E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/15.01.26

Research Article

Quantitative Culture of Bronchoalveolar Lavage Fluid for the Diagnosis of Bacterial Pneumonia at a Tertiary Care Centre

Chandrahas Kale[1*], Pankaj Joshi[2]
[1]Assistant Professor, Government Medical College, Miraj, India.
[2]Associate Professor, Government Medical College, Miraj, India.
Corresponding Author: Dr Chandrahas Kale
Assistant Professor, Government Medical College, Miraj, India.
Received: 10.02.25, Revised: 13.03.25, Accepted: 31.03.25

ABSTRACT
Background: Pneumonia remains the leading cause of infectious disease mortality globally, necessitating early diagnosis and appropriate antimicrobial management. Bronchoalveolar lavage (BAL) has been established as a crucial diagnostic tool in both immunocompetent and immunocompromised patients, offering advantages over conventional sputum samples by reducing contamination and providing accurate antimicrobial susceptibility data.
Objectives: This study aimed to evaluate the diagnostic yield of quantitative BAL fluid culture in identifying bacterial pathogens responsible for pneumonia and to assess the antimicrobial susceptibility of these pathogens to guide effective treatment.
Methods: Conducted at the Department of Microbiology, Government Medical College, Maharashtra, the study included patients over 18 years undergoing BAL via fiberoptic bronchoscopy for pneumonia diagnosis from June 2018 to May 2019. Quantitative cultures were grown on Blood Agar, MacConkey Agar, and Chocolate Agar, with a positive culture defined at ≥ 10^4 CFU/mL. Pathogen identification and antibiotic susceptibility testing were performed using standard microbiological techniques.
Results: Of the 63 patients studied, 57.14% showed a positive quantitative BAL culture. Staphylococcus aureus was the most frequently isolated pathogen, followed by Pseudomonas aeruginosa, Klebsiella pneumoniae, and Escherichia coli. Notably, Methicillin-resistant Staphylococcus aureus (MRSA) constituted a significant portion of S. aureus cases. Gram-negative bacteria showed high resistance to standard antibiotics but were sensitive to Imipenem and Piperacillin-Tazobactam.
Conclusion: Quantitative BAL fluid culture is a valuable diagnostic method for effectively identifying and managing bacterial pneumonia. The procedure not only confirms the pathogen but also informs targeted antibiotic therapy, thereby minimizing the use of broad-spectrum antibiotics and reducing the emergence of resistant bacterial strains.

Keywords: Bronchoalveolar lavage, Pneumonia, Antimicrobial susceptibility.

INTRODUCTION

Pneumonia causes more deaths worldwide than any other infectious disease.[1] Early diagnosis and proper choice of antimicrobials are crucial for successful management of pneumonia.[2]Bronchoalveolar lavage (BAL) and protected specimen brush are standard methods for identifying causative organisms.[3] The usefulness of endoscopic procedures, especially BAL, is well-established in both immunocompetent and immunocompromised patients with pneumonia.[4]

Bronchoalveolar lavage (BAL) was introduced as a research-oriented procedure way back in 1970.[5] It was originally used as a tool for obtaining secretions and cells from the lower respiratory tracts of patients with interstitial, occupational, or both types of pulmonary diseases[6]. It was used for first time in India in 1994 for its important role in diagnosis of infections and malignancies[7]. Lower Respiratory tract infections (LRTI), caused by various organisms like bacteria and fungi, can be isolated by culturing BAL samples[8]. Sputum samples are still considered effective in diagnosing infective lung conditions in our country, as they are easy to obtain. Although they have 24% diagnostic yield, contamination of sample from oral flora during expectoration makes it unsatisfactory for culture[9]. BAL has an advantage compared to repeat sputum sample collections as the contamination by oral flora can be avoided easily. Further, the quantitative culture with proper colony cut off provides a greater insight for therapy. Another distinct

advantage of BAL is that being an outpatient procedure, it is very much useful in suspected cases of community acquired pneumonia (CAP).[10]

The aim of this study was to determine the yield of quantitative BAL fluid bacterial culture for the early and accurate diagnosis of pneumonia and the antimicrobial sensitivity testing for appropriate and early management of the patients.

MATERIALS AND METHODS

The study was performed in the Department of Microbiology at Government Medical College of Maharashtra from June 2018 to May 2019. Patients over 18 years of age in whom BAL through fiberoptic bronchoscopy was performed to identify pneumonia-causing organisms were included in the study. A detailed history of the patients were taken. Quantitative Culture of BAL fluid was performed by calibrated loop techniques on Blood Agar, MacConkey Agar and Chocolate Agar. A positive quantitative culture was defined when bacteria were cultured from BAL samples at a concentration of 1×10^4 CFU/mL or more. [11]Identification of the isolates were done by conventional methods. Antibiotic susceptibility was performed by Kirby-Bauer disc diffusion method.[12]

RESULTS

Quantitative culture of BAL fluid was performed on 63 patients with pneumonia, comprising 45[71.43%] men and 18[28.57%] women. The mean Age of the patients was 47.5 years(range 18-71years). A positive quantitative culture (>10^4 CFU/mL) of BAL was documented in 36(57.14%) patients as shown in figure 1.

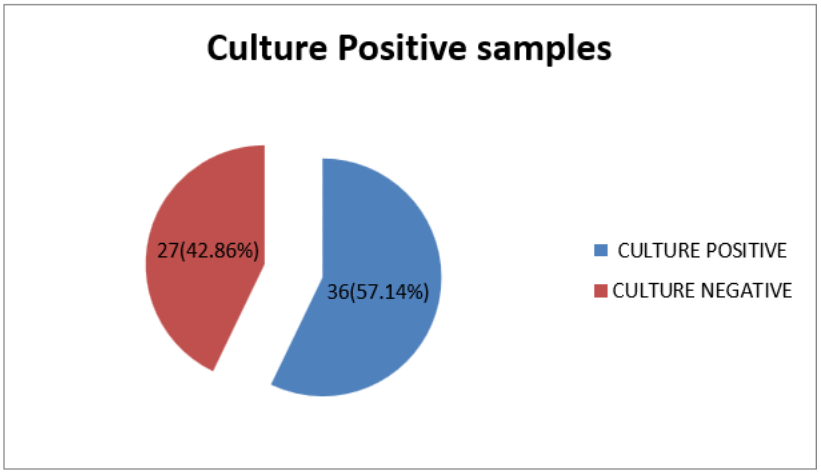

Figure 1: Culture positive samples.

The total number of bacterial isolates were 42 from 36 culture positive samples of which 6 samples were culture positive for two organisms each.

The most frequently isolated organism was Staphylococcus aureus 19(45.24%) followed by Pseudomonas aeruginosa 14(33.33%), Klebsiella pneumoniae 5(11.90%) and Escherichia coli 4(11.90%).

Table 1: Number of bacterial isolates.

Organism	No. of isolates	%
Staphylococcus aureus	19	45.24
Pseudomonas aeruginosa	14	33.33
Klebsiella pneumoniae	5	11.9
Escherichia coli	4	9.53
Total	42	100

Most of the Staphylococcus aureus isolates showed resistance to Penicillin, Erythromycin and Ciprofloxacin whereas they were sensitive to Cotrimoxazole, Tetracycline and Gentamicin.

Staphylococcus aureus isolates were 100% sensitive to Linezolid and Vancomycin.
Methicillin resistant Staphylococcus aureus accounted for 36.84% (7/19) of the isolates.

Pseudomonas aeruginosa was found to be least sensitive to Cephalosporins but was 100% sensitive to Imipenem and Piperacillin-Tazobactam. Klebsiella pneumoniae and Escherichia coli documented resistance to Cephalosporins, Ampicillin and Amoxicillin-Clavulanic acid but were sensitive to Amikacin, Imipenem and Piperacillin-Tazobactam.

The antimicrobial susceptibility pattern of Gram Positive Isolates and Gram Negative Isolates is Shown in Table 2 and Table 3 respectively.

Table 2: Sensitivity Percentage of Antibiotics for the Gram Positive Isolates

Antibiotic	Staphylococcus aureus	Methicillin resistant S. aureus
Vancomycin	100(12/12)	100(7/7)
Linezolid	100(12/12)	100(7/7)
Cotrimoxazole	91.66(11/12)	100(7/7)
Tetracycline	83.33(10/12)	71.42(5/7)
Gentamicin	75(9/12)	71.42(5/7)
Ciprofloxacin	33.33(4/12)	57.14(4/7)
Erythromycin	33.33(4/12)	28.57(2/7)
Penicillin	16.67(2/12)	0(0/7)

Table 3: Sensitivity Percentage of Antibiotics for Gram Negative Isolates

Antibiotic	Pseudomonas aeruginosa(n=14)	Klebsiella pneumoniae(n=5)	E. coli(n=4)
Imipenem	100(14)	100(5)	100(4)
Piperacillin-Tazobactam	100(14)	100(5)	100(4)
Amikacin	64.28(9)	100(5)	100(4)
Ciprofloxacin	71.42(10)	40(2)	50(2)
Piperacillin	64.28(9)	60(3)	75(3)
Gentamicin	57.14(8)	40(2)	50(2)
Ceftazidime	35.71(5)	20(1)	0(0)
Amoxicillin-clavulanate	28.53(4)	20(1)	25(1)
Ampicillin	14.28(2)	0(0)	0(0)
Cefotaxime	7.14(1)	0(0)	25(1)
Ceftriaxone	7.14(1)	0(0)	0(0)

DISCUSSION

BAL is a diagnostic method used in many studies to determine the cause of VAP, pneumonia in immunocompromised patients, nosocomial pneumonia, and CAP of severe nature or refractory to treatment.[13]

The number of culture positive patients in our study accounted for 36(57.14%) which correlates with the study conducted by GJC Pereira et al.[13] The study conducted in Brazil in 62 patients with pneumonia, BAL fluid was positive 45 out of 62 patients(72.6%) with 58 of 62 BAL performed under antibiotics. Quantitative culture of BAL allows exclusion of even low level of contamination of virtue of culture growth below diagnostic threshold (>10^4 colony forming units/ml). Low colony counts suggest oropharyngeal contaminants and high colony counts suggest pathogen.[14] In a study conducted by Kahn and Jones in 94 immunocompromised patients to analyze the laboratory protocol of BAL fluid analysis found BAL microscopy and culture both were diagnostic in 12 out of 18 cases (66%).

In our study Staphylococcus aureus (45.24%) was the most predominant isolate. The study conducted by E S Kim *et al* correlates with the findings of our study which showed Staphylococcus aureus as the major pathogen.[15] Other studies conducted such as Bhatia et al showed Klebsiella species as the predominant organism followed Escherichia coli and Staphylococcus aureus.[16]

Methicillin resistant Staphylococcus aureus accounted for 36.84% (7/19) of the isolates. Recent trend with spread of MRSA strains is documented in various studies and is also shown in the study conducted by E S Kim *et al*.[15]

The gram negative organisms were accounted for in 54.76% of the isolates.The predominance of gram-negative bacilli as aetiological agents in contrast to gram-positive bacteria in the present study was typical of the hospital-acquired infections. [16]The other predominant isolate was *Pseudomonas aeruginosa* 14(33.33%) which correlates with the findings of Magazine et al.[17] The other organisms which were isolated were *Klebsiella pneumoniae* and *Escherichia coli*.

The *Staphylococcus aureus* isolates were resistant to Penicillin, Erythromycin and Ciprofloxacin which correlates with the findings of Magazine et al. whereas they were sensitive to Cotrimoxazole, Tetracycline and Gentamicin. *Pseudomonas aeruginosa* was found to be least sensitive to Cephalosporins but was 100% sensitive to Imipenem and Piperacillin-Tazobactam which correlates with the study conducted by Magazine et al.[17] The study conducted by Ranjan N et al also showed maximum sensitivity to Carbepenems andPiperacillin-Tazobactam combination.[18] *Klebsiella pneumoniae* and *Escherichia coli* documented resistance to Cephalosporins, Ampicillin and Amoxicillin-Clavulanic acid but were sensitive to Amikacin, Imipenem and Piperacillin-Tazobactam. The multi drug resistant ESBL producing strains contribute to the failure of the antimicrobial therapy in pneumonia. Multiple antibiotic resistance to useful antibiotics, including the penicillins, cephalosporins, aminoglycosides, and fluoroquinolones, has gradually increased among a number of gram negative pathogens, especially Pseudomonas aeruginosa, Klebsiella pneumoniae and other gram negative isolates.[19]

CONCLUSION

BAL quantitative culture is performed to establish the bacterial etiologic diagnosis and to guide therapy specifically, minimizing the selection of resistant strains while reducing the side effects of empirically used antibiotics. Many studies including our study conclude that BAL may help to reduce inappropriate antibiotic use in cases of pneumonia. BAL examination offers valuable information on the diagnosis of pyogenic infections and also other diseases.

REFERENCES

1. Mizgerd JP. Acute lower respiratory tract infection. New England Journal of Medicine 2008;358:716-727.
2. Souweine B, Veber B, Bedos JP, et al. Diagnostic accuracy of protected specimen brush and bronchoalveolar lavage in nosocomial pneumonia: impact of previous antimicrobial treatments. Critical Care Medicine. 1998;26:236–244.
3. Timsit JF, Cheval C, Gachot B, et al. Usefulness of a strategy based on bronchoscopy with direct examination of bronchoalveolar lavage fluid in the initial antibiotic therapy of suspected ventilator-associated pneumonia.Intensive Care Medicine. 2001;27:640–647.
4. Narayanswami G, Salzman SH. Bronchoscopy in the human immunodeficiency virus-infected patient. SeminRespir Infect. 2003;18:80-86.
5. Baughman RP. How I Do Bronchoalveolar Lavage. J Bronchol. 2003;10:309-314.
6. Crossref
7. Hyaret R. Pulmonary host defenses. Interaction of respiratory antibodies with pseudomonas aeruginosa and alveolar macrophages. J Immunol. 1974;111:369-380.
8. Meyer KC, Raghu G, Baughman RP, et al. An official American Thoracic Society clinical practice guideline: The clinical utility of bronchoalveolar lavage cellular analysis in interstitial lung disease. Am J Respir Crit Care Med. 2012;185(9):1004-1014.
9. Crossref
10. Radha S, Afroz T, Prasad S, Ravindra N. Diagnostic utility of bronchoalveolar lavage. J Cyto. 2014;31(3):136-138.
11. Crossref
12. Mishra SK, Kattel HP, Acharya J, et al. Recent trend of bacterial aetiology of lower respiratory tract infections in a tertiary care center of Nepal. Int J Infect Microbiol. 2012;1(1):3-8.
13. Crossref
14. Rano A, Agusti C, Jimenez P, et al. Pulmonary infiltrates in non-HIV immunocompromised patients: a

diagnostic approach using non-invasive and bronchoscopic procedures. Thorax. 2001;56(5):379-87.

15. Crossref
16. Afessa B, Hubmayr RD, Vetter EA, Keegan MT, Swanson KL, BaddourLM, Cockerill FR, Peters SG. 2006. Bronchoscopy in ventilator ssociated pneumonia: agreement of calibrated loop and serial dilution. Am. J. Respir. Crit. Care Med. 173:1229 –1232.
17. Clinical And Laboratory Standards Institute. Performance standards for antimicrobial disk susceptibility testing. Approved standards, CLSI Document [CLSI]. 2014..
18. Joao Carlos Pereira Gomes, Wilson L Pedreira Jr, Evangelina M P, Araujo A,
19. Francisco G Soriano, Elnara M Negri et al.Impact of BAL in the Management of Pneumonia With Treatment failure-Positivity of BAL Culture Under Antibiotic Therapy.CHEST 2000;118:1739–46.
20. Baselski VS and Wunderink RG. Bronchoscopic diagnosis of pneumonia.Clin.Microbiol. Rev 1994;7(4):533.
21. Eun Sun Kim, Eui-Chong Kim, Sang-Min Lee, Seok-Chul Yang, Chul-GyuYoo, Young Whan Kim, Sung Koo Han and Jae-JoonYim Bacterial Yield from Quantitative Cultures of Bronchoalveolar Lavage Fluid in Patients with Pneumonia on Antimicrobial Therapy korean j intern med 2012;27:156-162.
22. G. C. Bhatia, N. Hemvani, D.S. Chitnis Role of Bronchoalveolar Lavage in Pulmonary infections Lung India 2006; 23 : 147-150.
23. Rahul Magazine, Bharti Chogtu, Shobitha Rao, Kiran Chawla Bacterial isolates from the bronchoalveolarlavage fluid of patients with pneumonia not responding to initial antimicrobial therapy Sahel Medical Journal / July-September 2013 / Vol 16 | Issue 3.
24. Ranjan N, Ranjan K P, Chaudhary U, Chaudhry D. Antimicrobial resistance in bacteria causing ventilator-associated pneumonia in a tertiary care hospital: one year prospective study. Int J Res Med Sci 2014;2:228-33.
25. C Mukhopadhyay, A Bhargava, A Ayyagari. Role of mechanical ventilation & development of multidrug resistant organisms in hospital acquired pneumonia. Indian J Med Res 2003 December;118:229-35.