Abstract

Viruses are responsible for a large proportion of lower respiratory tract infections (LRTIs). Other causes of LRTIs are bacteria: Streptococcus pneumoniae, Haemophilus influenzae, Klebsiella pneumoniae, and Staphylococcus aureus being the most common. Sputum samples are commonly used in the microbiological laboratory for diagnosing lower respiratory infections. **Objective:** The aim of this study to evaluate the causative bacteria and antibiotics sensitivity in culture of sputum samples. **Patients Methods:** A retrospective study performed in the microbiology department of Al Immamin Al Kahdimin Medical laboratory in Baghdad. The results of sputum cultures collected from the files between 2016 and 2019. A total number of 131 included in the study of adults and both sexes. Organisms were identified and tested for the antibiotic susceptibility did for selected cases which ordered by the doctor needed. **Results:** The number of 131 were enrolled. The age of patients was between 17-85 years with mean age 46.69. The higher incidence of patients between ages 51-60 years (21.4 %). The female were 40.5%, the male 59.5%. 65 (49.62%) patients from the medical ward, 50 (38.17) from respiratory care unit (RCU). Acinetobacter spp was the most common bacteria isolated, in forty four (33.59%) cases, which was resistant to most antibiotics. followed by Streptococcus pneumoniae (22.90%), Pseudomonas aeruginosa (16.03%),Escherichia coli in eleven (8.40) cases, with variable antibiotics sensitivity and resistance. **Conclusion:** sputum culture and sensitivity may help in identifying the organism and choosing the antibiotic, which may be resistant to many drugs as in Acinetobacter spp. **Key wards:** Bacteriological Profile, Antibiotic Sensitivity, Sputum Culture

1. Introduction

The Infections of upper and lower respiratory tract are a major cause of morbidity and mortality, particularly in patients at extremes of age, those with preexisting lung disease or with immune suppression [1]. Infection can occur because of infectious agents such as bacteria,
virus, fungus, and protozoa [2]. Sputum is most commonly used sample for the diagnosis of lower respiratory tract infections, its easy and non-invasive procedure [3]. The Gram stains and cultures of sputum specimens are performed to detect the potential respiratory pathogens [4].

Role of the sputum culture has been debatable and is limited by a fact that it is difficult to get a deep cough specimen in children and elderly patients and there is a possibility of contamination by the normal upper respiratory tract flora which poses problems in culturing the specimen and has direct and indirect effect on the treatment decisions and clinical outcome of the patients [5, 6]. The yield of the sputum cultures is further diminished if antibiotics received prior to producing the specimen, which occurs in about 25 percent of cases [7]. The Infectious Diseases Society of America/American Thoracic Society guidelines recommend that the sampling in hospitalized adult patients be restricted to those who are able to provide the high quality pretreatment specimen and where the quality performance measures for the sputum collection, transport and processing of samples can be met [8]. The good sputum sample depends on healthcare worker education and patient understanding [9]. The culture of good-quality sputum samples obtained from patients who received antibiotic treatment is probably not cost-effective [10].

During the management of bacterial infections, bacteria might develop resist to the one or more antibiotics [11]. The mechanisms by which organisms exhibit the resistance to antibiotics includes drug inactivation or modification, alteration of target site, alteration in the metabolic pathway, and reduced drug accumulation [12].

The patterns of microorganisms that causing infection and the antibiotic resistance pattern vary from one country to other country, as well as from hospital to hospital [13]. A cross-resistance and multi resistance patterns have been observed, throughout the world [14]. The aim of this study to evaluate the causative bacteria and antibiotics sensitivity in culture of sputum samples that causes lower respiratory tract infections.

2. Patient and Methods
A retrospective study performed in the microbiology department of Al Immamin Al Kahdimin Medical city in Baghdad. The results of sputum cultures collected from January 2016 and March 2019. A total of 131 included in the study of adults and both sexes (female 53 (40.50%) ,and male 78 (59.50%)), their age 17-85, the mean age 46.69±20.80. Information collected include the demographic data of the patient, admission unit department. Other data collected included isolated bacteria , sensitivity pattern
All the sputum samples were inoculated on Blood agar, Chocolate agar and Mac Conkey agar at 37°C for 24- 48 hours. The bacterial isolation and identification performed by using standard laboratory methods (15). Culture sensitivity was done by a diffusion method (16). According to the growth on culture, the sensitivity testing has done. Antibiotic used were: Trimethoprim sulfamethoxazole (TS), Rifampin (Rif), Clindamycin (Clin), Imipenem (Imi), Azithromycin (AZ), Amikacin (Ami), Ciprofloxacin (Cip), Tetracycline (T), Cefotaxime (Cef), Doxycycline (Dox), Netilmicine (Net), Levofloxacine (Lev). Antibiotic susceptibility of isolates was performed by agar disc diffusion method (16). Patients with no growth of sputum culture were excluded from the study. Descriptive statistics made using Statistical Package for Social Sciences (SPSS) 23 and Microsoft Excel 2013. Numerical data were described as mean and standard deviation, while, Categorical data were described as count and percentage.
3. Results

In this study a total number is 131 were enrolled. The age of patients between 17-85 years, divided into ≤20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years, 61-70 years, and >70 years with mean 46.69. The higher incidence of patients between ages 51-60 years (21.4%). The female were 40.5% while the male 59.5%, as in Table 1.

| Age groups | Value     |
|------------|-----------|
| 20-29      | 21 (16)   |
| 30-39      | 20 (15.3) |
| 40-49      | 14 (10.7) |
| 50-59      | 14 (10.7) |
| 60-69      | 28 (21.4) |
| 70-79      | 18 (13.7) |
| >80        | 16 (12.2) |

| Age | Mean± SD | Minimum-maximum |
|-----|----------|-----------------|
|     | 46.69±20.80 | 17-85           |

The distribution of patients according to word / unit, 65 (49.62%) from the medical ward, 50 (38.17) from respiratory care unit (RCU), 13 (9.92%) from out- patients, 3 (2.29%) from Hematology wards, as in Table 2.

| Ward unit          | No | %       |
|--------------------|----|---------|
| Medical ward       | 65 | 49.62%  |
| RCU                | 50 | 38.17%  |
| Out-patients       | 13 | 9.92%   |
| Hematology wards   | 3  | 2.29%   |
| Total              | 131| 100.00% |

Acinetobacter spp. was the most common bacteria isolated, in forty four (33.59%) cases, followed by Streptococcus pneumonia isolated in thirty (22.90%) cases. Pseudomonas aeruginosa was isolated in twenty one (16.03%) cases. Other less common organisms isolate were Escherichia coli in eleven (8.40) cases, Enterobacter spp eight (6.11%). Klebsiella pneumonia seven (5.34%), Moraxella catarrhalis four (3.05%), Staphylococcus aureus four (3.05%), Hemophilus influenza two (1.53%), the lowest are Proteus one (0.76%) and Pseudomonas lenteola one (0.76%), two cultures showed two bacteria as in Table 3.

| Organism              | No  | %       |
|-----------------------|-----|---------|
| Acinetobacter spp.    | 44  | 33.59%  |
| Streptococcus pneumonia | 30  | 22.90%  |
| Pseudomonas aeruginosa | 21  | 16.03%  |
| E. coli               | 11  | 8.40%   |
| Enterobacter          | 8   | 6.11%   |
| Klebsiella pneumonia  | 7   | 5.34%   |
| Moraxella catarrhalis | 4   | 3.05%   |
| Staphylococcus aureus | 4   | 3.05%   |
| Hemophilus influenzae | 2   | 1.53%   |
| Proteus               | 1   | 0.76%   |
| Pseudomonas lenteola  | 1   | 0.76%   |

Regarding the antibiotics resistance for Acinetobacter spp. for Amoxicillin/Clavulenic acid (AMC) 87.5%, Amikacin (AK) 56.7%, Cefotaxime (CTX) 100.0%, Ceftriaxone (CRO)
100.0%, Levofloxacin (LEV) 62.5%, Ciprofloxacin (CIP) 88.9%, Gentamycin (GM) 71.1%, Penicillin G (PIZ) 100.0%, Pipracillin (PI) 100.0%, Trimethoprim (TM) 95.0%, Imipenem (IPM) 83.3%, Ticarcillin (TC) 100.0%, Chloramphenicol (C) 91.7%, as in Table 4.

Table 4. Antibiotics sensitivity pattern for *Acinetobacter* spp

| Acinetobacter spp. | R | %  | S | %  |
|--------------------|---|----|---|----|
| AMC                | 14 | 87.5% | 2 | 12.5% |
| AK                 | 17 | 56.7% | 13 | 43.3% |
| CTX                | 9 | 100.0% | 0 | 0.0% |
| FOX                | 2 | 100.0% | 0 | 0.0% |
| CRO                | 27 | 100.0% | 0 | 0.0% |
| LEV                | 5 | 62.5% | 3 | 37.5% |
| CIP                | 8 | 88.9% | 1 | 11.1% |
| CD                 | 3 | 100.0% | 0 | 0.0% |
| GM                 | 27 | 71.1% | 11 | 28.9% |
| PIZ                | 5 | 100.0% | 0 | 0.0% |
| PI                 | 14 | 100.0% | 0 | 0.0% |
| TM                 | 19 | 95.0% | 1 | 5.0% |
| IPM                | 20 | 83.3% | 4 | 16.7% |
| TC                 | 13 | 100.0% | 0 | 0.0% |
| AMP                | 1 | 100.0% | 0 | 0.0% |
| C                  | 11 | 91.7% | 1 | 8.3% |
| ATM                | 2 | 100.0% | 0 | 0.0% |

Trimethoprim sulfamethoxazole (TS), Rifampin (Rif), Clindamycin (Clin), Imipenem (Imi), Azithromycin (AZ), Amikacin (Ami), Ciprofloxacin (Cip), Tetracycline (T), Cefotaxime (Cef), Doxycycline (Dox), Netilmicine (Net), Levofloxacin (Lev). Sensative (s), Resistance (R)

The antibiotics sensitivity pattern for *Streptococcus pneumonia*: Azithromycin (AZM) 46.2% sensitive and 53.8% resistance, Amoxicillin/Clavulnic acid (AMC) 37.5% sensitive and 62.5%, Amikacin (AK) 75.0% sensitive and 25.0%, Cefoxitine (FOX) 20.0% sensitive and 80.0% resistance, Ceftriaxone (CRO) 80.0% sensitive and 20.0% resistance, Ciprofloxacin (CIP) 75.0% sensitive and 25.0% resistance, Clindamycin (CD) 28.6% sensitive and 71.4% resistance, Gentamycin (GM) 95.0% sensitive and 5.0% resistance, Ipeminem (IPM) 90.9% sensitive and 9.1% resistance, Ampicillin (AMP) 90.0% sensitive and 10.0% resistance, Chloramphenicol (C) 73.7% sensitive and 26.3% resistance, as in Table 5.

Table 5. Antibiotics sensitivity pattern for *Streptococcus pneumonia*

| Streptococcus pneumonia | R | %  | S | %  |
|-------------------------|---|----|---|----|
| AZM                     | 7 | 53.8% | 6 | 46.2% |
| AMC                     | 5 | 62.5% | 3 | 37.5% |
| AK                      | 4 | 25.0% | 12 | 75.0% |
| CTX                     | 1 | 50.0% | 1 | 50.0% |
| FOX                     | 4 | 80.0% | 1 | 20.0% |
| CRO                     | 2 | 20.0% | 8 | 80.0% |
| CIP                     | 2 | 25.0% | 6 | 75.0% |
| CD                      | 15 | 71.4% | 6 | 28.6% |
| GM                      | 1 | 5.0% | 19 | 95.0% |
| PIZ                     | 1 | 100.0% | 0 | 0.0% |
| PI                      | 1 | 50.0% | 1 | 50.0% |
| RP                      | 0 | 0.0% | 2 | 100.0% |
| TM                      | 3 | 100.0% | 0 | 0.0% |
| IPM                     | 1 | 9.1% | 10 | 90.9% |
| TC                      | 2 | 66.7% | 1 | 33.3% |
Trimethoprim sulfamethoxazole (TS), Rifampin (Rif), Clindamycin (Clin), Imipenem (Imi), Azithromycin (AZ), , Amikacin (Ami), Ciprofloxacin (Cip), Tetracycline (T), Cefotaxime (Cef), Doxycycline (Dox), Netilmicine (Net), Levofloxacin (Lev).Sensative (s) ,Resistence (R)

The antibiotics sensitivity pattern for *Pseudomonas aeruginosa*: Amoxicillin\Clavulinic acid (AMC) 57.1% sensitive and 42.9% resistance, Amikacin (AK) 76.9% sensitive and 23.1% resistance, Cefotaxime (CTX) 20.0% sensitive and 80.0% resistance, Ciprofloxacin (CIP) 50.0% sensitive and 50.0% resistance, Gentamycin (GM) 82.4% sensitive and 17.6% resistance, Pipracillin (PI) 66.7% sensitive and 33.3% resistance, Ipimenem (IPM) 41.7% sensitive and 58.3% resistance, Ticarcillin (TC) 42.9% sensitive and 57.1% resistance, Chloramphenicol (C) sensitive 100.0% as in Table 6.

| Antibiotics | Pseudomonas aeruginosa |
|-------------|------------------------|
| AZM         | 0%                     |
| AMC         | 42.9%                  |
| AK          | 23.1%                  |
| CTX         | 80.0%                  |
| FOX         | 33.3%                  |
| CRO         | 33.3%                  |
| LEV         | 66.7%                  |
| CIP         | 50.0%                  |
| CD          | 100.0%                 |
| GM          | 17.6%                  |
| PI          | 33.3%                  |
| RP          | 100.0%                 |
| TM          | 50.0%                  |
| IPM         | 58.3%                  |
| TC          | 57.1%                  |
| AMP         | 66.7%                  |
| C           | 0.0%                   |

Trimethoprim sulfamethoxazole (TS), Rifampin (Rif), Clindamycin (Clin), Imipenem (Imi), Azithromycin (AZ), , Amikacin (Ami), Ciprofloxacin (Cip), Tetracycline (T), Cefotaxime (Cef), Doxycycline (Dox), Netilmicine (Net), Levofloxacin (Lev).Sensative (s) ,Resistence (R)

The antibiotics sensitivity pattern for *E. coli*: Amoxicillin\Clavulinic acid (AMC) 25.0% sensitive and 75.0% resistance, Amikacin (AK) 90.9% sensitive and 9.1% resistance, Cefotaxime (CTX) 20.0% sensitive and 80.0% resistance, Cefoxitme (FOX) 50.0% sensitive and 50.0% resistance, ceftriaxone (CRO) 33.3% sensitive and 66.7% resistance, Gentamycin (GM) 54.5% sensitive and 45.5% resistance, Ipeminem (IPM) 75.0% sensitive and 25.0% resistance, as in Table 7.

| Antibiotics | E. coli |
|-------------|---------|
| AZM         | 0%      |
| AMC         | 42.9%   |
| AK          | 23.1%   |
| CTX         | 80.0%   |
| FOX         | 33.3%   |
| CRO         | 33.3%   |
| LEV         | 66.7%   |
| CIP         | 50.0%   |
| CD          | 100.0%  |
| GM          | 17.6%   |
| PI          | 33.3%   |
| RP          | 100.0%  |
| TM          | 50.0%   |
| IPM         | 58.3%   |
| TC          | 57.1%   |
| AMP         | 66.7%   |
| C           | 0.0%    |

Trimethoprim sulfamethoxazole (TS), Rifampin (Rif), Clindamycin (Clin), Imipenem (Imi), Azithromycin (AZ), , Amikacin (Ami), Ciprofloxacin (Cip), Tetracycline (T), Cefotaxime (Cef), Doxycycline (Dox), Netilmicine (Net), Levofloxacin (Lev).Sensative (s) ,Resistence (R)

Table 6. Antibiotics sensitivity pattern for *Pseudomonas aeruginosa*

Table 7. The antibiotics sensitivity pattern for *E. Coli*
Trimethoprim sulfamethoxazole (TS), Rifampin (Rif), Clindamycin (Clin), Imipenem (Imi), Azithromycin (AZ), Amikacin (Ami), Ciprofloxacin (Cip), Tetracycline (T), Cefotaxime (Cef), Doxycycline (Dox), Netilmicine (Net), Levofloxacin (Lev). Sensative (s), Resistance (R)

4. Discussion:

Due to increasing usage of antibiotic, the antibiotic resistance became an important medical problem [17]. In this study male is higher than female which may be due to the different in social state. This is in agreement with that of Akansha et al [18] in which male is higher (73.4%) than females (26.6%). In this study the highest percent in age between 50-60 years, in Haroon study [19] the highest percent in age between 55-65 years. Also in this study most of the samples from patients admitted to respiratory care unit and medical ward, The Infectious Diseases Society of America/American Thoracic Society consensus (IDSA/ATS) guidelines recognize the limitations of sputum Gram stain and culture [20]. In which the expectorated sputum specimens are recommended for hospitalized patients with any of the following criteria: Intensive care unit admission, Failure of the antibiotic therapy (either hospitalized or outpatients patients), in addition to other criteria.

Regarding the organism isolated from sputum culture in this study, Acinetobacter spp is the most common organism isolated (33.59%), this high percent may be due to large number of our patients from ICU, as the risk of infection due to gram-negative organisms, including Acinetobacter baumannii, increased with ICU admission, increase the age of patients, use of the catheters or intubation, and prolonged hospital admission [21]. Streptococcus pneumonia in this study was 22.90%, in Akansha study [18] Streptococcus pneumonia was 20.22%, Pseudomonas aeruginosa in this study was 16.03%, in Akansha study [18] x 9.84%. E. coli in this study was 8.40%, in [22] study E. coli 11.7%. Enterobacter in this study was 6.11%, in Jean-Jacques study [23] Enterobacter 3%. Klebsiella pneumonia in this study 5.34%, in Miriam study [24] study Klebsiella pneumonia was 3.6%. Moraxella catarrhalis in this study was 3.05%, in Jean-Jacques study [23] was Moraxella 3%. Staphylococcus aureus in this study was 3.05%, in [23] study study Staphylococcus aureus was 3.6%. Haemophilus influenza in this study 1.53%, in Jean-Jacques study [23] Haemophilus influenza 3%. The Antibiotics sensitivity pattern for common microorganism isolated in this study.
For *Acinetobacter* spp. this study showed very high resistance rate to most of antibiotics. Al-Obeid study (25) for antimicrobial sensitivity of 506, 510 and 936 patients isolates *A. baumannii* during 2006, 2009, 2012, respectively. The resistant of *A. baumannii* to variety of antimicrobial drugs changed as following: 19% in (2006) to 89% in (2012) for meropenem, 36% in (2006) to 91.7% in (2012) for imipenem, 54% in (2006) to 89.2% in (2012) for ciprofloxacin, 71% in (2006) to 83% in (2012) for amikacin, and 75% in (2006) to 83% in (2012) for ceftazidime.

The antibiotics sensitivity pattern for streptococcus pneumonia in this study showed highly sensitive to Amikacin, CRO, Ciprofloxacin, Gentamycin, Imipenem, Amp, while it is highly resistant to AMC, CD, FOX. In Devanath study [25] *Streptococcus pneumoniae* was sensitive to ampicillin, amikacin, gentamicin, co-trimoxazole, penicillin and erythromycin. In Haroon study [19] *Streptococcus pneumoniae* was sensitive to meropenem, gentamicin, linezolid followed by moxifloxacin, ceftriaxone, ciprofloxacin, levofloxacin and azithromycin.

The antibiotics sensitivity pattern for pseudomonas aeruginosa in this study showed highly sensitive to Amikacin, Pi, Gentamycin, and it is highly resistant to CTX, while the resistant rate for Imipenem 58.3 % and for TC 57.1%. In Devanath study (26) Pseudomonas aeruginosa was mainly sensitive to piperacillin, gentamicin and amikacin. In Haroon Study (19) Pseudomonas aeruginosa was mainly sensitive to gentamicin and meropenem. The sensitivity rate was 65% for azithromycin and 28% for amoxicillin–clavulanic acid.

The antibiotics sensitivity pattern for *E. coli* pneumonia in this study showed highly sensitive to Amikacin, Imipenem. And it is highly resistant to ACM, CTX, CRO. In Ashis study (27) the sensitivity to Ertapenem 72.91%, Imipenem 85.41%, tigicycline 70.83%, chloramphenicol and amikacin 62.4%. these bacteria resistance to many antibatic because it have many mechanism such as development of enzymes , target modification , alternation of membrane permeability and alternation of metabolic pathway(28).

### 5. Conclusion

This retrospective study which evaluated the bacteriological found that *Acinetobacter* spp. is the most common organism isolated in this study, which has high resistant rate. Other common organism isolated were *Streptococcus pneumoniae, Pseudomonas aeruginosa, E. coli* with variable antibiotics sensitivity and resistant rates. Amikacin and gentamycin are most common sensitive drugs for these common bacteria.

### References

1. Reid P.T.; Innes. J.A. *Respiratory disease*. In: Brian R. Nicki R. Stuart H. *et al.* Davidson’s Principles and Practice of Medicine. 22th ed. Philadelphia: UK; 2014. 681.
2. World Health Organization. *Infections and infectious diseases: A manual for nurses and midwives in the WHO European Region*. Europe, 2001.
3. Ziyade, N.; Yagci, A. Improving Sputum Culture Results for Diagnosis Of Lower Respiratory Tract By Saline Washing. *Marmara Med J.* 2010. 23, 1, 30-36.
4. Chapin, K. *Clinical microscopy*. In: Murray PR, Baron EJ, Pfaller MA, *et al.*, eds. Manual of Clinical Microbiology, 6th ed. Washington, DC: American Society for Microbiology. 1995, 33-51.
5. Ewig, S.; Schlochtermeier, M.; Göke, N.; Niederman, M. Applying sputum as a diagnostic tool in pneumonia. *Chest*. 2002. 121: 1486-1492.
6. Cordero, E.; Pachón J.; Rivero, A. Usefulness of sputum culture for diagnosis of bacterial pneumonia in HIV infected patients. *Eur J Clin Microbiol Infect Dis*. 2002, 21, 362-367.
7. Bartlett, J.G.; Mundy, L.M. Community-acquired pneumonia. *N Engl J Med*. 1995, 333, 1618.
8. Mandell, L.A.; Wunderink, R.G.; Anzueto, A. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis*. 2007, 44, S27–S72.
9. Fuselier, P.A.; Garcin, L.S.; Procop, G.W. *Infections of the Lower Respiratory Tract*. In: Betty AF, Daniel FS, Alice SW, editors. Bailey and Scott’s Diagnostic Microbiology. Mosby, 2002, 884-898.
10. García-Vázquez, E.; Marcos; M. A.; Mensa, J. Assessment of the Usefulness of Sputum Culture for Diagnosis of Community-Acquired Pneumonia Using the PORT Predictive Scoring System. *Arch Intern Med*. 2004, 164, 16, 1807-1811.
11. About Antimicrobial Resistance Antibiotic. *Antimicrobial Resistance CDC*. 2017. http://www.cdc.gov/drugresistance/about.htm
12. Katzung, B. G. *Basic and Clinical Pharmacology*, Lange Medical Books. McGraw-Hill, 9th edition, New York, USA, 2004.
13. Pattanayaka, C.; Patanaikb, S.K.; Dattaa, P.P.; Pandaa, P. A. Study on antibiotic sensitivity pattern of bacterial isolates in the intensive care unit of a tertiary care hospital in Eastern India. *Int J Basic Clin Pharmacol*. 2013, 2, 2, 153-159.
14. Bolaji, A.S.; Akande, I.O.; Iromini, F.A.; Adewoye, S.O.; Opasola O.A. Antibiotic resistance pattern of bacteria spp isolated from hospital waste water in Ede South Western, Nigeria. *Eur. J Exp Bio*. 2011, 1, 4, 66-71.
15. Forbes BA, Sahm DF, Weissfeld AS. “Bailey and Scott's Diagnostic Microbiology”. International 12th ed, Mosby, USA 2007.
16. Clinical and Laboratory Standards Institute (CLSI). Performance Standards for Antimicrobial Susceptibility Testing: Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria That Grow Aerobically, 2012, 32 (2) ISSN 1558-6502.
17. World Health Organization. Tackling antibiotic resistance from a food safety perspective in Europe. 2011.
18. Akansha, R.; Archana, S.; Gaganpriya, P. Diagnostic Value of Sputum Gram’s Stain and Sputum Culture in Lower Respiratory Tract Infections in a Tertiary Care Hospital. *Int J Curr Microbiol App Sci*. 2017, 6, 7, 4310-4314.
19. Haroon, U.; Iftikhar, A. Pattern of Sputum Bacteriology in Acute Exacerbations of Chronic Obstructive Pulmonary Disease. *J Enam Med Coll*. 2018, 8, 80-84.
20. Mandell, L.A.; Wunderink, R.G.; Anzueto, A. Infectious Diseases Society of America/American Thoracic Society consensus guidelines on the management of community-acquired pneumonia in adults. *Clin Infect Dis*. 2007, 44 Suppl 2, S27.
21. Asaad, A.M.; Al-Ayed, M.S.Z.; Qureshi, M.A. Emergence of unusual nonfermenting gram-negative nosocomial pathogens in a Saudi hospital. *Jpn J Infect Dis*. 2013, 66, 7–11.
22. Aroma, O.; Aruna, A. *Bacteriological Profile, Serology and Antibiotic Sensitivity Pattern of Micro-organisms from Community Acquired Pneumonia*. JK SCIENC. 2006, 8, 79-82.
23. Jean-Jacques, L.; Mohamed, I.; Claude, P; Anissa, L.; Philippe, G. Usefulness of sputum Gram stain and culture for diagnosis of pneumonia in a geriatric institution. *J IMAB*. 2010, 16, 20-22
24. Buenviaje, B.M. Quantitative Sputum Culture and Gram Stain: Pulmonary Infection vs. Colonization. *Phil J Microbiol Infect Dis*. 1989, 18,1, 28-35.
25. Al-Obeid, S.; Jabri, L.; Al-Agamy, M.; Al-Omari, A.; Shibl, A. Epidemiology of extensive drug resistant *Acinetobacter baumannii* (XDRAB) at Security Forces Hospital (SFH) in Kingdom of Saudi Arabia (KSA). *J Chemother*. 2015, 27, 156–62.
26. Devanath, S.; Saroj, G.; Suhani, S. A bacteriological study of acute exacerbation of chronic obstructive pulmonary disease over a period of one year. *Int J Res Med Sci*. **2015**, *3*, 11, 3141-3146

27. Ashis, K.; Payodhi, D. Spectrum of Antimicrobial Sensitivity of Escherichia Coli in Sputum in a Tertiary Medical Centre in Kolkata, West Bengal, 7 Years’ Experience. *Int J Contemp Med Res*. **2017**, *4*, 2177-2180.

28. Giedraitienel, A.; Vitkauskiene, A.; Naginiene, R. and Pavilonis, A. Antibiotic Resistance Mechanisms of Clinically Important Bacteria. *Medicina(Kaunas)*. 2011, 47(3):137-146