

# Aetiology and treatment of acute bacterial infection of the external eye

D. V. SEAL,<sup>1</sup> S. P. BARRETT,<sup>1</sup> AND J. I. MCGILL<sup>2</sup>

From the <sup>1</sup>Department of Microbiology, General Hospital, Southampton SO9 4XY, and <sup>2</sup>Southampton Eye Hospital, Southampton SO9 4XW

**SUMMARY** The microbial flora of 738 patients with acute bacterial conjunctivitis, corneal ulceration, blepharitis, dacryocystitis, and discharging sockets has been investigated. *Staphylococcus aureus*, *Streptococcus pneumoniae*, and *Haemophilus influenzae* were the main pathogens isolated. *Str. viridans* was associated with conjunctivitis in patients aged under 1 year. *Moraxella sp.* was isolated on only one occasion. Overall, 40% of specimens were associated with *Staph. epidermidis* or mixed skin flora, which also occurred with cultures of the normal eye. *Clostridium welchii* was isolated on 3 occasions but was not associated with bullae or gas gangrene. The least overall resistance, of 6%, was to chloramphenicol, but no one antibiotic was effective against all pathogens. Gentamicin remains the antibiotic of choice for *Pseudomonas aeruginosa* infection.

The bacterial pathogens causing acute infection of the external eye, and their pattern of antibiotic sensitivity, have not been investigated recently in the United Kingdom, though they have been in the United States of America.<sup>1-3</sup> Initial antibiotic treatment is on an arbitrary basis, often without preceding cultures, and is necessarily based on previous work.<sup>4</sup> However, types of pathogenic bacteria are gradually changing, as are their antibiotic sensitivities, often resulting from plasmid transfer of inactivating enzymes. We carried out the present study to identify current pathogens in various acute conditions and to determine the most appropriate topical antibiotics with which to treat them.

## Materials and methods

Patients were examined and clinical data recorded in the Casualty Department and Outpatient Clinic of Southampton Eye Hospital during January to December 1980. Eyes were sampled by culturing conjunctivae or lid margins with sterile cotton-wool swabs, which were placed in Stuart's transport medium for transfer to the laboratory. Second swabs were collected for anaerobic culture and were placed directly into thioglycollate broth.

Aerobic culture was performed on chocolate agar in 5% CO<sub>2</sub> in air at 37°C for 48 hours; fluid enrichment

medium was not used, as we wished to establish the predominant aerobic bacterial flora on a semi-quantitative basis. Anaerobic culture was carried out by incubating the thioglycollate broths for one week at 37°C and then subculturing them on to blood agar, supplemented with cystine and menadione, incubated anaerobically for 48 hours. Bacteria were identified by standard laboratory methods.<sup>5</sup> Antibiotic sensitivity testing was performed by Stokes's control method with discs<sup>6</sup> with tetracycline, neomycin, and gentamycin at 10 µg, chloramphenicol at 50 µg, and sulphacetamide at 100 µg.

Control cultures were taken from normal volunteer students and staff in the hospital.

## Results

The percentage isolation rates of aerobic bacteria for each clinical condition are given as pure and mixed growths in Table 1. Isolation rates of anaerobic bacteria are similarly given in Table 2. The percentage rates of antibiotic resistance for the various bacteria isolated as 'pure growths' above are listed in Table 3, together with the overall resistance rate to each antibiotic.

## Discussion

*Staphylococcus epidermidis* was isolated in pure growth from 57% of normal conjunctival controls and

Correspondence to J. I. McGill, DPhil, FRCS, Southampton Eye Hospital, Wilton Avenue, Southampton SO9 4XW.

Table 1 Aerobic bacterial growth

Clinical condition	Pure bacterial growth										Mixed bacterial growth					Total number of eyes/sockets
	<i>Staph. aureus</i>	<i>Staph. epidermidis</i>	<i>Str. pneumoniae</i>	<i>Str. viridans</i>	Enterococci	<i>Haemophilus influenzae</i> (Koch-Weeks bacillus)	<i>Moraxella</i> sp. ( <i>Axenfeld bacillus</i> )	<i>Coliform</i> sp.	<i>Staph. aureus</i> + <i>Staph. epidermidis</i>	<i>Staph. aureus</i> + <i>Str. pyogenes</i>	<i>Staph. aureus</i> + <i>Str. pneumoniae</i>	<i>Haemophilus influenzae</i> + beta haemolytic str.	Mixed coliforms sp.	Mixed skin flora ( <i>diphtheroids</i> , <i>Neisseria</i> sp., <i>Str. viridans</i> )	No growth	
<b>Conjunctivae</b>																
Normal controls	23	57	0	0	0	0	0	0	0	0	0	0	0	0	20	30
Conjunctivitis under 1 year	30	2	8	12	2	12	0	15	0	2	3	5	2	6	1	118
1 to 80 years	23	39	4	1	0	5	0	5	0	0	0	1	0	6	16	409
Corneal ulceration	17	12	2	0	2	0	0	3	0	0	0	0	0	27	37	66
Dacryocystitis	32	32	10	0	0	3	0	3	0	0	0	0	0	4	16	31
Discharging socket	36	10	0	0	9	0	0	27	0	0	0	0	0	18	0	11
<b>Lids</b>																
Normal controls	7	50	0	0	0	0	0	27	0	0	0	0	0	17		30
Blepharitis	26	34	2	0	0	1	1	3	3	0	0	1	0	11	18	103

All figures given are percentages of the total for each group.

Table 2 Anaerobic bacterial growth

Clinical condition	<i>Clostridium perfringens</i> ( <i>welchii</i> )	Anaerobic cocci	Total number of eyes
Conjunctivitis under 1 year	0	0	7
1 to 80 years	1*	2	103
Blepharitis	0	3	30
Dacryocystitis	3*	0	27
Corneal ulceration	3*	3	28
Discharging socket	0	0	3

All figures given are percentages of the total for each group.

\*Not associated with gas gangrene.

50% of normal lid controls. *Staph. aureus* was found in 23% of normal conjunctival controls as a pure growth, but in 27% of normal lid controls as a mixed growth with *Staph. epidermidis*; it was, however, found predominantly as a pure growth in blepharitis. Perkins *et al.*<sup>1</sup> found a *Staph. epidermidis* rate of 70% and a *Staph. aureus* rate of 13% in their normal conjunctival controls, which compared with other studies. The normal conjunctiva is thus usually colonised with *Staph. aureus* or *epidermidis* with a propensity for a pure growth of either, which needs to be considered when reviewing results of cultures of eye swabs. However, streptococci, haemophili, and

coliforms were never isolated from normal conjunctivae and lids. While we failed to isolate anaerobic bacteria from our normal eyes, Perkins *et al.* did so in a different fluid-enriched medium, finding *Propionibacterium acnes* in 44%, peptostreptococci in 6%, and *Clostridium* sp. in 1%. It is known, however, that there is an anaerobic environment within the lacrimal duct,<sup>7</sup> which is their probable source, rather than the conjunctiva, which has an aerobic environment.

We have previously investigated the bacterial flora in ophthalmia neonatorum<sup>8</sup> and isolated predominantly *Streptococcus viridans* and *Haemophilus influenzae*<sup>9</sup> when compared with controls, as well as *Staph. aureus* and *Chlamydia trachomatis*. We have now isolated similar pathogens, except chlamydiae, in children under 1 year old with acute conjunctivitis, as well as isolating *Str. pneumoniae* and coliform bacilli. However, we have not isolated *Str. viridans* from children over 1 year old or from adults with acute conjunctivitis, suggesting that it then ceases to be pathogenic to the conjunctiva. Mixed growths of staphylococci or haemophili with streptococci occurred in conjunctivitis only in children under 1 year. No cases of conjunctivitis were due to gonococci, meningococci,<sup>10</sup> moraxella,<sup>11</sup> or *Aeromonas hydrophilia*.<sup>12</sup> However, *Clostridium perfringens* (*welchii*) was isolated from one case and

Table 3 Antibiotic resistances of bacteria isolated in pure growth

	<i>Staph. aureus</i> *	<i>Streptococci</i>	<i>Haemophilus influenzae</i>	<i>Coliform sp. inc. Pseudomonas</i>	<i>Clostridium perfringens (welchii)</i>	% overall resistance
Chloramphenicol	2	0	0	35†	0	6‡
Tetracycline	5	7	0	31†	0	9‡
Gentamicin	2	100	8	2	100	19
Neomycin	3	100	6	6	100	20
Sulphafurazole	12	8	39	42†	0	22‡
Total numbers	189	54	36	52	3	334

All figures given are percentages of the total for each group.

\*76% resistant to penicillin.

†15% innate resistance of *Pseudomonas aeruginosa*.

‡2.4% innate resistance of *Pseudomonas aeruginosa*.

anaerobic cocci from another 2, but there was no evidence of gas gangrene or anaerobic cellulitis.

The 27 cases of dacryocystitis all had a similar flora to conjunctivitis in the adult, though it may be primarily due to an actinomycete.<sup>7</sup>

We cultured 66 eyes with different types of corneal ulceration thought to be bacterial in origin, but 24 yielded no growth. In the remainder we had similar isolations to those from conjunctivitis in the adult, except *Haemophilus influenzae*, which was not isolated in association with corneal ulceration. No cases were due to beta haemolytic streptococci<sup>13</sup> or *Pseudomonas* sp.<sup>14</sup> One case occurred from which *Clostridium perfringens* was isolated, but it was not associated with a bulbous lesion or a frothy coagulum.<sup>15</sup>

Discharging sockets were associated with *Staphylococcus aureus*, coliform spp., mixed skin flora, and enterococci. This is similar to the findings of Christensen and Fahmy.<sup>16</sup>

Both *Staphylococcus aureus* and *epidermidis* were isolated in pure growth from patients with blepharitis, but the significance of the *Staph. epidermidis* is doubtful, as it was present at a higher percentage in controls (50% controls versus 34% patients). This was not the case with *Staph. aureus* (7% versus 26%), whose isolation was thus significant ( $\chi^2=5.1$ ,  $0.05 > p > 0.01$ ). However, chronic staphylococcal blepharoconjunctivitis can be due to *Staph. epidermidis* in compromised hosts.<sup>17</sup> Occasional isolates of other pathogens occurred, including *Moraxella* sp., which is usually associated with chronic blepharoconjunctivitis<sup>11</sup> but can be isolated from chronic corneal ulcers.<sup>18</sup> There were no further cases of *Streptococcus pyogenes* gangrene (necrotising fasciitis) of the lids.<sup>19</sup>

Chloramphenicol has remained the most effective antibiotic for topical treatment of infection of the external eye with the least overall resistance of 6%, while tetracycline was the next most effective, with a

comparative overall resistance of 9%. Both chloramphenicol and tetracycline were less effective with coliform bacilli, for which the antibiotic of choice is gentamicin. It has previously been suggested that chloramphenicol drops should be instilled hourly when treating conjunctivitis and that preparations also containing corticosteroid should *not* be used for treating superficial infections of the eye.<sup>4</sup> Gentamicin remains the treatment of choice for *Pseudomonas aeruginosa* infection, but streptococci are resistant to it and contributed to the higher overall resistance. However, most ocular infections were caused by *Haemophilus influenzae*, *Staphylococcus aureus*, or *Streptococcus pneumoniae* or *viridans*, all of which are sensitive to chloramphenicol, which remains the most effective topical antibiotic for 'routine' use.

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