Available online at *www.ujpronline.com*
Universal Journal of Pharmaceutical Research
An International Peer Reviewed Journal
ISSN: 2831-5235 (Print); 2456-8058 (Electronic)

RESEARCH ARTICLE

ASSESSMENT OF THE PRESENT BACTERIOLOGICAL PROFILE AND ANTIBIOTIC SENSITIVITY PATTERN IN CHRONIC SUPPURATIVE OTITIS MEDIA IN SANA'A, YEMEN

Khaled Saad Abdulrahman Al-Khamesy[1], Hassan Abdulwahab Al-Shamahy[1,2,3]
[1]*ENT Department, Faculty of Medicine and Health Sciences, Sana'a University, Republic of Yemen.*
[2]*Medical Microbiology and Clinical Immunology Department, Faculty of Medicine and Health Sciences, Sana'a University.*
[3]*Medical Microbiology department, Faculty of Medicine, Genius University for Sciences & Technology, Dhamar city, Republic of Yemen.*

Article Info:

Article History:
Received: 7 August 2023
Reviewed: 9 September 2023
Accepted: 26 October 2023
Published: 15 November 2023

Cite this article:
Al-Khamesy KSA, Al-Shamahy HA. Assessment of the present bacteriological profile and antibiotic sensitivity pattern in chronic suppurative otitis media in Sana'a, Yemen. Universal Journal of Pharmaceutical Research 2023; 8(5):58-64.
https://doi.org/10.22270/ujpr.v8i5.1010

***Address for Correspondence:**
Dr. Hassan A. Al-Shamahy, Sana'a University, Yemen; Tel: +967-1-239551.
E-mail: *shmahe@yemen.net.ye*

Abstract

Background and objectives: The drainage of pus from the ear through a ruptured tympanic membrane that lasts longer than 12 weeks is known as chronic suppurative otitis media (CSOM). The purpose of the study was to ascertain the microbiological profile of middle ear chronic inflammation (CSOM) and the isolates' susceptibility to locally accessible antibiotics.
Subjects and methods: Total 111 ear swab samples from patients with clinically confirmed active CSOM were used in this cross-sectional investigation. Following a standard protocol, ear swabs were cultured to identify microbes. A modified Kirby-Bauer disk diffusion method was used to test antibiotic susceptibility, and the Clinical Laboratory Standards Institute's guidelines were followed to determine the diameter of the zone of inhibition.
Results: During two years, 111 patients with chronic suppurative otitis media were collected from January 2020 to the end of December 2022. Most of the patients were males (63.96%) while females were 36.04%. 36.04% of the total patients were in the ≤10-year group, and 29.7% were in the ≥46-year group while the other age groups were less frequent. Microbial growth was seen in 91.9% of samples, but 7.2% of samples did not. Among the samples with growth, 71.2% were monomicrobial, 12.6% were polymicrobial, and 9% had mixed growth with more than three microorganisms. The most frequently isolated bacteria were *Pseudomonas aeruginosa* (34.95%) followed by *Staphylococcus aureus* (14.6%) and *Klebsiella* spp. (9.8%). The antibiotics most sensitive against *P. aeruginosa* were cefepime (97.7%), meropenem (95.3%), piperacillin-tazobactam (95.3%), and ciprofloxacin (93%). *Staphylococcus aureus* showed the highest sensitivity to rifampin (100%) and fusidic acid (88.9%).
Conclusion: In the bacteriological profile of CSOM, *P. aeruginosa*, *S aureus*, *Klebsiella* spp., and *Acinetobacter* spp. are highly prevalent. The distribution of CSOM varies depending on the age group. The antibiotic susceptibility pattern of the bacterial isolates decreased. It is critical to review antibiotic prescriptions based on susceptibility and to be informed of the current trend in bacteriological profiles.
Keywords: Antibiotic sensitivity, bacteriological profile, chronic suppurative otitis media, CSOM, Sana'a, Yemen.

INTRODUCTION

Otitis media infections are middle ear inflammatory diseases. One of the main types is acute otitis media (AOM), which is a fast-onset infection that typically results in ear pain. Otitis media with effusion (OME) is the second main type of otitis media, and it is usually not associated with symptoms, even though a sensation of fullness in the infected ear is sometimes illustrated. It is described as the presence of non-infectious fluid in the middle ear that may persist for weeks or even months after an incident of AMO. The third type of otitis media is chronic suppurative otitis media (CSOM); it is an infection of the middle ear that results in puncture of the eardrum membrane with ear discharge for more than six weeks. Hearing impairment has been linked to all three kinds of otitis media[1-4]. CSOM takes places after an upper respiratory infection

that caused acute otitis media. This makes progress to an extended inflammatory reaction causing middle ear mucosal edema, perforation and ulceration. The middle ear makes an effort to solve this ulceration by producing granulation tissue and forming polyps. This can lead to over-exocytosis, failure to stop the inflammation, and the development of CSOM, which is frequently associated with cholesteatoma. There may be sufficient pus flowing from the ear (otorrhea) or there may be insufficient pus visible only during an otoscope or binocular microscope examination[5-8]. Every year, 709 million people globally, or 11% of the population, suffer with AOM; of these, 4.4% may develop CSOM. The World Health Organization states that CSOM is a significant contributor to childhood hearing loss[9]. Recurrent episodes of CSOM among adults have a higher risk of developing permanent conductive and sensorineural hearing loss[6,8]. The incidence of CSOM worldwide varies widely with the prevalence being relatively low in high-income countries while in low-income countries such as Yemen, the prevalence may be as high as the three times[4,10]. Every year 21,000 people die worldwide due to complications of CSOM[9].

The Yemen reviews showed that there were no studies discussing the microbiological features of CSOM, and the sensitivity of isolates to antibiotics. Therefore, this study aimed to determine the microbiological profile of CSOM, and to determine the sensitivity of isolates to locally available antimicrobials.

SUBJECTS AND METHODS

Study population: In the Department of Medical Microbiology and Department of ENT at Sana'a University's Faculty of Medicine and Health Sciences, a cross-sectional study was carried out. Over the course of two years, patients were chosen from both public and private hospitals in Sana'a, Yemen, and sent to the Department of Microbiology at the National Center for Public Health Laboratories (NCPHL). Between January 2020 and the end of December 2022, 111 individuals with chronic suppurative otitis media were gathered throughout the course of two years.

Excluded criteria include: patients with, acute otitis externa, cholesteatoma, otomycosis, and tympanostomy tube, in addition to patients receiving treatment systemic or topical antibiotics or antifungal treatment in two weeks prior to sampling.

Clinical data: Age, gender, length of discharge, and past antibiotic use were all included in the thorough clinical history that was gathered. Upon arrival at the NCPHL, a medical professional with training conducted an otoscopy evaluation and then recorded auditory toilet use. The status of the middle ear, ear secretions, and tympanic membrane perforation—including the size and area of the eardrum perforation were noted.

Ear specimens: A sample of ear secretions from the middle ear was collected under sterile precautions from the area of the perforated tympanic membrane using a sterile aluminum stick with a diameter of 1.5 mm cotton wool-tipped applicator. The collected samples were cultured directly in the appropriate medium after collection.

Microbiological procedure: On blood agar, MacConkey agar, and chocolate agar, three loops were inoculated. MacConkey agar and blood agar were incubated aerobically for a full day at 37°C. The infected chocolate agar was then allowed to incubate for 24 hours at 37°C in an environment that was enhanced with carbon dioxide. The growth was then recognized using conventional bacteriological techniques[11].

Antibiotic sensitivity: Mueller-Hinton agar was used to test the antibiotic sensitivity of bacterial isolates using a modified Kirby-Bauer disc diffusion technique. The inhibitory zone diameter was interpreted in accordance with guidelines[12,13] of the 2017 Clinical Laboratory Standards Institute.

Ethical consideration: The Sana'a University Faculty of Medicine and Health Sciences' Medical Ethics and Research Committee has accepted this study under the number 437, dated December 4, 2019. Every procedure adhered to the standards of ethics established by the review committee. All participants gave their consent after being informed that participation is completely optional and they may withdraw at any time for any reason.

Statistical analysis: Version 6 of the Epi Info statistical tool (CDC, Atlanta, USA) was used to analyze the data. Communicating quantitative information, such as mean values and standard deviation (SD), in a normally distributed dataset. Percentages were used to express the qualitative data.

RESULTS

Table 1 show the age and sex data for the 111 patients participating in this study. The patients' ages ranged from 1 to 77 years, with a mean of 23 years. The peak incidence of CSOM was observed in patients between the ages of ≤10 years (36.04%) and ≥46 years (29.7%). Male sex was predominant, with a male: female ratio of 1.8:1. Table 2 shows the duration, affected aspect, etiological factors, and symptoms associated with CSOM. Considering the duration of infection, most patients had it for more than 12 months (47.8%), followed by 6-12 months (27%), while less than 6 months was only 25.2%. Most infections were unilateral (95.5%), and only 4.5% had bilateral ear infections with approximately equal number of affected sides (48.6% vs. 51.4%). consideration of precipitating factors; 59.5% of patients suffer from upper respiratory tract infection, 26.1% suffer from allergic rhinitis, and 14.4% do not suffer from disorders. Consider the accompanying symptoms; 31.5% of the patients suffered from hearing impairment, 14.4% experienced ear pain and 21.6% experienced ear itching, while 32.4% did not experience any symptoms. Table 3 presents the discharge characteristics in CSOM patients. In 47.7% of patients, the ear secretions were mucopurulent, 41.4% were purulent, and 10.8% were mucopurulent only. Foul smelling discharge was 3.6% while 96.4% of the samples had no odor. Table 4 summarizes the microbiological profiles. A total of 111

ear swab samples were collected for microbial identification. Among them, microbial growth was observed in 103 (92.8%) samples, while 7.2% of the samples showed no growth, 71.2% showed mono-microbial growth, 12.6% poly-microbial growth and 9% mixed growth. Gram-negative microorganisms were more commonly identified than Gram-positive bacteria (69.1% vs. 21.1%). *P. aeruginosa* was the most common microorganism isolated (34.95%), followed by *Staphylococcus aureus* (14.6%), *Klebsiella* spp. (9.8%), *Acinobacter* spp (7.3%) and *Proteus* spp (6.5%).

Table 1: Age and sex distribution of patients with chronic suppurative otitis media who attended the National Center for Public Health Laboratories, (NCPHL).

Characters	Number (%)
Sex	
Male	71 (63.96)
Female	40 (36.04)
Age groups	
≤10 years	40 (36.04)
11-20 years	17 (15.3)
21 - 40 years	21 (18.9)
≥46 years	33 (29.7)
Total	111 (100)
Median (IQR=39)	23 years
Min	1 years
Max	77 years

Fungal organisms were isolated in 9.8% of the samples. Table 5 shows the patterns of sensitivity to Gram-positive bacteria towards antibiotics. The most sensitive antibiotics against *S. aureus* were rifampin (100%), fusidic acid (88.9%), gentamicin (77.8%), cefoxitin (72.2%) and clindamycin (72.2%), with the lowest sensitivity being for penicillin G (16.7%), erythromycin (55.6%), ciprofloxacin (61.1%), and trimethoprim/ sulfametho-xazole (66.7%). Patterns of antibiotic sensitivity for Gram-negative bacteria are shown in Table 6. The most sensitive antibiotics against *P. aeruginosa* are Cefepime (97.7%), ceftazidime (95.3%), Meropenem (95.3%), piperacillin-tazobactam (95.3%), ciprofloxacin (93%) and amikacin (90.7%); with decreased sensitivity to gentamicin (74.4%) and imipenem (88.4%).

Table 2: Duration, affected side, precipitating factors, and symptoms associated with CSOM for patients Who attended the National Center for Public Health Laboratories (NCPHL), n = 111.

Characters	Number (%)
Duration of CSOM, months	
< 6 months	28 (25.2)
6 – 12 months	30 (27)
>12 months	53 (47.8)
Affected side	
Unilateral	106 (95.5)
Right	54 (48.6)
Left	57 (51.4)
Bilateral	5 (4.5)
Precipitating factors	
Upper respiratory tract infection	66 (59.5)
Allergic rhinitis	29 (26.1)
Nil	16 (14.4)
Associated symptoms	
Hearing loss	35 (31.5)
Pain	16 (14.4)
Itchiness	24 (21.6)
Nil	36 (32.4)

Abbreviation: CSOM: chronic suppurative otitis media.

DISCUSSION

The age of the patients in the current study ranged from 1 to 77 years, with a mean of 23 years. The peak incidence of CSOM was observed in patients between the ages of ≤10 years (36.04%) and ≥46 years (29.7%). The current results are similar to those reported from Malaysia by Draman *et al.*,[8] where the patients' age ranged from 1 to 90 years, with a mean of 24 years; also, the peak incidence of CSOM is observed in patients aged 1 to 10 years (33.0%) and over 40 years (35.1%)[8]. However, the current findings contradict those of Chirwa *et al.*,[14] and Bakari *et al.*,[15] which showed that CSOM infection occurred predominantly during the first 5 years of life and there was no peak of infection in the adult age groups[14,15]. The Eustachian

tubes of children are shorter, thinner, and more horizontal than those of adults, which may account for the greater frequency of CSOM in children[16]. This age group is also at a higher risk of developing upper respiratory tract infections (URTIs) than adults, which can progress to ear infections[17]. On the contrary, a study by Loy *et al.*, in Singapore showed a different prevalent age group, with the disease most common among patients in the age group 31 to 40 years[18]. In the current study, the male sex was dominant, with a male to female ratio of 1.8:1. This finding differs from studies conducted in Pakistan and Malaysia where the disease is more common in females[8,19-21]. Male predominance may be attributed to an increased vulnerability of males to the risk of developing CSOM and may also be due to an increase in health awareness among males, as they tend to seek early treatment. Moreover, a number of studies have revealed a male preponderance, which is explained by their active lives, which include swimming and diving[15,17,221]. Infection of the middle ear from contaminated swimming water can lead to intermittent ear discharge and frequent infections[4,8].

Table 3: Characteristics of discharge from chronic suppurative otitis media patients who attended the National Center for Public Health Laboratories (NCPHL), n=111.

Characters	Number (%)
Characteristic of discharge	
Mucoid	12 (10.8)
Mucopurulent	53 (47.7)
Purulent	46 (41.4)
Blood stained	0 (Nil)
Odor	
Foul smelling	4 (3.6)
Non-foul smelling	107 (96.4)

In this study, following a URTI, 59.5% of patients experienced active CSOM. Draman *et al.*,[8] and Koch *et al.*,[23] also demonstrated that URTIs raise the likelihood of contracting this illness. During URTI episodes, respiratory pathogens like *S. aureus*, *H. influenza*e, and *S. pneumoniae* can travel from the nasopharynx to the middle ear through the Eustachian tube[12,24]. In the current study, 26.1% of the patients had allergic rhinitis. Allergic rhinitis might cause inflammation of the nasal mucosa causing edema of the opening of the Eustachian tube. Nasal blockage can raise the nasopharynx negative pressure, leading to further obstruction of the Eustachian tubes. Both effects lead to the progress of negative middle ear pressure[1-4]. The results of the current study are similar to a study by Md Daud *et al.*,[25] where there is a significant association between CSOM and allergy. In this study, 47.7% of the patients, the ear secretions were mucopurulent, 41.4% were purulent, and 10.8% were mucoid only. The stench discharge was 3.6% while 96.4% of the samples had no odor. These results are almost identical to those reported in Malaysia by Draman *et al.*,[8] in which 48.4% of patients had mucopurulent ear secretions, 41.8% had purulent discharge, 9.9% had mucoid discharge, and only 2.2% had foul-smelling discharge.

Table 4: Microbiological profiles of chronic suppurative otitis media patients, n=111.

Characters	Number (%)
Type of isolated microorganisms	
Mono-microbial	79 (71.2)
Poly-microbial	14 (12.6)
Mixed growth	10 (9)
No growth	8 (7.2)
Name of isolated microorganisms	
Gram-positive bacteria	26 (21.1)
S. aureus	18 (14.6)
Streptococcus spp.	6 (4.9)
Enterococcus spp	2 (1.6)
Gram-negative bacteria	85 (69.1)
P. aeruginosa	43 (34.95)
Klebsiella spp.	12 (9.8)
Acinetobacter spp.	9 (7.3)
Proteus spp.	8 (6.5)
Enterobacter spp.	5 (4.1)
Escherichia coli	6 (4.9)
Serratia marcescens	2 (1.6)
Fungal organisms	**12 (**9.8)
Candida spp.	9 (7.3)
Aspergillus spp	3 (2.4)
Total isolates	123 (100)

Table 5: Antibiotic sensitivity pattern of gram-positive microorganisms isolated from CSOM, (n = 26).

Antibiotics	*S. aureus*, n=18 N (%)	*Streptococcus* spp, n=6 N (%)	*Enterococcus* spp, n=2 N (%)
Trimethoprim/sulfamethoxazole	12 (66.7)	2 (33.3)	1 (50)
Clindamycin	13 (72.2)	5 (83.3)	1 (50)
Erythromycin	10 (55.6)	6 (100)	0 (0.0)
Fusidic acid	16 (88.9)	-	-
Penicillin G	3 (16.7)	6 (100)	1 (50)
Gentamicin	14 (77.8)	-	-
Rifampin	18 (100)	-	-
Cefoxitin	13 (72.2)	-	-
Ciprofloxacin	11 (61.1)	-	-
Cephalexin	-	6 (100)	2 (100)

The most important sequelae of CSOM are mild to moderate conductive hearing loss, which was reported in 31.5% of cases in the current study. This result is lower than that reported by Draman *et al.*,[8] As 45.5% of patients have symptoms associated with hearing loss. This complication can be explained by that; in prolonged and recurrent episodes of active CSOM, inflammatory mediators generated during CSOM can penetrate the inner ear through the round window. This can lead to loss of hair cells in the cochlea, resulting in mixed conductive and sensorineural hearing loss[24,26].

In implementation, culturing of bacteria may not be obligated to diagnose CSOM; comprehensive studies have determined that 90% to 100% of chronic discharge of infected ears produces two or more isolates containing both anaerobic and aerobic bacteria. Most recommended treatments might eradicate middle ear bacteria effectively, but this does not guarantee the non-recurrence of otorrhea or total solution of the CSOM. However, bacterial cultures are recommended, in particular in cases of intractable infections or when bacterial resistance to antibiotics are suspected. The microbiology profile in the current study population revealed that 71.2% of the isolated organisms were monomicrobial, 12.6% were polymicrobial, and only 9% were mixed growth of more than 2 microorganisms.

Table 6: Antibiotic sensitivity pattern of gram-negative microorganisms isolated from CSOM patients.

Antibiotics	*P. aeruginosa* n=43 N (%)	*Klebsiella* spp. n=12 N (%)	*Acinetobacter* spp. n=9 N (%)	*Proteus* spp. n=8 N (%)	*E. coli* n=6 N (%)	*Enterobacter* spp. n=5 N (%)
Amikacin	39 (90.7)	11(91.7)	9 (100)	8 (100)	6 (100)	4 (80)
Ceftriaxone	-	11(91.7)	-	7 (87.5)	5 (83.3)	4 (80)
Cefuroxime	-	10 (83.3)	-	7 (87.5)	6 (100)	1 (20)
Ceftazidime	41(95.3)	10 (83.3)	8 (88.9)	8 (100)	6 (100)	4 (80)
Cefotaxime	-	9 (75)	8 (88.9)	8 (100)	5 (83.3)	3 (75)
Imipenem	38 (88.4)	11(91.7)	9 (100)	8 (100)	5 (83.3)	4 (80)
Meropenem	41 (95.3)	-	6 (66.7)	-	-	-
Ciprofloxacin	40 (93)	9 ((75)	6 (66.7)	6 (75)	6 (100)	5 (100)
Piperacillin-tazobactam	41 (95.3)	12 (100)	8 (88.9)	8 (100)	6 (100)	3 (75)
Cefepime	42 (97.7)	10 (83.3)	8 (88.9)	8 (100)	5 (83.3)	2 (40)
Gentamicin	32 (74.4)	10 (83.3)	7 (77.8)	7 (87.5)	4 (66.7))	1 (20)
Amoxillin clavulanate	-	8 (66.7)	-	5(62.5))	6 (100)	2 (40)
Ampicillin	-	0 (0.0)	1 (11.1)	2 (25)	2 (33.3)	4 (80)
Trimethoprim/sulfamethazole	-	8 (66.7)	-	2 (25)	3 (50)	5 (100)

These findings are roughly similar to that reported elsewhere[8,12,24]. The most common microorganism isolated in the current study was *P. aeruginosa* (34.95%), followed by *S. aureus* (14.6%) (Table 4). This finding is similar to other bacteriological studies of CSOM conducted in countries such as Malaysia, Nepal, Greece, Ghana, and Singapore[8,18,22,27]. Although *P. aeruginosa* is a widespread colonizer of the auditory canal, this bacteria can produce nosocomial infections and has expanded resistance to numerous powerful anti-pseudomonal antibiotics[28,29]. *P. aeruginosa* can additionally cause progressive damage to the mastoid structure and middle ear by liberating *P. aeruginosa* toxins and enzymes. Nevertheless, further studies described that *S. aureus* was the most common pathogenic bacteria, followed by *P. aeruginosa*[30,31]. In study by Bakari *et al.*, in Nigeria, the most common bacteria causing CSOM were found to be coliform comprising *Klebsiella* spp. followed by *E. coli*[15]. In addition, different results were obtained in studies conducted in Malawi, Kenya, and Ethiopia, where *Proteus mirabilis* was the most common bacteria isolated, ranging from 28.6% to 32.7% of the samples[14,32]. Finally, the current study revealed fungal growth in 9.8% of the cases of CSOM. The most common of these was *Candida* spp. 7.3%, followed by *Aspergillus* spp. 2.4%. This result is similar to other studies[8,14,33]. The present study showed that the most sensitive antibiotics against *P. aeruginosa* were cefepime (97.7%), ceftazidime (95.3%), meropenem (95.3%), piperacillin-tazobactam (95.3%), ciprofloxacin (93%) and amikacin (90.7%); With

reduced sensitivity to gentamicin (74.4%) and imipenem (88.4%). Previous studies conducted in Yemen showed that *P. aeruginosa* had an increased resistance rate toward aztroneome, ceftriaxone and ciprofloxacine that was 100%. Resistance rates ranged from 83.3-85.7% for amikacin, ampicillin sulbactam and levofloxacin. The rates were 71.4% for nitelmycin and 92.9% for chloram-phenicol[29]. The results of the current study are less sensitive than those reported from Malaysia where *P. aeruginosa* showed 100% sensitivity to cefepime, ceftazidime, piperacillin-tazobactam, and meropenem[8]. A study conducted in Pakistan also showed that *P. aeruginosa* had an increased resistance rate towards fluoroquinolones (48.7%)[20]. In the current study, the most sensitive antibiotics against *S. aureus* were rifampin (100%), fusidic acid (88.9%), gentamicin (77.8%), cefoxitin (72.2%), and clindamycin (72.2%), and were the least sensitive. for penicillin G (16.7%), erythromycin (55.6%), ciprofloxacin (61.1%), and trimethoprim/ sulfametho-xazole (66.7%). Our results are consistent with previous studies conducted in Yemen, which revealed an increasing pattern of antibiotic resistance of *S. aureus* with an increase in the rate of MRSA[34-42]. Obtained susceptibility rates were different from those reported in Malaysia, where *S. aureus* had the lowest sensitivity to ciprofloxacin (66.7%), gentamicin (80%), chloramphenicol (80%), and trimethoprim-sulfamethoxazole (80%). Furthermore, our findings align with a South Korean study that found a correlation between an elevated MRSA[43] rate and an elevated antibiotic resistance pattern in *S. aureus*.

Limitation of the study

The limitation of this study is that measuring the susceptibility to different antibiotics of the most common bacteria isolated was for one region in Yemen. Therefore, reviewing the CSOM antibiotic regimen to ensure the most effective and efficient treatment protocol for all of Yemen requires a multi-center study.

CONCLUSIONS AND RECOMMENDATIONS

Pseudomonas aeruginosa was shown to be highly prevalent in the bacteriological profile of CSOM in the current investigation, with *Staphylococcus aureus*, *Klebsiella* spp., *Acinobacter* spp., and *Proteus* spp. following closely behind. Their sensitivity to widely used antibiotics showed a pattern of decline. It is critical to review the antibiotic regimen in accordance with sensitivity and to be aware of the current trend in bacteriological profiles.

Poor patient compliance and irrational use of antibiotics led to bacterial resistance to frequently used antibiotics, which led to treatment failure in many cases of CSOM infections. Also one of the reasons for raising the resistance is the prolonged use of otological drugs in persistent otorrhea. Therefore, there is a need to reassess the resistance and sensitivity of bacteria isolated from CSOM patients to antibiotics obtainable in different countries of the world. By quantifying the strength of different antibiotic susceptibility to the most common bacteria isolated, the antibiotic regimen for CSOM should be reviewed to ensure the most effective and efficient protocol of treatment. This review will prevent recurrent complications and additional complications of CSOM by initiating the most appropriate and effective antibiotic therapy.

ACKNOWLEDGEMENTS

The National Center for Public Health Laboratories (NCPHL), Sana'a, Yemen, and especially its head of the microbiology department, Dr. Fuad Ali Bazel Al-Qupti, are acknowledged by the authors for their help.

AUTHOR CONTRIBUTIONS

Al-Khamesy KSA: writing original draft, methodology, investigation. **Al-Shamahy HA:** supervision, review. All authors read and approved the final manuscript for publication.

DATA AVAILABILITY

The datasets generated during this study are available from the corresponding author upon reasonable request.

CONFLICT OF INTEREST

No conflict of interest is associated with this work.

REFERENCES

1. Lieberthal AS, Carroll AE, Chonmaitree T, *et al*. The diagnosis and management of acute otitis media. Pediatrics 2013; 131 (3): e964-99. *https://doi.org/10.1542/peds.2012-3488*
2. Emmett SD, Kokesh J, Kaylie D. Chronic Ear Disease. The Medical Clinics of North America 2018; 102 (6): 1063-1079. *https://doi.org/10.1016/j.mcna.2018.06.008*
3. Qureishi A, Lee Y, Belfield K, Birchall JP, Daniel M. Update on otitis media - prevention and treatment. Infection Drug Resis 2014; 7: 15–24. *https://doi.org/10.2147/IDR.S39637*
4. Al-Khamesy KSA, Al-Moyed KA, Al-Shamahy HA. Colonization of pathogenic aerobic bacteria in the external ear and effects of cerumen types, age, and gender on colonization. Universal J Pharm Res 2023; 7(6):1-8. *https://doi.org/10.22270/ujpr.v7i6.872*
5. Gleeson M, Clarke R. Scott-Brown's Otorhinolaryngology. Head and Neck Surgery. Vol 3. 7th ed. Boca Raton, FL: CRC Press; 2018: 115-131.
6. Monasta L, Ronfani L, Marchetti F, *et al*. Burden of disease caused by otitis media: Systematic review and global estimates. PLOS ONE 2012; 7 (4): e36226. *https://doi.org/10.1371/journal.pone.0036226*
7. Vos T, Barber RM, Bell B, *et al*. Global, regional, and national incidence, prevalence, and years lived with disability for 301 acute and chronic diseases and injuries in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet 2015; 386 (9995): 743–800. *https://doi.org/10.1016/s0140-6736(15)60692-4*
8. Wan Draman WNA, Md Daud MK, Mohamad H, Hassan SA, Abd Rahman N. Evaluation of the current bacteriological profile and antibiotic sensitivity pattern in chronic suppurative otitis media. Laryngoscope Investig Otolaryngol 2021 Oct 18;6(6):1300-1306. *https://doi.org/10.1002/lio2.682*

9. Acuin J, WHO Dept. of Child and Adolescent Health and Development, WHO Programme for the Prevention of Blindness and Deafness. Chronic suppurative otitis media : burden of illness and management options. Geneve: World Health Organization 2004; hdl:10665/42941. ISBN 978-92-4-159158-4.
10. Monasta L, Ronfani L, Marchetti F, *et al*. Burden of disease caused by otitis media: Systematic review and global estimates. PLOS ONE 2012; 7 (4): e36226. *https://doi.org/10.1371/journal.pone.0036226*
11. Cheesbrough M. District laboratory practice in tropical countries. Cambridge: Cambridge University Press; 2010. *https://doi.org/10.1017/CBO9780511581304*
12. Church DL. Biochemical tests for the identification of aerobic bacteria. Clinical Microbiology Procedures Handbook. 4th ed. Washington, DC: American Society of Microbiology; 2016:3-17.
13. Wayne PA. Performance Standards for Antimicrobial Disc Susceptibility Testing. Vol 12. National Committee for Clinical Laboratory Standards; 2002:1-53.
14. 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; 27:120-124.
15. Bakari AA, Adoga AA, Afolabi OA, Kodiya AM, Ahmad BM. Pattern of chronic suppurative otitis media at the National Ear Care Centre Kaduna, Nigeria. J Med Trop 2010; 12:22-25.
16. Gleeson M, Clarke R. Scott-Brown's Otorhinolaryngology. Head and Neck Surgery. Vol 3. 7th ed. Boca Raton, FL: CRC Press; 2018: 115-131.
17. Ayson PN, Lopez JEG, Llanes EGDV. Chronic suppurative otitis media: Bacteriology and drug sensitivity patterns at the Quirino Memorial Medical Center (2004-2005): A preliminary study. Philipp J Otolaryngol Head Neck Surg 2006; 21:20-23.
18. Loy AHC, Tan AL, Lu PKS. Microbiology of chronic suppurative otitis media in Singapore. Singapore Med J 2002; 43:296-299.
19. Zahid T, Zeba A, Aqeel Z. Microbiology of chronic suppurative otitis media (CSOM) in tertiary care setup, Civil Hospital Karachi, Pakistan. Pak J Surg. 2016; 32:176-180.
20. Mansoor T, Musani MA, Khalid G, Kamal M. *Pseudomonas aeruginosa* in chronic suppurative otitis media: sensitivity spectrum against various antibiotics in Karachi. J Ayub Med Coll Abbottabad 2009; 21: 120-123.
21. Mohamad H, Md Daud MK, Hasan H, Wong CY. Does fungal infection is the main cause for persistent middle ear otorrhea? Egypt J Ear Nose Throat Allied Sci 2017; 18:79-82.
22. Appiah-Korang L, Asare-Gyasi S, Yawson AE, Searyoh K. Aetiological agents of ear discharge: A two year review in a teaching hospital in Ghana. Ghana Med J 2014; 48:91-95.
23. Koch A, Homøe P, Pipper C, Hjuler T, Melbye M. Chronic suppurative otitis media in a birth cohort of children in Greenland: Population based study of incidence and risk factors. Pediatr Infect Dis J 2011; 30:25-29.
24. Acuin J. Global Burden of Disease Due to Chronic Suppurative Otitis Media: Disease, deafness, deaths and DALYs Chronic suppurative otitis media-burden of illness and management options. Geneva: World Health Organisation; 2004:9-23.
25. Md Daud MK, Shahrjerdi B, Ramli RR, Abd RN. The association of allergy and chronic suppurative otitis media: a study in a tropical country. Med J Malaysia 2019; 74:205-208.
26. Verhoeff M, van der Veen EL, Rovers MM, Sanders EAM, Schilder AGM. Chronic suppurative otitis media: A review. Int J Pediatr Orl 2006; 70:1-12.
27. Bardanis J, Batzakakis D, Mamatas S. Types and causes of otorrhea. Auris Nasus Larynx 2003; 30:253-257.
28. Al-Safani AA, Al-Shamahy H, Al-Moyed K. Prevalence, antimicrobial susceptibility pattern and risk factors of MRSA isolated from clinical specimens among military patients at 48 medical compounds in Sana'a city, Yemen. Universal J Pharm Res 2018; 3(3):40-44. *https://doi.org/10.22270/ujpr.v3i3.165*
29. AL-Magrami RTF, H. A. Al-Shamahy. Pseudomonas aeruginosa skin-nasopharyngeal colonization in the inpatients: prevalence, risk factors and antibiotic resistance in tertiary hospitals in Sana'a city-Yemen. Universal J Pharm Res 2019; 3(6). *https://doi.org/10.22270/ujpr.v3i6.219*
30. Penido Nde O, Chandrasekhar SS, Borin A, Maranh~ao AS, Gurgel Testa JR. Complications of otitis media–A potentially lethal problem still present. Braz J Orl 2016; 82:253-262.
31. Mozafari Nia K, Sepehri G, Khatmi H, Shakibaie MR. Isolation and antimicrobial susceptibility of bacteria from chronic suppurative otitis media patients in Kerman. Iran Iran Red Crescent Med J 2011; 13: 891-894.
32. Aduda DSO, Macharia IM, Mugwe P, *et al*. Bacteriology of chronic suppurative otitis media (CSOM) in children in Garissa District, Kenya: A point prevalence study. Int J Pediatr Orl 2013;77:1107 - 1111.
33. Ibekwe AO, ZAS AS, Benayam A. Anaerobes and fungi in chronic suppurativeotitis media. Ann Otol Rhinol Laryngol 1997; 106:649-652.
34. Al-Shami A Z, Al-Haimi M, Al-Shamahy HA, *et al*. Patterns of antimicrobial resistance among major bacterial pathogens isolated from clinical samples in two tertiary's hospitals, in Sana'a, Yemen. Universal J Pharm Res 2021; 6(5):1-6. *https://doi.org/10.22270/ujpr.v6i5.674*
35. Alyahawi A, Alkaf A, Alnamer R, Alnosary T. Study of resistance for recently marketed carbapenem drug among hospitalised patients in Sana'a, Yemen. Universal J Pharm Res 2018; 3(5). *https://doi.org/10.22270/ujpr.v3i5.203*
36. Saleh AAM, Al-Shamahy HA, Al-Hrazi RMA, *et al*. Biofilm formation and antibiotic susceptibility of uropathogens in patients with catheter associated urinary tract infections in Ibb city-Yemen. Universal J Pharm Res 2020; 4(6). *https://doi.org/10.22270/ujpr.v4i6.329*
37. Ishak AA, Alhadi AM, Al-Moyed KAA, Al-Shamahy HA. Childhood urinary tract infection: clinical signs, bacterial causes and antibiotic susceptibility. Universal J Pharm Res 2021; 6(4). *https://doi.org/10.22270/ujpr.v6i4.643*
38. Al-Eryani SA, Alshamahi EYA, Al-Shamahy HA, Alfalahi GHA, Al-Rafiq AA. Bacterial conjunctivitis of adults: causes and ophthalmic antibiotic resistance patterns for the common bacterial isolates. Universal J Pharm Res 2021; 6, (1). *https://doi.org/10.22270/ujpr.v6i1.535*
39. Alshamahi EYA, Al-Shamahy HA, Musawa YA, Al-Shami HZ. Bacterial causes and antimicrobial sensitivity pattern of external ocular infections in selected ophthalmology clinics in Sana'a city. Universal J Pharm Res 2020; 5(3). *https://doi.org/10.22270/ujpr.v5i3.409*
40. Al-Haifi AY, Al Makdad ASM, Salah MK, Al-Shamahy HA, Al Shehari WAA. Epidemiology, bacterial profile, and antibiotic sensitivity of lower respiratory tract infections in Sana'a and Dhamar city, Yemen. Universal J Pharm Res 2020; 5(2):1-6. *https://doi.org/10.22270/ujpr.v5i2.386*
41. Al-Akwa AAY, Zabara AQMQ, Al-Shamahy HA, *et al*. Prevalence of *Staphylococcus aureus* in dental infections and the occurrence of MRSA in isolates. Universal J Pharm Res 2020; 5(2):1-6. *https://doi.org/10.22270/ujpr.v5i2.384*
42. Alhadi YAA, Al-Kibsi TAM, Al-Shamahy HA, Aldeen YASS. Surgical site infections: prevalence, associated factors and antimicrobial susceptibility patterns of the bacterial isolates among postoperative patients in Sana'a, Yemen. Universal J Pharm Res 2022; 7(3):1-6. *https://doi.org/10.22270/ujpr.v7i3.777*
43. Choi HG, Park KH, Park SN, Jun BC, Lee DH, Yeo SW. The appropriate medical management of methicillin-resistant *Staphylococcus aureus* in chronic suppurative otitis media. Acta Otolaryngol 2010; 130:42-46.