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Correspondence

High oxacillin, vancomycin and fluoroquinolone resistance amongst biofilm forming *Staphylococcus aureus* isolates from ulcerative keratitis infections

Dear Editor,

Increasing antibiotic resistance in *Staphylococcus aureus*, a leading cause of ulcerative keratitis in the developing world, is of great concern.[1] Its ability to form biofilms on ocular surfaces enhances antibiotic resistance through several mechanisms.[2] Understanding of the resistance patterns amongst clinical isolates is a prerequisite for devising better treatment strategies and measures to mitigate emerging antibiotic resistance.

A total of 42 independent *Staphylococcus* isolates from cases of ulcerative keratitis around Kanpur were evaluated for antibiotic resistance using antibiotic discs (Hi Media, Mumbai, India) as per CLSI guidelines.[3] The ability of the isolates to form biofilms was characterised using the static microtitre plate assay.[4] Microbiological and biochemical characterisation of the isolates was performed as per Bergey's determinative bacteriology.[5] Of these, 75% (30/40) isolates were *S. aureus* and 23.8% (10/42) were coagulase-negative *Staphylococcus epidermis* and 4.7% (2/42) were *Micrococcus* sp.

85.72% (36/42) of the isolates were found to be high biofilm formers and 83% (35/42) were biofilm forming, multiple drug resistant (resistant to three or more classes of antibiotics). Pearson's correlation between biofilm formation and antibiotic resistance was found for *S. aureus* isolates of 0.6. Table 1 details the percentage resistance of total and biofilm forming isolates to the various antibiotics. Of the total isolates, 83.3% (35/42) were found to be oxacillin resistant, 57.14% (24/42) were ceftriazone resistant, 54.7% (23/42) were vancomycin resistant and 47.6% (20/42) were tobramycin resistant. It is alarming to note the high percentage of resistance to a number of antibiotics preferentially used for treatment of ocular infections, such as fluoroquinolones. Frequent usage of moxifloxacin in the treatment of ocular infections may be the cause of 76.2% (32/42) resistance to the fourth-generation fluoroquinolone moxifloxacin over ofloxacin (30.9%; 13/42) and levofloxacin (40.4%; 17/42). Low resistance is reported to gentamicin (26.1%; 11/42) which is less frequently used in ocular infections due to problems of poor ocular penetration. Low resistance to extended β lactamase antibiotic imipenem (4.7%; 2/42) is likely a consequence of drug usage only in emergency situations. Judicious use of emerging drugs is advisable as high antibiotic resistance is being measured in biofilm forming, methicillin-resistant *S. aureus* (MRSA) ocular infections to the most commonly used ophthalmic drugs.

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Table 1: Antibiotic resistance and biofilm formation in ulcerative keratitis isolates

Isolates		Antibiotics								
		CTR	GEN	IPM	LE	MO	OF	OX	TB	VA
S. aureus N = 30	Total	17 (56.5)	10 (33.3)	1 (3.3)	13 (43.3)	23 (76.6)	10 (33.3)	26 (86.6)	17 (56.5)	17 (56.5)
	Biofilm formers N = 27	16 (53.3)	9 (30)	1 (3.3)	12 (40)	21 (70)	9 (30)	24 (80)	16 (53.3)	13 (43.3)
S. epidermis N = 10	Total	6 (60)	0 (0)	0 (0)	3 (30)	8 (80)	2 (20)	8 (80)	2 (20)	5 (50)
	Biofilm formers N = 8	4 (40)	0 (0)	0 (0)	2 (20)	4 (40)	1 (10)	4 (40)	0 (0)	2 (20)
Micrococcus sp. N = 2	Total	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)
	Biofilm formers N = 2	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)	1 (50)
Total N = 42	Total	32 (76.2)	11 (26.1)	2 (4.7)	17 (40.4)	32 (76.2)	13 (30.9)	35 (83.3)	20 (47.6)	23 (54.7)
	Biofilm formers	21 (50)	10 (23.8)	2 (4.7)	15 (35.7)	26 (61.9)	11 (26.1)	29 (69)	17 (40.4)	16 (38)

CTR, Ceftriazone (30 mcg); GEN, Gentamicin (10 mcg); I, IPM (10 mcg); LE, Levofloxacin (5 mcg); MO, Moxifloxacin (5 mcg); OF, Ofloxacin (5 mcg); OX, Oxacillin (1 mcg); TB, Tobramycin (10 mcg); VA, Vancomycin (30 mcg) Figure within parentheses indicates percentage resistance

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