

# Spectral Analysis of Bacterial Keratitis and its Antibiotic Sensitivity in Western Odisha Population

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## Abstract

**Purpose:** Bacterial keratitis can cause severe corneal damage and vision loss due to ulcers, opacification, perforation, and endophthalmitis, but timely antimicrobial treatment and risk factor management can reduce complications. Aim of the study was to analyze the risk factors, changing spectrum of microbiological profile, antibiotic sensitivity pattern, treatment outcome by commonly used antibiotics inpatients, with diagnosed bacterial keratitis, in last half decade, at DHH and BBMCH tertiary eye care centre, Balangir. **Methods:** A retrospective study was done, based on review of all medical records of all patients diagnosed with bacterial keratitis and underwent corneal scraping for cultures at DHH and BBMCH tertiary centre, Balangir from March 1st 2017 to Feb 28th 2022. Demographics, clinical pattern, microbiological spectrum, antibiotic sensitivity and resistance and treatment outcome benefits were assessed. **Results:** Out of 1520 corneal ulcer samples, microorganisms were detected in 1175 (77.3%) patient samples. Bacterial isolates were found in 954 samples (81.2%). The most common bacterial isolates were of different species of *Staphylococcus epidermidis* i.e. 510(53.5%), followed by *Staphylococcus aureus* 128(13%), followed by *Streptococcus pneumoniae* 62 (6.5%) and *Pseudomonas aeruginosa* 60(6.3%). Out of all positive bacterial scrapes, Gram positive and Gram negative isolates were noticed in 78.8% and 21.2% samples respectively. Gram positive bacterial isolates were most susceptible to Gatifloxacin (96%) followed by Moxifloxacin and Ofloxacin. 92% of *Pseudomonas aeruginosa* isolates showed susceptibility to Amikacin and Gentamycin. Multidrug resistance i.e. resistance to more than three antibiotics was found in 28(45%) of 62 isolates of *Streptococcus pneumoniae*, 58(11.4%) of 510 isolates of *Staphylococcus epidermidis*, 22(17.2%) of 128 isolates of *Staphylococcus aureus*. No significant changes were observed profiles of microbial isolates and antibiotic sensitivity over time. Evisceration was done in 36 cases (2.4%) to check the infection. **Conclusions:** *Staphylococcus epidermidis* were the most common bacteria, responsible for bacterial keratitis in Western Odisha. Most of Gram positive and Gram-negative bacteria showed susceptibility to Gatifloxacin and Moxifloxacin respectively. Multi drug resistance was appreciated more in *Streptococcus pneumoniae* isolates. Duo antibiotic therapy should be preferred until culture and antibiotic sensitivity.

**Keywords:** Spectral analysis, Bacterial Keratitis, antibiotic sensitivity, microbial isolates, multi-drug resistance

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## Introduction

Bacterial keratitis is largely associated with vision loss, as sequelae due to Corneal opacification from scars, perforation and Endophthalmitis. Standard treatment protocols by use of antimicrobials along with check on risk factors lessens the prevalence of complications. The incidence of bacterial keratitis is showing increased shift in last few years, due to more contact lens users, increased facilities for culture and sensitivity, higher Ocular surface diseases (Dry eye) and systemic disorders like Diabetes, due to sedentary lifestyle. Keeping the increased prevalence and drug resistance in mind, broad spectrum antibiotics are used as empirical first line treatment of provisionally diagnosed cases. Hence this study was conducted to evaluate the spectrum of bacterial keratitis in the tertiary eye care set up of Western Odisha.

## Materials and Methods

This retrospective analysis of medical records was done at District Head Quarters / Bhima Bhoi Medical college Hospital, Balangir, taking surveys of presumed bacterial keratitis patients (corneal infiltrate >1 mm<sup>2</sup> with or without epithelial defect). Non-Corneal samples or NonBacterial infectious keratitis patients were excluded from this study.

Collected data included parameters like age, sex, affected eye, associated systemic disorders like Diabetes, Ocular surface disorders due to contact lens use, trauma, Steven Johnson syndrome, history of Ocular surgery or topical Corticosteroid use, detected microorganisms from Corneal culture, Antibiotic sensitivity and resistance.

Corneal scrapings were taken under topical anaesthesia. It was

collected by sterile disposable #15 Blade. Culture plates used for inoculation are Blood agar, Chocolate agar, Sabouraud's Dextrose agar or with chloramphenicol and brain heart infusion broth.

Incubation of plates was done at 37°C in 5% CO<sub>2</sub>. Culture positivity was finalized as significant, by growth of bacteria along line of inoculation or more than one solid medium or from one liquid and solid medium.

Bacterial isolates were divided as sensitive, intermediate or resistant, to tested antibiotics, which included Amikacin (30 micro gram), Chloramphenicol (30 micro gram), Gatifloxacin (5 micro gram), Ciprofloxacin (5 micro gram), Gentamycin and Tobramycin (10 micro gram), Moxifloxacin (5 micro gram). Antibiotic susceptibility was done by Standard agar disc diffusion method using discs from Hi media.

## Results

Over a period of five years, one thousand five hundred and twenty patients of Corneal ulcers, had been scrapped to analyze, the bacterial spectrum profile of infectious keratitis. The mean age of presentation was 48.2 +/- 19.2 years. Out of 954 Bacterial samples 532 (55.7%) were males and 422 were females (44.3%). Infective organisms (Bacteria, Fungi and Acanthameoba) were found in 1175 (77.3%) out of 1520 samples (Table - 1).

Seventy two percent of diagnosed infectious keratitis sample had reported previous ocular trauma by objects, followed by other mentioned risk factors too. (Table - 2)

Annual average of corneal scrapings from 2017 to 2022 was found as 304 +/- 53. Out of total 954 bacterial isolates, 731 were solely bacterial isolates and rest of 221 were of mixed type i.e. more than one species of bacteria or bacteria with fungus (Table - 1)

Presence of bacteria could not be revealed in 18 of 731 gram stained smears with single bacteria culture samples as compared to 7 of 221 patients whose culture showed mixed microbial growth. Out of 345 patient samples showing no growth, 82 Gram stained smears of corneal scrapings showed either Gram positive cocci or Gram negative bacilli markedly.

Isolates of gram stained samples accounted for gram positive and Gram negative in 752 (78.8%) and 202 (21.2%) cases respectively. (Table-3) Of all positive bacterial cultures, 645 (67.6%) samples had various species of Staphylococcus, followed by Streptococcus Pneumoniae(62,6.5%), Pseudomonas (60,6.3%), Bacillus sp. (32,3.3%), Acinetobacter sp. (56,5.8%). Less frequently isolated organisms were Enterobacter sp. Klebsiella pneumoniae, Flavobacterium and Serratia species. (Table-3)

Antibiotic susceptibility to isolated bacterial organisms were analyzed in Table- 4. Commonly used testing antibiotics like Gatifloxacin, Moxifloxacin, Ofloxacin, Tobramycin, Amikacin, Gentamycin, Chloramphenicol, Ciprofloxacin were considered because of their frequent usage.

Ninety six percent of Gram-positive isolates were susceptible to Gatifloxacin, followed by Moxifloxacin and Ofloxacin. 92% of Pseudomonas aeruginosa isolates showed susceptibility to Amikacin and Gentamycin and less to fluoroquinolones comparatively.

Twenty eight of 62 (45%) Streptococcus pneumonia isolates, 58 of 510 (11.4%) of Staphylococcus epidermidis and 22 of 128 (17.2%). Staphylococcus aureus isolates showed multi drug resistance. Even 4 out of 60 (7%) Ps. aeruginosa strains, 3 of 32 (9.3%) Bacillus sp. and 2 of 56 (3.6%). Acinetobacter sp. showed resistance to more than 3 antibiotics. None of the bacterial isolates showed resistance to all 8 antibiotics. (Table-5).

**Table 1: Spectral aetiological analysis of isolates of infectious keratitis over 5 years (2017 to 2022) at Western Odisha eye care.**

Year	Bacteria Only (n)	Fungal Only (n)	Mixed (Both) (n)	Others*	No Growth (n)	Total (n)
2017-18	155	46	48	6	72	327
2018-19	136	38	42	3	65	298
2019-20	162	42	49	5	70	334
2020-21	127	33	39	4	61	277
2021-22	151	45	43	1	77	284
Total	731	204	221	19	345	1520

**Table 2 : Spectral risk factors for infectious keratitis patients (2017-22)**

	Total	Bacteria Only	Fungal Only	Mixed	Others	No Growth
No. of patients	1520	731	204	221	19	345
	<b>846 (72%)</b>					
Trauma						
Mud/Soil	288	99	66	43	2	83
Leaf and Vegetable Matter	267	99	53	17	4	94
Insect	143	47	26	13	1	56
Stick	92	5	5	1	1	80
Tail	49	8	8	2	2	29
Stone	3	1	1	0	0	1
Wood	1	0	1	0	0	0
Ball	3	1	0	0	0	2
Irrational Use of Natural Eye Medicine	176	68	67	13	2	26
Use of anti-microbial eye drops	138	12	11	2	1	112
Contact lens wear	15	8	0	2	0	5

**Table 3: Spectral variation of bacterial isolates over 5 year study period (2017 to 2022)**

Bacterium	Total n (%)	2017-18	2018-19	2019-20	2020-21	2021-22
		n	n	n	n	n
Staphylococcus epidermidis	510 (53.5%)	112	98	104	99	97
Staphylococcus aureus	128 (13%)	30	24	26	27	21
Staphylococcus saprophyticus	7 (0.7%)	2	2	1	1	1
Staphylococcus Total	645 (67.6%)	144	124	131	127	119
Streptococcus pneumoniae	62 (6.5%)	14	13	14	12	9
Viridans streptococci	8 (0.8%)	3	1	1	1	2
Streptococci Total	70 (7.3%)	17	14	15	13	11
Total Gram-positive cocci	715	161	138	146	140	130
Bacillus sp.	32 (3.3%)	8	7	6	6	5
Corynebacterium diphtheria	5 (0.5%)	1	1	1	1	1
Gram positive bacilli Total	37	9	8	7	7	6
Gram positive isolates Total	752	170	146	153	147	136
Pseudomonas aeruginosa	160 (60.2%)	12	12	13	12	11
Acinetobacter	56 (5.8%)	11	12	10	13	10
Aeromonas sp.	21 (2.2%)	4	5	4	5	3
Enterobacter sp.	24 (2.5%)	4	4	6	4	4
Klebsiella pneumoniae	27 (2.8%)	6	5	6	6	4
Serratia sp.	8 (0.8%)	2	2	1	2	1
Flavobacterium	6 (0.6%)	2	1	1	1	1
Gram -ve total	202	41	41	41	45	34
Total isolates	954	211	187	194	192	170

**Table 4: Susceptibility of different common bacterial isolates (2017-2022)**

Organism (No of isolates)	GF n (%)	MO n (%)	CF n (%)	C n (%)	AK n (%)	G n (%)	TB n (%)	OF n (%)
Staphylococcus epidermis (510)	482 (94.5%)	358 (70%)	370 (72.5%)	376 (73.7%)	466 (91.3%)	435 (85.3%)	430 (84.3%)	361 (70.8%)
Staphylococcus Aureus (128)	124 (96.8%)	106 (82.8%)	108 (84.3%)	101 (78.9%)	122 (95.3%)	105 (82%)	102 (79.6%)	104 (81.2%)
Streptococcus Pneumoniae (62)	58 (93.5%)	54 (87%)	48 (77.4%)	46 (74.2%)	26 (41.4%)	23 (37.1%)	24 (38.7%)	49 (79.1%)
Bacillus spp. (32)	30 (90%)	26 (81%)	23 (71.8%)	22 (68.7%)	28 (87.5%)	27 (84.5%)	28 (87.5%)	24 (75%)
Pseudomonas (60)	45 (75%)	43 (71.5%)	42 (70%)	28 (46.7%)	55 (91.7%)	54 (90%)	52 (86.7%)	44 (73.3%)
Acinetobacter (56)	53 (94.6%)	51 (91%)	45 (80%)	44 (78.6%)	52 (92.8%)	46 (82.1%)	39 (69.6%)	46 (82.1%)

GF-Gatifloxacin, MO-Moxifloxacin, CF-Ciprofloxacin, C- Chloramphenicol, AK- Amikacin, G-Gentamycin, TB- Tobramycin, OF – Ofloxacin.

**Table 5: Spectrum of antibacterial resistance over period of 5 years (2017-2022)**

Resistance	S. epidermidis n (%)	S. aureus n (%)	S. pneumoniae n (%)	Bacillus sp. n (%)	Acinetobacter n (%)	Pseudomonas n (%)
0 antibiotic	234 (45.9%)	67(52.3%)	11(17.7%)	17(53.1%)	26(46.4%)	29(48.3%)
1 antibiotic	126 (24.7%)	23(18%)	11(17.7%)	9(28.1%)	18(32.1%)	16(26.6%)
2 antibiotic	92 (18%)	16(12.5%)	12(19.3%)	6(18.7%)	10(17.8%)	11(18.4%)
3 antibiotic	26 (5.1%)	12(9.3%)	14(22.6%)	2(6.2%)	1(1.78%)	2(3.3%)
4 antibiotic	22 (4.3%)	8(6.2%)	12(19.3%)	1(3.1%)	1(1.78%)	1(1.6%)
5 antibiotic	4 (0.8%)	1(0.8%)	1(1.6%)	0	0	1(1.6%)
6 antibiotic	4 (0.8%)	1(0.8%)	1(1.6%)	0	0	0
7 antibiotic	2 (0.4%)	0	0	0	0	0
8 antibiotic	0	0	0	0	0	0
Total isolates	510	128	62	32	56	60

n- number of antibiotics showing resistance

%- corresponding percentage

Tested antibiotics- Gatifloxacin, Moxifloxacin, Ciprofloxacin, Ofloxacin, Gentamycin, Amikacin, Tobramycin, Chloramphenicol

## Discussion

Bacterial keratitis is a sight threatening infection of cornea which leads to infiltration and corneal ulceration. Proper diagnosis and active treatment can lessen the complications there by resolving the infection completely. Culture of isolated corneal samples and test antibiotic sensitivity, plays major role in treatment outcome.

Trauma was found to be the most common predisposing factor (64%) in our study. Similar to Qatar [1], Iran [1], and Sudan [2]. Even mud, dust, soil (32%) followed by vegetative matter (28%) were reported to larger extent. Extreme climatic conditions of Western Odisha, perhaps triggered the exposure to more of wind, dust and mud.

Both urban and rural population are covered in our study population. So in contrast to more of contact lenses users, risk factors in Saudi Arabia, France and Australia [3], our study showed only in 14 patients (1.5%).

Around 77.3% corneal scrapings of four study isolates, had presence of microorganisms and it was relatively on higher side has compared to earlier studies in Australia, France [4,5,6] and other parts of world between 40% to 75%. In our analysis Gram positive cocci was recorded as 715 out of 954 (75%) bacterial isolates, which were almost similar to 69.1% [7] and 66% of other Indian studies. In contrary Bharati et al [8] and Donald et al [9] reported value as 83%.

Staphylococcus epidermis was the most common bacterial isolate in our study accounting to 53.5% of which resembled other studies of India, USA, Israel, Canada, France, New Zealand [10-13] Australia, Switzerland. Butler et al [14] and actively. Though S. pneumonia was detected as commonest causative bacterial organism in earlier results of Bangladesh, Saudi Arabia [15,16] and India (17) it was found only in 6.5% cases of our sample isolates. Our study percentage resembled with an Australian study where 8% of isolate were S. Pneumoniae.

Pseudomonas aeruginosa accounted for only 6.29% of isolates in our study as compared to commonest organism in studies from Florida and HongKong [18,19]. Climatic variations, lifestyle changes also contribute a lot, for differences in causative organism presentations of different study groups.

Ninety six percent of Staphylococcus species and 94% of S. pneumonia were susceptible to Gatifloxacin with 80% value of other studies. In our study around 74% of Gram positive organisms were susceptible to Ciprofloxacin, with S. epidermidis showing even less susceptibility. But comparatively 71.2% of S. epidermidis, 74.2% of S. aureus and 88.4% of S. pneumonia isolates were susceptible to Moxifloxacin. Hence it can be interpreted from our study, that Gatifloxacin should be preferred as first line therapy for gram positive bacterial keratitis which coincides with study results of Parmar et al [20]. Like other new Fluoroquinolones, Gatifloxacin also inhibits both DNA Gyrase and Topoisomerase IV, thereby showing less drug resistance.

Even large percentage of Ps. aeruginosa isolates showed susceptibility to Amikacin (92%), Gentamycin (92%) and relatively less susceptibility to Fluoroquinolones, i.e Ciprofloxacin (84.6%), Moxifloxacin (83.2%) and Gatifloxacin (77.4%). However various other studies showed varied range over period of years i.e. from as low as less than 1% to as high as 30% [21-23]. 100% susceptibility to all types of Gram stain isolates was reported, only in Moss et al study [24].

In our study susceptibility to Chloramphenicol was reported as 46% by Ps. aeruginosa isolates, there by contradicting the 100%

drug resistance of Tan DT et al study results and advised to be less preferred [25].

Table-5 shows the spectral pattern of common bacterial isolates, ranging from 100% susceptibility to multi drug resistance (even 8 antibiotics resistance). S. pneumoniae showed maximum degree of Multidrug resistance (45%) as compared to S. epidermidis (11.4%), S. aureus (17.2%), Ps.aeruginosa (9%), Bacillus sp. (9.3%) and Acinetobacter (7.7%). No bacterial isolates showed resistance to all the eight antibiotics, though some S. epidermidis strains showed resistance between 3 -7 antibiotics like Tuft SJ et al study results [26], Miller et al [27] and Agarwal et al [28] study results reflected the increased resistance pattern to newer fluoroquinolones, thereby sending an alarming signal to treatment outcomes of standard drug therapy.

## Conclusion

Staphylococcus epidermidis was mostly responsible for bacterial keratitis in Western Odisha. Gatifloxacin and Moxifloxacin were the susceptible antibiotics. Streptococcus pneumonia isolates showed maximum multi-drug resistance. Increased prevalence of bacterial keratitis and its complications over period of years, due to changes in antibiotic susceptibility patterns, is a huge challenge for successful visual outcome. Standard protocols of diagnosis and treatment should be strictly followed by treating or referring physicians. Antibacterials with less resistance, broad spectrum range and significant attainable therapeutic concentration should be indicated.

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