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# Potential bacterial pathogens of external ocular infections and their antibiotic susceptibility pattern at Hawassa University Teaching and Referral Hospital, Southern Ethiopia

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**Bacterial external ocular infection is a common health problem along with increase and spread of drug resistance in Ethiopia. The objective of this study was to identify potential bacterial isolate of external ocular infections and their antimicrobial susceptibility patterns in patients attending eye clinic of the Hawassa University Teaching and Referral Hospital, from December 2012 to April 2013. A total of 281 consecutive, non-repetitive ocular specimens were collected among conjunctivitis cases (n=140), blepharitis cases (n=55), keratitis cases (n=31), dacryocystitis cases (n=19), and other cases (n=36). All samples were processed for culture and identification by standard methods. Susceptibility testing was done by Kirby-Bauer method as per Clinical and Laboratory Standards Institute (CLSI) guideline. Out of 281 ocular specimens submitted to culture, 137 (48.8%) specimen were positive. The most common bacterial isolates were Gram positive cocci (n=88; 61.5%). The predominant bacterial species isolated was *Staphylococcus aureus* (n=30; 21.0%) followed by coagulase negative Staphylococci (CoNS) (n=26; 18.2%) and *Streptococcus pneumoniae* (n=20; 14.0%). *In vitro* ciprofloxacin was effective against 86% of isolated pathogen. Multi-drug resistance was observed in 69.9% of the bacterial isolates. Our study confirmed that *S. aureus* was the overall predominant isolated pathogen followed by CoNS, *S. pneumoniae and Klebsiella* spp. Gram positive isolates were more susceptible to amoxicillin-clavulanic acid and vancomycin, whereas Gram negative isolates were more susceptible to ciprofloxacin and gentamicin. Relatively, ciprofloxacin is effective against most isolated pathogen.**

**Key words:** External ocular infections, conjunctivitis, blepharitis, keratitis, dacryocystitis, susceptibility.

## INTRODUCTION

Ocular infections can cause damage to structures of the eye, which can lead to reduced vision and even blindness if left untreated. The cause of ocular infections can be bacteria, fungi, viruses and parasites (Joseph, 2009).

Bacteria are the most common pathogens and involved in infections of all the tissues of the eye. The most frequently affected part of the eye is conjunctiva, lid and cornea (Ubani, 2009) which are external part of the eye. External bacterial infections of the eye are usually localized but may frequently spread to adjacent tissue due to some predisposing factors such as during trauma, previous surgery, ocular surface disease, contact lens wear, ocular adnexal dysfunction (including tear deficiencies) and other exogenous factors, systemic diseases (Bharathi et al., 2003) and immunosuppression may alter the defense mechanisms of the outer eye and permit bacteria to spread (AOA, 1995; Seal and Uwe, 2007).

Bacterial agents are known to cause external ocular infections such as conjunctivitis, keratitis, blepharitis, hordeolum, dacryocystitis, etc. which are responsible for increased incidence of morbidity and blindness worldwide (Modarrres et al., 1998; Sharma, 2011). Clinical presentations are not diagnostic of the cause, so microbiological isolation and identification of bacterial pathogens along with antibiotic susceptibility pattern is essential (Finegold et al., 1990)

Even though, the clinical importance of external eye infections has been reported in some studies in Ethiopia (Alene and Abebe, 2000; Tiliksew, 2002), by clinical observation only, there are no much microbiologic studies with culture and drug sensitivity test which showed the magnitude of the problem. Due to lack of access to microbiology laboratory, high cost and long time for diagnosis, most clinicians advocate the use of broad-spectrum, empirical therapy and reserve culture for hyper acute conditions or those that fail to respond to initial therapy which in turn leads to emergence of antibiotic resistant bacteria and increased cost for proper management of infection.

In Ethiopia, it is a common practice that antibiotics can be purchased without prescription, which leads to misuse of antibiotics. This may contribute to the emergence and spread of antimicrobial resistance (Anagaw et al., 2011; Teweldeet al., 2013). Moreover, poor hygienic and infection control practice in the area may play a major role in an increased prevalence of resistant bacteria in a community. Thus, periodic monitoring of etiology and re-evaluation of antimicrobial agents is important to make a rational choice of initial antimicrobial therapy.

As far as our knowledge is concerned, no study has been conducted on identification of potential bacterial isolate and its distribution in the case of external ocular infection in different clinical features and their antibiotic susceptibility pattern in study area. Therefore, the aim of this study was to identify potential bacterial isolate and its distribution in the case of external ocular infection in different clinical features and their antibiotic susceptibility pattern of bacterial isolate at Hawassa University Teaching and Referral Hospital.

## MATERIALS AND METHODS

A cross-sectional study was conducted to identify potential bacterial isolate and their drug susceptibility pattern among 281 patients who were diagnosed as having external ocular infections at Hawassa University Teaching and Referral Hospital from December, 2012 to April, 2013. The hospital is a tertiary level teaching hospital that provides health service to over six million inhabitants in southern Ethiopia and is located 273 km south of Addis Ababa.

All patients examined and diagnosed on the slit-lamp bio-microscope by ophthalmologist as external ocular infections and willing to give written consent were included in this study. Patients on antibiotics for the past 1week were excluded. Demographic data was collected from patients using structured and predesigned questionnaire. Sample from external parts of the eye (eyelid, conjunctiva, lacrimal sac and cornea) was collected using either swabbing or scraping as per the routine clinical management of the patients (Tabbara and Robert, 1995). Specimens were immediately delivered to the bacteriology section for culture and other bacteriological analysis.

Specimens were cultured by the streak plate methods using wire loop into chocolate agar, MacConkey agar and two blood agar plates (Oxoid Basingstoke, UK). MacConkey agar and one blood agar plates were incubated at 37°C aerobically and the other blood agar and chocolate agar plates were incubated at 37°C with in a candle jar to enhance the growth of bacterial pathogens that needs 5-10% $CO_2$.

After overnight incubation, plates were examined for the growth of bacteria. Specimens taken from the eyelid, conjunctiva or lacrimal sac were considered as culture positive according to microbiological procedure for diagnosis of ocular infection (Therese and Madhavan, 2004). In the case of microbial keratitis, a culture was considered positive when there was growth of the same organism on two or more media or confluent growth of a known ocular pathogen at the site of inoculation on one solid medium (Pinna et al., 1999). Plates which did not show any growth were further incubated for additional 24 h. All positive cultures were identified by their characteristic appearance on their respective media and Gram stain reaction. Furthermore, it was confirmed by the pattern of biochemical reactions using the standard method (Cheesbrough, 2006).

Antimicrobial susceptibility testing was performed for bacterial isolates using disc diffusion method on Mueller-Hinton agar (Oxoid Basingstoke, UK) according to the direction of the Clinical and Laboratory Standards Institute (CLSI) (Bauer et al., 1966; CLSI, 2007). The antimicrobials for disc diffusion testing were obtained from Oxoid Basingstoke, UK in the following concentrations: trimethoprim-sulphamethoxazole (SXT, 25 μg), gentamicin (CN, 10 μg), penicillin (P, 10 IU), vancomycin (VA, 30 μg), ceftriaxone (CRO, 30 μg), erythromycin (E, 15 μg), ciprofloxacin (5 μg), tetracycline (30 μg), chloramphenicol (C, 30 μg), amoxicillin-clavulanicacid (AMC, 30 μg), ampicillin (AMP, 10 μg) and oxacillin (OX, 1 μg). *Escherichia coli* (ATCC 25922), *Staphylococcus aureus* (ATCC 25923) and *Pseudomonas aeruginosa* (ATCC 27853) were used as reference strains for culture and sensitivity testing. Data entry and analysis was performed using SPSS version-16. Descriptive summaries were presented and Chi-square test ($x^2$)

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**Table 1.** External ocular infections and different demographic characteristics among patients attending Hawassa University Teaching and Referral Hospital, 2013.

| Characteristics | Total tested (%) | Number positive (%) | Chi-square value | P-value |
|---|---|---|---|---|
| **Sex** | | | | |
| Male | 167(59.4) | 77(46.1) | 1.154 | 0.283 |
| Female | 114(40.6) | 60(52.6) | | |
| **Age in years** | | | | |
| ≤ 5 | 40(14.2) | 20(50.0) | 5.392 | 0.249 |
| 6-15 | 42(14.9) | 17(40.5) | | |
| 16-34 | 86(30.6) | 42(48.8) | | |
| 35-55 | 57(20.3) | 24(42.1) | | |
| >55 | 56(19.9) | 34(60.7) | | |
| **Residence** | | | | |
| Urban | 101(35.9) | 48(47.5) | 0.095 | 0.757 |
| Rural | 180(64.1) | 89(49.4) | | |
| **Occupation** | | | | |
| Farmer | 84(29.9) | 41(49.4) | 6.401 | 0.380 |
| House wife | 44(15.7) | 25(55.6) | | |
| Student | 49(17.4) | 23(46.9) | | |
| Employee | 31(11.0) | 10(32.3) | | |
| Merchant | 16(5.7) | 7(43.8) | | |
| Pre-school | 42(14.9) | 21(50.0) | | |
| Others* | 15(5.3) | 10(66.7) | | |
| **Education** | | | | |
| Pre-school | 43(15.3) | 22(51.2) | 1.242 | 0.537 |
| Illiterate | 124(44.1) | 64(51.6) | | |
| Literate | 114(40.6) | 51(44.7) | | |

Others*- daily laborer, driver and retired

was used to assess difference between proportions. P-value less than 0.05 were considered as statistically significant.

The study was approved by the Research and Ethical Review Committee of College of Medicine and Health Sciences, Hawassa University. Written consent was sought from all adult patients, while for the children and infants; written consent was obtained from their parents/guardians. All the data obtained were kept confidential by using only code numbers and locking the data. Participation of the study subjects was purely voluntary. Culture positive patients were treated accordingly.

## RESULTS

### Socio-demography of study population

A total of 281 patients clinically diagnosed as external ocular infection gave specimens for microbiological evaluation during the study period. Of these, 167 (59.4%) were males and 114 (40.6%) were females. The median age of the study subjects was 30 years (range, 1 day to 100 years). Most of the study participants were rural, 180 (64.1%) in residence, farmer 83 (29.5%) in occupation and illiterate 124 (44.1%) in educational status (Table 1).

### Bacterial isolate and clinical feature

Of the total processed external ocular specimens, 137 (48.8%) were found culture positive. The majority, 131 (95.6%) of the infected participants had single infection; while 6 (4.4%) were mixed infection, which makes the total number of bacterial isolates 143 (50.9%). *S. aureus* were the most predominant bacteria in mixed growth. The rate of isolation was higher among the age group > 55 years (60.7%) followed by age group ≤5 years (50.0%), among female (52.6%), those who were rural residence (49.4%) and among house wife (55.6%). Bacterial isolation in both sexes (P-value = 0.283) and various age

**Table 2.** Frequency of bacterial isolate from different clinical futures of ocular infections among patients attending Hawassa University Teaching and Referral Hospital, 2013.

| Clinical features | Total cases N (%) | Culture positive cases N (%) | Single bacterial isolates N (%) | Mixed bacterial isolates (%) | Total bacterial isolates N (%) |
|---|---|---|---|---|---|
| Blepharitis | 55(19.6) | 27(49.1) | 26(96.3) | 1(3.7) *** | 28 (19.6) |
| Conjunctivitis | 140(49.8) | 63(45.0) | 59(93.7) | 4(6.3) **** | 67 (46.9) |
| Blepharo-conjunctivitis | 7(2.5) | 2(28.6) | 2(100) | 0 | 2(1.4) |
| Keratitis | 31(11.0) | 14(45.2) | 13(92.9) | 1(7.1) ***** | 15(10.5) |
| Ex.Hordeolum* | 11(3.9) | 3(27.3) | 3(100) | 0 | 3(2.1) |
| Dacryocystitis | 19(6.8) | 16(84.2) | 16(100) | 0 | 16(11.2) |
| Lid abscess | 6(2.1) | 4(66.7) | 4(100) | 0 | 4(2.8) |
| Others ** | 12(4.3) | 8(66.7) | 8(100) | 0 | 8(5.6) |
| Total | 281 | 137(48.8) | 131(95.6) | 6(4.4) | 143(100) |

*Ex.hordeolum= external hordeolum, **orbital and preseptal cellulitis, post traumatic suppurativescleritis and lid laceration**,** ***1 case (*S.aureus* + *S. marcesens*), ****4 cases (*S. aureus* + *H.influenzae; S. pneumoniae* + *P. mirabilis, S. pyogenes; S. Viridians* + *E. coli*) ***** 1 case (*S. Aureus* + *E. coli*).

**Table 3.** Distribution of bacterial isolates from different clinical features of external ocular infections at Hawassa University Teaching and Referral Hospital, 2013.

| Bacterial isolate No. (%) | Blepharitis (55) | Conjunctivitis (140) | B. Conjunctivitis (=7) | Keratitis (=31) | Ex.hordeolum (=11) | Dacryocystitis (=19) | Lidabsces (=6) | Other (=12) | Total (=281) |
|---|---|---|---|---|---|---|---|---|---|
| *S. aureus* | 9(32) | 11(16.4) | 0 | 3(20) | 2(66.7) | 2(12.5) | 0 | 3(37.5) | 30(21) |
| CoNS* | 10(35.6) | 9(13.4) | 1(50) | 1(6.7) | 1(33.3) | 3(18.8) | 0 | 1(12.5) | 26(18.2) |
| *S. pneumoniae* | 1(3.6) | 8(11.9) | 0 | 4(26.6) | 0 | 5(31.3) | 1(25) | 1(12.5) | 20(14) |
| *S .pyogenes* | 1(3.6) | 4(6) | 0 | 1(6.7) | 0 | 0 | 0 | 0 | 6(4.2) |
| *S. viridians* | 1(3.6) | 3(4.5) | 0 | 1(6.7) | 0 | 0 | 0 | 1(12.5) | 6(4.2) |
| *Moraxella* spp. | 0 | 1(1.5) | 0 | 1(6.7) | 0 | 2(12.5) | 0 | 0 | 4(2.8) |
| *H. influenzae* | 0 | 6(8.9) | 0 | 0 | 0 | 0 | 0 | 0 | 6(4.2) |
| *Pseudomonas* spp. | 1(3.4) | 4(6) | 0 | 2(13.2) | 0 | 0 | 0 | 0 | 7(4.9) |
| *E. coli* | 1(3.6) | 3(4.5) | 1(50) | 1(25) | 0 | 0 | 0 | 0 | 7(4.9) |
| *Klebsiella* spp. | 0 | 5(7.5) | 0 | 1(6.7) | 0 | 2(12.5) | 0 | 0 | 9(6.3) |
| *Citrobacter* spp. | 0 | 2(3) | 0 | 0 | 0 | 1(6.2) | 0 | 0 | 3(2.1) |
| *Entrobacter* spp. | 1(3.6) | 3(4.5) | 0 | 0 | 0 | 0 | 0 | 1(12.5) | 5(3.4) |
| *S.marcescens* | 1(3.6) | 1(1.5) | 0 | 0 | 0 | 0 | 2(50) | 0 | 4(2.80 |
| *P.mirabilis* | 1(3.6) | 3(4.5) | 0 | | 0 | 1(6.2) | 0 | 0 | 5(3.4) |
| Other NLF** | 1(3.6) | 4(6) | 0 | 0 | 0 | 0 | 0 | 0 | 5(3.4) |
| Total (%) | 28(19.6) | 67(46.8) | 2(1.4) | 15(10.5) | 3(2.1) | 16(11.2) | 4(2.8) | 8(5.6) | 143(100) |

*Ex.hordeol um = external hordeolum, *CoNS: Coagulase negative *Staphylococci,* **other NLF: non lactose fermenter Gram negative rods (*Salmonella, Shigella* and *Providencia* spp.)

groups (P-value = 0.249) were not statistically significant.

Out of 281 cases of eye infections studied, conjunctivitis accounted for 140 (49.8%) followed by blepharitis 55 (19.6%), keratitis 31 (11.0%), dacryocystitis 19 (6. 8%), external hordeolum 11 (3.8%), blepharo-conjunctivitis 7 (2.5%), lid abscess 6 (2.1%) and others like orbital and preseptal cellulitis, post traumatic suppurative scleritis and lid laceration accounted for 12 (4.3%). The rate of culture-positivity was found to be significantly higher among study subjects with dacryocystitis 84.2% (AOR = 7.876 (95% CI: 1.80-34.29) (p=0.006), than lid abscess 66.7% (4 of 6), blepharitis 49.1% (27 of 55), keratitis 45.2% (14 of 31), conjunctivitis 45% (63 of 140), blepharoconjunctivitis 28.6% (2 of 7), external hordeolum 27.3% (3 of 11) and other infections 66.7% (8 of 12) (Table 2).

In this study, the predominant isolate observed in blepharitis cases was CoNS (35.6%) followed by *S. aureus* (32%); in conjunctivitis was *S. aureus* (16.4%); in keratitis and dacryocystitis were *S. pneumoniae* (26.6 and 31.3%), respectively. All the isolated *Haemophilus influenzae* were recovered from conjunctivitis cases (Table 3).

The overall predominant isolated pathogen was *S. aureus* (30; 21%) followed by CoNS (26; 18.2%), *S. pneumoniae* (20; 14.0%), *Klebsiella* spp. (9; 6.3%),

**Table 4.** Antibiotics sensitivity pattern of bacterial isolates at Hawassa University Teaching and Referral Hospital, 2013.

| Bacterial isolates | No. of strains sensitive to Antibiotics (%) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | AMP | AMC | CRO | C | CIP | CN | TE | SXT | OX | E | P | VA |
| **Gram positive** | | | | | | | | | | | | | |
| *S. aureus* | 30 | 9(30) | 27(90.0) | 28(93.3) | 28(93.3) | 28(93.3) | 28(93.3) | 12(40.0) | 23(76.7) | 28(93.3) | 25(83.3) | 5(16.7) | 29(96.7) |
| CoNS* | 26 | 18(69.2) | 25(96.2) | 22(73.3) | 19(73.1) | 21(81.8) | 20(76.9) | 9(34.6) | 16(61.5) | 21(80.8) | 23(88.5) | 2(7.7) | 24(92.3) |
| *S. pneumoniae* | 20 | 16(80.0) | 20(100) | 20(100) | 18(90.0) | 18(90.0) | 6(30.0) | 14(70.0) | 11(55.0) | 15(75.0) | 19(95.0) | 13(65.0) | 20(100) |
| *S. pyogenes* | 6 | 6(100) | 6(100) | 6(100) | 5(83.3) | 5(83.3) | 3(50.0) | 4(66.7) | 2(33.3) | 6(100) | 5(83.3) | 6(100) | 6(100) |
| *S. viridians* | 6 | 6(100) | 6(100) | 6(100) | 5(83.3) | 5(83.3) | 4(66.7) | 5(83.3) | 3(50.0) | 4(66.7) | 6(100) | 4(66.7) | 6(100) |
| **Total Gram positive** | 88 | 55(62.5) | 84(95.5) | 82(93.1) | 75(85.2) | 75(85.2) | 59(67) | 43(48.9) | 55(62.5) | 73(83.0) | 75(85.2) | 28(31.8) | 85(96.6) |
| *Moraxella* spp. | 4 | 4(100) | 4(100) | 4(100) | 4(100) | 4(100) | 3(75.0) | 2(50.00 | 3(75.0) | ND | ND | ND | ND |
| *H. influenzae* | 6 | 2(33.3) | 6(100) | 6(100) | 6(100) | 5(83.3) | 5(83.3) | 3(50.0) | 2(33.3) | ND | ND | ND | ND |
| *Pseudomonas* spp. | 7 | 0 | 1(14.3) | 1(14.3) | 5(71.4) | 7(100) | 7(100) | 5(71.4) | 7(100) | ND | ND | ND | ND |
| *E. coli* | 7 | 4(57.1) | 7(100) | 5(71.4) | 6(85.7) | 5(71.4) | 5(71.4) | 6(85.7) | 6(85.7) | ND | ND | ND | ND |
| *Klebsiella* spp. | 9 | 1(11.1) | 7(77.8) | 8(88.9) | 8(88.9) | 8(88.9) | 8(88.9) | 8(88.9) | 8(88.9) | ND | ND | ND | ND |
| *Citrobacter* spp. | 3 | 1(33.3) | 3(100) | 2(66.7) | 1(33.3) | 3(100) | 1(33.3) | 0(0.0) | 2(66.7) | ND | ND | ND | ND |
| *S. marcescens* | 4 | 1(25.0) | 1(25.0) | 1(25.0) | 3(75.0) | 4(100) | 4(100) | 3(75.0) | 4(100) | ND | ND | ND | ND |
| *P. mirabilis* | 5 | 0 | 3(60.0) | 3(60.0) | 3(60.0) | 5(100) | 5(100) | 3(60.0) | 3(60.0) | ND | ND | ND | ND |
| Other NLF | 5 | 0 | 1(20.0) | 3(60.0) | 3(60.0) | 5(100) | 5(100) | 3(60.0) | 5(100) | ND | ND | ND | ND |
| Total Gram negative | 55 | 16(29.1) | 37(67.3) | 38(69.1) | 38(69.1) | 49(89.1) | 48(87.3) | 36(65.5) | 44(80.0) | | | | |
| Overall total | 143 | 68(47.5) | 117(81.8) | 115(80.4) | 114(79.7) | 123(86) | 101(70.6) | 77(53.8) | 95(66.4) | 74(84.1) | 78(88.6) | 30(34.1) | 85(96.5) |

*CoNS: Coagulase negative *Staphylococci*, Amp- Ampicillin, AMC-Amoxicillin-clavulanic acid, CRO- Ceftriaxone, C- Chloramaphenicol , CIP- Ciprofloxacin, CN- Gentamycin, TE- Tetracycline, SXT- Co-trimoxazole , OX, oxacillin, E- Erythromycin, P- penicillin, VA- Vancomycin, ND-not done.

*Pseudomonas* spp. and *E. coli* (7; 4.9% each), *Streptococcus pyogenes, Streptococcus viridians and H. influenzae* (6; 4.2% each), *Entrobacter* spp., *P. mirabilis*, *Moraxella* spp. and *S. marcescens* (4; 2. 8% each), *Citrobacter* spp. (3; 2.1%) and non-lactose fermenting (NLF) Gram negative rods (5; 3.4%) (Table 3).

### Antibiotic resistance profile of bacterial isolate

Antimicrobial susceptibility of isolated bacteria is as follows: Vancomycin (96.5%), Erythromycin (88.6%), Ciprofloxacin (86%), Oxacillin (84.1%), Amoxicillin-clavulanic acid (81.8%), Ceftriaxone (80.4%), Chloramaphenicol (79.7%), Gentamycin (70.6%), Trimethoprim-sulphamethoxazole (66.4%), Tetracycline (53.8%), Ampicillin (47.5%), Penicillin (34.1%) (Table 4).

### Multidrug resistance

In this study, the overall multi-drug resistance (resistance two or more) antimicrobials were 100 (69.9%) and only 14 (9.8%) were sensitive to all antimicrobials tested (Table 5).

## DISCUSSION

An external ocular infection is a major public health problem in Ethiopia. In this study, the overall prevalence of bacterial external ocular infections was 48.8%, which is similar to previous result in central Ethiopia (Addis Ababa) (47.4%) (Nigatu, 2004) and northwest Ethiopia (Gondar) (54.2%) (Anagaw et al., 2011). However, it is lower than result from other study in Gondar (60.8%) (Dagnachew et al., 2014), southwest Ethiopia (Jimma) (74.7%) (Tewelde et al., 2013) and other countries such as: India (58.8%)

**Table 5.** Multiple antibiotic resistance pattern of bacterial isolate from external ocular infection, Hawassa University Teaching and Referral Hospital, 2013.

| Organism | Antibiogram pattern | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | No. (%) | R0 | R1 | R2 | R3 | R4 | R5 | R6 |
| *S. aureus* | 30(21.0) | 2(6.7) | 3(10.0) | 6(20.0) | 13(43.3) | 2(6.7) | 1(3.3) | 3(10.0) |
| CoNS* | 26(18.2) | 0 | 7(27.0) | 1(3.8) | 7(27.0) | 3(11.5) | 3(11.5) | 5(19.2) |
| *S. pneumoniae* | 20(14.0) | 2(10.0) | 6(30.0) | 5(25.0) | 2(10.0) | 1(5.0) | 2(10.0) | 2(10.0) |
| *S. pyogenes* | 6(4.2) | 0 | 1(16.7) | 3(50.0) | 1(16.7) | 1(16.6) | 0 | 0 |
| *S. viridians* | 6(4.2) | 1(16.7) | 1(16.7) | 2(33.2) | 1(16.7) | 1(16.7) | 0 | 0 |
| *Moraxella* spp | 4(2.8) | 2(50.0) | 1(25.0) | 0 | 1(25.0) | 0 | 0 | 0 |
| *H. influenzae* | 6(4.2) | 1(16.7) | 1(16.7) | 1(16.7) | 2(33.2) | 1(16.7) | 0 | 0 |
| *Pseudomonas* spp. | 7(4.9) | 0 | 1(14.2) | 0 | 2(28.7) | 4(57.1) | 0 | 0 |
| *E. coli* | 7(4.9) | 2(28.6) | 2(28.6) | 2(28.6) | 0 | 0 | 0 | 1(14.2) |
| *Klebsiella* spp. | 9(6.3) | 0 | 5(55.6) | 1(11.1) | 3(33.3) | 0 | 0 | 0 |
| *Citrobacter* spp. | 3(2.1) | 1(33.3) | 0 | 0 | 0 | 2(66.7) | 0 | 0 |
| *Entrobacter* spp. | 5(3.4) | 3(60.0) | 0 | 0 | 1(20.0) | 1(20.0) | 0 | 0 |
| *S. marcesens* | 4(2.8) | 0 | 1(25.0) | 0 | 1(25.0) | 2(50.0) | 0 | 0 |
| *P. mirabilis* | 5(3.5) | 0 | 0 | 1(20.0) | 2((40.0) | 2(40.0) | 0 | 0 |
| NLF Gram negative rods*[2] | 5(3.5) | 0 | 0 | 2(40.0) | 1(20.) | 2(40.) | 0 | 0 |
| Total | 143(50.9) | 14(9.8) | 29(20.3) | 24(16.8) | 37(25.9) | 22(15.4) | 6(4.1) | 11(7.7) |

$R_o$ - sensitive to all antibiotics; $R_1$ - resistant to 1 antibiotic; $R_2$ - resistant to 2 antibiotics; $R_3$- resistant to 3 antibiotics; $R_4$- resistant to 4 antibiotics, $R_5$ - resistant to 5 antibiotics $R_6$ - resistant to 6 and more antibiotics, *CoNS: coagulase negative Staphylococci.

(Bharathi et al., 2010). The varying rate of isolation from one place to another might be due to varying distribution of bacterial aetiology with geographic variation, study period, variation with the study population and infection prevention practice in diverse settings.

In this study, Gram positive cocci are still the most common isolates (61.5%). Several other studies in Ethiopia (Nigatu, 2004; Anagaw et al., 2011; Tewelde et al., 2013 and Dagnachew et al., 2014); in India (Sherwal and Verma, 2008; Bharathi et al., 2010; and Ramesh et al., 2010), in Nigeria (Ubani, 2009); in USA (Adebukola et al., 2011) and other parts of world have shown similar results inferring Gram positive cocci as a primary cause of bacterial ocular infection. The predominant bacterial isolates were *S. aureus* (21.0%) followed by CoNS (18.2%) and *S. pneumoniae* (14.0%). This finding is in agreement with previous works elsewhere (Modarrres et al., 1998; Nigatu, 2004; Ubani, 2009; Bharathi et al., 2010 and Anagaw et al., 2011). However, in other studies by Dagnachew et al. (2014) and Summaiya et al. (2012), the predominant isolates were CoNS. The increased prevalence of Gram positive cocci may be due to contamination of the eye from skin normal flora as a result of touching eyes with hands, cataract extraction, lens implantation, and use of contact lens.

The rate of isolation was higher among the age group >55 years (60.7%) followed by age group ≤5 years (50.0%). The prevalence of ocular infection was not significantly associated with age. However, statistically significant association was observed in the age group ≤ 2 years in study conducted in Gondar (Dagnachew et al., 2014) and Iran (Modarrres et al., 1998). The reason for increased susceptibility to infection in babies may be that they are at a greater risk after their maternal immunity has disappeared and before their own immunity system had matured (Ubani, 2009), while in old age it may be due to dry eye and weaning immunity. Moreover, similar to previous study conducted in Ethiopia (Anagaw et al., 2011) and Iran (Modarrres et al., 1998*)* the prevalence of ocular infection has no significant association with sex.

Among the clinical features, significant association of culture-positivity was observed among study subjects with dacryocystitis which is in agreement with the study done in India (Bharathi et al., 2010). *S. pneumoniae* was found to be the predominant isolate in the cases of microbial dacryocystitis (31.3%) and keratitis (26.6%). This is in agreement with study conducted in Addis Ababa (Nigatu, 2004) and India (Bharathi et al., 2003, 2007; Sherwal and Verma, 2008; Prakash et al., 2012). However, studies conducted in Jimma (Tewelde et al., 2013), China (Zhang et al., 2008) and Malaysia (Hooi, 2005) showed *P. aeruginosa,* was found to be the predominant isolate in cases of microbial keratitis. This may be due to difference in study population, study period, health of cornea and geographic location. While, the predominant isolate observed in blepharitis cases were CoNS (35.6%) followed by *S. aureus (*32%). This is in agreement with the study conducted in Iran (Modarrres et al., 1998), i India (Sherwal and Verma, 2008), Nigeria (Ubani, 2009) and Jimma (Tewelde et al., 2013). The reason for high rate of CoNS and *S. aureus* among blepharitis cases may be virulence factor such as exoenzymes and a surface slime that may play a role in the pathogenesis (Abdalla et al., 2014).

Rapid use of antibiotics for severe ocular infections is routine in ophthalmic practice resulting in increased drug resistance. In our study, among the commonly used topical antibiotics 20.3% of all strains were chloramphenicol resistant; 29.4% of all strains and 70% of *S. pneumoniae* were resistant to gentamicin. Moreover, 46.8% of all strains were tetracycline resistant. While, ciprofloxacin were susceptible in 80-100% of all strains except for *E. coli* (71.4%). This is in agreement with the study conducted in Gondar (Anagaw et al., 2011) and Jimma (Tewelde et al., 2013). The reason for increased resistance for chloramphenicol, gentamicin and tetracycline may be earlier exposure of the isolates to these drugs (allocated as first line drug). Moreover, these drugs are very common due to low cost and often purchased without prescription in different areas while, ciprofloxacin were reserved for refractory cases (DACA, 2010).

In this study, most of bacterial isolates have shown high resistance to penicillin (65.9%), ampicilin (52.5%) and trimethoprim-sulphamethoxazole (33.6%). Similar findings have been reported in Gondar (Anagaw et al., 2011), Jimma (Tewelde et al., 2013) and Iran (Modarrres et al., 1998). However, ceftriaxone (80.4%), amoxicillin-clavulanic acid (81.8%), oxacillin (84.1%), erythromycin (88.8%) and vancomycin (95.6%) showed susceptibility. This is in agreement with study conducted in Gondar (Ferede et al., 2012) and Gujarat (Summaiya et al., 2012).

Prevalence of multidrug resistance (MDR) to two or more of bacterial isolates to the commonly prescribed antimicrobials was observed in 69.9% of the isolates. This is in agreement with the previous studies (Anagaw et al., 2011; Ferede et al., 2012). However, high prevalence of multidrug resistance was previously reported in Gondar (Dagnachew et al., 2014). This may be due to the difference in type and generation of antibiotic that we use for susceptibility testing. In this study, the limitations were due to lack of facility anaerobic bacteria and *Chlamydia trachomatis* were not isolated.

## Conclusion

*S. aureus* was the overall predominant isolated pathogen followed by CoNS, *S. pneumoniae and Klebsiella* spp. High rate of culture-positivity was observed among study subjects with dacryocystitis. Gram positive isolates were more susceptible to amoxicillin-clavulanic acid and vancomycin, whereas Gram negative isolates were more susceptible to ciprofloxacin and gentamicin. Relatively ciprofloxacin is effective against most isolated pathogen.

## Conflict of interest

The authors declare that no potential competing interest exists.

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