**Chemical Injuries of the Cornea**

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**Case 1 Presentation**

58 yo WM Dennis L.

- Was working in IA (consultant) helping to fix a pipe at a laundry facility and got NaOH in OS.
- Wears glasses but took off to see pipe better.
  - No safety glasses
  - Immed flushed eyes.
  - Went to Medical clinic in Iowa and flushed eyes there
  - Gave Vigamox but lost

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**What would you do?**

- How many would put patient on topical Ab?
- How many would use a topical NSAID?
- How many would put patient on topical steroid?
  - QID?
  - Q1h?
- How many would use a BSCL?
- How many would use a pressure patch?
- How many would turf??

**ANSWER?**

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**Anatomy**

- Corneal Epithelium
  - 5-6 cell layers thick
  - Non-keratinized stratified squamous cells
  - No goblet cells
  - Conjunctival epithelium consists of stratified columnar epithelium w/ numerous goblet cells.
  - Rapidly renewing tissue which loses its surface cells into tear film
  - Turnover 4-6 days
  - Maintains smoothness of optical surface
  - Barrier against micro-organisms
  - Maintains deturgescence of stroma
  - Regulates metabolic activity of stromal keratocytes
- At limbus thickens to 10 cell layers
- Basal epithelial cells of the limbus

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**Limbal Stem Cells**

- Basal cells lie deep in thickened epithelial cell layer (protected)
  - Tightly attached to underlying BM
  - Rich network of blood supply
  - “Limbal palisades of Vogt”
  - Limbal Stem Cells
  - Undifferentiated cells which serve as an important source of new epithelium
  - Make up 5-15% of cells at limbus and reside in this basal layer
They are the precursor for all other cells of the tissue
• They have a self maintaining population
• Undergo asymmetric cell division
  • producing a stem cell
  • daughter early transient amplifying cell
  • transient amplifying cells (TAC)
  • terminally differentiated cells (DC)
• Slow cycling
  • can become highly proliferative to help replenish the stem cell pool.

**Epithelial Regeneration**

- Centripetal and circumferential movement of cells from the peripheral cornea responsible for post traumatic healing
  - Adjacent cells will fill in small defects
  - Limbal cells are called in to fill in large defects
  - Moving centrally at rate 17 um/day
  - Central defects heal by migration 0.69-1.46 mm²/hr
- Large defects heal at a faster rate due to increased mitotic activity of TAC, although recovery time is longer
  - If complete loss of stem cells and conj region is required it will be greatly prolonged
- Conjunctival stem cells are located in the fornical region and migrate in a centripetal fashion away from fornices to cover bulbar and tarsal conj

**Anatomy**

- **Corneal Stroma**
  - Collagen constitutes 80% of stroma
  - Keratocytes are pluripotential cells of neuroectodermal origin
  - Most resp is maintenance and regeneration of stroma
- **Capable of wide variety of fibroblastic activity.**
- **Phagocytosis of collagen fibrils**
- **Secretion of collagen**
- **Glycosaminoglycan ground substance**
- **Collagenase (MMP) and collagenase inhibitors**
  - Keratocytes are static and inactive w/o appr. synthesis of collagen or collagenase, unless trauma
  - Metabolic function of keratocytes regulated from cytokines from epithelium, inflm cells and other keratocytes
  - Mobilized from adj areas to repopulate damaged area
  - Migration begins on endothelial side
  - Keratocyte synthesis of collagen requires ascorbate from the aqueous
  - CB epi typically secretes but damaged by increasing pH

**Etiology of Chemical Burns**

- **Ocular burn injuries**
  - Radiant (thermal, UV)
  - Chemical (acid, alkali) – True Ocular Emergency
- **Epidemiology**
  - Eye injuries account for 4-7% of workplace injuries
  - Location of Chemical Injuries
    - Work place injuries (66%)
    - Safety glasses are no match for strong chemicals under high pressure
    - Construction sites
    - Chemical plants
    - Machine factories
  - Home based injuries (33%)
    - Most serious injuries by lime and drain cleaners
    - Safety glasses helpful
  - School based (1%)
- **Incidence**
  - 30 per 10,000
  - 82-91% men
  - Occurring in prime of life 16-45 years
  - 90% accidental
  - Automotive battery acid burns are increasingly common — during recharging of lead-acid storage battery (25% sulfuric acid, hydrogen and oxygen gases)
  - 10% intentional
  - Most occurring as a results of assault
  - ½ were chronic alcoholics — 32% intoxicated at time of admission

Lucky most chemical injuries are mild with a good prognosis
**Alkali Burns**

- Chemical Injuries of the Cornea
  - **Acid- low pH**
  - **Alkali- high pH**
  - **Irritant- neutral pH**
  - **Surfactants – detergents – neither acid or alkali**
    - Cationic, anionic, nonionic, zwitterionic
    - BAK
    - Liquid dishwashing detergent

- **Modifying factors**
  - Duration of contact
  - Solution pH
  - Solution quantity
  - Solution penetrability

- **Alkali Burns**
  - **Substances that have basic pH**
    - More severe than acid burns
    - As pH rises, emulsification of lipids in cell membranes occur
      - Destroying barriers to penetration facilitating deeper penetration to Ant Segment
    - Injurious effect on stroma involves:
      - Temporary binding of alkali cations to corneal mucopolysaccharides and collagen
      - Rapid destruction of corneal mucopolysaccharides
      - Hydration of glycosaminoglycans results in stromal haze
      - Increasing as the pH is raised above 11.5
    - Lipophilic
    - Penetrate more rapidly than acids
    - Detectable levels in A.C. in seconds to minutes
      - Once external pH is restored to normal can take 20 min -3 hr to neutralize AC, depending on penetration
    - Collagen fibril distortion and shortening, leading to trabecular meshwork alterations
    - Inflammatory mediators released stimulate the release of prostaglandins

- **Acid Burns**
  - **Intact corneal epi affords moderate protection against penetration of dilute or weak acids**
    - Little damage seen unless pH < 2.5
    - Acids bind to corneal proteins and act as chemical barrier
    - Severe damage if epi removed
    - Cause protein coagulation in corneal epithelium
    - Also acts as barrier
    - Ground glass appearance
  - **Usually non-progressive and superficial**
    - **Hydrofluoric acid is exception**
    - Fluoride ion penetrates stroma
    - Acts as alkali

- **Rates of penetration**
  - **Sulfuric Acid – slowest**
  - **Hydrochloric acid - fast**
  - **Sulfurous acid – faster**
  - **Hydrofluoric acid - fastest**

- **Alkali Burns**
  - **Cause saponification of cell membrane fatty acids**
    - Stimulates inflammatory response
    - Liquefactive necrosis

- **Rates of penetration**
  - Calcium hydroxide (Lime) - slowest
  - Potassium hydroxide (Caustic Potash) – faster
  - Sodium hydroxide (Lye)– even faster
  - Ammonia hydroxide (Ammonia) – fastest
  - Found in aqueous in 5 sec of contact

- **Low pH**
  - Sulfuric acid
  - Sulfurous acid
  - Hydrochloric acid
  - Nitric acid
  - Acetic acid
  - Chromic acid
  - Hydrofluoric acid

- **3 most common**
  - Calcium hydroxide Ca(OH)₂ (Lime)
    - Found in plaster, sweep fornix
    - Superficial opacification of cornea
  - Sodium hydroxide NaOH (Lye)
    - Found in drain cleaners
    - Pearly opacification of deep stroma
  - Ammonium hydroxide NH₃ (ammonia)
    - Found in household cleaners
    - Deep tissue injury, corneal edema, endo damage, cataracts

- **Fireworks - combined chemical and thermal injury**
The following liquid products are harmless to the eye:
- bubble bath
- cosmetics, deodorant
- foods (e.g., lemon juice)
- hair conditioner, hair spray
- hand lotion
- laundry detergent (liquid)
- medications
- shampoo
- shaving cream
- soap
- sunscreen
- toothpaste

The following substances will cause transient irritation:
- hydrogen peroxide
- rubbing alcohol
- vinegar
- Mace and pepper spray are used in personal protection devices. Eye exposure results in marked eye pain and tearing. Usually these symptoms subside in 30 minutes and there is no lasting damage.

Causative Agents – In the home
- Fish bile has been shown to cause 14% of ocular chemical burns in Norway
- In India severe ocular alkali burns have occurred as a result of bursting of chuna packets (edible calcium hydroxide paste), a popular additive to chewing tobacco in India
- In 2009 40% of chemical burns involving children’s eyes under 5 years old were because of washing detergent capsules
  - The liquid detergent is a mixture of three active agents
    - anionic detergent (20-30%)
    - non-ionic detergent
    - cationic surfactant dissolved in water to give an alkaline solution

Causative Agents – Self inflicted

Causative Agents – Irritants

Causative Agents – Irritants

Treatment - Irrigation
- Irrigation
  - Tetracaine
  - Lid speculum
  - Physiological saline
    - Tap water better?
  - Borate buffer (greater reduction in aqueous pH)
  - Amphoteric substances (Diphoterine or Previn solutions)
    - Avail at many workplaces and hospitals, esp Europe
  - Paracentesis and reformation of the anterior chamber with phosphate buffer if w/in 15 min, not after 30 min
- Time is of the essence with chemical injuries
  - always recommend immediate irrigation.
  - The longer hazardous materials remain in the eye, the more severe the damage.
- Irrigate with water under low pressure for 15 minutes. Use the best option that is immediately available.
  - A sink faucet
  - Hose without a spray nozzle
  - Shower to flush both eyes at the same time if needed.
  - Try to keep the water tepid or at room temperature.
  - Do not delay irrigation for contact lens removal.
  - Contacts can be removed after irrigation.

Treatment - Irrigation
- Must neutralize pH first
  - Goal 7.0 to 7.2
  - Check every 15-30 minutes
    - pH testing OU, even if claims only one eye affected
    - Trapped particles will cause pH change after initial normalization
    - Special attention to fornix
Exam
- Only after irrigation and neutralization of pH should an examination be performed
- Inspect and sweep inferior and superior fornices
  - Cotton swab / Glass rod
- IOP
  - digital
  - Tonopen
- Check MSDS
  - www.msdsonline.com
- Local poison control center
  - www.aapcc.org
  - 1-800-222-1222

Limbal Ischemia
- Blanching of the vessels at the limbus
  - Injected is good
  - White is bad

Classification Schemes
- Determine extent of damage to corneal epithelium, limbus, and conjunctiva
- Determine presence or absence of limbal ischemia
- Depth of penetration
- Toxicity of substance
- Determine quality of view through cornea
- Gauge ultimate prognosis
  - Grade I
  - Grade II
  - Grade III
  - Grade IV

Use of grading system to estimate, then confirm actual limbal stem cell injury is therapeutically useful since it can form the basis of recommendations regarding appropriate consideration for early limbal stem cell replacement.

Exam
- Determine area of involvement
  - Assessed by extent of FL staining
  - Careful not to underestimate
- Estimate depth of corneal penetration
  - Evaluate loss of stromal clarity
- Assess depth of conjunctival penetration
  - Vascular ischemia / necrosis of limbal and bulbar conj

Classification Schemes
- Original classification scheme by Hughes et al 1946
  - Based on clinical findings during acute phase
- Modified by Thoft 1979
  - Divides chem injuries into 4 categories
  - Pfister in 1983
  - Mild, mild-mod, mod, severe, very severe
- Bagley et al 2006 classification scheme by
  - Depth of corneal injury
  - Involvement of corneal endothelium

Across the pond
- 1964 Ballen
- 1965 Roper-Hall
- 2001 Dua - 6 Grades / conjunctiva

Grade I
- Involves corneal epithelium only
- Limbal stem cells spared
- Cornea remains clear
- Epithelium denuded
- No opacity
- No limbal ischemia
- Prognosis: Excellent for full recovery of normal corneal appearance and function

Grade 1 ocular surface burn. Large corneal burn following accidental exposure to ammonia. There is no limbal or conjunctival involvement. Fluorescein stained diffuse view of the cornea.
Grade II
- Partial loss of limbal stem cells
- Focal limbal ischemia
  - < 1/3 of limbus
- Cornea is hazy, but anterior segment structures are visible
- Prognosis: Good
  - Concerns:
    - Persistent epithelial dysfunction
    - Conjunctivalization
    - Haze
    - Neovascularization

Grade III
- Extensive limbal ischemia
  - 1/3 to 1/2 of limbus
- Loss of most limbal stem cells
- Stromal haze limits visualization of iris and lens
- Prognosis: Guarded
  - Surgery needed for visual rehabilitation

Grade IV
- Complete loss of corneal epithelium and limbal stem cells
- Loss of proximal conjunctival epithelium
- Opaque cornea
  - No view of iris or pupil
  - Porcelainization
- Limbal ischemia (more than 50%)
- Ischemic necrosis of proximal conjunctiva and sclera
- Prognosis: Extremely poor
  - High risk for sterile ulceration and corneal melt
- Even with most aggressive tx limbal stem cell death most likely too advanced

Stage of Ocular Surface Recovery
- McCulley et al divided the clinical course into 4 distinct phases
  - Immediate (Day 0)
    - Grades I-IV (V and VI)
  - Acute (Days 1 to 7)
  - Intermediate/early repair (Days 7 to 21)
  - Late repair (After day 21)

Acute - Day 1 to 7
- Epithelial regrowth begins
  - Keratocyte activation begins in response to injury
  - Allows initiation of collagen synthesis
  - Little or no collagen breakdown occurs
  - First wave of cell infiltration occurs
  - Decrease inflammation

Avoid topical medications damaging to epithelium
Continuation of epithelial migration
- Re-epithelialized – Grade I
- PED - Grade II
- Delayed in Grade III
- Non-existent Grade IV
- Extremely Frontalized

Ocular surface inflammation may be present
- Persists as long as cornea is denuded
- Keratocytes working to repair damage to stroma
- Resultant collagen and collagenase production
- Collagen breakdown vs. collagen synthesis
- Dictates potential for corneal melting
- Goals: maximize collagen synthesis and minimize collagenase activity

Second wave of inflammatory cell infiltration
- Important in G II/III to hit early with Pred
- Debridement G IV

Grade 4 alkali burn 10 days after initial injury. Cornea is beginning to show some clearing centrally, however, a significant epithelial defect and ocular surface inflammation remains

Clinical suspicion of a confirmed total limbal stem cell loss should develop by the end of the early repair phase if there is no epi inside limbus

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Initial Treatment
- Encourage epithelial healing
  - Proper corneal phenotypic transdifferentiation
- Augment Collagen synthesis while minimizing collagen breakdown
  - Sterile ulceration
- Control 1st and 2nd wave of inflammation
- Prevent infection

Epithelial recovery will be slowed due:
- Persistent inflammation
- Enzymatic products of degranulating PMN leukocytes
- Stimulation of keratocyte collagenase by leukocyte cytokines

Corneal stromal inflammation persists as long as the epithelial defect remains, or as long as necrotic Conjunctival tissue provides a focus of inflammatory infiltration

all contribute toward sterile enzymatic digestion of the corneal stroma during 2-3 post-injury weeks

Inflammation Control
- First Wave occurs 12-24 hours after chem injury with infiltration of peripheral cornea with PMN and mononuclear leukocytes.

Resulting from:
- Blood elements from injured vessels in conj and uvea
- Necrotic tissue of bulbar and tarsal conj
- Chemotactically attracted byproducts of epi and stromal tissue

Second, more aggressive wave of inflammatory cell infiltration begins at 7 days and peaks when corneal repair and degradation are maximal (bet 14-21 day)

Inflammation Control
- Prompt debridement of necrotic bulbar and tarsal conj tissue eliminates source of infiltration on enzymatic signals

Aggressive Tx of 1st wave infiltration is imperative to dec incidence of corneal ulceration & Pv 2nd Wave
**Inflammation Control**

- Corticosteroids help by:
  - Reduce cell infiltration and stabilize PMN membranes
  - Know SE of Interfere w/ stromal wound repair by impairing keratocyte migration and collagen synthesis
  - Key to successful use is to maximize their antiinflamm effect during 1st 7-10d when risk-benefit favorable
- Progestational steroids – 1% topical medroxyprogesterone
  - Medroxyprogesterone Acetate 0.5% or 1% Ophthalmic Suspension - less potent but min effect on stromal repair & collagen synthesis

**Grade I Medical Management**

- Antibiotic ointment QID
- Cycloplegia for comfort
- Preservative free tears
- Topical corticosteroids when epithelium healed
  - prednisolone acetate 1% QID with taper
- Follow up every 1-2 days
- Supportive therapy to ocular surface

**Grade II –III Medical Management**

- Topical NSAIDs and BCL have limited benefit

  - There is little role for topical non-steroidal agents in a severe chemical injury. Their anti-inflammatory power is dwarfed by that of the recommended topical corticosteroids and they have the potential to cause issues with epithelial healing.
  - Bandage contact lenses are of marginal utility in the acute management of chemical burns, as the eye is usually too inflamed to tolerate a foreign body on its surface and does not cover the defect.

**Medical Management**

- Autologous Serum
  - Use first described in 1984 by Fox et al
  - Unpreserved, non-antigenic
  - Utilizes patients own blood serum
  - Blood is drawn and serum is spun down and mixed with artificial tears.
  - Doesn’t contain red blood cells and clot factors
  - Replaces individualized antibodies

- 10% Ascorbate – Topical Vit C
  - Ascorbic Acid 10% Ophthalmic Suspension $87.85/10ml

- 10% Citrate – Topical – Calcium chelator
  - Sodium Citrate 10% Ophthalmic Solution $69.10/10ml

- TCN /DCN
  - Autologous Serum
  - N-Acetylcysteine (Mucomyst)
  - Acetyl Cysteine 5-20% Ophthalmic Solution pf $77.95-97.70/10ml
  - Oral NSAID

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  - Sodium Citrate 10% Ophthalmic Solution $69.10/10ml

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  - Oral NSAID
Medical Management

- Umbilical Cord Serum
  - Compared to AS, UC serum
    - higher concentration of essential tear components
    - many growth factors
      - such as Epidermal Growth Factor, Vitamin A, and Transforming Growth Factor-
      - b, and neurotropic factors, such as Substance P, insulin-like growth factor-1, and nerve growth factor
  - Study - by month 3, the extent of limbal ischemia with cord serum showed dramatic improvement
  - Serum and artificial tears, respectively (P = 0.008). More patients had clear corneas with cord serum compared with autologous serum and artificial tears (P = 0.048).

Surgical Management

- If epithelial healing falters or comes to a complete halt or progressive corneal melting occurs, then surgical maneuvers recommended
- Therapies
  - Debridement
  - Cyanoacrylate
  - Perforation seal
  - RGP's
  - Augmented tenoplasty
  - PTK
  - Tenoplasty
  - AMT
  - LSCT
  - PK
  - Avastin for corneal neo
  - Keratoprosthesi
  - Simple mask G2 therapy

PTK

- Study of rabbit corneas treated with HCl and NaOH exhibited immediate epithelial defects that slowly healed over time.
- In PTK-treated corneas, the re-epithelialization rate was accelerated compared with that of controls
- After corneal chemical damage, 193-nm excimer laser PTK accelerates epithelial wound healing.

Hard Contact Lens

- Glued to stroma
- Serves as artificial epithelium and protects cornea from early complications
- Helps prevent conjunctivization
- Avoids keratoplasty

Surgical Management

- Amniotic membranes
  - Innermost of 3 membranes forming the fetal membrane
  - Transplant membrane composed of an inner layer of epithelial cells, basement membrane that is connected to a thin connective tissue membrane by fibrous strands
  - Avascular and acellular. It will facilitate epithelial healing acting as a basement membrane
  - Combined action with other cytokines is supposed to stimulate epithelialization and SC proliferation
  - Acts as barrier for efflux of immune cells giving anti-inflammatory properties
  - Reduces intolerable pain
  - Temporizing measure for LSCT and inhibit fibrosis
  - Does not re-establish the ocular surface or prevent ulceration in severe burns

Grades IV limb burn (a) At presentation, right eye had total limbal ischemia, 100% epithelial defect and superior conjunctival necrosis (b) After 2 months of AMT granulomas pyogranulitis, PED, corneal vascularization, and symblepharon were noted.
Sutureless ProKera®
FDA-approved Device

- Easy to insert in the office, bedside, and OR
- Monitor healing by fluorescein and IOP by Tonopen™ without removal
- Does not interfere with antibiotic penetration

Tx for chemical burns effective within the first week
65778 (the CPT code for ProKera’s insertion) $1670.34

Tape-sorrhaphy

A tape over the lid crease - Narrows the eye opening, Keeps ProKera centered, and Minimizes discomfort

Sutureless Amniotic Membrane's

Surgical Management

- Limbal Stem Cell Transplantation
  - Involves harvesting two crescents of peripheral corneal limbal epithelium corresponding sectors of conjunctiva from the limbus
  - Uninjured eye - autograft
  - Close relative - allograft
  - Expand in culture in vitro
  - Success is dependent on medical control of inflammation prior
  - Can be performed as early as 3 weeks after injury
  - Only technique available to re-establish a normal corneal phenotype
  - Re-establishment of intact epithelium is also effective means of minimizing ulceration

Keratoprosthesis

- Artificial corneas approved for use in the United States
  - AlphaCor® artificial cornea
  - Dohlman-Doane or Boston Keratoprosthesis (Boston KPro)
  - Oculaid Keratoprosthesis
Alternative Treatment Options

Study by Sharifipour et al
Looked at oxygen therapy vs. conventional therapy
Main outcome measures:
- improve perilimbal ischemia
- healing time for epithelial defect
Secondary outcome measures:
- VA
- corneal transparency
- vascularization
- complications


Alternative Treatment Options

Oxygen group had:
- Improved corneal healing time
- Improved vascularization time to ischemic areas
- More corneal transparency and less vascularization
- No cases of symblepharon or corneoscleral melting

Conclusion:
- Oxygen therapy improves limbal ischemia, accelerates epithelialization, increases corneal transparency, and decreases corneal vascularization
  * But....

Ocular Sequelae

- Advanced glaucoma
- Persistent epithelial defects / RCE
- Infectious keratitis
- Stromal melt
- Perforation
- Intraocular damage
- Phthisis

Case 1 Presentation

58 yo WM Dennis L.

Day 1
- OS blurry and painful but more comfortable today
- pH = 7
- VA cc 20/100 PH 20/40
- L/L erythema and edema
- Conj = 2-3 inj –
  * Defect inferior
- Cornea OS: 95% Epithelial defect w/sloshed tissue along edges
  * Approx 3 limbal involvement
  * OD clear
  * A/C view hazy but appreciable cell
  * Iris details somewhat visible
  * Fundus – difficult views appears intact
  * T(a) 14

Rx topical citrate and ascorbate through compounding pharm

58 yo WM Dennis L.

Dx – Grade II Alkali burn of cornea and conjunctiva
- Plan – debride loose tissue
  * Vigamox 0.5q4h OS
  * Pred Forte Q1h OS
  * Atropine BID OS
  * Ciloxan ung QHS OS
  * NP Art Tears Q1h OS
- NO topical NSAID or BSSL

Case 1 Presentation
Case 1 Presentation
58 yo WM Dennis L.
Day 2
- Pt reports feeling a little better. Using most gtts but did not get the Ascorbate and Citrate due to cost.
- VA cc 20/50 PH20/25
- Corneal defect unchanged. Worse?
- CPM RTO 1 day

Case 1 Presentation
58 yo WM Dennis L.
Day 8
- Unable to come in at last visit
- Eye bothers pt more in AM than PM
- Certain moments it will hurt.
- VA cc 20/50 PH 20/40
- Ta = 9mmHg
- Corneal defect closed in 360 leaving residual central defect. Descemet fold and haze noted in stroma
- CPM. Cut Pred to BID RTO 2 day

Case 1 Presentation
58 yo WM Dennis L.
Day 16
- Went out of town. Unable to come in last week.
- Vision seems to be improving
- VA cc 20/80 PH 20/50
- Ta = 20mmHg
- Corneal defect finally resolved. Haze noted in stroma
- D/C Atropine, D/C Vigamox
- Cont Ciloxan ung TID, tears q1h, inc PF QID
- RTO 7 day

Case 1 Presentation
58 yo WM Dennis L.
Day 60
- Feeling better. Vision definitely better.
- VA cc 20/25 PH 20/20
- MR -0.50 -0.75 x 090 20/20
- Ta = 14mmHg
- Punctate keratopathy. Inf nasal stromal scar
- D/C Ciloxan ung Cont Refresh PM BID tears q4h,
- PF QD
- Plugs for PED

Summary
- Its impossible to over-irrigate
- Debride necrotic conjunctival tissue immediately
- Properly control stromal inflammation and institute immediate medical management
- Address persistent limbal stem cell dysfunction early

Summary
Medical Management
- Topical Pred Forte Q1h or Durezol Q2h x 7 d then taper & switch to
  1% topical medroxyprogesterone QID
  1% Atropine QD
  Zymaxid / Moxeza / Besivance QID
  Prokera Amniotic Membrane by day 3
  Non Preserved artificial tears q1h
- 100mg Doxycycline BID PO
- 500 mg Diamox BID PO
- Ultram 100mg PO q4-6h
- Topical 10% ascorbate and 10% Citrate Q2h
Thank You.

Please feel free to contact us:

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