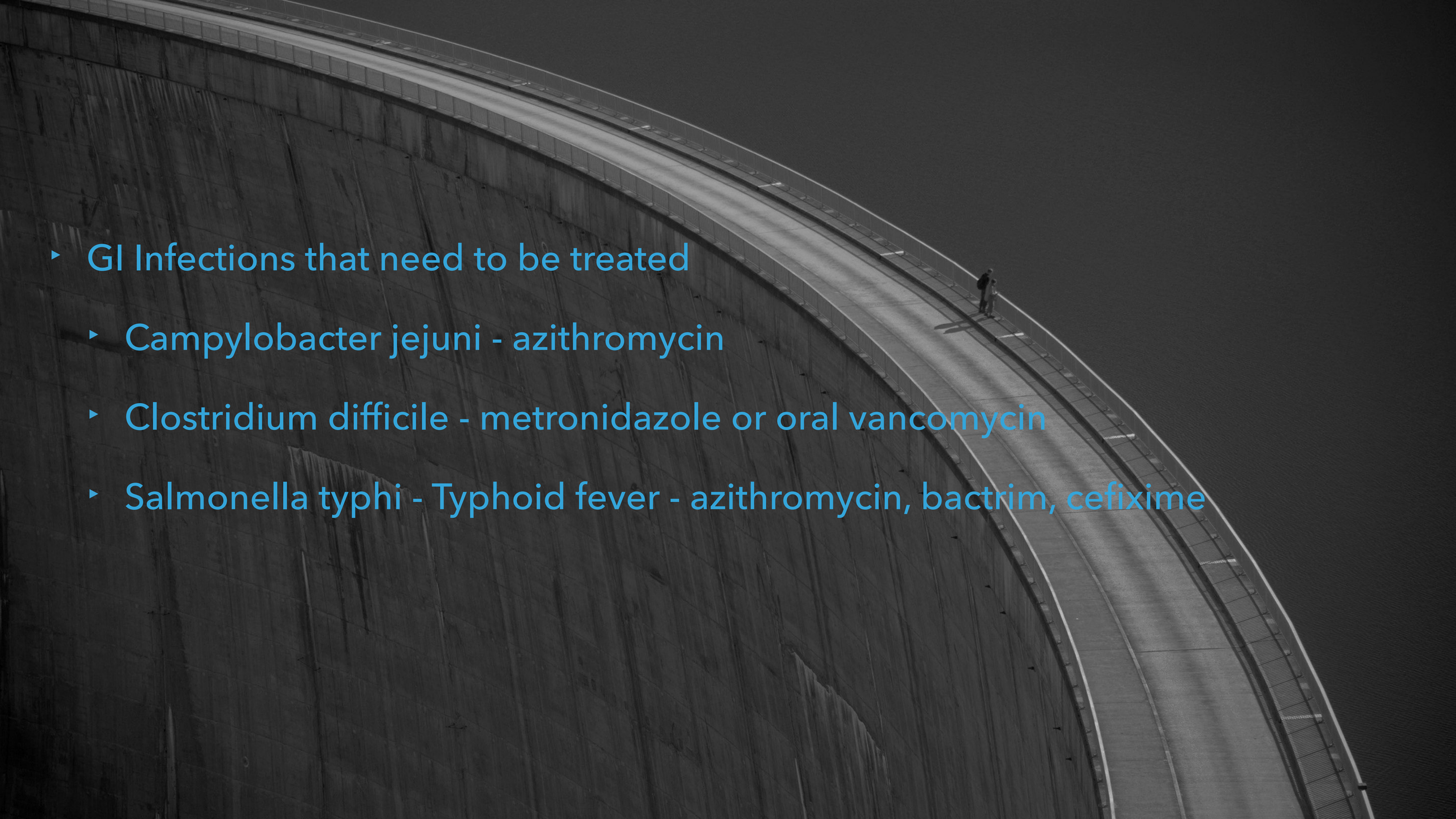


- Animal Bites
  - Complications - septic arthritis, osteomyelitis, tenosynovitis, abscess
  - Treatment (even if wound looks clean)
    - Augmentin or clindamycin

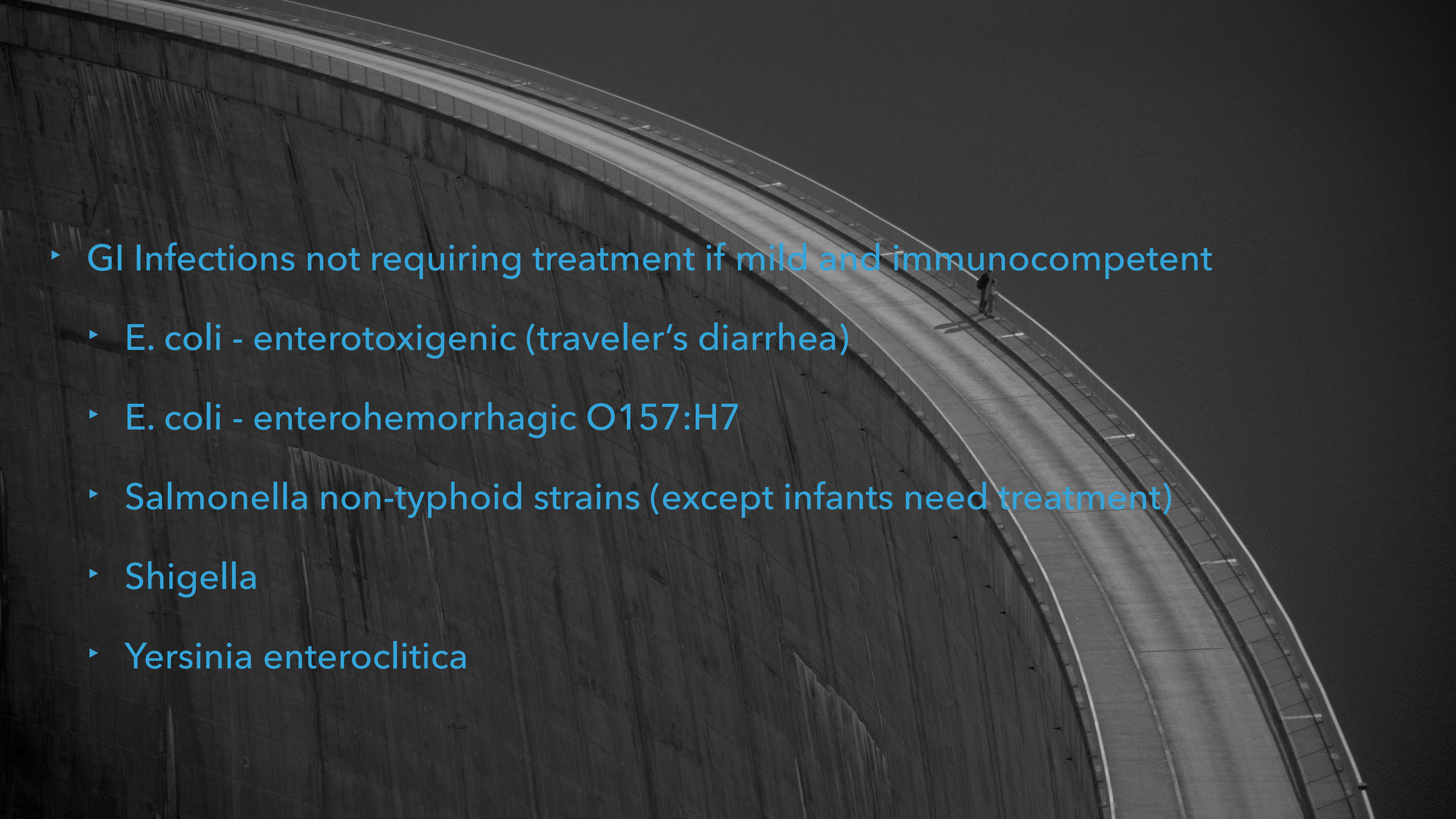


- Cat Scratch (simple)
  - Bartonella henselae
  - Nontender solitary lymphadenitis, shiny in appearance and usually proximal to cat/kitten scratch
  - Treatment not necessary for mild disease
  - may chose to treat with azithromycin

- Bacterial GI Infections
  - Typically epidemic from daycare or household contacts
    - Decision point
    - viral or not
    - bloody or not



- GI Infections that need to be treated
  - Campylobacter jejuni - azithromycin
  - Clostridium difficile - metronidazole or oral vancomycin
  - Salmonella typhi - Typhoid fever - azithromycin, bactrim, cefixime



- GI Infections not requiring treatment if mild and immunocompetent
  - E. coli - enterotoxigenic (traveler’s diarrhea)
  - E. coli - enterohemorrhagic O157:H7
  - Salmonella non-typhoid strains (except infants need treatment)
  - Shigella
  - Yersinia enteroclitica

- Summary
  - Understanding differences in viral vs. bacterial
  - Treatment options
  - Follow-up

- Questions?

PART 2

ANTIBIOTIC TREATMENT OF INPATIENT PEDIATRIC INFECTIONS

IV ANTIBIOTIC FACTORS

Frequency of administration

Length of treatment

Intravenous vs. Intramuscular

Penetration

Conversion to oral therapy

FEVER WITHOUT A SOURCE

Frequent admission for children up to 36 months of age

NOT Fever of unknown etiology (FUO)

FEVER WITHOUT A SOURCE

Occult bacteremia, urinary tract infection, meningitis, or certain viral infections

FEVER WITHOUT A SOURCE

Age Dependent Pathogens
0 to 3 months – GBS, E. coli, Salmonella, Listeria

3 –36 months – S. pneumo, N. meningitides, E. coli, HiB

FWS EVALUATION

CBC, blood culture, urinalysis, urine culture, CRP, ESR

LP with CSF studies if under 3 months or if high suspicion for meningitis
Some flexibility with LP after 6 weeks of age if well appearing

FWS EMPIRIC TREATMENT

Infants – Ampicillin/Gentamicin +/- acyclovir

1–3 months – amp/cefotaxime

3–36 months – ceftriaxone +/- vancomycin

PNEUMONIA

Similar to outpatient but admission needed for infants, immunocompromised, or children with need for supplemental oxygen

Medically complex children may have aspiration pneumonia

PNEUMONIA

Empiric - Ceftriaxone and Vancomycin +/- Azithromycin

Aspiration - Clindamycin + ceftriaxone or meropenem

OSTEOMYELITIS

Pain, swelling, fever, limping, refusal to bear weight
S. aureus, pseudomonas aeruginosum, salmonella (SS)

OSTEOMYELITIS DIAGNOSIS

Imaging – bone scan but MRI best

Blood cultures

Increased WBC, CRP and ESR

If surgery performed then operative culture is useful

OSTEOMYELITIS

MSSA – nafcillin, cefazolin

MRSA – clindamycin or vancomycin

Can transition to oral abx when CRP normalizes

Treatment is 6 weeks

SEPTIC ARTHRITIS

Swollen, warm, erythematous joint,

refusal to bear weight

Dx – MRI

Joint aspiration

SEPTIC ARTHRITIS

Infants and children – Staph, GAS, HiB, Kingella – Ceftaroline, clindamycin, cefazolin

Adolescents – Gonococcal – Ceftriaxone for 7 days with azithromycin

FEBRILE NEUTROPENIA

Considered an emergency requiring early empiric therapy

Etiology often viral but need to cover bacterial as patients are severely immunocompromised

CVL infections common

FEBRILE NEUTROPENIA

Empiric Therapy – broad spectrum
Cefipime and Vancomycin
If concerned about Pseudomonas would use Imipenem
Treat until source found and the narrow or until afebrile and culture negative

BACTERIAL MENINGITIS

Age Dependent Pathogens

Group B Streptococcus – infants < 2 months of age

Streptococcus pneumoniae is then most common

11 – 17 years old – Neisseria meningitidis

MENINGITIS

CSF studies – presence of WBC, low glucose, high protein, Gram stain

Imaging often diagnostic – MRI

MENINGITIS

Empiric therapy

Infants – Ampicillin and cefotaxime

All others – ceftriaxone

ENDOCARDITIS

Due to bacteremia and turbulent vascular flow

Risks in congenital heart disease patients, dental procedures

Fever, malaise, and new murmur

ENDOCARDITIS

Blood culture and echocardiogram are diagnostic

Often S. Aureus, Coag – staph, viridens strep

Empiric treatment – ceftriaxone and gentamicin +/– vancomycin

STAPH SCALDED SKIN

Staph aureus

Toxin mediated

STAPH SCALDED SKIN

Cefazolin, Nafcillin or Oxacillin for MSSA

Vancomycin should be administered if MRSA is suspected

Also wound care and sufficient intravenous fluids

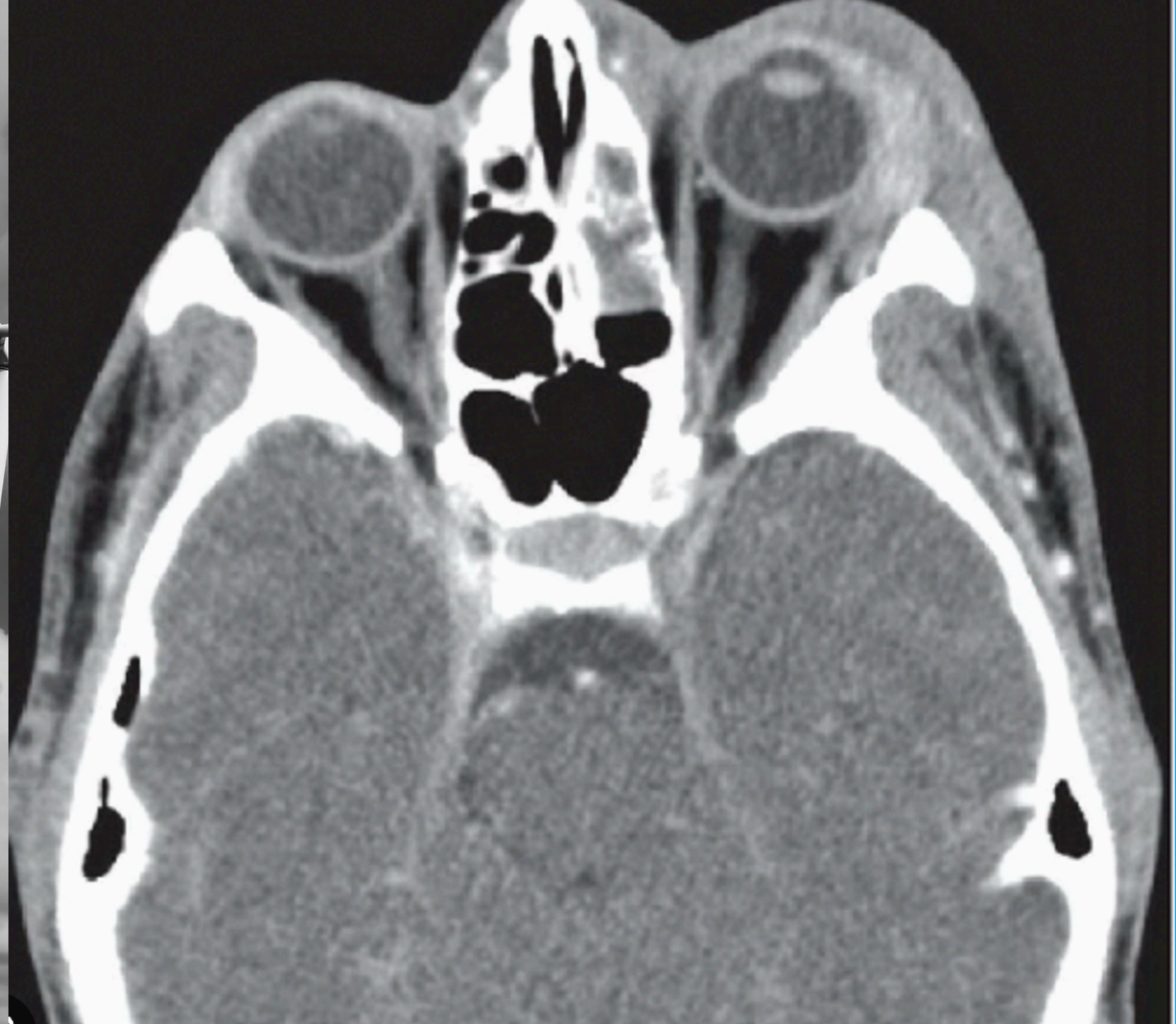
No corticosteroids

ORBITAL CELLULITIS

Redness and severe perioribtal swelling

Reduced extra ocular movements

Fever, headache, painful, not itchy



ORBITAL CELLULITIS

S. Aureus, respiratory flora

Empiric therapy – ceftiraxone, and clindamycin

Surgical required if subperiostial abscess present on imaging

SUMMARY

Understanding empiric therapy

Use culture data to narrow spectrum

Determine length of therapy and whether or not conversion to orals is possible

QUESTIONS?

PART 3

TICK BORNE ILLNESS IN CHILDREN

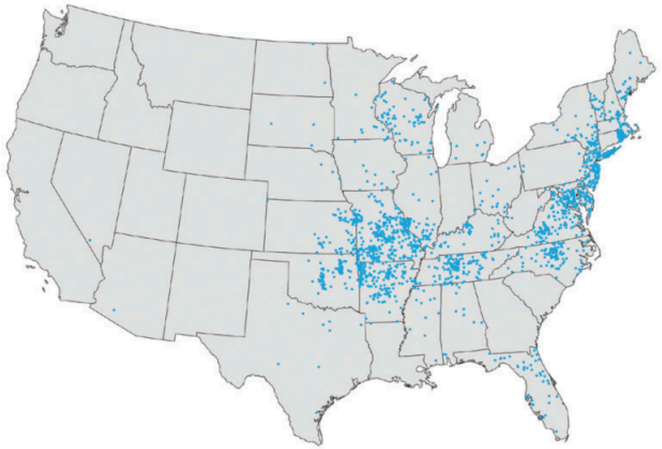
MEDICAL IMPORTANCE

TICKS ARE RESPONSIBLE FOR OVER 95% OF VECTOR-BORNE DISEASE CASES

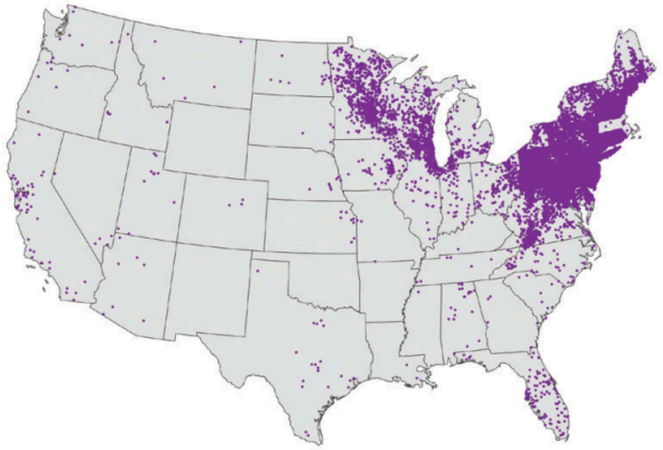
APPROXIMATELY 300,000 CASES OF LYME DISEASE ARE DIAGNOSED ANNUALLY

ABOUT 10-FOLD HIGHER THAN THE NUMBER OF REPORTED CASES

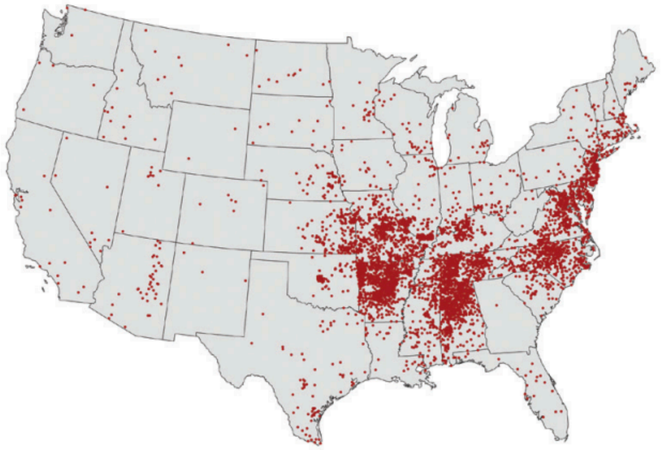
TICKS ARE VECTORS FOR BACTERIA, VIRUSES, AND PARASITES CAUSING A HOST OF DISEASES FORM THE BENIGN TO FATAL DISEASE



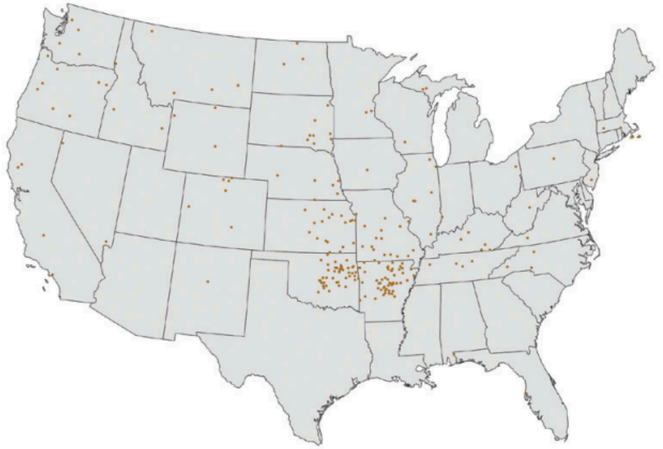
EHRLICHIOSIS



LYME DISEASE



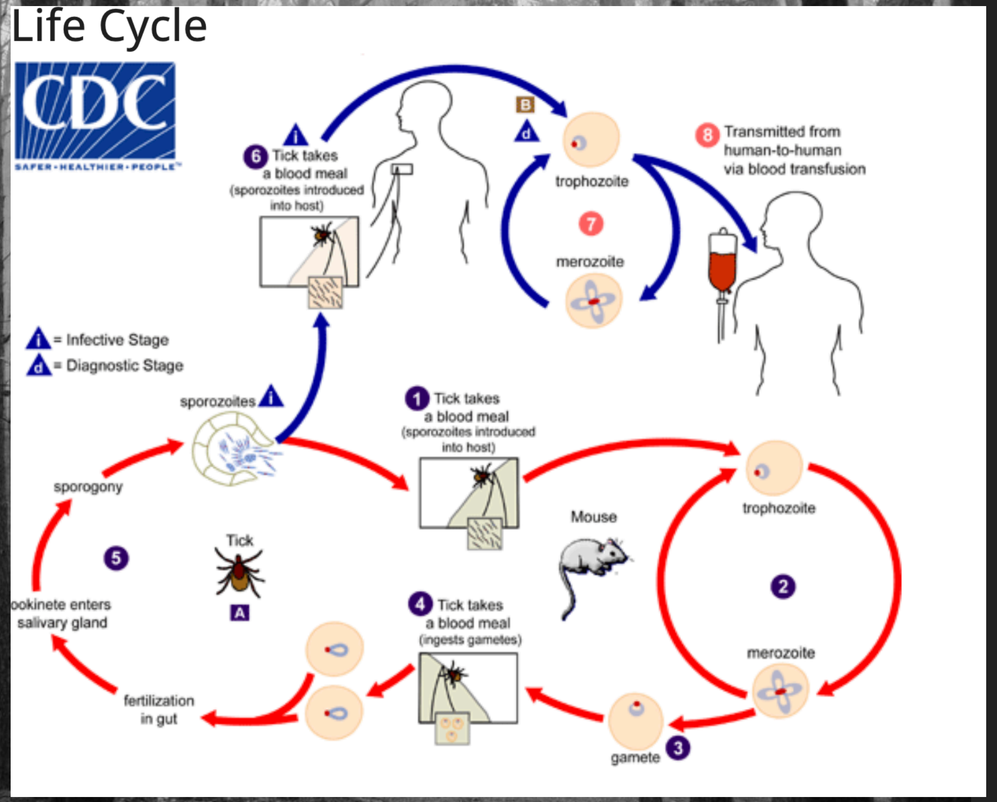
SPOTTED FEVER RICKETTSIOSIS
(INCLUDING ROCKY MOUNTAIN SPOTTED FEVER)



TULAREMIA

LOCATION

BABESIOSIS



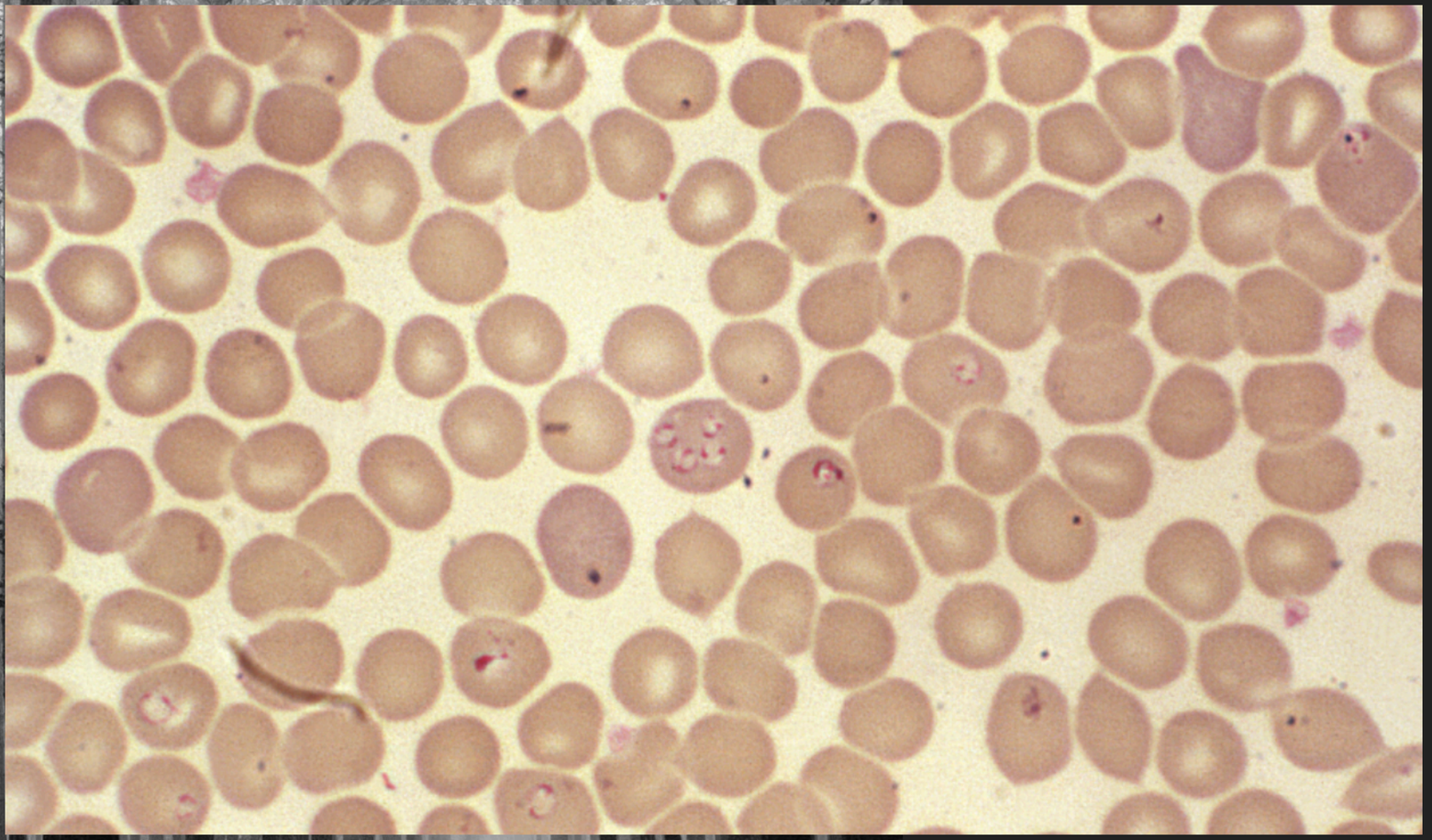
CAUSED BY A MICROSCOPIC PARASITE THAT INFECTS RED BLOOD CELLS

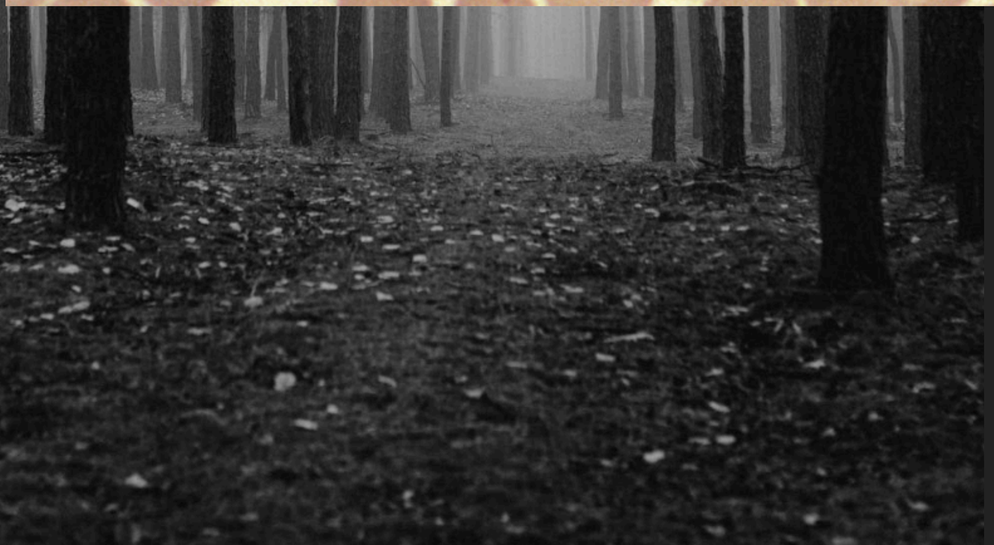
BABESIA MICROTI IS TRANSMITTED BY THE BITE OF INFECTED IXODES SCAPULARIS (BLACK-LEGGED) TICK

FEVER, FATIGUE, AND MUSCLE ACHES

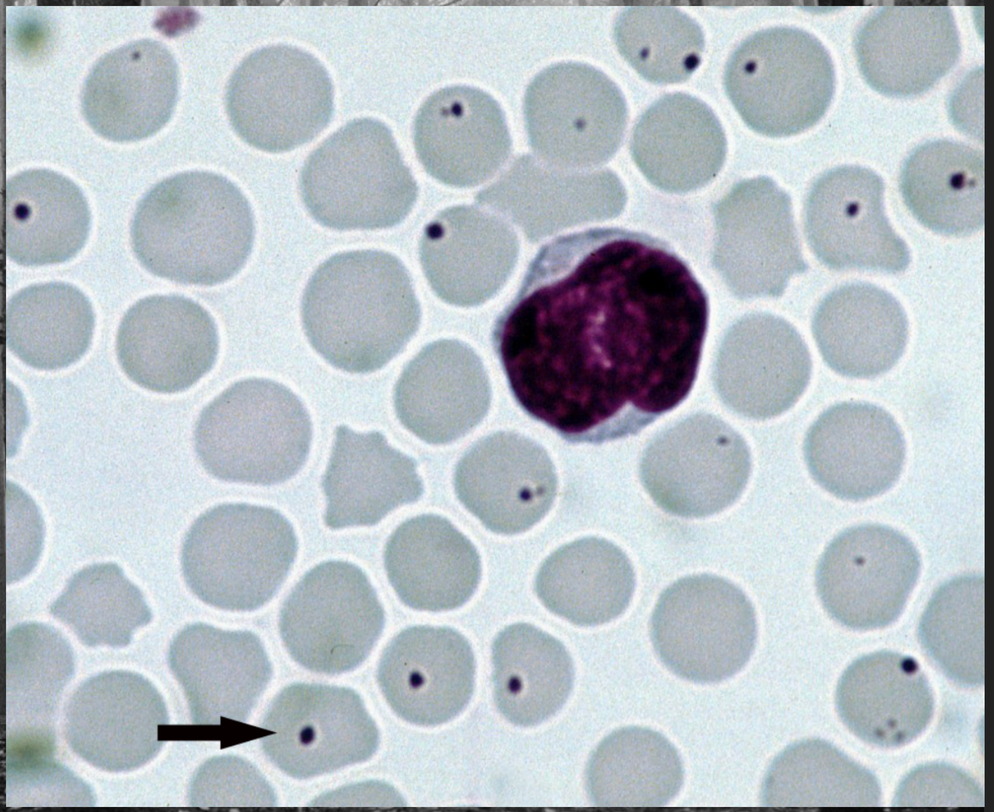
TREATMENT 7-10 DAYS

ATOVAQUONE AND AZITHROMYCIN OR CLINDAMYCIN AND QUININE





DIAGNOSED ON BLOOD SMEAR AND WITH SEROLOGY



ANAPLASMOSIS

ANAPLASMA PHAGOCYTOPHILUM

TRANSMITTED BY BLACK-LEGGED TICK

FEVER, HEADACHE, MUSCLE ACHES, AND FATIGUE

IF SEVERE ORGAN FAILURE AND EVEN DEATH

ANAPLASMOSIS

DIAGNOSED WITH PCR AND SEROLOGY

TREATMENT - DOXYCYCLINE

LYME DISEASE

CAUSED BY A BACTERIUM - BORRELIA BURGDORFERI

TRANSMITTED BY INFECTED BLACK-LEGGED TICK

FEVER, HEADACHE, FATIGUE, AND A CHARACTERISTIC BULL'S EYE RASH

CHILDREN WITH FACIAL NERVE PARALYSIS

ERYTHEMA MIGRANS

- SINGLE OR MULTIPLE LESIONS
- RASH CAN APPEAR UP TO 3 MONTHS AFTER BEING BITTEN BY AN INFECTED TICK
- USUALLY APPEARS WITHIN 1 TO 4 WEEKS
- CAN LAST FOR SEVERAL WEEKS

LYME

UNTREATED - CHRONIC LYME

JOINT PAIN AND SWELLING, HEART PALPITATIONS, AND NERVOUS SYSTEM PROBLEMS, INATTENTION

LAB TESTING

RASH AFTER BEING IN AN AREA WHERE LYME DISEASE IS COMMON CAN BE DIAGNOSED CLINICALLY AS SEROLOGIC TESTS MAY BE NEGATIVE DURING THE FIRST FEW WEEKS OF INFECTION BEFORE ANTIBODIES HAVE DEVELOPED

SEROLOGIC TESTS ARE HIGHLY SENSITIVE IN PATIENTS WITH DISSEMINATED LYME DISEASE

TWO-STEP SEROLOGIC TESTING IS RECOMMENDED

VALIDATED FIRST- AND SECOND-TIER TESTS ACCORDING TO A STANDARD OR MODIFIED TWO-TEST ALGORITHM

TREATMENT

ACUTE - DOXYCYCLINE, AMOXICILLIN, OR CEFUROXIME FOR 14 DAYS

CARDITIS OR NERVOUS SYSTEM INVOLVEMENT - AS ABOVE FOR 21 DAYS

ROCKY MOUNTAIN SPOTTED FEVER

CAUSED BY THE BACTERIUM RICKETTSIA RICKETTSII

FEVER, HEADACHE, AND A SPOTTED RASH THAT USUALLY STARTS ON THE WRISTS AND ANKLES AND SPREADS TO THE REST OF THE BODY

CAN CAUSE DAMAGE TO INTERNAL ORGANS AND LEAD TO DEATH

ROCKY MOUNTAIN SPOTTED FEVER

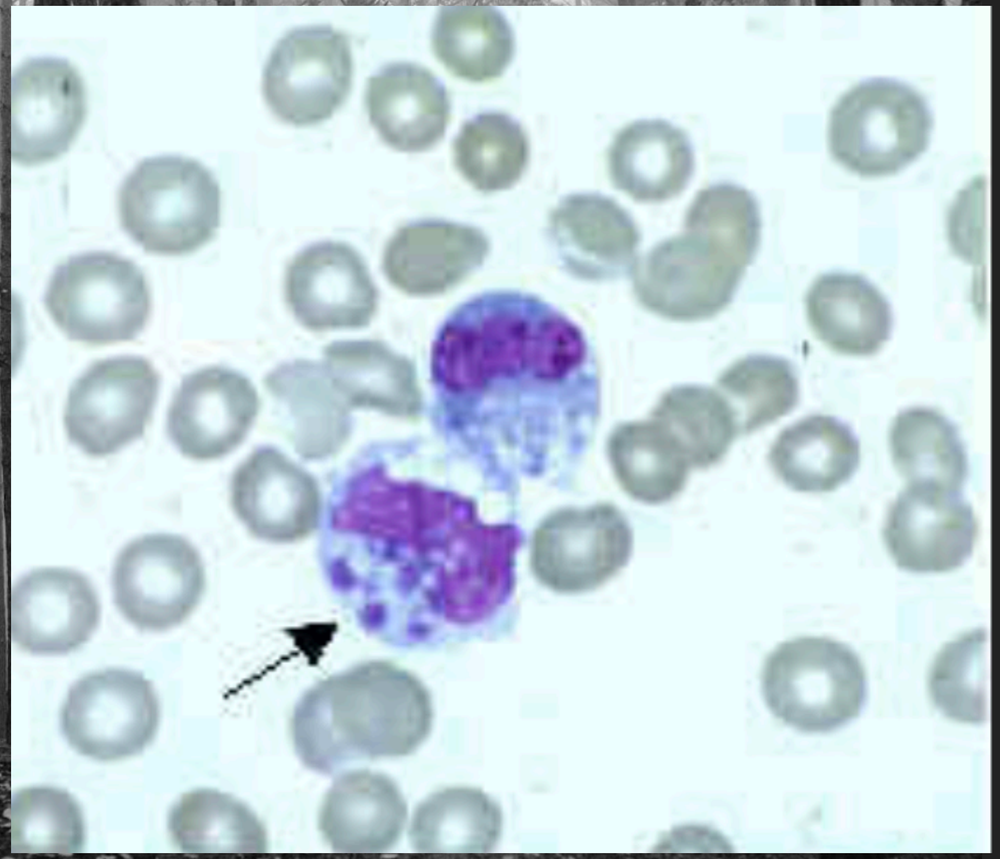
RECENT TICK BITE, EXPOSURE TO AREAS WHERE TICKS ARE COMMONLY FOUND INCLUDING WOODED AREAS OR BRUSHY AREAS WITH HIGH GRASSES AND LEAF LITTER

IN ARIZONA AND MEXICO ASK ABOUT EXPOSURE TO DOGS

TRAVEL HISTORY (DOMESTIC AND INTERNATIONAL) TO AREAS WHERE ENDEMIC

IF SUSPECTED DON'T WAIT FOR TESTING BUT TREAT IMMEDIATELY - DOXYCYLCINE

DIAGNOSTIC TESTING WITH SEROLOGY AND PCR



ERLICHIOSIS

CAUSED BY THE BACTERIA EHRLICHIA CHAFFEENSIS AND EHRLICHIA EWINGII

TRANSMITTED VIA BITE OF AN INFECTED LONE STAR TICK

FEVER, HEADACHE, MUSCLE ACHES, AND FATIGUE

IN SEVERE CASES, IT CAN CAUSE ORGAN FAILURE AND EVEN DEATH

ERLICHIOSIS

DIAGNOSED WITH PCR

DON'T WAIT TO TREAT IF CONCERNED

DOXYCYCLINE

TULEREMIA

BACTERIAL DISEASE CAUSED BY FRANCISELLA TULARENSIS

TRANSMITTED TO HUMANS THROUGH THE BITE OF INFECTED TICKS, DEER FLIES, OR OTHER INSECTS

SYMPTOMS OF TULAREMIA INCLUDE FEVER, CHILLS, HEADACHE, MUSCLE ACHES, AND FATIGUE

SEVERE CASES, IT CAN CAUSE PNEUMONIA AND EVEN DEATH

ULCEROGLANDULAR - LOCALIZED LYMPHADENOPATHY CUTANEOUS ULCER AT INFECTION SITE

OCULOGLANDULAR - PHOTOPHOBIA, EXCESSIVE LACRIMATION, CONJUNCTIVITIS

PREAURICULAR - SUBMANDIBULAR AND CERVICAL LYMPHADENOPATHY

OROPHARYNGEAL: EXUDATIVE PHARYNGITIS OR TONSILLITIS, CERVICAL, PREPAROTID, AND/OR RETROPHARYNGEAL LYMPHADENOPATHY

PNEUMONIC - COUGH, PLEURITIC CHEST PAIN HILAR ADENOPATHY, INFILTRATE, OR PLEURAL EFFUSION

TYPHOIDAL -ANY COMBINATION OF THE GENERAL SYMPTOM WITHOUT LOCALIZATION

TULEREMIA

DIAGNOSIS - CULTURE, SEROLOGY, AND PCR

TREATMENT

GENTAMICIN OR CIPROFLOXACIN FOR 10 -14 DAYS

DOXYCYCLINE FOR 21 DAYS

SUMMARY

KNOWLEDGE OF LOCAL EXPOSURE RISKS

INCLUDING IN DIFFERENTIAL DIAGNOSIS

PROMPT TREATMENT AND APPROPRIATE TESTING

QUESTIONS?