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Acute bacterial infections of the eye: their aetiology and treatment

V. M. MAHAJAN

From the Ocular Microbiology Section of Dr Rajendra Prasad Centre for Ophthalmic Sciences, All-India Institute of Medical Sciences, New Delhi—110029, India

SUMMARY The aerobic microbial flora of 823 eyes with acute bacterial conjunctivitis, corneal ulceration, dacryocystitis, discharging sockets, blepharitis, and postoperative infections has been investigated. Staphylococci, *Streptococcus pneumoniae*, and nonfermenting Gram-negative bacilli including *Pseudomonas aeruginosa* were the main pathogens. Fermenting coliforms were also infrequently isolated. The least overall resistance of 30·9% was to chloramphenicol, but no one antibiotic was effective against all pathogens. Cloxacillin is the best drug for staphylococcal and polymyxin B for pseudomonas infections.

The bacterial pathogens causing acute bacterial infections of the eye and their pattern of antibiotic sensitivity have recently been reported from the United Kingdom and the United States of America.[1–3] These types of pathogenic bacteria have gradually changed over the years, as have their antibiotic sensitivities. We carried out the present study to identify current pathogens in various acute conditions and to determine the most appropriate antibiotics for their treatment.

Materials and methods

The patients (543 eyes) were examined clinically in the Outpatient Department and admitted to hospital in the Dr Rajendra Prasad Centre for Ophthalmic Sciences during January to June 1981 before bacteriological specimens were taken from their eyes. Culturing of conjunctivae, lid margins, or sockets was done with sterile cotton-wool swabs. No transport medium was used, since the swabs were streaked on to sheep blood agar medium without any appreciable delay. Only aerobic cultures were done. Bacteria were identified by standard laboratory procedures. The sensitivity of these organisms to penicillin (10 units), streptomycin (15 μg), tetracycline (30 μg), chloramphenicol (10 μg), erythromycin (15 μg), framycetin (30 μg), gentamicin (10 μg), cloxacillin (1 μg), and polymyxin B (300 units) was tested by the disc diffusion technique, and the results were interpreted as recommended by Bauer *et al.*[4] Resistant strains of pseudomonas were tested against 10 μg of tobramycin.

Control cultures (280 eyes) were taken from patients who had come mostly for cataract extraction. Only clinically were clean eyes chosen. Postoperative infections included surgical wounds, endophthalmitis, and infections of the buckle or the corneal grafts.

Results

The percentage isolation rates of bacteria for each clinical category are given in Table 1. The percentage rates of antibiotic resistance for the various bacteria isolated are listed in Table 2 except those from postoperative infections, which have been separately shown in Table 3, for such infections in hospital patients could well be due to hospital strains.

Discussion

Staphylococcus epidermidis was isolated in pure cultures from 37·1% of normal conjunctival controls. No lid cultures were made from control subjects, since no significant difference has been reported to occur in the floras recovered from the eyelid margins and the conjunctiva.[5] *Staph. aureus* was found in 6·4% of the normal sacs as a pure growth. The lower rates in our study[1 3 5] are in all probability due to the use of dry cotton swabs for collection of material and not using a suitable transport medium to preserve the viability of the small number of organisms present.

Correspondence to Dr V. M. Mahajan.

Table 1 *Aerobes isolated from ocular tissues*

Clinical condition	*Percentage isolation rates*								*Total no. of eyes/sockets*
	Staph. aureus	*Staph. epidermidis*	*Str. pneumoniae*	*Ps. aeruginosa*	*Acineto-bacter*	*Coliforms*	*Mixed growth*	*No growth*	
Normal controls	6·4	37·1	0·3	0·7	1·0	—	2·4	51·8	280
Conjunctivitis	18·7	16·2	7·5	1·2	1·2	1·2	1·2*	52·5	80
Corneal ulceration	23·2	26·0	2·7	6·8	—	1·3	1·3†	39·0	73
Dacryocystitis	14·6	12·0	33·3	4·0	1·3	2·6	—	32·0	75
Discharging sockets	22·5	16·1	9·6	9·6	3·2	—	3·2‡	35·4	31
Fellow eyes	5·3	21·1	5·3	—	5·3	—	—	63·0	19
Blepharitis	73·3	6·7	3·3	—	6·7	—	—	10·5	30
Postoperative infections	34·4	16·5	0·4	5·1	1·2	—	—	42·1	235
% Overall positivity	20·8 (37·4)	24·6 (44·2)	4·8 (8·7)	3·1 (5·6)	1·2 (2·1)	0·4 (0·8)	0·4 (0·8)	44·2	823

*One case *Ps. aeruginosa*+*Acinetobacter*. †*Staph. aureus*+*Entero-aerogenes*+*Pr. mirabilis*. ‡One case *Staph. aureus*+*Acinetobacter*.
Percentages are of the total for each group, except those in parentheses, which are percentages of the total positive cultures.

Table 2 *Antibiotic resistance patterns (%) of bacteria isolated from ocular tissues*

Name of the organism	*No. of strains tested*	*P*	*S*	*T*	*CH*	*E*	*F*	*G*	*CL**	*PB*
Staph. aureus	91	97·8 (90·7)	66·6 (59·7)	69·2 (67·2)	29·6 (57·4)	36·2 (58·3)	69·2 (42·1)	36·2 (19·9)	0·0 —	NT
Staph. epidermidis	37	100·0 (89·4)	78·3 (76·8)	83·7 (85·4)	40·5 (79·4)	62·1 (78·8)	70·2 (32·4)	37·8 (27·1)	0·0 —	NT
Str. pneumoniae	37†	91·8	54·0	54·0	5·4	21·6	64·8	51·3	NT	NT
Ps. aeruginosa	14‡	NT	64·2 (56·3)	85·7 (83·9)	71·4 (88·5)	NT	78·5 (21·8)	28·5 (3·4)	NT	21·4 (27·6)
Acinetobacter	9	NT	44·4 (47·6)	55·5 (33·3)	44·4 (28·6)	NT	66·6 (19·0)	11·1 (23·8)	NT	NT
Fermenting coliforms	6	NT	66·6 (30·0)	66·6 (90·0)	33·3 (50·0)	NT	66·6 (0·0)	16·6 (0·0)	NT	NT
% Overall resistance	194	93·8 (89·2)	61·8 (61·1)	69·5 (72·8)	30·9 (64·9)	38·7 (66·1)	69·0 (32·6)	36·5 (19·1)	0·0	21·4 (27·6)

Abbreviations: P=penicillin, S=streptomycin, T=tetracycline, CH=chloramphenicol, E=erythromycin, F=framycetin, G=gentamycin, CL=cloxacillin, PB=polymyxin B, NT=not tested. Figures in parentheses denote percentages in our previous study.
*Sensitivity testing to cloxacillin was started in 1980.
†Sensitivity testing of pneumococci was also started in 1980.
‡One strain resistance to all, was sensitive to tobramycin.

Table 3 *Antibiotic resistance patterns (%) of bacteria isolated from postoperative infections of the eye*

Name of the organism	*No. of strains tested*	*P*	*S*	*T*	*CH*	*E*	*F*	*G*	*CL*	*PB*
Staph. aureus	81	100·0	90·0	91·3	77·7	85·1	98·7	93·8	3·7	NT
Staph. epidermidis	39	100·0	84·6	89·7	58·9	69·2	87·1	79·4	2·5	NT
Str. pneumoniae	1	Resistant to P, ST, T, and F							NT	NT
Ps. aeruginosa	12	NT	75·0	66·6	75·0	NT	75·0	58·3	NT	0 (0·0)
Acinetobacter	3	100·0	33·3	66·6	0·0	NT	33·3	0·0	NT	NT
% Overall resistance	136	100·0	86·0	88·2	69·8	79·3	91·9	83·8	3·3	0·0

Abbreviations as under Table 2.

The use of swabs wetted in broth for collection or the use of Stuart's medium during transport to the laboratory is clearly indicated and recommended. Only 2·4% of the cultures were mixed, diphtheroids being one of the organisms. Though the normal sac appears to be colonised mainly by *Staph. epidermidis* or *Staph. aureus*, other organisms like *Acinetobacter calcoaceticus*, *Pseudomonas aeruginosa*, and *Strepto-*

coccus pneumoniae were also isolated. The number of sterile cultures was also higher than in other reports.

Conjunctivitis in this series was chiefly caused by *Staph. aureus*, *Str. pneumoniae*, nonfermenting Gram-negative organisms, and fermenting coliforms. None of our cases yielded *Str. viridans*, *Neisseria*, *Moraxella*, or *Haemophilus* sp.[3] The high proportion of sterile cultures in this group, and the absence of these organisms from frank mucopurulent discharge, strongly suggest that routine inclusion of more media like chocolate agar is desirable. All the 6 isolates of pneumococci were from children under 3 years, and none from adults.[3]

We isolated 25 strains of *Str. pneumoniae* from 61 infants with dacryocystitis but only one from 14 adults. One adult yielded *Staph. aureus* not only from the eyes but also from the nose. In our study dacryocystitis in children seems to be caused mainly by pneumococci, though other pathogens may also be infrequently seen. It is noteworthy that over 90% of our isolates were resistant to penicillin—a finding hitherto infrequently reported.

We cultured 73 eyes with corneal ulceration, clinically diagnosed as bacterial in origin, but 28 yielded no growth. In the remaining 82·2% were the staphylococci (*Staph. epidermidis* 19, *Staph. aureus* 18). *Haemophilus* sp. and *Str. pyogenes* were never isolated. We did isolate *Ps. aeruginosa*, *Str. pneumoniae*, *Proteus mirabilis*, and *Enterobacter aerogenes*. These findings are similar to those reported elsewhere.[3 5]

A total of 31 discharging sockets yielded no growth in 35·4%. The remainder were associated with staphylococci, pneumococci, *Ps. aeruginosa*, and *Acinetobacter*. *Staph. aureus* was isolated from 22·5% of the sockets,[6 7] whereas only 5·3% of the fellow eyes harboured it. Interestingly, 63·0% of the fellow eyes did not contain any organism, though both the eyes were simultaneously swabbed and cultured. It would be more interesting to record that the strains of *Staph. epidermidis* isolated from fellow eyes were of different sensitivity patterns when compared with those from the sockets. The latter were resistant to many antibiotics.

Our results on cases of blepharitis differ significantly from those reported by Seal *et al.*[3] Of the 30 eyes cultured by us only 3 were sterile. Of the remainder 22 (73·3%) isolates were *Staph. aureus*. The strains of *Staph. epidermidis* in this category were the fewest.

Postoperative infected eyes (235) were also cultured. In this group the material was collected either from the conjunctiva, surgical wound, buckle, or corneal surface or was in the form of aqueous or vitreous aspirates. Of the 235 samples examined 42·1% were sterile, the figure nearly similar to other category of lesions. Staphylococci both coagulase positive and negative predominated. *Staph. aureus* outnumbered *Staph. epidermidis*, and next in frequency was *Ps. aeruginosa*. Nearly 60% of the 136 positive cultures were strains of *Staph. aureus*, whereas *Staph. epidermidis* accounted for only 28·6%. Here also nearly all the strains were resistant to most of the antibiotics.

The role of *Staph. epidermidis* in ocular disease has been the subject of much controversy recently, though it is known to be a potential pathogen after insertion of a surgical prosthesis and in urinary tract infections.[8 9] In ocular infections, also, sporadic reports have appeared of its being pathogenic in corneal ulcers,[10] postoperative infections,[11–13] and blepharoconjunctivitis.[14 15] Much experimental evidence has also accumulated to suggest that it caused corneal lesions of varying severity and also blepharitis in rabbits.[16–18] It therefore does not seem wise to ignore these organisms as commensals if they are isolated in some numbers from infected sites in view of the claims by clinical colleagues that corneal ulcers or postoperative infections due to this species responded to the timely application of appropriate antibiotics.[13 19 20] We therefore investigate routinely all cases of corneal ulcers, postoperative infections, chronic cases of conjunctivitis, and blepharitis for coagulase-negative staphylococci and report the sensitivities of the isolates. Interestingly, 30% of such isolates were shown to be capable of eliciting dermonecrotoxicity for rabbit skin, indicating the presence of alpha toxin. Highly dermonecrotoxic strains were haemolytic also for sheep and rabbit erythrocytes.[21]

Since we reported our previous study[22] certain notable differences have occurred in the resistance patterns of these organisms. For instance, the least overall resistance of 19·1% to gentamicin and 32·6% to framycetin has risen to 36·6% and 69·0% respectively. The number of strains resistant to penicillin has further increased. There has, however, been a considerable decline in percentage resistance of chloramphenicol and erythromycin. These 2 antibiotics are the second best to cloxacillin in treating staphylococcal infections. Chloramphenicol is also as effective as gentamicin against streptococci and infections due to Gram-negative organisms. The 100% resistance of penicillin to postoperative strains of staphylococci is noteworthy, as also is their increased resistance to other antibiotics. It is possible that the most frequently isolated strains of staphylococci from postoperative infections sensitive to either cloxacillin alone or to cloxacillin and chloramphenicol only are hospital strains. Accordingly cloxacillin, chloramphenicol, and gentamicin are the most frequently used topical ophthalmic preparations in our hospital. But polymyxin B is the first choice in infections due to *Ps. aeruginosa*.

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