Bacterial keratitis in the critically ill

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Abstract

Background—In the 4 year period (1988–91) there were nine cases of bacterial keratitis in five critically ill patients on an intensive care unit (‘unit A’), all except one due to *Pseudomonas aeruginosa*. Many of these patients had serious ocular complications requiring surgery and all surviving patients were left with significant visual deficits. One further case of keratitis due to *P aeruginosa* occurred on unit A in April 1993. The problem of keratitis in ventilated patients is not unique to this unit as a further four cases in three patients from additional units in this area have been treated.

Methods—Predisposing factors in unit A were established through subsequent investigations. It was found, in particular, that all the ocular infections were preceded by colonisation of the respiratory tract with the pathogenic organism. Recommendations concerning eye care and tracheal suctioning were adopted by unit A in 1991.

Results—In the subsequent 4 years (1991–5), the frequency of isolation of pseudomonas from the respiratory tract per patient treated in unit A remained relatively high at 3.8% (153/4032). However, the conjunctival pseudomonas isolation rate has decreased significantly (p <0.001) from 0.8% (19/2430) to 0.05% (2/4032).

Conclusions—Ventilated patients may be at risk from inoculation of pathogens into the eyes. The principal risk factor for bacterial keratitis in this series was corneal exposure secondary to conjunctival chemosis or lid damage. The adoption of simple preventative measures on unit A had a significant impact on the incidence of eye infections due to pseudomonas, despite the high proportion of patients whose respiratory tracts were colonised with the same organism. There is a need for additional research into the most effective method of eye care for ventilated patients in order to reduce the frequency of this avoidable condition.

In the past few years a total of 13 cases of bacterial keratitis in nine critically ill patients have been referred to Bristol Eye Hospital from a number of high dependency units in the region. Initially, a cluster of eight cases in two adults and three children were referred from one intensive care unit (‘unit A’). The effectiveness of revised eye care guidelines subsequently adopted by this unit was assessed by analysis of microbiological data. Since then there has been a further case on this unit. In addition we have treated two cases from a burns unit (‘unit B’), and another two cases from a paediatric intensive care unit (‘unit C’). Despite previous reports of similar cases, the problem persists and is not unique to this region, as there has been a report of five cases in other units this year.

Methods

The first five patients from unit A were treated between 1988 and 1991 (period 1) and a review of the eye care procedures resulted in recommendations which were adopted in the subsequent period 1991 to 1995 (period 2). Specimens were sent to the microbiology department for investigation when clinically indicated and were processed following the same protocols throughout the period 1988 to 1995. Data were collected and analysed retrospectively for the two periods from the database of routine microbiology stored on the pathology department computer system. Microbiological data have not been obtained from the other units where recent isolated cases have occurred.

Results

The surgical and ophthalmological details of the nine patients are summarised in Tables 1 and 2. All were in a critical condition, the majority requiring prolonged ventilation, and three did not survive their illness. The visual acuity of the six surviving patients was significantly impaired as a consequence of the ulceration and four required penetrating keratoplasty for corneal perforation. A summary of the microbiological results for unit A in the two periods before and after the introduction of the revised guidelines (Table 3) is displayed in Table 4. There were only two patients with positive conjunctival swabs for pseudomonas in the second period.
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Table 2  Ophthalmological and microbiological aspects of cases

<table>
<thead>
<tr>
<th>Case</th>
<th>Unit</th>
<th>Colonising organism* (day post admission)</th>
<th>Time between colonisation* and corneal ulceration (days)</th>
<th>Ocular isolate</th>
<th>Ocular pathology</th>
<th>Ocular outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>P aeruginosa (3)</td>
<td>3</td>
<td>P aeruginosa</td>
<td>Bilateral corneal ulcers</td>
<td>R clear graft amblpyia</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R corneal perforation requiring graft</td>
<td>VA 6/10 corrected</td>
</tr>
<tr>
<td>2</td>
<td>A</td>
<td>P aeruginosa (5)</td>
<td>3</td>
<td>P aeruginosa</td>
<td>L corneal ulcer and abscess</td>
<td>VA 2/60 corrected</td>
</tr>
<tr>
<td>3</td>
<td>A</td>
<td>P aeruginosa (6)</td>
<td>2</td>
<td>P aeruginosa</td>
<td>Bilateral corneal ulcers</td>
<td>VA 6/18 corrected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R corneal perforation requiring graft</td>
<td>VA 6/10 corrected</td>
</tr>
<tr>
<td>4</td>
<td>A</td>
<td>P aeruginosa (4)</td>
<td>1</td>
<td>Culture negative†</td>
<td>Bilateral corneal ulcers</td>
<td>VA 6/18 corrected</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>Streptococcus viridans (1)</td>
<td>2</td>
<td>Streptococcus viridans</td>
<td>R epithelial defect</td>
<td>VA 6/18 corrected</td>
</tr>
<tr>
<td>6</td>
<td>A</td>
<td>P aeruginosa (11)</td>
<td>2</td>
<td>P aeruginosa</td>
<td>L corneal ulcer</td>
<td>VA 6/0 corrected</td>
</tr>
<tr>
<td>7</td>
<td>B</td>
<td>P aeruginosa (6)</td>
<td>11</td>
<td>P aeruginosa</td>
<td>R corneal ulcer and perforation requiring graft</td>
<td>VA 6/0 corrected</td>
</tr>
<tr>
<td>8</td>
<td>B</td>
<td>P aeruginosa (18)</td>
<td>4</td>
<td>P aeruginosa</td>
<td>R corneal ulcer and perforation</td>
<td>VA 6/0 corrected</td>
</tr>
<tr>
<td>9</td>
<td>C</td>
<td>Streptococcus aureus (4)</td>
<td>7</td>
<td>Streptococcus aureus</td>
<td>Bilateral corneal ulcers</td>
<td>VA 6/10 corrected</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NPL (occipital infarcts)</td>
<td>VA 6/10 corrected</td>
</tr>
</tbody>
</table>

*Colonisation of respiratory tract, except cases 7 and 8 where wounds became colonised.
†Topical antibiotics commenced before swabs taken.
VA = visual acuity; HM = hard movements; NPL = no perception of light.

The overall proportion of patients treated on the unit who had a positive conjunctival pseudomonas isolate decreased by a factor of 16, from 0.8% in the first period to 0.05% in the second (p <0.001, Fisher’s exact test). There was also a significant reduction from 3% to 0.97% (p <0.001, χ² test) in the proportion of patients who required conjunctival swabs, and the pseudomonas isolation rate in these patients has significantly decreased from 26% to 5.1% (p = 0.015, Fisher’s exact test).

These differences are not due to a reduction in the time patients stayed on the unit, as there was an increase in the length of stay in days in the second period (Mann-Whitney U test: mean difference 9.9 days, p = 0.029). Equally, the background incidence of pseudomonas infection does not account for the differences, as there is no significant difference in the overall isolation rate of pseudomonas per specimen sent for analysis between the two periods (613/18 230 in period 1, 409/12 706 in period 2; χ² test, p=0.5).

The respiratory tract pseudomonas isolation rate in period 2 per patient treated on unit A was 3.8% (153/4032). This is lower than other studies, which have found colonisation rates between 6.5% and 7.8%. The isolation rate in period 1 is not known with certainty, as 1093 respiratory tract samples out of a total of 1698 did not specify their ward of origin accurately.

Discussion
Bacterial keratitis is a preventable sight threatening complication in the critically ill. Eye care should be a high priority even when the survival of the patient is in doubt, as poor vision can have a devastating effect on quality of life in those who recover. Thirteen cases in nine patients are reported in this series which occurred in three different units in this region.

There are many potential causative organisms of bacterial keratitis and it is important to prevent infection with any pathogen. The organism responsible both for the majority and for the most serious infections in this and other series, however, was Pseudomonas aeruginosa. This characteristically causes a devastating and rapid keratitis, that may lead to corneal thinning and perforation (Table 2).

To confirm a statistically significant reduction in bacterial keratitis rates before and after the adoption of the revised guidelines, a very large sample analysed over a long period...
would be necessary as bacterial keratitis as a proportion of patients treated is rare. However, in common with the other series,1-4 the majority of patients were colonised with the pathogenic organism in the period immediately before the keratitis developed (Table 2). Consequently, a comparison of the background incidence, colonisation, and ocular isolation rates between the two periods does give an indication of the effectiveness of eye care in preventing the spread of the organism from exogenous and endogenous sources to the eyes. After the introduction of the revised guidelines, despite a relatively high proportion of patients with respiratory tract pseudomonas isolates, there were fewer conjunctival isolates in all patients treated on unit A. Additionally, fewer patients had the clinical requirement for microbiological testing of conjunctival swabs, and of those analysed, fewer were positive for pseudomonas. All these differences are statistically significant (Table 4).

The elimination of the source of the pathogenic organisms is not realistic as long term critically ill patients have in common many risk factors for colonisation with such organisms5-11 (Table 1). The investigation of unit A revealed that suction of the trachea had been carried out over the patients’ heads. It has been shown in a prospective study that inoculation of respiratory pathogens into the tracheal stroma is possible, but a possible advantage may be that it forms a moist chamber and so protects the cornea even when marked exposure is present. There is a need for other units to be made aware of the risk to eyesight particularly in the presence of corneal exposure, and for evidence based nationally agreed guidelines for the eye care of critically ill patients to prevent further cases of this potentially serious problem.

However, it is not sufficient alone to adequately maintain lid closure when there is marked conjunctival chemosis, and it is possible for the gauze to cause a corneal abrasion if the gel is allowed to dry. There is as yet no published clinical trial on the use of Geliperm for eye care in intensive care units.

Another method of maintaining lid closure is by placing securing tape in a horizontal position over the closed eyelids.15 This was the recommended procedure on unit A for period 2. However, this may cause irritation to the skin and it may be difficult to obtain adequate lid closure, particularly if there is any lubricating ointment on the lids. Other methods include the use of Frost sutures or cling wrap.

The authors have no experience with cling wrap, but a possible advantage may be that it forms a moist chamber and so protects the cornea even when marked exposure is present. There is an urgent need for a prospective study on the most effective method of preventing corneal exposure on intensive care units.

The recommendations made to unit A are given in Table 3, and these have been effective in reducing the spread of pseudomonas to the eyes. These are not, however, intended to be definitive. In particular, although the early use of ganciclovir may prevent the infection becoming established, resistance may be encouraged. There is a need for other units to be made aware of the risk to eyesight particularly in the presence of corneal exposure, and for evidence based nationally agreed guidelines for the eye care of critically ill patients to prevent further cases of this potentially serious problem.