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# Bacterial Profile and their Antibiotic Resistance Pattern among HIV Patients Diagnosed with Pneumonia in Felege-Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia

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## Abstract
**Background:** Bacterial pneumonia remains the major cause of morbidity and admission diagnosis among human immunodeficiency virus-infected individuals. In the study area, data about the bacterial profile of pneumonia and their antimicrobial resistance pattern among people living with human immunodeficiency virus is limited. Hence, this study was aimed to estimate the prevalence of bacterial pneumonia, antibiotic resistance patterns of isolated bacteria, and associated factors among HIV patients in Felege Hiwot Referral Hospital.
**Method:** A Hospital-based cross-sectional study was conducted from February 15 to June 15, 2019. Sputum specimens were collected from 163 pneumonia presumptive HIV seropositive individuals. Data on socio-demographic characteristics and risk factors were also collected using a structured questionnaire. Blood, Chocolate, and MacConkey agar plates were used to grow the isolates. The isolated colonies were identified based on Gram Stain, colony morphology, hemolysis, and biochemical tests. The antimicrobial susceptibility test was performed using the modified Kirby-Bauer Disc Diffusion method. Descriptive and multivariate analyses were performed using SPSS version 23. P-value < 0.05 was considered statistically significant.
**Result:** Out of 163 sputum samples, 68 (41.7%) were culture positive for common bacterial infections. The predominant bacterial isolates were *Klebsiella pneumoniae* 19 (27.9%), and *Staphylococcus aureus,* 17 (25%). From multivariate analysis, age groups 18-29 (AOR = 5.4, 95 % CI: 1.26-23.35), age groups 30-39 (AOR = 3.8, 95% CI: 1.03 13.80), recent viral load greater than or equal to 150 copies/ml (AOR= 24.3, 95 % CI: 2.61-56.38), viral load less than 150 copies/ml (AOR= 5.1, 95% CI: 1.26-21.04), cigarette smoking (AOR=15.5, 95% CI: 1.61-48.59), and alcohol consumption (AOR=8.1, 95% CI: 2.76-23.51) were found to have statistically significant association with bacterial pneumonia. Out of the tested antibiotics, 46 (70.8%) were resistant to cotrimoxazole and P. aeruginosa were 100% resistant to gentamycin and ceftazidime. Overall, 77.9% of the isolates were MDR.
**Conclusion:** The study showed a high prevalence of bacterial pneumonia and a high percentage of drug resistance including MDR in the study area. Therefore, we recommend that culture and antimicrobial susceptibility tests should be routinely performed for the selection of appropriate treatment.

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## Introduction

### Background

The respiratory tract is the most frequently affected site in human immunodeficiency virus (HIV), infected individuals. From the respiratory tract, the lung was the most frequently infected, ranging from 100% in the early period of the HIV epidemic to 70% in the era of highly active antiretroviral treatment (HAART) [1]. Thus, pulmonary complications are a major cause of morbidity and mortality among HIV-infected patients worldwide [2]. Pulmonary infection represents a common and frequently fatal complication in HIV infected population. It accounted for 72% of AIDS deaths globally [3].

Pneumonia is one of the most common pulmonary complications in HIV infected patients. It is caused by different groups of micro-organisms from which bacteria are the common etiological agents [4]. Bacterial pneumonia remains the commonest cause of hospitalization and mortality in countries where the HIV epidemic is high [5]. Following the introduction of ART, the incidence of HIV-associated cases of pneumonia has decreased [6] but bacterial pneumonia became the most frequent infection in HIV-infected patients, as well as the most common admission diagnosis [1]. It accounts for the major cause of death and remains the main problem of HIV-infected individuals. Its rate of occurrence ranges from 1.93 to 19.2 cases per 100 patients per year in HIV infected individuals [7]. *S. pneumoniae*, *H. influenzae*, *K. pneumoniae*, *P. aeruginosa*, *E. coli*, and *S. aureus* are the most common pathogens that cause bacterial pneumonia in HIV infected patients [8]. From these *S. pneumoniae* are the most common cause of pneumonia [9] which accounts for 40% of all bacterial pneumonia where the etiological agents are identified and *H. inluenzae* is the next most common cause in HIV-infected individuals [10].

Antimicrobial resistance in bacteria that cause infectious diseases is a global problem, even if it varies from region to region depending upon the antibiotic pressure in that locality [11]. Bacteria isolated from HIV patients with pneumonia show a varying degree of antimicrobial resistance to common antimicrobials [12]. Since bacterial pneumonia in HIV patients is a common pulmonary complication. Information about the common bacterial agents and their respective antimicrobial resistance in these groups of the population is important [4]. In the study area drugs are prescribed for patients with pneumonia based on the empirical clinical or radiological diagnosis which favors the emergence of drug-resistant bacterial strains. The emergence of drug-resistant bacterial strains will face difficulty in the management of pneumonia in HIV infected patients. Yet, there is a scarcity of information about the bacterial profile of pneumonia and their antimicrobial resistance pattern among people living with HIV in the study area. Hence, this study aimed to describe the bacterial profile and their antimicrobial resistance pattern among HIV patients diagnosed with pneumonia in ART clinics of Felege-Hiwot Referral Hospital, Bahir Dar, Northwest Ethiopia.

## Materials and Methods

### Study settings, Design and Period

A hospital-based cross-sectional study was conducted from February 15, 2019, to June 15, 2019, at ART Clinic of Felege-Hiwot Referral Hospital Bahir Dar, North West Ethiopia. The hospital has 13 wards, 430 beds, and about 531 health professionals. The daily outpatient clients are more than 600. The ART Clinic at Felege-Hiwot referral hospital is one of the largest in the Amhara region, which has been serving more than 400 patients per week.

### Sample Size and Sampling Technique

A total of 165 HIV patients diagnosed with pneumonia were included in the study, based on the inclusion/exclusion criteria. A convenience sampling technique was employed to include study participants who meet the inclusion criteria until the required sample size is achieved.

### Inclusion and Exclusion Criteria

Human immunodeficiency virus-positive, antiretroviral therapy users, and non-users aged ≥ 18 with a diagnosis of pneumonia as described by the clinician were included in the study. Patients who were critically ill, who cannot produce sputum, who took antibiotics during the past two-week period except cotrimoxazole prophylaxis, patients whose age < 18 years were excluded from the study.

### Data Collection Procedures

Data on socio-demographic characteristics and associated factors were collected using a structured and pretested questionnaire.

### Specimen Collection, Transport and Processing

Pneumonia suspected individuals showing clinical symptoms such as shortness of breath, chest pain, fever, chills, tiredness, and cough were examined by clinicians and the sputum samples were collected using a clean, dry, wide-necked, leak-proof container. The patients were requested to take a deep breath, cough deeply, and vigorously to produce about 2ml of purulent sputum specimen. Then it was labeled with a screening ID number and/or patient ID number and transported to Flege Hiwot Referral Hospital microbiology laboratory for processing within 2hrs or stored at $4^0$C until further processing. The macroscopic examination was done to

determine the sample integrity and Gram staining was performed from the purulent part of the sputum. Slides with more than 25 leucocytes and fewer than 10 epithelial cells per low power field (10x) were accepted for culture. Samples that had more than 10 epithelial cells and less than 25 leukocyte counts per low power field were discarded [8].

### Cultivation and Identification of Isolates

Blood, Chocolate, and MacConkey agar plates were prepared as per the manufacturers‟ instructions. Using a sterile wire loop, a purulent sputum sample was streaked onto each agar plate. Chocolate agar plates were incubated at 37ºC for 24 hours in a candle jar. MacConkey agar and blood agar plates were incubated aerobically at 37ºC for 24 hours. After incubation, the plates were inspected for any growth, and negative plates were incubated for an additional 24 hours. To get a pure colony, the samples were streaked in four quadrants of the plate [13]. Following the standard microbiological procedure, the bacterial isolates were characterized using colony morphology, hemolysis, gram stain, and employing a panel of biochemical tests. For gram-positive bacteria, we used catalase, coagulase, optochin, bile solubility test and for gram-negative bacteria motility, indole, urea, lysine decarboxylase (LDC), oxidase, triple sugar iron agar (TSI), and citrate utilization tests and growth in blood agar with *S. aureus* (satellitizm test) for *H. influenzae* [14].

### Antimicrobial Susceptibility Test

Antibiotic sensitivity test for the isolated organism was done by using Kirby Bauer Disc Diffusion Method. Bacterial inoculums were prepared from 3-5 pure colonies by suspending the freshly grown bacteria in 25ml of sterile nutrient broth (Oxoid, Ltd., England) and mixed thoroughly to make the suspension homogenous. The suspension was compared with turbidity equivalent to 0.5 McFarland standard and was streaked on the entire Muller-Hinton agar plate for those organisms that are not fastidious. For fastidious organisms like *Haemophilus* spp.; it was streaked onto chocolate agar and for *Streptococcus* species; it was streaked onto blood agar [15]. The disks containing the antimicrobial agents were applied within 15 minutes of inoculation on the Muller-Hinton agar plate. The discs were about 25mm apart from each other. They were pressed down firmly to ensure complete level contact with the agar and incubated overnight at 35ºC. The diameter of a zone of inhibition was measured, and the CLSI zone diameter criterion was used to interpret the level of susceptibility to each antibiotic [16, 17]. The antimicrobial agents that were used for gram-positive bacteria include, oxacillin (1µg), chloramphenicol (30µg), ciprofloxacin (5µg), clindamycin (2µg), cotrimoxazole (1.25/23.75µg), tetracycline (30µg), erythromycin (15µg), and Cefoxitin (30µg). For gram-negative bacteria, Gentamycin(10µg), amoxicillin (25µg), augmentin (20/10µg), chloramphenicol (30µg), ciprofloxacin (5µg), cotrimoxazole (1.25/23.75µg), tetracycline (30µg) and ceftazidime (30µg) were used. All antibiotics were obtained from Abtek Biologicals Ltd., UK.

### Quality Control

The filled questionnaires were checked for their completeness. Media preparations were made based on the manufacturer's instruction. Standard operating procedures were followed during specimen collection, handling, transportation, microbiological analysis, and interpretation. Ten percent of media per batch were incubated overnight for sterility check. Standard reference strain of American type culture collection *S. aureus* (ATCC-25923), *E. coli (*ATCC-25922), and *P. aeruginosa* (ATCC-27853) were used as control bacteria strains to evaluate the support of media for bacterial growth and evaluation of the efficacy of antimicrobial discs. The interpretation of a zone of inhibition diameter was performed based on the updated 2019 CLSI guideline.

### Data Processing and Analyses

Data were entered into EpiData and exported to SPSS statistical software version 23 for analysis. Descriptive statistics were calculated to visualize the distribution of the outcome variable to socio-demographic characteristics and other possible associated factors. A univariate logistic regression model was used to determine the possible association of each variable with the outcome variable. All covariates that were associated with the outcome variable in the univariate analysis were subsequently included in the multivariable analysis. Multivariable analysis was done to those independent variables with a p-value $< 0.05$ to identify factors that are independently associated with the dependent variable. The strength of the association was interpreted using an odds ratio in a 95% confidence interval. In all cases, P-values less than 0.05 were considered statistically significant.

## Results

### Socio-Demographic Characteristics

A total of 163 HIV infected individuals were included in the study. Of these, 101 (62%) were females. Among the study participants, 138 (84.7%) were urban dwellers and 25 (15.3%) were rural dwellers. The mean age of the study participants was 39.77 ± 10.64, with a range of 18-68 years old (Table 1).

**Table 1:** Socio-demographic characteristics of the study participants in the ART clinic of FHRH, Bahir Dar, Ethiopia

| Variables | Frequency | Percent (%) |
|---|---|---|
| **Gender** | | |
| Male | 62 | 38.0 |
| Female | 101 | 62.0 |
| **Residence** | | |
| Urban | 138 | 84.7 |
| Rural | 25 | 15.3 |
| **Age** | | |
| 18-29 | 24 | 14.7 |
| 30-39 | 62 | 38.0 |
| 40-49 | 46 | 28.2 |
| 50-68 | 31 | 19.0 |
| **Occupation** | | |
| Farmer | 17 | 10.4 |
| Merchant | 27 | 16.6 |
| Employed | 40 | 24.5 |
| Student | 9 | 5.5 |
| Other | 70 | 42.9 |
| **Educational level** | | |
| Can‟t read and | 58 | 35.6 |
| Only read and write | 12 | 7.4 |
| 1-8 | 44 | 27.0 |
| 9-12 | 33 | 20.2 |
| College and above | 16 | 9.8 |
| **Marital status** | | |
| Single | 36 | 22.1 |
| Married | 61 | 37.4 |
| Divorced | 39 | 23.9 |
| Widowed | 27 | 16.6 |

## Prevalence of Bacterial Pneumonia

Bacterial pneumonia was observed in 68 (41.7 %) and out of these 45 (66.2 %) of them were female participants. From the total of bacterial isolates, 19 (27.9%) were gram-positive bacteria and 49 (72.1%) were gram negatives. Bacterial pneumonia was found highest in the age group 30-39, 30 (44.1%), and lowest in the age group 50-68, 7 (10.3%). Out of the 68 isolates, 55 (80.9%) were isolated from urban dwellers (Table 2).

**Table 2:** Rate of bacterial pneumonia among study participants in FHRH, Bahir Dar, Ethiopia

| Bacterial occurrence | | | |
|---|---|---|---|
| **Variables** | **Positive N (%)** | **Negative N (%)** | **Total N (%)** |
| **Gender** | | | |
| Male | 23(33.8) | 39(41.1) | 62 (38.0) |
| Female | 45(66.2) | 56(58.9) | 101 (62.0) |
| **Residence** | | | |
| Urban | 55(80.9) | 83(87.4) | 138 (84.7) |
| Rural | 13(19.1) | 12(12.6) | 25 (15.3) |
| **Age** | | | |
| 18-29 | 12(17.6) | 12(12.6) | 24 (14.7) |
| 30-39 | 30(44.1) | 32(33.7) | 62 (38.0) |
| 40-49 | 19(27.9) | 27(28.4) | 46 (28.2) |
| 50-68 | 7(10.3) | 24(25.3) | 31 (19.0) |
| **Occupation** | | | |
| Farmer | 10(14.7) | 7(7.4) | 17 (10.4) |
| Merchant | 13(19.1) | 14(14.7) | 27(16.6) |
| Employed | 16(23.5) | 24(25.3) | 40(24.5) |
| Student | 1(1.5) | 8(8.4) | 9(5.5) |
| Other | 28(41.2) | 42(44.2) | 70(42.9) |
| **Educational level** | | | |
| Can"t read and write | 26(38.2) | 32(33.7) | 58(35.6) |
| Only read and write | 6(8.8) | 6(6.3) | 12(7.4) |
| 1-8 | 19(27.9) | 25(26.3) | 44(27.0) |
| 9-12 | 11(16.2) | 22(23.2) | 33(20.2) |
| College and above | 6(8.8) | 10(10.5) | 16(9.8) |
| **Marital status** | | | |
| Single | 10(14.7) | 26(27.4) | 36(22.1) |
| Married | 24(35.3) | 37(38.9) | 61(37.4) |
| Divorced | 22(32.4) | 17(17.9) | 39(23.9) |
| Widowed | 12(17.6) | 15(15.8) | 27(16.6) |

## Bacterial Isolates

Of the total 68 bacterial isolates, the predominant isolate was *Klebsiella pneumoniae* 19(27.9%) followed by *Staphylococcus aureus* 17(25%), *Escherichia coli* 11(16.2%), *Acinetobacter baumanii 6*(8.8%), *Klebsiella species 5*(7.4%), *Pseudomonas aeruginosa* 3(4.4%), *Haemophilus influenzae* 3(4.4%), *Streptococcus pneumoniae* 2(2.9%), *Enterobacter species* 2(2.9%) (Figure 1).

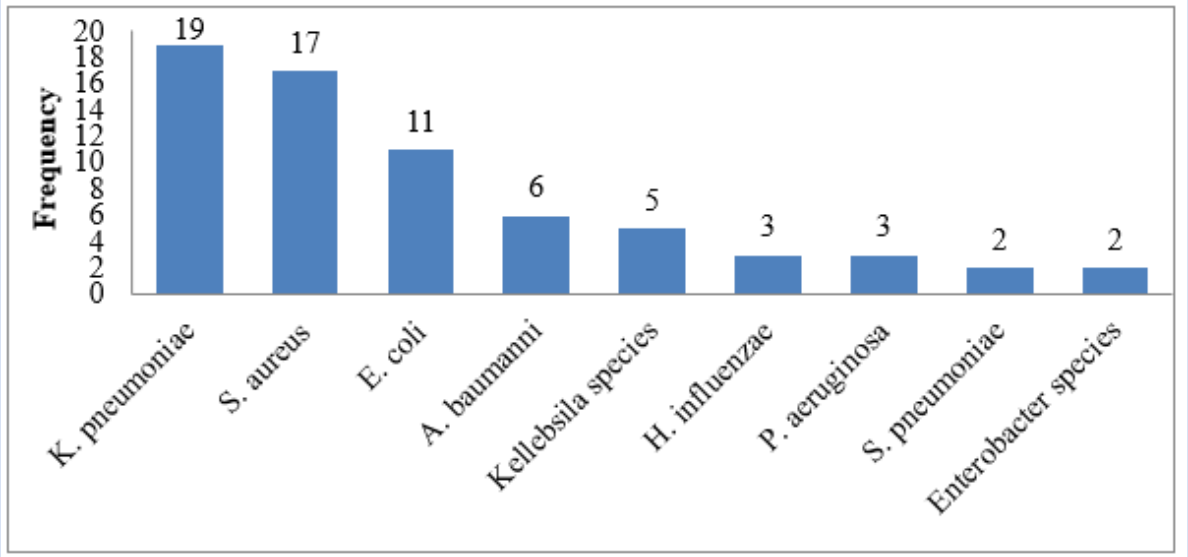


**Figure 1:** The distribution of bacterial isolates identified from the study participants in FHRH, 2019

## Antimicrobial Susceptibility Pattern of Bacterial Isolates

Out of the tested antibiotics for different bacterial isolates, 46 (70.8%) were resistant to cotrimoxazole, and 31 (52.2%) were resistant to tetracycline. From gram-positive isolates, 9 (47.4%) were resistant to erythromycin and 5 (26.3%) were resistant to clindamycin. Similarly, 24 (52.2%) of gram-negative isolates were resistant to gentamycin. On the other hand, most of the isolates were less resistant to chloramphenicol 20 (33.9%) and ciprofloxacin 28 (42.4%). Methicillin resistance was observed from 9 (52.9%) isolates of *S. aureus* (Table 3). Multi-drug resistance was observed in 53 (77.9%) of the isolates (Table 4).

**Table 3:** Antimicrobial resistance patterns of bacterial isolates among study participants in FHRH, Bahir Dar, Ethiopia

| Bacterial isolate(n) | Antibiotics | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Amo | Ag | Ox | Cl | Gen | Cip | Ch | Co | Cef | Cez | Tet | Ery |
| **K.pneumoniae(19)** | 19(100.0) | 17(89.5) | NT | NT | 7(36.8) | 10(52.6) | 10(52.6) | 13(68.4) | NT | 11(57.9) | 9(47.4) | NT |
| **S.aureus(17)** | NT | NT | NT | 4(23.5) | NT | 2(11.8) | 5(29.4) | 12(70.6) | 9(52.9) | NT | 7(41.2) | 9(52.9) |
| **E. coli (11)** | 10(90.9) | 8(72.7) | NT | NT | 8(72.7) | 8(72.7) | 2(18.2) | 8(72.7) | NT | 5(45.5) | 8(72.7) | NT |
| **A.baumanii (6)** | NT | NT | NT | NT | 4(66.7) | 5(83.3) | NT | 6(100.0) | NT | 5(83.3) | NT | NT |
| **P. aeruginosa (3)** | NT | NT | NT | NT | 3(100.0) | 2(66.7) | NT | NT | NT | 3(100.0) | NT | NT |
| **S. pneumoniae (2)** | NT | NT | 1(50.0) | 1(50.0) | NT | NT | 0.0 | 1(50.0) | NT | NT | 1(50.0) | 0.0 |
| **H. influenza (3)** | 3(100.0) | 2(66.7) | NT | NT | NT | 0 | 1(33.3) | 2(66.7) | NT | 1(33.3) | 3(100.0) | NT |
| **Enterobacter spp (2)** | 2(100.0) | 2(100.0) | NT | NT | 1(50.0) | 1(50) | 1(50.0) | 2(100.0) | NT | 2(100.0) | 2(100.0) | NT |
| **Klebsiella spp (5)** | 5(100.0) | 1(20.0) | NT | NT | 1(20.0) | 0.0 | 1(20.0) | 2(40.0) | NT | 1(20.0) | 1(20.0) | NT |
| **Total n (%)** | 39(97.5) | 30(75.0) | 1(50.0) | 5(26.3) | 24(52.2) | 28(42.4) | 20(33.9) | 46(70.8) | 9(52.9) | 28(57.1) | 31(52.5) | 9(47.4) |
| **Total n (%)** | 39(97.5) | 30(75.0) | 1(50.0) | 5(26.3) | 24(52.2) | 28(42.4) | 20(33.9) | 46(70.8) | 9(52.9) | 28(57.1) | 31(52.5) | 9(47.4) |

NT= not tested, Amo= amoxicillin, Ag= agumentin,Ox= oxacillin, Cl= clindamycin, Gen= gentamycin, Cip= ciprofloxacin, Ch= chloramphenicol, Co=cotrimoxazole, Cef=cefoxitin, Cez=ceftazidime, Tet=tetracycline, and Ery=erytromycin

**Table 4:** Multidrug resistance pattern of bacterial isolates among study participants in FHRH, Bahir Dar, Ethiopia

| Organism isolated (No.) | Degree of resistance R0 to ≥R6 N (%) | | | | | | | Total MDR isolates ≥R3 |
|---|---|---|---|---|---|---|---|---|
| | R0 | R1 | R2 | R3 | R4 | R5 | R≥6 | |
| **S.aureus (17)** | 1(5.9) | 2(11.8) | 4(23.5) | 2(11.8) | 3(17.6) | 3(17.6) | 2(11.8) | 10(58.8) |
| **S.pneumoniae(2)** | - | 1(50) | - | 1(50) | - | - | - | 1(50) |
| **K.pneumoniae(19)** | - | - | 1(5.3) | 1(5.3) | 3(15.8) | 7(36.8) | 7(36.8) | 18(94.7) |
| **E. coli (11)** | - | - | 2(18.2) | - | 1(9.1) | 3(27.3) | 5(45.5) | 9(81.8) |
| **A.baumanni (6)** | - | - | - | 5(83.3) | 1(16.7) | - | - | 6(100) |
| **P.aeruginosa (2)** | - | - | 1(33.3) | 2(66.7) | - | - | - | 2(66.7) |
| **Enterobacter species (2)** | - | - | - | - | - | - | 2(100) | 2(100) |
| **Kellebsila species (5)** | - | 2(40) | 1(20) | - | 2(40) | - | - | 2(40) |
| **H.influenzae (2)** | - | - | - | 1(33.3) | 1(33.3) | 1(33.3) | - | 3(100) |
| **Total(n=68)** | 1(1.5) | 5(7.4) | 9(13.2) | 12(17.6) | 11(16.2) | 14(20.6) | 16(23.5) | 53(77.9) |

**R0:** susceptible to all antibiotics, **$R_1$**=Resistant to one antibiotic class, **R2**=Resistant to two antibiotic class, **R3**= Resistant to three antibiotic class, **R4**=Resistant to four antibiotic class, **R5**=Resistant to five and **≥R6**=Resistant more than to six and above antibiotic class, MDR= Multidrug resistance

## Associated Factors

Based on the multivariable logistic regression analysis, variables like the age groups 18-29 (AOR = 5.4, 95 % CI: 1.26-23.35, P ≤ 0.023), age groups 30-39 (AOR = 3.8, 95% CI: 1.03-13.80, P ≤ 0.046), recent viral load ≥ 150 copies/ml (AOR= 24.3, 95 % CI: 2.61-56.38, P≤ 0.005), viral load < 150 copies/ml (AOR= 5.1, 95% CI: 1.26-21.04, P ≤ 0.023), cigarette smoking (AOR=15.5, 95% CI: 1.61-48.59, P≤ 0.015), and alcohol consumption (AOR=8.1, 95% CI: 2.76-23.51, P≤ 0.001) were found to have statistically significant association with bacterial pneumonia. Gender, occupation, period of ART enrolment and WHO clinical stage didn't show a statistically significant association with bacterial pneumonia (Table 5).

**Table 5:** Factors associated with bacterial pneumonia among study participants in FHRH, Bahir Dar, Ethiopia

| Variables | Bacterial occurrence | | COR (95% CI) | P-value | AOR (95% CI) | P-value |
|---|---|---|---|---|---|---|
| | Positive N (%) | Negative N (%) | | | | |
| **Gender** | | | | | | |
| Male | 23(37.1) | 39(62.9) | 1 | | | |
| Female | 45(44.6) | 56(55.4) | 1.4(0.71-2.60) | 0.349 | | |
| **Age (in years)** | | | | | | |
| 18-29 | 12(50) | 12(50) | 3.4(1.07-10.95) * | 0.038 | 5.4(1.26-23.35) * | 0.023 |
| 30-39 | 30(48.4) | 32(51.6) | 3.2(1.21-8.55) * | 0.019 | 3.8(1.03-13.80) * | 0.046 |
| 40-49 | 19(41.3) | 27(58.7) | 2.4(0.87-6.73) | 0.093 | 1.5(0.38-5.89) | 0.570 |
| 50-68 | 7(22.6) | 24(77.4) | 1 | | 1 | |
| **Occupation** | | | | | | |
| Farmer | 10(58.8) | 7(41.2) | 2.1(0.73-6.29) | 0.166 | | |
| Merchant | 13(48.1) | 14(51.9) | 1.4(0.57-3.40) | 0.467 | | |
| Employed | 16(40) | 24(60) | 1.0(0.45-2.21) | 1.000 | | |
| Student | 1(11.1) | 8(88.9) | 0.2(0.02-1.58) | 0.124 | | |
| Other | 28(40) | 42(60) | 1 | | | |
| **History of bacterial pneumonia** | | | | | | |
| No | 49(39.5) | 75(60.5) | 1 | | | |
| Yes | 19(48.7) | 20(51.3) | 1.5(0.71-3.00) | 0.311 | | |
| **Recent viral load** | | | | | | |
| ≥150 copies/ml | 14(93.3) | 1(6.7) | 30.0(3.82-68.76) * | 0.001 | 24.3(2.61-56.38) * | 0.005 |
| <150 copies/ml | 12(75) | 4(25) | 6.4(1.96-21.12) * | 0.002 | 5.1(1.26-21.04) * | 0.023 |
| Undetected | 42(31.8) | 90(68.2) | 1 | | 1 | |
| **Marital status** | | | | | | |
| Single | 10(27.8) | 26(72.2) | 0.5(0.17-1.38) | 0.173 | | |
| Married | 24(39.3) | 37(60.7) | 0.8(0.32-2.03) | 0.654 | | |
| Divorced | 22(56.4) | 17(43.6) | 1.6(0.60-4.35) | 0.340 | | |
| Widowed | 12(44.4) | 15(55.6) | 1 | | | |
| **History of tuberculosis** | | | | | | |
| No | 64(40.5) | 94(59.5) | 1 | | | |
| Yes | 4(80) | 1(20) | 5.9(0.64-53.78) | 0.117 | | |
| **Cotrimoxazole prophylaxis** | | | | | | |
| No | 44(40.7) | 64(59.3) | 1 | | | |
| Yes | 24(43.6) | 31(56.4) | 1.1(0.58-2.17) | 0.723 | | |
| **IV drug use** | | | | | | |
| No | 60(39) | 94(61) | 1 | | 1 | |
| Yes | 8(88.9) | 1(11.1) | 12.5(1.53-42.75) | 0.019 | 0.00 | 1.000 |
| **Cigarette smoking** | | | | | | |
| No | 59(38.6) | 94(61.4) | 1 | | 1 | |
| Yes | 9(90) | 1(10) | 14.3(1.77-46.10) * | 0.013 | 15.5(1.61-48.59) * | 0.015 |
| **Alcohol consumption** | | | | | | |
| No | 37(29.4) | 89(70.6) | 1 | | 1 | |
| Yes | 31(83.8) | 6(16.2) | 12.4(4.79-32.28) * | 0.000 | 8.1(2.76-23.51) * | <0.001 |
| **Period of ART enrolment** | | | | | | |
| ART >90 days | 64(41.6) | 90(58.4) | 0.9(0.23-3.44) | 0.865 | | |
| ART in 90days | 4(44.4) | 5(55.6) | 1 | | | |
| **WHO stage** | | | | | | |
| I | 16(42.1) | 22(57.9) | 1 | | | |
| II | 19(43.2) | 25(56.8) | 1.0(0.43-2.51) | 0.922 | | |
| III | 26(37.1) | 44(62.9) | 0.8(0.36-1.82) | 0.614 | | |
| IV | 7(63.6) | 4(36.4) | 2.4(0.60-9.63) | 0.215 | | |

COR=crude odds ratio; CI=confidence interval; AOR=adjusted odds ratio; 1: referent; ∗statically significant at p ≤ 0.05.

## Discussion

Bacterial pneumonia is the most frequent cause of pulmonary infection and one of the most common causes of pneumonia that oblige hospitalization in HIV-infected individuals [8, 18]. In this study, the overall prevalence of bacterial pneumonia was 41.7%. This is in line with reports in Nigeria 42.9% [18] , Ethiopia 43.7% [8] and India 44.3% [19]. This may be because immune-compromised patients are more prone to bacterial infections due to their decreased protective immunity. Our finding is higher than the findings from the two studies in India (16.6% [20] & 21.71% [21]) and Malawi 29% [22]. However, lower than the studies reported in Nigeria, 55.6% [7] & 54.07% [23]. The inconsistency between these studies might be due to the socio-demographic variability of the study participants, the type of sample used, and/or immune status of the study participants involved.

In this study, *K. pneumoniae* and *S. aureus* were the predominant bacterial agents identified in HIV patients suspected of pneumonia. These agents were also similarly identified as the predominant isolates in studies from Nigeria [23] and Nepal [15]. On the other hand, bacterial isolates such as *K. pneumoniae* and *S. pneumoniae* in Ethiopia and India [8, 19], and *E. coli* and *P. aeruginosa* in Nigeria [7] were reported as the predominant isolates among HIV infected patients. In our study, the least commonly encountered bacterial isolates were *S. pneumoniae*, 2.9%, and *Enterobacter species*, 2.9%. The possible reasons for the different frequencies of bacterial isolates in different studies among HIV patients may be due to variations in climate and geographic distribution, the sample used, and the method of sample processing in the study areas.

In this study, *E. coli,* 11 (16.2%) was the second most common gram-negative bacterial isolate which was similarly reported in Ethiopia (14.5%), Nepal (8.3%), and India (6.8%) [8, 15, 24]. From the gram-positive bacteria, *S. pneumoniae* 2 (2.9%) was the second most commonly isolated bacteria and it is in line with the studies reported in Nepal (18.8%) and Nigeria (9.6%) [15, 23]. The occurrence of these bacteria might be due to aspiration from the previously colonized site, nosocomial infection during hospitalization, recurrent bacterial pneumonia, and systemic spread through the blood to the lung [1, 25].

Cotrimoxazole is recommended by WHO as a prophylactic agent against opportunistic infections among HIV/AIDS patients. But in our study, 70.8% of bacterial isolates were resistant to cotrimoxazole. This may be due to long-term receiving of cotrimoxazole that may lead to increased development of cotrimoxazole resistant bacterial isolates in the study area. In this study, *S. aureus* showed 29.4% resistance to chloramphenicol and 70.6% resistance to cotrimoxazole. A previous study conducted in Nepal reported a similar finding, 30% resistance to chloramphenicol, and 70% resistance to cotrimoxazole in this regard [15]. However, 52.9% and 41.2% of these isolates were resistant to erythromycin and tetracycline, respectively. This is in line with the study conducted in India, at which 50% resistance to erythromycin and 37.5% resistance to tetracycline [24].

*K. pneumoniae* were 52.6% resistant to ciprofloxacin and 68.4% resistant to cotrimoxazole in our study which was comparable with the finding from Nepal, 53.8% resistant to ciprofloxacin, and 69.2% resistant to cotrimoxazole [15]. In our finding, we also noted a high level of resistance to amoxicillin, augmentin, and cotrimoxazole. This may be, due to the incorrect antibiotics being prescribed for a condition, wrong doses, incomplete schedules, or inadequate timing of the intake of an antibiotic. The other contributing factor may be the economic status of the patient which compels patients to abort their treatment halfway and stop taking their medicines, as they cannot afford to buy the full schedule of an antibiotic. On the other hand, patients who are not economically disadvantaged are also known to stop their treatment well before the schedule ends since they "feel better" and do not find a reason to complete the full course of the antibiotic. This does not kill all the organisms causing the infection nor eradicate it. Those that survive reproduce, thus helping to propagate resistant strains. Out of the *S. aureus* isolates, 52.9% were methicillin-resistant. This finding was higher from the reports in Ethiopia (44.4%) [8] and a study reported in India (37.5%) [24].

The overall prevalence of MDR was 77.9% which was relatively similar as compared to the study done in Cameroon, where the prevalence was 79.4% [26] but slightly higher from a study in Nigeria 66.7% [27]. This high prevalence of MDR might be contributed by misuse of antimicrobial agents in resource constraint areas like in our study area where there is no well-organized bacteriology laboratory for isolation of the etiologic agents. Also, Weak infection control practices and poor general hygiene in several health-care facilities, especially in resource-limited settings, facilitate the emergence and spread of multi-drug resistant organisms. The other contributing factor may be the use of drugs by buying from private pharmacies without a physician prescription.

In our study, we have assessed the association of different variables to bacterial pneumonia. Thus, the age group, recent viral load of ≥ 150 copies/ml, and recent viral load < 150 copies/ml, cigarette smoking, and alcohol consumption showed a significant association to have bacterial pneumonia. The age groups 18-29 and 30-

39, were 5.4 and 3.8 times more likely to have bacterial pneumonia respectively as compared to the age group of 50-68 which is comparable with studies reported in Ethiopia [8] and Nepal [28]. The reason might be because that these age groups are active and can involve various predisposing factors. Besides, a large number of younger age groups of our study participants were having a detected number of viral loads and WHO stage III compared to those aged between 50 and 68. This can contribute to increased bacterial pneumonia observed in our study participants. In contrary to our finding, the studies reported in Spain [1] and France [29] showed common bacterial pneumonia in older age groups.

In this study, the recent viral load is another factor identified. Study participants with a recent viral load of ≥ 150 copies/ml and individuals with a recent viral load of < 150 copies/ml but detected viral loads, were 24.3 and 5.1 times more likely to have bacterial pneumonia, respectively as compared to individuals having an undetected recent viral load. This might be due to effective control of the HIV viral load which has a significant positive impact on decreasing the risk of bacterial pneumonia. This finding was consistent with studies reported in Spain [1] and South Africa [25].

Cigarette smoking is one of the potential risk factors for the development of pneumonia. In our study, the prevalence of bacterial pneumonia was higher among cigarette smokers, and they were 15.5 times more likely to have bacterial pneumonia than non-smokers. This may be because of smoking which alters lung function by damaging epithelial cells and cilia of the lung. This may inhibit the ability to prevent the entry of microorganisms into the respiratory tract. This was supported by a previous study [8]. Alcohol consumption was also found to be a statistically significant association with bacterial pneumonia. Alcohol consumers were 8.1 times more likely to have bacterial pneumonia than non-consumers. This may be because of the sedative properties of alcohol which can reduce the oropharyngeal tone, leading to an increased risk of aspiration of microbes. Furthermore, high levels of alcohol intake can modify alveolar macrophage function, hence diminishing pulmonary defense against infection [30]. This was consistent with studies in Ethiopia [8], South Africa [31], and North America [32].

This study has provided valuable data on the bacterial isolates and their drug resistance profile among HIV positive patients who are clinically diagnosed with pneumonia. Despite this, our study has some limitations. We did not attempt to isolate atypical bacterial agents like *Chlamydia*, *Mycoplasma*, and *Legionella species* due to resource limitations. As well molecular characterization of the isolated bacterial agents was not done because of a lack of resources. Hence, further studies that will overtake the above limitations are recommended.

## Conclusions

The overall prevalence of bacterial pneumonia among HIV-infected patients was 41.7% in the study area. A relatively higher percentage of bacterial pneumonia was caused by gram-negative bacteria of which *K. pneumoniae* and *E. coli* were the dominant isolates. In gram-positive isolates, *S. aureus* was the most dominant species of bacteria. A low level of resistance was observed to ciprofloxacin and chloramphenicol by most of the isolates. However, a high rate of antimicrobial resistance including MDR was observed to commonly prescribed antibiotics such as amoxicillin, cotrimoxazole, and tetracycline. A younger age group, detectable recent viral load, cigarette smoking, and alcohol consumption showed a significant association with bacterial pneumonia. Based on these findings, routine culture and antimicrobial susceptibility tests are recommended for HIV positive clients, for the selection of appropriate treatment.

## Abbreviations

AIDS: Acquired Immune Deficiency Syndrome
ART: Antiretroviral Treatment
ATCC: American Type Culture Collection
CLSI: Clinical Laboratory Standard Institution
FHRH: Felege-Hiwot Referral Hospital
HAART: Highly Active Antiretroviral Treatment
HIV: Human Immunodeficiency Virus
LDC: Lysine Decarboxylase
MDR: Multi-Drug Resistance
SPSS: Statistical Package for Social Science
TSI: Triple Sugar Iron
WHO: World Health Organization

### Data availability

Data supporting the conclusions of this article are available by request from G. Deribew. The relevant raw data will be made available to researchers wishing to use them for noncommercial purposes.

### Ethics approval

Ethical clearance was obtained from Bahir Dar University, College of Medicine and Health Sciences Institutional Review Board.

### Consent

Informed written consent was obtained from the study participants after explaining the purpose and objective of the study. The laboratory result from the study participant was communicated to their physicians for

appropriate management. All patient data were kept confidential.

### Consent for publication

Not applicable in this section.

### Conflicts of Interest

The authors declare that they have no competing interests.

### Authors' contributions

DG conceived the research idea and has also involved in the data collection and interpretation of the result. YZ has been involved in the interpretation of the result and evaluating the scientific content of the study as well as in rationalizing the method section and manuscript preparation. TA has been involved in manuscript preparation. All authors read and approved the final manuscript for submission.

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## References

1. Benito N, Moreno A, Miro J, Torres A. (2012). Pulmonary infections in HIV-infected patients: an update in the 21st century. Eur Respir J. 39(3):730-745.
2. Koss CA, Jarlsberg LG, den Boon S, Cattamanchi A, Davis JL, Worodria W, et al. (2015). A clinical predictor score for 30-day mortality among HIV-infected adults hospitalized with pneumonia in Uganda. PLoS One. 10(5):e0126591.
3. Iwai S, Huang D, Fong S, Jarlsberg LG, Worodria W, Yoo S, et al. (2014). The lung microbiome of Ugandan HIV-infected pneumonia patients is compositionally and functionally distinct from that of San Franciscan patients. PloS one. 9(4):e95726.
4. Tural Önür S, Dalar L, İliaz S, Yalçın AD. (2016). Pneumonia in HIV-infected patients. Eurasian J Pulmonol. 18(1):11-17.
5. Kengne M, Lebogo MBB, Nwobegahay JM, Ondigui BE. (2018). Antibiotics susceptibility pattern of Streptococcus pneumoniae isolated from sputum cultures of human immunodeficiency virus infected patients in Yaoundé, Cameroon. Pan Afr Med J. 31(16).
6. Morris A, Crothers K, Beck JM, Huang L. (2011). An official ATS workshop report: Emerging issues and current controversies in HIV-associated pulmonary diseases. Proc Am Thorac Soc. 8(1):17-26.
7. Ojo-Bola O, Oluyege A. (2014). Antibiotics resistance of bacteria associated with pneumonia in HIV/AIDS patients in Nigeria. American Journal of Infectious Diseases and Microbiology. 2(6):138-44.
8. Adhanom G, Gebreegziabiher D, Weldu Y, Gebreyesus Wasihun A, Araya T, Legese H, et al. (2019). Species, Risk Factors, and Antimicrobial Susceptibility Profiles of Bacterial Isolates from HIV-Infected Patients Suspected to Have Pneumonia in Mekelle Zone, Tigray, Northern Ethiopia. Biomed Res Int. 2019:1-9.
9. López-Palomo C, Martín-Zamorano M, Benitez E, Fernández-Gutiérrez C, Guerrero F, Rodríguez-Iglesias M, et al. (2004). Pneumonia in HIV-infected patients in the HAART era: Incidence, risk, and impact of the pneumococcal vaccination. J Med Virol. 72(4):517-524.
10. Nimmo C, Capocci S, Honeyborne I, Brown J, Sewell J, Thurston S, et al. (2015). Airway bacteria and respiratory symptoms are common in ambulatory HIV-positive UK adults. Eur Respir J. 46(4):1208-1211.
11. Agmy G, Mohamed S, Gad Y, Farghally E, Mohammedin H, Rashed H. (2013). Bacterial profile, antibiotic sensitivity and resistance of lower respiratory tract infections in upper Egypt. Mediterr J Hematol Infect Dis. 5(1):e2013056.
12. Goyet S, Vlieghe E, Kumar V, Newell S, Moore CE, Bousfield R, et al. (2014). Etiologies and resistance profiles of bacterial community-acquired pneumonia in cambodian and neighboring countries' health care settings: a systematic review (1995 to 2012). PLoS One. 9(3):e89637.
13. Leboffe MJ, Pierce BE. (2012). Microbiology: laboratory theory and application: Morton Publishing Company.
14. Mahon CR. (2019). Textbook of Diagnostic Microbiology-E-book: Elsevier health science.
15. Khushbu Y, Satyam P. (2015). Bacteriological Profile of Lower Respiratory Tract Infection (LRTI) among HIV Seropositive Cases in Central Terai of Nepal. Int J Curr Microbiol App Sci. 4(11):431-442.
16. Tille P. (2015). Bailey & Scott's diagnostic microbiology-E-Book: Elsevier Health Sciences.

17. Wayne P. CLSI. (2019). Performance Standards for Antimicrobial Susceptibility Testing. 29th ed. CLSI supplement M100. Clinical and Laboratory Standards Institute.
18. Salami A, Oluboyo P, Akambi II A, Fawibe E. (2006). Bacterial pneumonia in the AIDS patients. West Afr J Med. 25(1):1-5.
19. Shailaja V, Pai L, Mathur D, Lakshmi V. (2004). Prevalence of bacterial and fungal agents causing lower respiratory tract infections in patients with human immunodeficiency virus infection. Indian J Med Microbiol. 22(1):28-33.
20. Shreevidya K, Dias M. (2012). Pulmonary bacterial and fungal infections in human immunodeficiency virus patients: A study from India. Ann Trop Med Public Health. 5(2):80-84.
21. Kandati J, Boorsu SK, lakshmi Ponugoti M, Samudrala V. (2017). Bacterial and fungal agents causing lower respiratory tract infections in patients with human immunodeficiency virus infection. Int J Res Med Sci. 4(8):3595-3600.
22. Hartung TK, Chimbayo D, van Oosterhout JJ, Chikaonda T, van Doornum GJ, Claas EC, et al. (2011). Etiology of suspected pneumonia in adults admitted to a high-dependency unit in Blantyre, Malawi. Am J Trop Med Hyg. 85(1):105-112.
23. Urama EU, Enweani IB, Oshim IO, Okeke-Nwolisa BC, John GU. (2018). Microbiological Profile of Respiratory Tract Infections among HIV Sero-positive Subjects Attending Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria. American Journal of Medicine and Medical Sciences. 8(3):37-42.
24. Mane A, Gujar P, Gaikwad S, Bembalkar S, Gaikwad S, Dhamgaye T, et al. (2018). Aetiological spectrum of severe community-acquired pneumonia in HIV-positive patients from Pune, India. Indian J Med Res. 147(2):202-206.
25. Feldman C, Anderson R. (2013). HIV-associated bacterial pneumonia. Clin Chest Med. 34(2):205-216.
26. Marbou WJ, Kuete V. (2017). Bacterial resistance and immunological profiles in HIV-infected and non-infected patients at Mbouda AD LUCEM Hospital in Cameroon. J Infect Public Heal. 10(3):269-276.
27. Adeyemi FM, Ako-nai KA, Adejuyigbe E, Ebhodaghe BI, Osho PO, Oyeniyi TT, et al. (2015). Molecular characterization and antibiotic resistance profiles of bacterial isolates cultured from HIV seropositive patients. Arch Clin Microbiol. 6(1):269-276.
28. Ojha CR, Rijal N, Khagendra K, Palpasa K, Kansakar P, Gupta B, et al. (2015). Lower respiratory tract infections among HIV positive and control group in Nepal. VirusDisease. 26(1-2):77-81.
29. Bénard A, Mercié P, Alioum A, Bonnet F, Lazaro E, Dupon M, et al. (2010). Bacterial pneumonia among HIV-infected patients: decreased risk after tobacco smoking cessation. ANRS CO3 Aquitaine Cohort, 2000–2007. PLoS One. 5(1):e8896.
30. Simou E, Britton J, Leonardi-Bee J. (2018). Alcohol and the risk of pneumonia: a systematic review and meta-analysis. BMJ open. 8(8):e022344.
31. Segal LN, Methé BA, Nolan A, Hoshino Y, Rom WN, Dawson R, et al. (2011). HIV-1 and bacterial pneumonia in the era of antiretroviral therapy. Proc Am Thorac Soc. 8(3):282-287.
32. Park DR, Sherbin VL, Goodman MS, Pacifico AD, Rubenfeld GD, Polissar NL, et al. (2001). The etiology of community-acquired pneumonia at an urban public hospital: influence of human immunodeficiency virus infection and initial severity of illness. J Infect Dis. 184(3):268-277.

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