AMJ
ISSN: 0005-2523

ISSN: 0005-2523
Volume 62, Issue 06, August, 2022

Aerobic bacteriological study of chronic suppurative otitis media and their antibiogram in a tertiary care hospital in north Karnataka

Praveen Kumar Doddamani[1], Ravish Kumar M[1], Anil Kumar Doddamani[2], Srikanth[3*]

Department of Microbiology, ESIC Medical College, Gulbarga, 585106, Karnataka, India[1]
Department of ENT, ESIC Medical College, Gulbarga, 585106, Karnataka, India[2]
Department of Pharmacology, ESIC Medical College, Alwar, 301030, Rajasthan, India[3]

Corresponding author: 3*

Keywords:
Chronic suppurative otitis media, Antibiogram, Pseudomonas aeruginosa, Staphylococcus aureus, Aerobic bacteria, Resistance.

ABSTRACT

Chronic suppurative otitis media (CSOM) is a commonly encountered middle ear infection. Empirical use of anti-microbials for treatment of CSOM although effective, but at times, may contribute to development of anti-microbial resistance. The present study was conducted to know the antibiogram of aerobic bacteria isolated from CSOM. This was a cross-sectional, prospective study conducted in North Karnataka region from October 2021 to May 2022. The sample collection, transportation, identification of organisms and antibiogram was done using standard guidelines. Out of 124 samples, microbial growth was observed in 109 cases (65%), while no growth was seen 15 (28%) cases. Pseudomonas aeruginosa was the most common organism isolated (45.7%), followed by Staphylococcus aureus (32.5%). Highest resistance of Staphylococcus aureus was seen with Ampicillin (54.7%), Ciprofloxacin (52.3%) and Erythromycin (52.3%). 100% sensitivity was seen with Teicoplanin, Vancomycin and Linezolid. Highest resistance of Pseudomonas aeruginosa was seen with Ciprofloxacin (62.7%), Levofloxacin (59.3%), Cefpodoxime (49.1%) and Gentamicin (35.5%). No antibiotic was 100% sensitive to Pseudomonas aeruginosa. Staphylococcus aureus, Pseudomonas aeruginosa and other Gram-negative organisms causing CSOM showed resistance to commonly used antibiotics. Every hospital is different and so are its infections. Hence, antibiogram studies should be conducted at regular intervals to identify the changing trends in resistance to antibiotics. Based on the local antibiogram studies, all hospitals should have antibiotic policy which should be periodically updated so as to prevent indiscriminate use of antibiotics, complications of CSOM and emergence of multi drug resistant organisms.

1. Introduction

Chronic suppurative otitis media (CSOM) is a middle ear infection which is commonly encountered in

clinical practice and is caused due to tympanic membrane perforation, characterized by repeated ear discharge. CSOM can cause inner ear injury and intracranial complications leading to consequences like hearing loss, poor academic performance, impaired speech development and social interaction [1]. CSOM most commonly occurs 0-6 years age group and is one of the important infectious diseases which affects around 65–330 million people per annum worldwide [2].

CSOM is a commonly encountered infectious disease in developing countries like India due to various factors like repeated upper respiratory tract infections, inadequate nutrition, over-crowding, poor hygiene, poor socio-economic status, irrational use of antibiotics and inadequate health care [3]. CSOM usually develops after recurrent upper respiratory viral infections which is followed by the invasion of organisms [4]. Despite treatment, CSOM is known for its persistence of infection and recurrence.

CSOM can cause various adverse effects like damage of ossicles, cochlea and facial nerve which can result in hearing impairment and other intra and extracranial complications especially in developing countries like India [5]. Empirical use of antimicrobials for treatment of CSOM although effective, but at times, may contribute to development of antimicrobial resistance [6]. Another reason is the irrational use of antimicrobials which contributes to antimicrobial resistance, which mandates for periodic surveillance of antimicrobial sensitivity. Hence the present study was conducted to know the antibiogram of aerobic bacteria isolated from CSOM.

2. Material and Methods

This was a cross-sectional, prospective study conducted in department of ENT at a tertiary care teaching hospital in North Karnataka region from October 2021 to May 2022. The study was conducted after getting approval by Institutional Ethics Committee and informed consent was taken from all the participants.

2.1 Inclusion Criteria

1) Patients age group of 6 months to 60 years with both gender and clinically diagnosed CSOM cases by an ENT surgeon.

2.2 Exclusion Criteria

1) Patients with ear discharge and intact tympanic membrane.
2. Patients receiving antibiotics (systemic or topical) within a week of presentation of CSOM symptoms
3) Patients having attico-antral type of CSOM, history of malignancy, history of ear surgery, patients with history of radiation to the head and neck region, patients with active tuberculosis were excluded from the study.

2.3 Sample Collection and Transportation

70% ethyl alcohol was used to cleanse the external ear and was allowed to dry for 40 seconds. Under strict aseptic precautions, ear discharge was collected using a sterile cotton swab. Two swabs were collected, one for Gram's stain and other for aerobic bacterial culture and antibiotic susceptibility testing.

2.4 Gram's Stain

The first swab was used Gram stain.

2.5 Aerobic Bacterial Culture

The second swab was inoculated onto Chocolate agar, Blood agar and MacConkey agar. The media were then incubated aerobically at 37°C for 24 hours. If no growth was observed after 24 hours, the inoculated

ISSN: 0005-2523
Volume 62, Issue 06, August, 2022

media were further incubated for 24 hours. If no growth was seen even after 48 hours, the medica were discarded. The isolated organisms were identified based on their microscopy, colony morphology, biochemical reaction and cultural characteristics per the standard operating procedures [7], [8].

2.6 Anti-microbial Susceptibility Testing

Antibiogram of the organism was done on Mueller Hinton agar using Kirby- Bauer disc diffusion method. By identifying isolates of similar morphology, bacterial suspension was prepared on to 4 - 5ml of peptone water and incubated at 37^0C for 2 - 4 hours. The turbidity of the growth was adjusted to 0.5 Mac Far land turbidity standards and lawn culture in made on the surface of the medium with sterile cotton swabs. The selected antibiotic discs were then placed aseptically on this media 1.5 cm apart using sterile forceps. The plates were incubated at 37^0C for 18-24 hours as per the Clinical Laboratory Standards Institute guidelines (CLSI 2017) [9].

2.7 Antibiotics Tested for Gram Positive Cocci

Ampicillin (10µg), Amoxycillin-clavulanic acid (30µg), Co-trimoxazole (25µg), Ciprofloxacin (5µg), Levofloxacin (5µg), Erythromycin (15µg), Gentamicin (10µg), Amikacin (30µg), Clindamycin (2µg), Cefoxitin (30µg), Cefuroxime (30 µg), Teicoplanin (30µg), Vancomycin (30µg) and Linezolid (15µg).

2.8 Antibiotics Tested for other Gram-Negative Bacilli

Ampicillin (10µg), Amoxycillin-clavulanic acid (30µg), Levofloxacin (5µg), Ofloxacin (5µg), Gentamicin (10µg), Amikacin (30µg), Cefepime (30µg), Ceftriaxone (30µg), Cefotaxime (30µg), Piperacillin-tazobactam (100/10µg) and Imipenem (10µg).

2.9 Antibiotics Tested for Pseudomonas Species

Gentamicin (10µg), Amikacin (30µg), Ciprofloxacin (5µg), Levofloxacin (5µg), Piperacillin (100µg), Piperacillin-Tazobactum (100/10µg), Ceftazidime (30µg), Cefepime (30µg), Cefpodoxime (10µg), Imipenem (10µg) and Aztreonam (30µg).

2.10 Statistical analysis

Descriptive statistics was used in the present study. The data was recorded and analyzed using Microsoft Excel (2019 version) and the results are explained in frequency and percentage.

3. Results

In the present study, of total 124 CSOM samples were collected during the study period. Out of 124 samples, microbial growth was observed in 109 cases (65%), while no growth was seen 15 (28%) cases. Among the 109 microbial growth, 97 were monomicrobial and 12 samples were of mixed growth. The age and gender distribution of the CSOM cases is shown in table 1.

Table 1: Age and gender distribution of the CSOM cases (n=109)

Age group	Male (%)	Female (%)	Total (%)
6 months - 1year	05 (4.5%)	03 (2.7%)	08 (11%)
1 - 10 years	11 (11%)	04 (3.6%)	15 (13.7%)
11- 20 years	09 (8.2%)	06 (5.5%)	15 (13.7%)
21 – 30 years	14 (12.8%)	11 (11%)	24 (22%)
31 – 40 years	11(11%)	08 (7.3%)	19 (17.4%)
41 – 50 years	08 (7.3%)	06 (5.5%)	14 (12.8%)
51 – 60 years	08 (7.3%)	05 (4.5%)	13 (11.9%)
Total	66 (60.5%)	43 (39.4%)	109 (100%)

The highest number of CSOM cases was seen in males (60.5%) and in the age group of 21-30 years and the least number of cases were seen in 6 months-1 year age group. The most affected ear was the right year in 65% of the cases.

The bacteria isolated from CSOM cases is shown in table 2.

Table 2: Bacteria isolated from CSOM cases (n=129)

Bacteria	Number	Percentage
Gram Positive Bacteria		
Staphylococcus aureus	42	32.5
Coagulase negative staphylococcus	02	1.5
Enterococcus spp.	01	0.7
Gram Negative Bacteria		
Pseudomonas aeruginosa	59	45.7
Escherichia coli	14	10.8
Proteus spp.	06	4.6
Klebsiella spp.	03	2.3
Acinetobacter spp.	02	1.5

Most common isolated bacteria belonged to Gram negative group (65.1%), Gram positive bacteria accounted for 34.9% of the cases. Pseudomonas aeruginosa was the most common organism isolated (45.7%), followed by Staphylococcus aureus (32.5%).

The antibiotic susceptibility pattern of Staphylococcus aureus is shown in table 3.

Table 3: Antibiotic susceptibility pattern of Staphylococcus aureus (n=42)

Antibiotic	Sensitive (%)	Resistant (%)
Ampicillin	19 (45.2)	23 (54.7)
Amoxycillin-clavulanic acid	25 (59.5)	17 (40.4)
Co-trimoxazole	25 (59.5)	17 (40.4)
Ciprofloxacin	20 (47.6)	22 (52.3)
Levofloxacin	24 (57.1)	18 (42.8)
Erythromycin	20 (47.6)	22 (52.3)
Gentamicin	26 (61.9)	16 (38)
Amikacin	27 (64.2)	15 (35.7)
Clindamycin	31 (73.8)	11 (26.1)
Cefoxitin	29 (69)	13 (30.9)
Cefuroxime	30 (71.4)	12 (28.5)
Teicoplanin	42 (100)	0
Vancomycin	42 (100)	0
Linezolid	42 (100)	0

Highest resistance was seen with Ampicillin (54.7%), followed by Ciprofloxacin (52.3%) and Erythromycin (52.3%). Staphylococcus aureus was 100% sensitive to higher antibiotics like Teicoplanin, Vancomycin and Linezolid.

The antibiotic susceptibility pattern of Pseudomonas aeruginosa is shown in table 4.

Table 4: Antibiotic susceptibility pattern of Pseudomonas aeruginosa (n=59)

Antibiotic	Sensitive (%)	Resistant (%)

ISSN: 0005-2523
Volume 62, Issue 06, August, 2022

Gentamicin	38 (64.4)	21 (35.5)
Amikacin	41 (69.4)	18 (30.5)
Ciprofloxacin	22 (37.2)	37 (62.7)
Levofloxacin	24 (40.6)	35 (59.3)
Piperacillin	51 (86.4)	08 (13.5)
Piperacillin-Tazobactum	57 (96.6)	02 (3.3)
Ceftazidime	55 (93.2)	04 (6.7)
Cefepime	40 (67.7)	19 (32.2)
Cefpodoxime	30 (50.8)	29 (49.1)
Imipenem	54 (91.5)	05 (8.4)
Aztreonam	49 (83)	10 (16.9)

Highest resistance was seen with Ciprofloxacin (62.7%), followed by Levofloxacin (59.3%), Cefpodoxime (49.1%) and Gentamicin (35.5%). Highest sensitivity of Pseudomonas aeruginosa was seen with Piperacillin-Tazobactum (96.65), Ceftazidime (93.2%) and Imipenem (91.5%). No antibiotic was 100 % sensitive to Pseudomonas aeruginosa.

The antibiotic susceptibility pattern of other Gram negatives organisms is shown in table 5.

Table 5: Antibiotic susceptibility pattern of Gram negatives organisms (Sensitive strains)

Antibiotic	**E. coli (14) n (%)**	**Proteus spp. (06) n (%)**	**Klebsiella spp. (03) n (%)**
Ampicillin	05 (35.7)	00	00
Amoxy-clav	08 (57.1)	02 (33.3)	01 (33.3)
Levofloxacin	12 (85.7)	05 (83.3)	02 (66.6)
Ofloxacin	14 (100)	06 (100)	03 (100)
Gentamicin	12 (85.7)	04 (66.6)	01 (33.3)
Amikacin	14 (100)	06 (100)	02 (66.6)
Cefepime	13 (92.8)	06 (100)	02 (66.6)
Ceftriaxone	12 (85.7)	06 (100)	02 (66.6)
Cefotaxime	11 (78.5)	05 (83.3)	01 (33.3)
PP-TZ	12 (85.7)	04 (66.6)	02 (66.6)
Imipenem	14 (100)	05 (83.3)	03 (100)

Amoxy-clav = Amoxycillin-Clavulanic acid. PP-TZ = Piperacillin-Tazobactam

Highest sensitivity in E. Coli was seen with Ofloxacin (100%), Amikacin (100%) and Imipenem (100%). Highest sensitivity in Proteus spp. was seen with Ofloxacin (100%), Cefepime (100%), Ceftriaxone (100%) and Amikacin (100%). Highest sensitivity in Klebsiella spp. was seen with Ofloxacin (100%) and Imipenem (100%).

4. Discussion

CSOM is a major infectious disease worldwide, commonly encountered in developing countries like India. India belongs to the one of the countries with high prevalence (>4%), according to a report by WHO [9]. Empirical use of antibiotics is an important step in management of CSOM. Selection of an antibiotic is determined by many factors such as its safety, efficacy, local resistance pattern of bacteria and cost. Hence, knowledge of local organism responsible for infection, their antibiogram and having an effective hospital infection policy can significantly help in the management of CSOM and prevent CSOM cases getting fatal [10].

In the present study, most number of cases was in males (60.5%). The highest number of CSOM cases was seen in male and in the age group of 21-30 years and the least number of cases were seen in 6 months-1 year age group. These findings are similar to other studies, where males were predominantly affected and 21-30 years was the most common age group affected [11], [13]. However, some studies have reported female preponderance and paediatric age group [0-8 years) as the most common affected by CSOM [14], [15]. Adult males in the age group of 21-30 years are working, travel more and are in engaged in more outdoor activities than females, which can make them vulnerable for developing upper respiratory tract infections frequently and then into CSOM [10].

Out of 124 samples, microbial growth was observed in 109 cases (65%), while no growth was seen 15 (28%) cases. The culture positive growth was lower when compare with other studies [16- 18]. Among the 109 microbial growth, 97 were monomicrobial and 12 samples were of mixed growth. These findings are in accordance with other studies [10], [19]. Most common isolated bacteria belonged to Gram negative group (65.1%), Gram positive bacteria accounted for 34.9% of the cases. Pseudomonas aeruginosa was the most common organism isolated (45.7%), followed by Staphylococcus aureus (32.5%). These findings are in accordance with other recent studies [10], [11], [16]. The frequent isolation of organisms like Pseudomonas and Staphylococcus and their increasing resistance to antibiotics can be attributed to irrational use of antibiotics, failure to diagnose early, multi drug resistance and poor patient compliance. But, some studies have reported Staphylococcus aureus and Proteus spp. as the most frequent organisms, with Pseudomonas spp. as the second or thirst most organism isolated [20- 22].

Highest resistance of Staphylococcus aureus was seen with Ampicillin (54.7%), followed by Ciprofloxacin (52.3%) and Erythromycin (52.3%). Staphylococcus aureus was 100% sensitive to higher antibiotics like Teicoplanin, Vancomycin and Linezolid. These findings are similar to other recently conducted studies [10-12], [23]. Highest resistance of Pseudomonas aeruginosa was seen with Ciprofloxacin (62.7%), followed by Levofloxacin (92.3%), Cefpodoxime (49.1%) and Gentamicin (35.5%). Highest sensitivity of Pseudomonas aeruginosa was seen with Piperacillin-Tazobactum (96.65), Ceftazidime (93.2%) and Imipenem (91.5%). No antibiotic was 100% sensitive to Pseudomonas aeruginosa.

In a recently conducted study by [10], [19], Pseudomonas aeruginosa was highly sensitive to colistin, ceftazidime (100%), piperacillin tazobactam (95.5%) and ceftazidime-tazobactam (92.9%). In contrast, other studies have reported varied findings with ciprofloxacin being the most sensitive [16], gentamicin [23], piperacillin and piperacillin tazobactam [25]. Highest sensitivity in E. Coli was seen with Ofloxacin (100%), Amikacin (100%) and Imipenem (100%). Highest sensitivity in Proteus spp. was seen with Ofloxacin (100%), Cefepime (100%), Ceftriaxone (100%) and Amikacin (100%). Highest sensitivity in Klebsiella spp. was seen with Ofloxacin (100%) and Imipenem (100%). In other studies, the Gram-negative isolates have reported 100% sensitivity to Cefoperazone-Sulbactam, Carbapenems and Piperacillin-Tazobactam [26], 75% sensitive to Ceftazidime, Cefotaxime and Colistin [27] more sensitive to Amikacin and quinolone antibiotics [28]. The above difference in sensitivity to antibiotics might be due to varied geographical differences, patient compliance, hygiene and local health care facilities available.

Limitations of the study

The present study was conducted in a single center and the sample size was small and due to lack of resources we did not include anaerobic bacteria

5. Conclusion

In the present study, Staphylococcus aureus, Pseudomonas aeruginosa and other Gram-negative organisms

ISSN: 0005-2523
Volume 62, Issue 06, August, 2022

causing CSOM showed resistance to commonly used antibiotics. Every hospital is different and so are its infections. Hence, antibiogram studies should be conducted at regular intervals to identify the changing trends in resistance to antibiotics. Based on the local antibiogram studies, all hospitals should have antibiotic policy which should be periodically update so as to prevent indiscriminate use of antibiotics, complications of CSOM and emergence of multi drug resistant organisms.

Acknowledgement: We authors thank the participants of the study

6. References

[1] Chirwa M, Mulwafu W, Aswani JM, Masinde PW, Mkakosya R, Soko D. Microbiology of chronic suppurative otitis media at Queen Elizabeth Central Hospital, Blantyre, Malawi: A cross-sectional descriptive study. Malawi Med J 2015; 27:120-4.

[2] Sengodan R, Sukumar N. Microbiological profile of chronic suppurative otitis media (CSOM) in a tertiary care hospital. Int J Bioassays 2017; 6:5355–9.

[3] Kumar H, Seth S. Bacterial and Fungal study of 100 cases of chronic suppurative otitis media. J Clin Diagn Res 2011; 5:1224-7.

[4] Fliss DM, Shoham I, Leiberman A, Dagan R. Chronic suppurative otitis media without cholesteatoma in children in southern Israel: Incidence and risk factors. Pediatr Infect Dis J 1991; 10:895-9.

[5] Sharma S, Rehan HS, Goyal A, Jha AK, Upadhyaya S, Mishra SC. Bacteriological profile in chronic suppurative otitis media in Eastern Nepal. Trop Doct 2004; 34:102-4.

[6] Grevers G, First International Roundtable ENT Meeting Group. Challenges in reducing the burden of otitis media disease: An ENT perspective on improving management and prospects for prevention. Int J Pediatr Otorhinolaryngol 2010; 74:572-7.

[7] Colle JG, Marmion BP, Fraser AG, Simmons A. Mackie & McCartney Practical Medical Microbiology. 14th ed. Elsevier: London;1996.

[8] CHARTS In: Washington CW, Stephen DA, William MJ, Elmer WK, Gary WP, Paul CS et al, Koneman's Color atlas and Textbook of Diagnostic Microbiology, 6th edition: Lippincott Williams & Wilkins 2006;1443-1535.

[9] Sharma K, Oberoi L, Narula V. Present scenario of microbiological pattern in chronic suppurative otitis media and its management guidelines. J Acad Cli Microb 2017;19(1):47-53.

[10] Kombade SP, Kaur N, Patro SK, Nag VL. Clinico-bacteriological and antibiotic drug resistance profile of chronic suppurative otitis media at a tertiary care hospital in Western Rajasthan. J Family Med Prim Care 2021; 10:2572-9.

[11] Rathi S, Jaiswal AA, Sharma N, Banerjee PK, Garg AK. Bacteriological profile and drug sensitivity patterns in chronic suppurative otitis media patients at J.L.N. Hospital. IP Indian Journal of Anatomy and Surgery of Head, Neck and Brain.2018;4:27-37.

[12] Agrawal R, Khatri P, Parihar R, Shah H. Microbial assessment of chronic suppurative otitis media in a tertiary care center of Rajasthan. Int J Health Sci Res 2017; 7:120-6.

[13] Agrawal A, Kumar D, Goyal A, Goyal S, Singh N, Khandelwal G. Microbiological profile and their antimicrobial sensitivity pattern in patients of otitis media with ear discharge. Indian J Otol 2013; 19:5-8.

[14] Shrestha BL, Amatya RC, Shrestha I, Ghosh I. Microbiological profile of chronic suppurative otitis media. Nepalese Journal of ENT Head and Neck Surgery 2011; 2:6-7.

[15] Malkappa SK, Kondapaneni S, Surpam RB, Chakraverti TK. Study of aerobic bacterial isolates and their antibiotic susceptibility pattern in chronic suppurative otitis media. Indian Journal of Otology 2012; 18:136.

[16] Hassan SJ, Semen YS, Josep DO, Gabriel EO, Kingsley O, Calista SN. Antimicrobial susceptibility in patients with chronic suppurative otitis media in a North-Central secondary health facility in Nigeria. Indian J Otol 2021; 27:44-6.

[17] Moorthy PN, Lingaiah J, Katari S, Nakirakanti A. Application of a microbiological study on chronic suppurative otitis media. Int J Otolaryngol Head Neck Surg 2013; 2:290-4.

[18] Deb T, Ray D. A study of the bacteriological profile of chronic suppurative otitis media in Agartala. Indian J Otolaryngol Head Neck Surg 2012; 64:326-9.

[19] Khatoon A, Rizvi M, Sultan A, Khan F, Sharma M, Shukla I, et al. Chronic suppurative otitis media: A clinico-microbiological menace. Int J Res Med Sci 2015; 3:1932-6.

[20] Seid A, Deribe F, Ali K, Kibru G. Bacterial otitis media in all age group of patients seen at Dessie referral hospital, North East Ethiopia. Egypt J Ear Nose Throat Allied Sci 2013; 14:73-8.

[21] Muluye D, Wondimeneh Y, Ferede G, Moges F, Nega T. Bacterial isolates and drug susceptibility patterns of ear discharge from patients with ear infection at Gondar University Hospital, Northwest Ethiopia. BMC Ear Nose Throat Disord 2013; 13:10.

[22] Argaw-Denboba A, Abejew AA, Mekonnen AG. Antibiotic-Resistant Bacteria Are Major Threats of Otitis Media in Wollo Area, Northeastern Ethiopia: A Ten-Year Retrospective Analysis. Int J Microbiol 2016; 2016:8724671.

[23] Pavani K, Krishnamurthy S, Swetha K S, Supriya P S. Chronic Suppurative Otitis Media (CSOM): Evaluation of fungal and aerobic bacterial agents and antibiotic sensitivity pattern of the bacterial isolates. Int J Med Microbiol Trop Dis 2019;5(4):214-7.

[24] Kumar R, Singh G. Study of Bacterial Pathogens and Antibiotic Sensitivity Pattern of Ear Infections in Patients with Chronic Suppurative Otitis Media Attending a Tertiary Care Hospital in Panipat, India. J Med Sci Health 2019;5(2):19-23.

[25] Soumya S, Vagrali M, Nagmoti JM, Hogade S. Prevalence and antibiogram of pseudomonas aeruginosa in Chronic suppurative otitis media (CSOM). J Med Sci Clin Res 2018; 6:999-1005.

ISSN: 0005-2523
Volume 62, Issue 06, August, 2022

[26] Garg A, Agarwal L, Gupta M, Mathur R. A Study on bacteriological profile and the antibiotic susceptibility pattern in cases of chronic suppurative otitis media in Haroti region. Med J DY Patil Vidyapeeth 2022; 15:27-31.

[27] Kiran Gopal, Solabannavar S.S, Mohammed Riyas. Aerobic bacteriology of chronic suppurative otitis media and its antibiotic susceptibility pattern in a tertiary care hospital, Bagalkot. Trop J Path Micro 2019;5(11):911-9.

[28] Viswanatha B, Balan S. Microbiology of chronic suppurative otitis media: a prospective study in a tertiary care hospital. J Otolaryngol ENT Res 2017;9(1):568–70.