Evaluation of corneal ulcers
Solving the corneal ulcer jigsaw

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Kode Venkatadri Chowdary Campus,
LV Prasad Eye Institute, Vijayawada
Poll Question 1

What is your position?

1. Ophthalmologist
2. Ophthalmologist-in-training (registrar/resident)
3. Nurse
4. Ophthalmic Technician / Allied Health
5. Medical Student
6. Mixed Group of Different Positions
7. Cornea surgeons
Microbial Keratitis

Why is this topic important?
# Microbial Keratitis

<table>
<thead>
<tr>
<th>Country</th>
<th>Incidence / (million pop)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nepal</td>
<td>7990</td>
<td>Br J Ophth 2001</td>
</tr>
<tr>
<td>India</td>
<td>1130</td>
<td>Br J Ophth 1997</td>
</tr>
<tr>
<td>Myanmar</td>
<td>7100</td>
<td>*Country report</td>
</tr>
<tr>
<td>Bhutan</td>
<td>3390</td>
<td>*Country report</td>
</tr>
<tr>
<td>USA 1993</td>
<td>530</td>
<td>Arch Ophth</td>
</tr>
</tbody>
</table>

840,000 new cases of corneal ulcer cases occur each year in India
Microbial Keratitis

Incidence

Corneal ulceration in the developing world—a silent epidemic

Anyone who has spent time in Asia or Africa can invariably recall a vivid image of a blind beggar, sometimes an elderly person but frequently a child with opaque corneas, haunt-

Even though the prevalence of corneal scarring in a population may be used as an indication of the occurrence of corneal ulceration, the true incidence of keratitis can

However, data from the Madurai study indicate that corneal ulceration is much more frequent in developing countries than previously recognised, and it also appears to be occurring in epidemic proportions. A comparison of population-based studies in the USA and India indicates

Poll Question 2

How often do you manage a case of Microbial keratitis

1. 0-5 cases per month
2. 5-10 cases per month
3. > 10 cases per month
Learning objectives

• Importance of history taking
• Evaluation of risk factors
• Understanding diagnostics
• Documentation and Color coding
• Management decision tree
• Outcomes
Nuances in history taking
Nuances in history taking
Nuances in history taking
Nuances in history taking
Nuances in history taking
Nuances in history taking
Evaluation of risk factors

• History of trauma/vegetative injury
• Unsolicited corticosteroid use
• Polypharmacy/over the counter medications
• Poor ocular surface
• Immunocompromised patient
• Uncontrolled diabetic
• Patency of lacrimal passages
• Contact lens use
Review of epidemiological features, microbiological diagnosis and treatment outcome of microbial keratitis: Experience of over a decade

Usha Gopinathan, Savitri Sharma, Prashant Garg¹, Gullapalli N Rao¹

Table 2: Predisposing ocular factors in microbial keratitis (n=2881)

<table>
<thead>
<tr>
<th>Factors</th>
<th>Bacterial No. (%)</th>
<th>Fungal No. (%)</th>
<th>Parasitic No. (%)</th>
<th>Bacterial + Fungal No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>*Trauma</td>
<td>838 (46.6)</td>
<td>712 (81.9)</td>
<td>42 (95.5)</td>
<td>122 (71.7)</td>
</tr>
<tr>
<td>Prior surgery</td>
<td>394 (22.0)</td>
<td>83 (9.5)</td>
<td>0 (0)</td>
<td>21 (12.4)</td>
</tr>
<tr>
<td>Corneal scar</td>
<td>113 (6.3)</td>
<td>19 (2.2)</td>
<td>0 (0)</td>
<td>3 (1.8)</td>
</tr>
<tr>
<td>Epithelial defect</td>
<td>111 (6.2)</td>
<td>14 (1.6)</td>
<td>1 (2.2)</td>
<td>8 (4.7)</td>
</tr>
<tr>
<td>Corneal edema</td>
<td>100 (5.6)</td>
<td>4 (0.5)</td>
<td>0 (0)</td>
<td>2 (1.2)</td>
</tr>
<tr>
<td>Dry eye</td>
<td>62 (3.4)</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>53 (2.9)</td>
<td>8 (0.9)</td>
<td>0 (0)</td>
<td>1 (0.6)</td>
</tr>
<tr>
<td>Lagophthalmos</td>
<td>51 (2.8)</td>
<td>15 (1.7)</td>
<td>0 (0)</td>
<td>8 (4.7)</td>
</tr>
<tr>
<td>Blepharitis</td>
<td>40 (2.2)</td>
<td>11 (1.8)</td>
<td>0 (0)</td>
<td>3 (1.8)</td>
</tr>
<tr>
<td>Contact lens wear</td>
<td>36 (2.0)</td>
<td>3 (0.3)</td>
<td>1 (2.3)</td>
<td>2 (1.2)</td>
</tr>
<tr>
<td>Total</td>
<td>1798</td>
<td>869</td>
<td>44</td>
<td>170</td>
</tr>
</tbody>
</table>

Data not available for 682 cases; *P < 0.001
### Table 3: Treatment received by the patients prior to presentation at the institute

<table>
<thead>
<tr>
<th>Type of keratitis</th>
<th>No.</th>
<th>Appropriate antimicrobial therapy</th>
<th>Indiscriminate combination therapy*</th>
<th>Antibiotics with steroids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial</td>
<td>907</td>
<td>405 (AB)</td>
<td>331</td>
<td>171</td>
</tr>
<tr>
<td>Fungal</td>
<td>825</td>
<td>415 (AF)</td>
<td>395</td>
<td>15</td>
</tr>
<tr>
<td>Parasitic</td>
<td>50</td>
<td>0</td>
<td>50</td>
<td>0</td>
</tr>
<tr>
<td>B + F</td>
<td>147</td>
<td>60 (AB)</td>
<td>20</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>14 (AF)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>44 (AF+AB)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B + P</td>
<td>15</td>
<td>7 (AB)</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>F + P</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1945</td>
<td>945 (48.4%)</td>
<td>804 (41.3%)</td>
<td>196 (10.0%)</td>
</tr>
</tbody>
</table>

AB – Antibiotic; AF – Antifungal; B – Bacteria; F – Fungus; P – Parasite.
* Antiviral, Antibiotic, Antifungal
Poll Question 3

Do you have microbiology lab support for management of corneal infections

1. Yes
2. No
Poll Question 4

Are you comfortable to independently perform Gram’s staining and KOH wet mount

1. Yes
2. No
Microbiology of corneal ulcers

- **Microscopy**
  - CFW mount
  - Gram stain
  - Giemsa stain

- **Culture**
  - 5% Sheep Blood agar (Aerobic)
  - 5% Sheep Blood agar (Anaerobic)
  - Chocolate agar (5% CO₂)
  - Potato Dextrose agar
  - Sabouraud Dextrose agar
  - Thioglycolate broth
  - Brain Heart Infusion broth

Slide Courtesy: Dr. Chetan Videkar
Sensitivity and specificity

Table 4: Sensitivity and specificity of corneal scraping smears in the detection of microorganisms with culture as gold standard

<table>
<thead>
<tr>
<th>Smears n*</th>
<th>Bacteria</th>
<th></th>
<th>Fungi</th>
<th></th>
<th>Acanthamoeba</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sensitivity %</td>
<td>Specificity %</td>
<td>Sensitivity %</td>
<td>Specificity %</td>
<td>Sensitivity %</td>
<td>Specificity %</td>
</tr>
<tr>
<td>Gram 3442</td>
<td>56.6</td>
<td>97.8</td>
<td>89.8</td>
<td>93.7</td>
<td>73.3</td>
<td>99.8</td>
</tr>
<tr>
<td>Giemsa 2774</td>
<td>ND</td>
<td>ND</td>
<td>85.2</td>
<td>96.1</td>
<td>72.2</td>
<td>99.8</td>
</tr>
<tr>
<td>KOH + CFW 2555</td>
<td>ND</td>
<td>ND</td>
<td>90.6</td>
<td>94.3</td>
<td>84.0</td>
<td>99.8</td>
</tr>
</tbody>
</table>

A – Sensitivity; B – Specificity; ND – Not Done; KOH+CFW – potassium hydroxide + calcofluor white, n* is different for each staining method as all procedures could not be done for all cases.

Confocal Microscopy
Poll Question 5

Do you have access to confocal microscopy?

1. Yes
2. No
a) **Anterior stroma** More cellular (1000/mm$^2$), elongated nuclei, Activated keratocytes, Nerve fibers

b) **Posterior stroma** Less cellular (700/mm$^2$) Oval / bean shaped nuclei, Scanty nerves, Brighter background

c) **Endothelium** – Monolayer, Hexagonal / polygonal cells, Maximum intensity Homogenous bright cell body Dark borders, Nuclei: not seen

d) **Subepithelial plexus** - Beneath Bowman’s layer, 3 - 7 µ Wavy Beaded appearance, **Sub basal plexus** - Above Bowmans layer 2 - 4 µ

e,f) **Stromal Nerves**- Anterior-mid stroma Thicker (10 - 15 µ), Uniform thickness, Linear “ Y-shaped ” bifurcation.
Figure (a-e) Representative confocal photographs of patients with fungal keratitis – Fungal filaments appear as high reflective, double walled, septate filaments Size 3 - 8 μ, uniform width, irregular branching.
**Figure (1)**- Bacterial keratitis is characterized, activated keratocytes, with infiltration of leucocytes, and Langerhans cells. Bacteria typically not visualized.

**Figure (2)**- Acanthamoeba cysts present as highly reflective, double walled round particles 10–20 µm in diameter within the corneal epithelium and stroma. The inner wall has a hexagonal configuration.

**Figure (3)**- Viral keratitis is characterized by ovoid dendritic cells at the level of sub epithelial cells which are an indicator of disease activity which is often over looked on slit lamp examination.
Color coding the cornea

Fig 3.—Color code used in corneal drawing.
Fig 1.—Frontal view (left) and slit view (right) of acute herpes simplex iridocyclitis with hypopyon.

Fig 2.—Frontal (left) and slit (right) sketches of eye in Fig 1. (KP indicates keratic precipitates; HSV indicates herpes simplex keratitis.)
The management of corneal ulcer in developing nations poses several challenges.
Rationale management and early referral are crucial.
Microbial Keratitis

Objective

To give pearls on

- Etiological diagnosis based on clinical examination
- Initial treatment when microbiology back-up is unavailable
- Referral guidelines
- Role of fluoroquinolones, corticosteroids and voriconazole
Microbial Keratitis

How to make etiological diagnosis based on clinical examination?
Microbial Keratitis

Clinical Examination

- Detailed history
- Good slit-lamp biomicroscopic examination
  - Size of epithelial defect & infiltrate
  - Nature, depth and edges of infiltrate
  - Associated thinning
  - Surrounding cornea
Rapidly progressive disease with suppurative infiltrate
Microbial Keratitis

Clinical Picture

Slowly progressive disease with localized infiltrate
Microbial Keratitis

Clinical Picture

Rapidly progressive disease with suppurative infiltrate

- Bacteria
  - S. aureus
  - S. pneumoniae
  - Pseudomonas
  - N. gonorrhoea

- Mixed Infection
Microbial Keratitis

Clinical Picture

Slowly progressive disease with localized infiltrate

- Fungi
- Protozoa
Microbial Keratitis

Clinical Picture

Slowly progressive disease with localized infiltrate

- **Fungi**
- **Protozoa**
- **Bacteria**
  - *S. epidermidis*
  - \( \alpha \) hemolytic Streptococci
  - Actinomycetales
  - Moraxella
Microbial Keratitis

Clinical Picture

Gram positive cocci
Microbial Keratitis

Clinical Picture

Gram negative bacilli
Microbial Keratitis

Clinical Picture

Moraxella  
N. gonorrhoea
Microbial Keratitis

Clinical Picture

Nocardia
Microbial Keratitis
Clinical Picture

Nocardia

NTM
Microbial Keratitis
Clinical Picture

Fungi
Microbial Keratitis

Clinical Picture

Acanthamoeba
Microbial Keratitis

Clinical Picture

What is the role of microbiology?
Microbial Keratitis

Clinical Picture
Characteristic clinical features as an aid to the diagnosis of suppurative keratitis caused by filamentous fungi

P A Thomas, A K Leck and M Myatt

Br. J. Ophthalmol. 2005;89;1554-1558
doi:10.1136/bjo.2005.076315

CONCLUSIONS
The clinical features of microbial keratitis may vary considerably and no one clinical feature can be considered as absolutely pathognomonic of a particular type of aetiological agent.

Ophthalmologists are urged to send corneal scrapes for microbiology examination where facilities for ocular microbiology are available. However, where such facilities are not available, consider using the clinical diagnosis of filamentous fungi.
Microbial Keratitis
Clinical Picture

Characteristic clinical features as an aid to the diagnosis of suppurative keratitis caused by filamentous fungi

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Ophthalmologists are urged to send corneal scrapes for microbiology examination where facilities for ocular microbiology are available. However, where such facilities are not available, rapid assessment of clinical diagnosis of filamentous fungi is paramount.

Management based on laboratory work-up
Microbial Keratitis

Laboratory work-up

Requirement

- Well equipped laboratory
- Trained staff
- Cost and logistics
Microbial Keratitis

Laboratory work-up

Requirement

- Well equipped laboratory
- Trained staff
- Cost and logistics

Most Ophthalmologists cannot afford or do not have access to specialist microbiology facilities.
Microbial Keratitis

Laboratory work-up

Is this protocol necessary in all cases of infiltrative keratitis?

Empirical V/S Microbiology Based
Microbial Keratitis

Objective

To give pearls on

• Etiological diagnosis based on clinical examination
• Initial treatment when microbiology back-up is unavailable
• Referral guidelines
• Role of fluoroquinolones, corticosteroids and voriconazole
Microbial Keratitis

Guidelines for the Management of Corneal Ulcer at
Primary, Secondary & Tertiary Care health facilities in the South-East Asia Region

World Health Organization
Regional Office for South-East Asia
2004
Light microscopic examination of 10% KOH mount

This helps rule in fungal and acanthamoeba infection (Specificity 92%)
Microbial Keratitis

Management

Non-severe ulcer
(Unlikely to be fungal or Acanthamoeba)
Non-severe ulcer (smear negative)
(Unlikely to be fungal or Acanthamoeba)
Non-severe ulcer (smear negative)
(Unlikely to be fungal or Acanthamoenba)

Empirical therapy broad spectrum antibiotics
Poll Question 6

What types of empirical treatment do you commonly use

1. Fortified Cefazolin + Ciprofloxacin
2. Fortified Cefazolin + Gentamicin
3. Commercially available newer generation fluoroquinolones – Moxifloxacin
4. Broad spectrum Antibiotics and Antifungals
Microbial Keratitis
Management

Treatment of bacterial keratitis

• Ciprofloxacin / aminoglycoside
• Fortified cefazolin
• OR
• Either Moxifloxacin / Gatifloxacin
Non-severe ulcer
(Likely to be fungal)
Microbial Keratitis
Management

Non-severe ulcer (smear positive)
(Likely to be fungal)
Microbial Keratitis

Management

Non-severe ulcer (smear positive)
(Likely to be fungal)

Treat with antifungal agents
Microbial Keratitis

Management

Non-severe ulcer (smear negative)
(Likely to be fungal)
Microbial Keratitis

Management

Non-severe ulcer (smear negative)
(Likely to be fungal)

Refer to tertiary eye care centre
Microbial Keratitis

Management

Treatment with antifungal and anti-Acanthamoeba drugs must be started only after the organisms have been documented.
Microbial Keratitis

Objective

To give pearls on

• Etiological diagnosis based on clinical examination
• Initial treatment when microbiology back-up is unavailable
• Referral guidelines
• Role of fluoroquinolones, corticosteroids and voriconazole
Microbial Keratitis

Management

Severe keratitis cases must be treated at tertiary eye care center
Microbial Keratitis

Management

Referral

• All severe keratitis cases
• Clinically suspected fungal keratitis cases where fungi could not be demonstrated
• Cases worsening on empirical therapy
Microbial Keratitis

Objective

To give pearls on

- Etiological diagnosis based on clinical examination
- Initial treatment when microbiology back-up is unavailable
- Referral guidelines
- Role of fluoroquinolones, corticosteroids and voriconazole
Microbial Keratitis

Treatment

• History of pain, redness, watering, white opacity (OS)
• Denied history of trauma
• Associated dacryocystitis

Combination therapy?

Monotherapy?
Microbial Keratitis

Treatment

• **Gram Positive**
  - Cefazolin 50 mg/ml-133 mg/ml
  - Ceftazidime 50 mg/ml-133 mg/ml
  - Vancomycin 25-50 mg/ml
  - Chloramphenicol
  - Gatifloxacin/Moxifloxacin

• **Gram Negative**
  - Tobramycin 14 mg/ml
  - Gentamicin 14 mg/ml
  - Amikacin 50 mg/ml
  - Ciprofloxacin 3 mg/ml
  - Imipenem 5-10 mg/ml

Based on identification of organism
Microbial Keratitis

Case

- 35-year male
- H/O pain, redness, watering, white opacity (OS)
- Denied history of trauma
- Associated dacryocystitis

Fortified antibiotics?

Commercially available preparation?
Microbial Keratitis

Treatment

Fortified antibiotics

- Commercially not available
- Limited shelf-life
- pH and tonicity issues
- Toxicity
Microbial Keratitis

Treatment

Fluoroquinolones
• Commercially available
• Shelf life is not an issue
• Safe PH and tonicity
• Non-toxic
Time to Clinical Success

Kaplan-Meier Estimate of Life-Table Curves

(Preferred Analysis)

Log-Rank test:
Ofloxacin vs Fortified $p = 0.868$
Antibiotic Resistance

Fluoroquinolones

% of S. aureus Isolates Susceptible


Keratitis
Endophthalmitis
Conjunctivitis/blepharitis

## Antibiotic Resistance

### Fluoroquinolones

<table>
<thead>
<tr>
<th>Organism</th>
<th>Susceptibility</th>
<th>Gatifloxacin sensitivity (%)</th>
<th>Moxifloxacin sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cipro sensitive S.aureus</strong></td>
<td></td>
<td>39 (100)</td>
<td>37 (94.9)</td>
</tr>
<tr>
<td><strong>Cipro resistant S.aureus</strong></td>
<td></td>
<td>40 (41.2)</td>
<td>7 (7.2)</td>
</tr>
<tr>
<td><strong>Cipro sensitive CONS</strong></td>
<td></td>
<td>120 (100)</td>
<td>103 (85.3)</td>
</tr>
<tr>
<td><strong>Cipro resistant CONS</strong></td>
<td></td>
<td>84 (75.7)</td>
<td>28 (25.2)</td>
</tr>
<tr>
<td><strong>Cipro sensitive S.pneumoniae</strong></td>
<td></td>
<td>294 (97.7)</td>
<td>251 (83.5)</td>
</tr>
<tr>
<td><strong>Cipro resistant S.pneumoniae</strong></td>
<td></td>
<td>2 (40)</td>
<td>1 (20)</td>
</tr>
</tbody>
</table>
Microbial Keratitis

Treatment

Initial treatment: ≤2 mm infiltrate

• Fluoroquinolone
Microbial Keratitis

Treatment

Initial treatment – > 2 mm infiltrate

- Fortified cefazolin
- Fluoroquinolone or aminoglycoside
Microbial Keratitis

Treatment

Antibiotic Therapy

• Continue for as long as necessary
• Stop abruptly
• Do not taper
Microbial Keratitis

What is the role of corticosteroids?
Microbial Keratitis

Corticosteroids

- Blair et al. Canada J Ophthalmol 2011
- SCUT. Arch Ophthalmol 2012
## Microbial Keratitis

### Corticosteroids

**Cochrane Review**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>BSCVA</th>
<th>Healing rate / Time to re-epithelialization / Scar size</th>
<th>Adverse response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carmichael 1990</td>
<td>Insignificant</td>
<td>Insignificant</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Srinivasan 2009</td>
<td>Insignificant</td>
<td>Insignificant</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Blair 2011</td>
<td>Insignificant</td>
<td>Insignificant</td>
<td>Insignificant</td>
</tr>
<tr>
<td>SCUT 2012</td>
<td>Insignificant</td>
<td>Insignificant</td>
<td>Insignificant</td>
</tr>
</tbody>
</table>
Corticosteroids have limited role & are best avoided in corneal ulcers.
Microbial Keratitis

Case

- A 37-year male
- Symptoms of 21 days duration

How will you treat this case?
Fungal Keratitis

Management

Antifungal agents

• Polyenes – amphotericin B, natamycin
• Imidazole – Fluconazole, Itraconazole, Econazole
• Triazoles
• Fluorinated pyrimidines
# Fungal Keratitis Management

## Newer antifungal agents

<table>
<thead>
<tr>
<th>Azoles</th>
<th>Echinocandins</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voriconazole</td>
<td>Micafungin</td>
</tr>
<tr>
<td>Posaconazole</td>
<td>Caspofungin</td>
</tr>
<tr>
<td></td>
<td>Anidulafungin</td>
</tr>
</tbody>
</table>
Poll Question 7

What is the first line topical drug that you would prefer to use for management of fungal keratitis?

1. Natamycin
2. Voriconazole
3. Amphotericin B
4. Fluconazole
5. Others
Fungal Keratitis

What is the role of Voriconazole?
Fungal Keratitis Treatment

Comparison of Natamycin and Voriconazole for the Treatment of Fungal Keratitis

*Arch Ophthalmol.* 2010;128(6):672-678
Fungal Keratitis Management

Medical interventions for fungal keratitis (Review)

FlorCruz NV, Evans JR

THE COCHRANE COLLABORATION®
Fungal Keratitis

Management

Cochrane review – Key findings

- Variable quality & underpowered
- No good evidence for most comparisons except Natamycin and Voriconazole
### Fungal Keratitis Management

**Natamycin v/s Voriconazole**

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Arora et al 2011</th>
<th>MUTT 2013</th>
<th>Prajna et al 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical cure</strong></td>
<td>Nata N=15</td>
<td>Vori N=15</td>
<td>Nata N=162</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Vori N=161</td>
</tr>
<tr>
<td><strong>Number (%)</strong></td>
<td>15 (100)</td>
<td>14 (93.3)</td>
<td>NR</td>
</tr>
<tr>
<td><strong>Relative Risk</strong></td>
<td>1.07 (0.89 – 1.28)</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NR</td>
</tr>
</tbody>
</table>
## Fungal Keratitis Management

### Natamycin v/s Voriconazole

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Arora et al 2011</th>
<th>MUTT 2013</th>
<th>Prajna et al 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microbiological cure</td>
<td>Nata N=15</td>
<td>Nata N=155</td>
<td>Nata N=60</td>
</tr>
<tr>
<td></td>
<td>Vori N=15</td>
<td>Vori N4143</td>
<td>Vori N=60</td>
</tr>
<tr>
<td>Number (%)</td>
<td>NA</td>
<td>132 (85.2)</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 (52.1)</td>
<td>NA</td>
</tr>
<tr>
<td>Relative risk (95% CI)</td>
<td></td>
<td>1.64</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.38 to 1.94)</td>
<td></td>
</tr>
</tbody>
</table>
# Fungal Keratitis Management

## Natamycin v/s Voriconazole

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Arora et al 2011</th>
<th>MUTT 2013</th>
<th>Prajna et al 2010</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BCVA (Mean)</strong>&lt;br&gt;Nata N=15</td>
<td>1.37±0.88</td>
<td>0.39±0.53</td>
<td>0.69±0.88</td>
</tr>
<tr>
<td></td>
<td>Vori N=15</td>
<td>1.78±1.04</td>
<td>0.57±0.66</td>
</tr>
<tr>
<td><strong>Mean difference (95%CI)</strong></td>
<td>0.41 (−1.10 to 0.28)</td>
<td>-0.18 (−0.32 to −0.04)</td>
<td>0.06 (−0.22 to 0.34)</td>
</tr>
</tbody>
</table>
# Fungal Keratitis Management

## Natamycin v/s Voriconazole

<table>
<thead>
<tr>
<th>Outcome</th>
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</thead>
<tbody>
<tr>
<td>Adverse response</td>
<td>Nata N=15</td>
<td>Vori N=15</td>
<td>Nata N=60</td>
</tr>
<tr>
<td></td>
<td>Vori N=15</td>
<td>Nata N=141</td>
<td>Vori N=143</td>
</tr>
<tr>
<td>Number (%)</td>
<td>0 (0)</td>
<td>1 (6.66)</td>
<td>9 (15)</td>
</tr>
<tr>
<td></td>
<td>18 (12.8)</td>
<td>34 (23.8)</td>
<td>10 (16.6)</td>
</tr>
<tr>
<td>Relative risk (95%CI)</td>
<td>0.33 (0.89 to 7.58)</td>
<td>0.54 (0.32 to 0.90)</td>
<td>0.90 (0.39 to 2.06)</td>
</tr>
</tbody>
</table>
Conclusions

- Natamycin is currently the best drug against both molds and yeast.
- Contrary to popular belief, Voriconazole was found to be inferior especially against *Fusarium*.
- Voriconazole use is associated with a higher risk of adverse reactions.
Microbial Keratitis

Summary

It is important to be familiar with

• the science of managing corneal ulcer

• Art of making etiological diagnosis based on clinical examination

• WHO guidelines when microbiology is unavailable including referral

• Role of fluoroquinolones, corticosteroids and voriconazole
Acknowledgement

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Dr. Pravin V Krishna
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