Bacterial Meningitis among Adult Patients at University of Gondar Comprehensive Specialized Referral Hospital: Prevalence and Antimicrobial Susceptibility Patterns

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Abstract

Background: Bacterial meningitis is a bacterial infection that causes inflammation of the membranes that surround the brain and spinal cord. The most frequent causes of bacterial meningitis are *N. meningitidis*, *Streptococcus pneumonia*, *Listeria monocytogenes*, and *Homophiles influenza*. This study aimed to determine bacterial meningitis and their antibiotic susceptibility patterns among adult patients.

Methods: A retrospective cross-sectional study was conducted on 3,683 patients to determine bacterial meningitis and their antibiotic susceptibility patterns from 2011 to 2020. Cerebrospinal fluid samples were collected and inoculated on blood and chocolate agar plates, and then incubated at 37^{o}c for 24 hours. Bacterial identification performed using morphological characters, gram stain, and standardized biochemical tests. Records of 3,683 culture results were collected and reviewed using a checklist from the registration book. Finally, data was entered, cleared, and checked using Epi-info version 7 and exported to SPSS version 20 for analysis. Logistic regression used for statistical association. The results were displayed using tables and figures. P-value $\leq$ 0.05 at 95% CI was considered as statistically significant.

Results: Of the 3,683 patients, the overall prevalence of bacterial meningitis was 1.28% (47/3683). Of them, bacterial meningitis in males was 0.9% (33/3683) whereas, it was 0.38% (14/3683) in females. Bacterial meningitis among inpatients, 1.16% (43/3683) was higher than their outpatient counterparts, 0.12% (4/3683). Ceftriaxone, chloramphenicol, ciprofloxacin, vancomycin, clindamycin, and erythromycin were the most effective antibiotics whereas penicillin, tetracycline, and cotrimoxazole were the least effective antibiotics for isolates. Being male in sex (P = 0.048, AOR = 0.53, CI = 0.283-0.993) was significantly associated with bacterial meningitis.

Conclusions: The prevalence of bacterial meningitis among adult patients was 1.28%, which is considerably high. Being male in gender is a risk factor for bacterial meningitis. Therefore, infection preventive measures are required with a particular focus on adult patients. Further research is needed to explore the epidemiology and risk factors of meningitis.

Background

Meningitis is an infection caused by bacterial, viral, fungal, or protozoan agents that causes inflammation of membranes that surrounds the brain and spinal cord (meninges). Bacteria and viruses are the most common causes of meningitis. But bacterial meningitis (BM) is usually severe and common [1]. The most common etiologic agents of BM are *E. coli*, *H. influenza*, *N. meningitidis*, *S. pneumonia*, and *L. monocytogenes* [2]. The classic symptoms of BM are fever, neck stiffness, altered mental status, and headache [3]. But the classical signs of BM are not always present in adults, and we cannot rule out based on the classical signs and symptoms alone [4, 5]. BM is a severe infectious disease of the membranes lining the brain resulting in high mortality and morbidity throughout the world [6]. So, accurate and timely identification of the etiological agents is vital to initiate public health measures and ensure appropriate management [7].

Bacterial meningitis remains a common disease worldwide. The incidence of BM is between 3 and 5 per 100,000 people per year, and more than 2,000 deaths are reported annually in the United States [8]. The incidence of BM is a significant burden in adults with a mortality rate of up to 30% [9], and it requires prompt recognition and treatment [10]. *S. pneumonia*, *H. influenza*, and *N. meningitidis* have been responsible for 118.400, 83.000, and 75.000 deaths, respectively [12]. *N. meningitidis* was accountable for the large majority of BM epidemics in the meningitis belt of Sub-Saharan Africa [6, 11] and developing countries. *S. pneumonia* becomes a leading cause of meningitis among adults [12]. Adult BM is caused by *P. aeruginosa*, which usually found in the hospital area and patients with a post neurosurgical state [13]. The introduction of vaccines has reduced the burden of the two most common etiological agents for BM in adults such as *S. pneumoniae* and *N. meningitidis* [14].

Microbiological laboratory examination of cerebrospinal fluid (CSF) is the most definitive investigation for BM and guides possible choice of antibiotics and duration of therapy like third-generation cephalosporin is the initial antibiotics of choice in the absence of penicillin allergy and bacterial resistance. Amoxicillin is used if *Listeria monocytogenes* suspected in adults [15]. Besides, mass vaccinations can lead to herd immunity resulting in a dramatic reduction in infection rates among populations at risk [16]. Therefore, this study aimed to determine the prevalence and antimicrobial susceptibility patterns of bacterial meningitis among patients at the University of Gondar comprehensive specialized hospital.

Methods

Study area

The study was conducted at University of Gondar comprehensive specialized referral hospital, which serves more than five million people in Gondar town and the surrounding area. The town has 8 health centers, 21 private clinics, and one referral hospital which has more than 500 beds that provides health services such as surgery, internal medicine, pathology, TB/HIV, dermatology, antenatal care, delivery, postnatal care, laboratory, pharmacy, maternal and neonatal care, and other services for the population of Gondar town and surrounding areas.

Study design, period and data collection

A retrospective cross-sectional study was conducted to determine the prevalence and antimicrobial susceptibility patterns of bacterial meningitis among patients at University of Gondar compressive specialized hospital from 2011 to 2020. Records of 3683 patients were collected and reviewed using a checklist from the registration book at medical bacteriology unit. Information concerning bacterial meningitis test results, age, sex, and type of patient visit (Inpatient or outpatient) of patients recorded from 2011 to 2020 in the registration book was collected using a data collection format.

Laboratory inoculation and identification

Each cerebrospinal fluid samples were inoculated onto blood and chocolate agar plates and incubated aerobically at 37^{o}C for 24 hours. Samples that were culture positive on blood and chocolate agar plates, and the isolates obtained were identified using standard microbiological methods including colony morphology, Gram's stain reaction, and standardized biochemical tests such as indole production, lactose fermentation, hydrolysis of urea, citrate utilization, lysine decarboxylation, motility test, mannitol fermentation, catalase, and coagulase tests. A suspension of a pure colony from each confirmed culture isolate was performed by using 0.85% sterile normal saline for antimicrobial susceptibility testing and adjusted at 0.5 MacFarland standard. Using a sterile cotton tip applicator stick, the suspension was distributed evenly on Muller-Hinton agar, and a modified Kirby-Bauer disk diffusion technique implemented for antibiotic susceptibility pattern using different antibiotics.

Data management and statistical analysis

The quality of data was assured using a structured data collection format, asking laboratory staff how data registered including abbreviations in the laboratory and cross-checking by members of the data collector. Then data entered in statistical package EP-Info version 7, and data cleaned and analyzed using the statistical package SPSS version 20. Frequency distribution, percentages, and summary statistics were used to describe the study population concerning relevant variables. Odds Ratio (OR) was computed to assess statistical association, and the significance of statistical association was assured using p-value < 0.05 at 95% confidence interval (CI).

Results

Socio-demographic characteristics of study participants

In this study, a total of 3683 adult patients greater than 18 years of age were included at University of Gondar teaching hospital during the study period. Out of these, 55.7% (2052/3683) were males, and 44.3% (1631/3683) were females. The mean age of the study participants was 36.115 years with a SD of ±14.41with an age range of 18-97 years. The majority of the study participants, 32.6% (1199/3683), belonged to 18-27 years of age, while 29% (1067/3683) of patients belong to 28-37 years of age. The majority, 90% (3313/3683) of patients were from inpatient visits while the rest, 10% (370/3683) of them were from outpatient departments. The majority, 32.27% (1069/3313) of the inpatients are belong 18-27 years of age, followed by 28-37 years of age 32.2% (1067/3313) and 55.45% (1837/3313) of the inpatients are males. In this study, cerebrospinal fluid samples collected by lumbar puncture, and the most frequently observed patient's age was 30 followed by 40. Most of the study participants were involved in 2018 and 2014, 13.9% (512/3683), and 11.5% (425/3683), respectively. The age and sex distribution of patients involved in this study are presented (Table 1).

Prevalence of bacterial meningitis and risk factors

A total of 3,683 cerebrospinal fluid samples analyzed, the prevalence of bacterial meningitis among adult patients greater than 18 years was 1.28% (47/3683), and 12 different types of bacterial species were isolated. Of these, *Streptococcus pneumonia* (0.4%, 15/3683) was the commonest isolated bacteria followed by *Staphylococcus aureus*, (0.2%, 6/3683), *Escherichia coli*, (0.2%, 6/3683), and *N. meningitidis*, (0.1%, 5/3683) (Figure 1). The prevalence of bacterial meningitis among adult patients of different age category showed 12 (0.33%), 18 (0.49%), 9 (0.24%), 4 (0.11%), 3 (0.08%) and 1 (0.03%) among the age groups 18-27 years, 28-37 years, 38-47 years, 48-57 years, 58-67 years and ≥ 67 years, respectively. The proportion of bacterial meningitis among male patients was 0.896% (33/3683), but 0.38% (14/3683) among females. Bacterial meningitis among inpatients, 1.16% (43/3683) were higher than their outpatient counterparts, 0.12% (4/3683). Maximum bacterial isolates were found in 2019, 0.27% (10/3683) followed by 2011, % (7/3683), 2015, % (7/3683) and 2012, % (6/3683). Maximum bacterial isolates were found at age of 32 and 40, 5 (0.14%) and 4 (0.11%), respectively. Being male in gender (P = 0. 048; AOR = 0.530; CI = 0.283-0.993) was significantly associated with bacterial meningitis in adult patients. However, age (P = 0.916; AOR =1.011; CI = 0. 822-1.244) and patient visits (inpatients and outpatient visits) (P = 0.725; AOR = 0.831; CI = 0.297-2.329) were not significantly associated with bacterial meningitis.

Trends ofbacterial meningitis

Over the ten years study periods, the prevalence of bacterial meningitis was higher in 2019 (0.272%, 10/3683), 2015 (0.19%, 7/3683), 2011 (0.19%, 7/3683) and 2012 (0.163%, 6/3683), while lower in 2013 (0.082%, 3/3683), 2014 (0.082%, 3/3683), 2016 (0.082%, 3/3683), 2017 (0.082%, 3/3683), 2018 (0.054%, 2/3683), and 2020(0.054%, 2/3683) (Figure 2).

Antimicrobial susceptibility patterns of bacterial isolates

Bacterial antimicrobial susceptibility tests done for bacterial isolates, and it shows that among 47 isolates tested for different antimicrobials; *S. pneumonia* isolates were sensitive for ampicillin (100%, 6/6), ceftriaxone (100%, 6/6), chloramphenicol (77.8% 7/9), ciprofloxacin (83.3%, 5/6), penicillin (100%, 11/11), vancomycin (87.5%, 7/8), erythromycin (80%, 4/5) and tetracycline (43%, 3/7). However, four *S. pneumonia* isolates were resistant to cotrimoxazole (66.8%, 4/6). *S. aureus* isolates were sensitive for cefoxitin (100%, 3/3), clindamycin (100%, 3/3), erythromycin (66.8%, 4/6), and amoxicillin (66.8%, 2/3) (Table 2). On the other hand, *E. coli* isolates were sensitive for ciprofloxacin (60%, 3/5), gentamycin (66.8%, 4/6). But five *E. coli* isolates were resistant to ampicillin (100%, 5/5). And three *N. meningitidis* isolates were sensitive for amoxicillin (100%, 3/3) and erythromycin (100%, 3/3). But, three *N. meningitidis* isolates resistant to penicillin (100%, 3/3), and two *K. pneumonia* isolates were sensitive for ceftazidime (100%, 2/2) (Table 3).

Discussion

Bacterial meningitis, a life-threatening worldwide disease, has to be reviewed periodically because the specific microorganisms responsible for the infection vary with time, geography, and patient age. It has become a disease of adults with a significant mortality rate that ranges from 20–30%. We performed this study to summarize prevalence figures obtained from CSF samples, with an exclusive focus on adults. The overall prevalence of bacterial meningitis among adult patients in this study is 1.28%, which is higher than a study carried in Indonesia (0.68%) [17]. However, it is lower than reported in Ethiopia (6.9%) [18], Malawi (5.25%) [19], South African (10.7%) [20], Kenya (11.2%) [21], Netherlands (13%) [22], Yemen (52.7%) [23] and Qatar (53.6%) [24], which differs noticeably among studies, might be due to differences in characteristics and geographical distribution of the study population, sample size, diagnostic techniques, and differences in infection control policies. We noticed a significant prevalence of bacterial meningitis among adult patients, which indicates adults remain the population where the diseases meningitis prevalent and strict prevention strategies are required.

The present study showed that *Streptococcus pneumonia*, *Staphylococcus aureus*, *Escherichia coli,* and *N. meningitidis* were the predominant pathogens that caused bacterial meningitis. *S. pneumoniae* was the predominant pathogen, and it remains an important cause of bacterial meningitis, which is in agreement with the results of a previous study by Amaya-Villar R et al [25], Van de Beek D et al [26], Wall EC et al [27], Mook-Kanamori BB et al [28], Adriani KS et al [29], Weisfelt M et al [30], and Mirecka A [31]. However, other studies reported that *N. meningitidis* (18), *Mycobacterium tuberculosis* [20], coagulase-negative staphylococci [24], and *Listeria monocytogenes* [32] were the leading cause of bacterial meningitis. Moreover, *Staphylococcus aureus* and *Escherichia coli* were the second frequent etiological agent, which is comparable with a study conducted by Mook-Kanamori BB et al (28) and Mirecka A [31].

The trends of bacterial meningitis among adult patients tend to decrease in 2013 (0.08%), 2014 (0.08%), 2016 (0.08%), 2017 (0.08%), 2018 (0.05%), and 2020 (0.05%). However, the prevalence of bacterial meningitis significantly increased in 2011 (0. 22%), 2012 (0.16%), 2015 (0.19%), and 2019 (0.27%). The highest prevalence of bacterial meningitis was observed in 2019 (0.27%), and the lowest prevalence of bacterial meningitis was observed in 2018 (0.05%) and 2020 (0.05%). The prevalence of bacterial meningitis was not constantly decreased or increased in this study, However, differs noticeably between years, which might be due to the difference in the management of the disease, the prevention and infection control policies from year to year.

In this study, the majority of the isolated *S. pneumonia* were sensitive to ampicillin (100%), ceftriaxone (100%), chloramphenicol (77.8%), ciprofloxacin (83.3%), penicillin G (100%), vancomycin (87.5%), and erythromycin (80%). This finding was in agreement with studies conducted by Purwanto DS et al [17] and by Gudina EK et al [33]. However, a study by Assegu Fenta D et al [18] and Khan FY et al [24] reported that *S. pneumoniae* was resistant to ceftriaxone and penicillin. *S. aureus* isolates were sensitive for cefoxitin (100%), clindamycin (100%), erythromycin (66.8%), and amoxicillin (66.8%). However, a study conducted by Assegu Fenta D et al [18] reported that *S. aureus* isolates were found to be (100%) resistant to amoxicillin. On the other hand, *E. coli* isolates were sensitive for ciprofloxacin (60%) but resistant for ampicillin (100%) which is comparable with a study conducted by Gordon SB et al [19]. Furthermore, *N. meningitidis* isolates were sensitive for amoxicillin (100%), and erythromycin (100%), but resistant for penicillin (100%). However, Mirecka A [31] reported that *Neisseria meningitidis* isolates were sensitive to penicillin. The differences in the susceptibility pattern of the isolates might be due to the differences in the management of antibiotics and diagnostic techniques employed.

Even if there are several factors considered as a risk factors for bacterial meningitis, and we found that being male in gender is significantly associated with bacterial meningitis in adult patients. The proportion of bacterial meningitis among male patients was higher than females. Male patients were 0.53 times more at risk of acquiring the disease meningitis as compared with female patients. This higher prevalence in males might be due to males more exposed to smoking, alcohol drinking and HIV infection which makes them more vulnerable to bacterial infection. In this study, age is not is not significantly associated with meningitis ($p > 0.05$). However, a study by Abdulrab A et al [23], Amaya-Villar R et al [25], and Van de Beek D et al [26] reported that age was independently associated with bacterial meningitis. Bacterial meningitis among inpatients were higher than their outpatient counterparts. But being inpatient in a hospital is not significantly associated with bacterial meningitis ($p > 0.05$).

Conclusions And Recommendations

In conclusion, the prevalence of bacterial meningitis among adult patients was 1.28%, which is considerably high. Being male in gender is a risk factor for bacterial meningitis. Therefore, infection preventive measures are required with a particular focus on adult patients. Further research is needed to explore the epidemiology and risk factors of meningitis.

Abbreviations

BM-Bacterial Meningitis, CSF-Cerebrospinal Fluid, CI-Confidence Interval, OR-Odds Ratio

Declarations

Ethical approval and consent to participate

Ethical approval was obtained from the University of Gondar ethical review committee. A legal permission and support letter was obtained from College of Medicine and Health Sciences hospital director office. The objectives of the study were explained to the heads of the hospital director and health care providers who worked at medical microbiology department and clarification was given before starting data collection from the registrations and client cards. To ensure confidentiality of information from participant's records, no personal identifiers were recorded in the client information extraction pre-designed form, and data secured from participant records were not available to anyone except for the main investigator.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analyzed during this study were included in this article. Data that support the findings of this study are also available from the corresponding author upon reasonable request.

Competing interest

We declare that we have no competing interests.

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Authors' contribution

All authors contributed equally to the conception, drafting, study design, execution, acquisition, analysis, and interpretation of data, write up and critically reviewing of the manuscript; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Tables

Table 1: Frequency of study participants by age groups, gender and year at University of Gondar Compressive Specialized Hospital, Gondar, Northwest Ethiopia, 2020.

Variables			Frequency	Percent
Socio-demographic characteristics	Age group	18-27	1199	32.6%
		28-37	1067	29%
		38-47	682	18.5%
		48-57	360	9.8%
		58-67	214	5.8%
		≥ 68	161	4.4%
	Sex	Male	2052	55.7%
		Female	1631	44.3%
	Patient visit	Inpatient	3313	90%
		Outpatient	370	10%
Year of data collection	2011	Male	224	54.8%
		Female	185	45.2%
	2012	Male	92	46%
		Female	108	54%
	2013	Male	203	51.5%
		Female	191	48.5%
	2014	Male	250	57.6%
		Female	184	42.4%
	2015	Male	218	52.7%
		Female	196	47.3%
	2016	Male	184	60.7%
		Female	119	39.3%
	2017	Male	180	55.4%
		Female	145	44.6%
	2018	Male	267	52.1%
		Female	245	47.9%
	2019	Male	272	64%
		Female	153	36%
	2020	Male	162	60.7%
		Female	105	39.3%

Table 2: Antimicrobial susceptibility profile of gram negative bacterial isolates at University of Gondar specialized hospital, Northwest Ethiopia, from January to August, 2020.

Antibiotics	*E. coli*		*N. meningitidis*		*K. pneumonia*		*K. ozanae*		*S. dysenteriae*		*Citrobacter* spss		NLF gram negative rods	
	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)
Ampicillin	0 (0)	5 (100)	1 (100)	0 (0)	1 (50)	1 (50)	0 (0)	3 (100)	0 (0)	1 (100)	1 (100)	0 (0)	1 (100)	0 (0)
Ceftriaxone	3 (100)	0 (0)	3 (75)	1 (25)	2 (100)	0 (0)	0 (0)	1 (100)	0 (0)	1 (100)	1 (100)	0 (0)	1 (50)	1 (50)
Chloramphenicol	2 (50)	2 (50)	1 (100)	0 (0)	1 (100)	0 (0)	1 (100)	0 (0)	N/A	N/A	1 (100)	0 (0)	1 (100)	0 (0)
Ciprofloxacin	3 (60)	2 (40)	2 (67)	1 (33)	3 (75)	1 (25)	2 (100)	0 (0)	1 (100)	0 (0)	N/A	N/A	2 (66.7)	1 (33.3)
Gentamycin	4 (67)	2 (33)	0 (0)	1 (100)	2 (67)	1 (33)	1 (33)	2 (67)	N/A	N/A	1 (100)	0 (0)	1 (50)	1 (50)
PencillinG	N/A	N/A	2 (67)	1 (33)	N/A	N/A	1 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A
Cotrimoxazole	3 (100)	0 (0)	3 (100)	0 (0)	1 (33)	2 (67)	0 (0)	2 (100)	N/A	N/A	1 (100)	0 (0)	1 (50)	1 (50)
Amoxicillin	0 (0)	1 (100)	3 (100)	0 (0)	1 (100)	0 (0)	N/A	N/A	N/A	N/A	1 (100)	0 (0)	1 (100)	0 (0)
Norfloxacilin	0 (0)	1 (100)	2 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vancomycin	N/A	N/A	1 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Clindamycin	N/A	N/A	1 (100)	0 (0)	N/A	N/A	1 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A
Cefoxtin	N/A	N/A	1 (50)	1 (50)	N/A	N/A	N/A	N/A	0 (0)	1 (100)	N/A	N/A	N/A	N/A
Meropenem	1 (100)	0 (0)	1 (100)	0 (0)	1 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A	0 (0)	1 (100)
Tetracycline	3 (100)	0 (0)	3 (100)	N/A	N/A	0 (0)	2 (100)	N/A	N/A	N/A	0 (0)	1 (100)	1 (100)	0 (0)
Erythromycin	N/A	N/A	3 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Imipenem	N/A	N/A	N/A	N/A	1 (100)	0 (0)	N/A	N/A	1 (100)	0 (0)	N/A	N/A	N/A	N/A
Cefuroxime	N/A	N/A	N/A	N/A	1 (100)	0 (0)	0 (0)	1 (100)	0 (0)	1 (100)	N/A	N/A	0 (0)	1 (100)
Tobramycin	N/A	N/A	N/A	N/A	N/A	N/A	0 (0)	1 (100)	N/A	N/A	N/A	N/A	0 (0)	1 (100)
Ceftazidime	N/A	N/A	N/A	N/A	2 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A	0 (0)	1 (100)

S = Sensitive, R = Resistant, NLF = Non Lactose Fermenter, N/A = Not Applicable

Table 3: Antimicrobial susceptibility profile of gram positive bacterial isolates at University of Gondar specialized hospital, Northwest Ethiopia, from January to August, 2020.

Antibiotics	*Streptococcus pneumoniae*		*Streptococcus viridians*		*Staphylococcus aureus*		*Coagulase negative staphylococci*		*Listeria monocytogenes*	
	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)	S (%)	R (%)
Ampicillin	6 (100)	0 (0)	N/A	N/A	1 (33.3)	2 (66.7)	N/A	N/A	1 (100)	0 (0)
Ceftriaxone	6 (100)	0 (0)	N/A	N/A	3 (100)	0 (0)	1 (100)	0 (0)	1 (100)	0 (0)
Chloramphenicol	7 (77.8)	2 (22.2)	0 (0)	1 (100)	0 (0)	1 (100)	N/A	N/A	1 (100)	0 (0)
Ciprofloxacin	5 (83.3)	1 (16.7)	N/A	N/A	2 (66.7)	1 (33.3)	N/A	N/A	N/A	N/A
Gentamycin	1 (25)	3 (75)	0 (0)	1 (100)	N/A	N/A	N/A	N/A	1 (100)	0 (0)
PencillinG	11 (100)	0 (0)	0 (0)	1 (100)	1 (50)	1 (50)	1 (100)	0 (0)	N/A	N/A
Cotrimoxazole	2 (33.3)	4 (66.7)	N/A	N/A	0 (0)	3 (100)	1 (100)	0 (0)	N/A	N/A
Amoxicillin	3 (100)	0 (0)	N/A	N/A	2 (66.7)	1 (33.3)	N/A	N/A	1 (100)	0 (0)
Norfloxacilin	3 (100)	0 (0)	N/A	N/A	1 (100)	0 (0)	N/A	N/A	N/A	N/A
Vancomycin	7 (87.5)	1 (12.5)	1 (100)	0 (0)	2 (66.7)	1 (33.3)	1 (100)	0 (0)	1 (100)	0 (0)
Clindamycin	N/A	N/A	N/A	N/A	3 (100)	0 (0)	N/A	N/A	1 (100)	0 (0)
Cefoxtin	2 (100)	0 (0)	N/A	N/A	3 (100)	0 (0)	N/A	N/A	N/A	N/A
Tetracycline	3 (42.9)	4 (57.1)	N/A	N/A	1 (33.3)	2 (66.7)	0 (0)	1 (100)	N/A	N/A
Erythromycin	4 (80)	1 (20)	N/A	N/A	4 (66.7)	2 (33.3)	0 (0)	1 (100)	N/A	N/A
Cefuroxime	1 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kanamycin	1 (100)	0 (0)	N/A	N/A	N/A	N/A	N/A	N/A	1 (100)	N/A

S = Sensitive, R = Resistant, NLF = Non Lactose Fermenter, N/A = Not Applicable

Figures

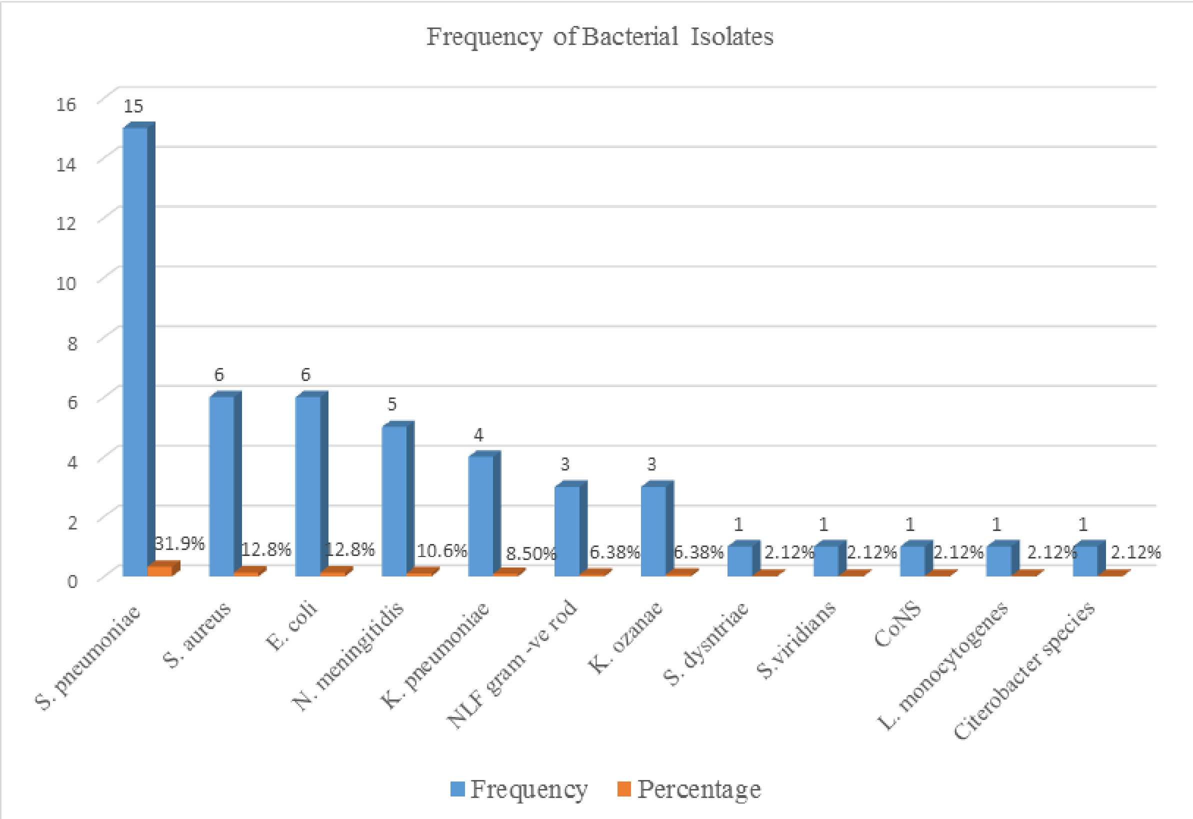

Figure 1

Frequency and percentage of bacterial isolates at University of Gondar Compressive Specialized Hospital, Gondar, Northwest Ethiopia, 2020.

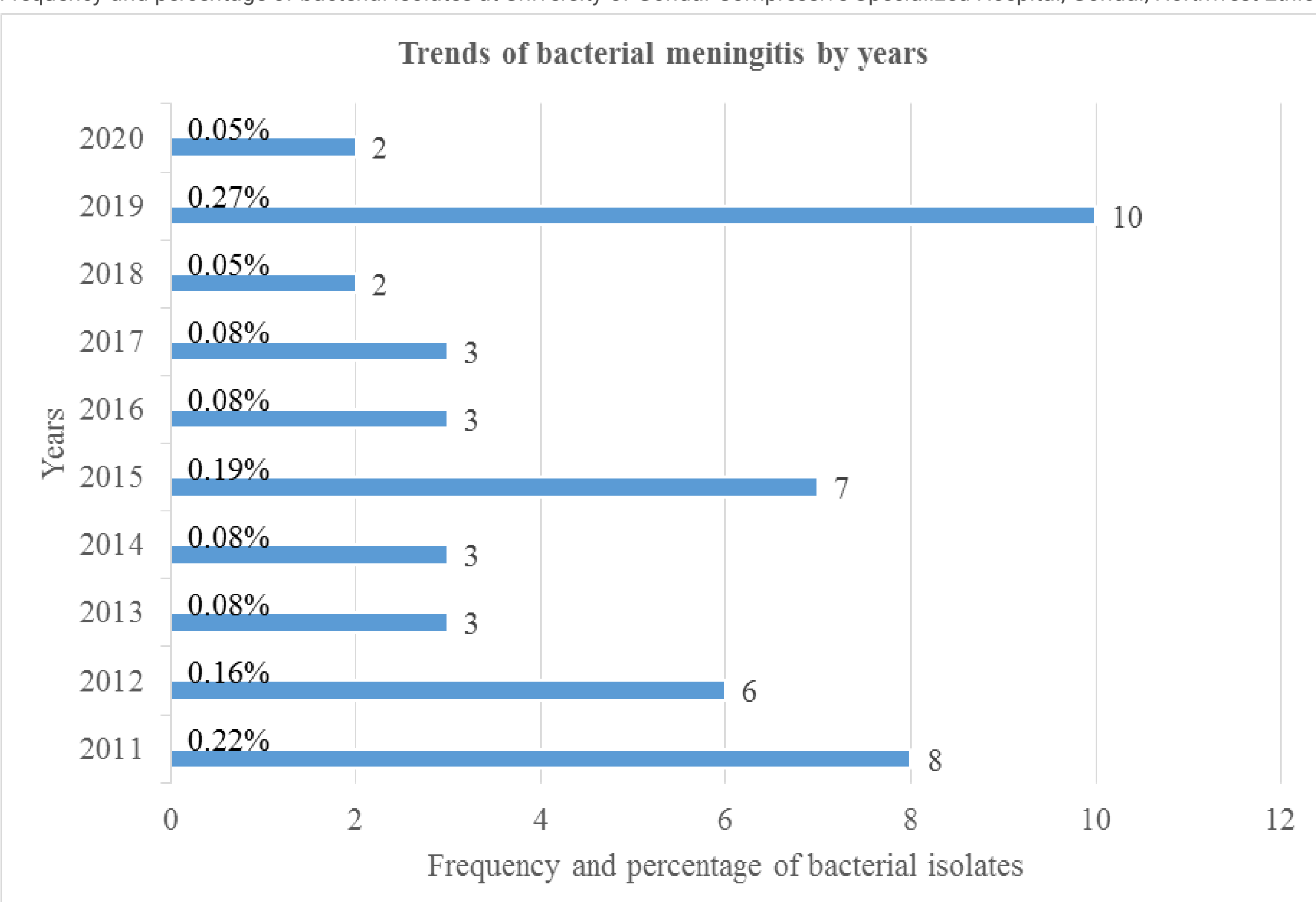

Figure 2

Trends of bacterial meningitis by years at University of Gondar Compressive Specialized Hospital, Gondar, Northwest Ethiopia, 2020.