Original Article

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Microbiology Section

Prevalence and Antimicrobial Susceptibility Pattern of Bacterial Agents Involved in Lower Respiratory Tract Infection at a Tertiary Care Hospital, Jaipur, Rajasthan, India

ASHINA SINGLA[1], NITIN KUMAR[2], PREETI CHAUDHARY[3], VED PRAKASH MAMORIA[4]

ABSTRACT

Introduction: Lower Respiratory Tract Infection (LRTI) is one of the commonest health problems which is not a single disease but a group of specific infections with varying aetiology and symptomatology. These infections are the leading cause of illness and mortality in children and adults across the world because of different epidemiology, pathogenesis, clinical presentation, and outcomes.

Aim: To find out the prevalence, bacteriological profile and antimicrobial susceptibility pattern of clinical isolates causing LRTI.

Materials and Methods: This was a laboratory based observational study which was carried out between June 2019 to May 2020. All the lower respiratory tract samples (sputum, Endotracheal (ET) aspirate, Bronchoalveolar Lavage (BAL) etc.,) were collected and sample processing was done for isolation and identification by standard methods and antimicrobial susceptibility testing was done using Kirby Bauer disc diffusion method. The data was analysed in Microsoft Office excel worksheet.

Results: A total number of 1364 samples were processed in which 615 were culture positive. ET aspirates 65.04% (n=400) showed higher positivity rate than sputum 32.03% (n=197). In this study, gram positive and gram negative bacteria (GNB) were 4.23% (n=26) and 92.19% (n=567) respectively with yeast recovered in only 3.58% (n=22) of the specimens. Among the isolates, *Klebsiella pneumoniae* 171 (30.15%) was the most common organism. The overall susceptibility of GNB was highest towards tigecycline (51.85%) followed by gentamicin (38.62%).

Conclusion: Specific antibiotic utilisation strategies like antibiotic restriction, combination therapy may help to decrease or prevent the emergence of resistance. There is a need for further community based studies to identify the best treatment protocol for individual patients.

Keywords: Endotracheal aspirate, *Klebsiella pneumoniae*, Sputum culture

INTRODUCTION

The LRTIs are amongst the most common infectious diseases of humans worldwide [1]. These are the leading cause of illness and death in children and adults across the world. LRTIs are any infection in the lungs, trachea, bronchi, bronchioles, alveoli, or below the larynx. LRTI's is not only one disease, but a cluster of specific infections each with different epidemiology, pathogenesis, clinical presentation, and outcome. The symptoms and aetiology of respiratory diseases vary with age, gender and the type of population at risk. LRTI's may be defined as those infections presenting with symptoms including cough, expectoration, dyspnea, wheeze, and/or chest pain/discomfort usually for a period ranging from 1-3 weeks. Acute manifestations of LRTIs that may or may not involve lungs include acute bronchitis, bronchiolitis, influenza, community-acquired pneumonia either with or without radiological evidence, acute exacerbation of Chronic Obstructive Pulmonary Disease (COPD), and acute exacerbation of bronchiectasis [2]. A 4.4% of all hospital admissions and 6% of all general practitioner consultations are due to infections of the lower respiratory tract [3].

Hospital-acquired and community-acquired LRTI's have been on the rise as seen with other immunocompromised conditions which include asthma, COPD, diabetes, chronic kidney disease [4-6]. Respiratory infection accounts for a major health burden causing about 50 million deaths per year [7]. It has been seen that 13.3% of Disability–Adjusted Life Years (DALYs) are due to respiratory diseases [8]. As reported by the World Health Organisation (WHO), among the infectious disease deaths in India LRTI's have been attributed to account for almost 20% mortality [9]. They account for 3-5% of deaths in adults [10]. The problem is much greater in developing countries where pneumonia is the most common cause of hospital attendance in adults [11]. In developing countries, the situation is more complicated and management is often difficult due to the problem associated with the identification of the aetiological agents and administration of appropriate treatment in cases requiring antibiotic therapy [12]. Since the aetiological agents of LRTI cannot be determined clinically, microbiological investigation is required for both treatment and management of the individual case and epidemiological purposes [13,14]. This study aims to determine the prevalence and antimicrobial susceptibility pattern of bacterial agents causing LRTI at a tertiary care hospital of Jaipur, Rajasthan, India.

MATERIALS AND METHODS

This was a laboratory based observational study which was carried out between June 2019 to May 2020 at Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India, after getting the Institutional Ethical Committee (IEC) approval (MGMCH/IEC/JPR/2019/16) and informed consent. A total of 1364 respiratory specimens were received during the study period.

Inclusion criteria: Lower respiratory tract sample were included in the study.

Exclusion criteria: Sample other than lower respiratory tract sample were excluded from the study.

Study Procedure

All the lower respiratory tract samples (sputum, ET aspirate, BAL etc.,) of patients coming to the outpatient and in-patient department of MGMCH with symptoms of LRTI were collected for bacteriological culture into a wide-mouthed sterile containers, transported to the laboratory and processed within two hours.

Gram's staining was done for all the received samples and then inoculated onto Blood agar, Chocolate agar and MacConkey agar. Streaked culture plates were incubated at 37°C overnight. On the next day, the bacterial growth was observed, and was further processed for identification. Bacterial isolates were identified on the basis of colony characteristics, gram-staining, and a battery of biochemical tests. The antimicrobial susceptibility test was done by Kirby Bauer disc diffusion method. Interpretation of antimicrobial susceptibility was done by Clinical and Laboratory Standards Institute (CLSI) guidelines [15].

STATISTICAL ANALYSIS

The data was entered in Microsoft office excel worksheet. The data was analysed as number and percentage.

RESULTS

A total of 1364 respiratory specimens were received during the study period. Out of which 615 (45.08%) were culture positive. ET aspirates showed higher positivity 65.04% (n=400/615) followed by sputum 32.03% (n=197/615) and BAL 2.93% (n=18/615). Most of the culture positive samples were received from the IPD 97.24 (n=598) and 2.76% (n=17) were from OPD.

Patients enrolled in the study included male 81.14% (n=499) as compared to female 18.86% (n=116). Most of the culture positive isolates were from patients in the age group of 61-70 years (n=137, 22.27%) [Table/Fig-1].

Out of the 615 positive cultures, bacterial isolates were recovered from 96.42% (n=593) and fungal isolates from 3.58% (n=22) cultures. Out of the bacterial isolates, gram positive and gram negative bacteria were 4.23% (n=26) and 92.19% (n=567), respectively with yeast isolates recovered in only 3.58% (n=22) of the specimens.

Among the gram negative isolates, *Klebsiella pneumoniae* 30.15% (n=171) was the most common organism isolated, followed by *Acinetobacter baumanii* 28.21% (n=160), *Pseudomonas aeruginosa* 19.40% (n=110), *Escherichia coli* 15.16% (n=86) [Table/Fig-2].

Among the gram positive bacteria, *Staphylococcus aureus* was the most predominant spp. isolated 50% (n=13) followed by *Staphylococcus haemolyticus* 26.92% (n=07) [Table/Fig-3].

The antimicrobial susceptibility pattern of the isolated bacteria is as follows: Gram negative bacteria showed highest sensitivity against Tigecycline (51.85%) and Gentamicin (38.62%) [Table/Fig-4].

In Gram positive bacteria Linezolid (88.5%) and Tigecycline (84.6%) showed high sensitivity [Table/Fig-5].

S. No.	Age (Years)	Total	Percentage (%)
1	0-10	6	0.98
2	11-20	27	4.39
3	21-30	80	13
4	31-40	69	11.21
5	41-50	90	14.63
6	51-60	131	21.30
7	61-70	137	22.28
8	71-80	61	9.92
9	81-90	12	1.95
10	91-100	2	0.33
	Total	615	100
	Gender		
1	Male	499	81.14
2	Female	116	18.86
	Total	615	

[Table/Fig-1]: Age and gender wise distribution of culture positive cases (n=615).

S. No.	Organism name	Number	Percentage (%)
1	*Acinetobacter baumannii*	160	28.21
2	*Klebsiella pneumoniae*	171	30.15
3	*Escherichia coli*	86	15.16
4	*Pseudomonas aeruginosa*	110	19.40
5	*Serratia marcescens*	9	1.58
6	*Stenotrophomonas maltophilia*	7	1.23
7	*Citrobacter* spp.	4	0.70
8	*Enterobacter aerogenes*	5	0.88
9	*Enterobacter cloacae*	5	0.88
10	*Serratia ficaria*	1	0.17
11	*Burkholderia cepacia*	5	0.88
12	*Providencia rettgeri*	1	0.17
13	*Proteus mirabilis*	1	0.17
14	*Raoultella ornithinolytica*	1	0.17
15	*Serratia rubidaea*	1	0.17
Total		567	100

[Table/Fig-2]: Distribution of Gram-negative organisms (n=567).

S. No.	Organism name	Number	Percentage (%)
1	*Staphylococcus aureus*	13	50
2	*Staphylococcus haemolyticus*	7	26.92
3	*Enterococcus faecium*	5	19.23
4	*Enterococcus faecalis*	1	3.85
Total		26	100

[Table/Fig-3]: Distribution of gram positive organisms (n=26).

Antibiotics	Klebsiella pneumoniae (N=171)	*Acinetobacter baumannii* (N=160)	*Pseudomonas aeruginosa* (N=110)	*E. coli* (N=86)	Other GNB (N=40)	Total
Gentamicin	67 (39.2%)	14 (8.75%)	83 (75.45%)	41 (47.67%)	14 (35%)	38.62%
Tigecycline	58 (34%)	122 (76.3%)	10 (9.09%)	86 (100%)	18 (45%)	51.85%
Amikacin	43 (25%)	4 (2.5%)	79 (71.81%)	54 (62.79%)	15 (37.5%)	34.39%
Imipenem	32 (18.71%)	7(4.4%)	78 (70.90%)	42 (48.83%)	9 (22.5%)	29.62%
Ertapenem	28 (16.4%)	3 (1.88%)	2 (1.81%)	34 (39.53%)	9 (22.5%)	13.4%
Piperacillin-tazobactam	27 (15.8%)	6 (3.75%)	61 (55.45%)	20 (23.25%)	7 (17.5%)	21.34%
Cotrimoxazole	25 (14.61%)	21 (13%)	6 (5.45%)	26 (30.23%)	15 (37.5%)	16.40%
Minocycline	22 (12.9%)	5 (3.12%)	2 (1.81%)	30 (34.88%)	6 (15%)	11.46%
Cefepime	18 (10.5%)	5 (3.12%)	76 (69.09%)	11 (12.79%)	11 (27.5%)	21.34%
Amoxicillin-clavulanate	14 (8.2%)	1 (0.6%)	3 (2.72%)	10 (66.62%)	1 (2.5%)	5.11%
Ceftriaxone	13 (7.6%)	-	1 (0.9%)	4 (6.65%)	7 (17.5%)	4.40%

Doxycycline	11 (6.43%)	2 (1.25%)	1 (0.9%)	3 (3.48%)	2 (5%)	3.35%
Cefuroxime	10 (5.85%)	1 (0.6%)	1 (0.9%)	4 (4.65%)	-	2.82%
Ciprofloxacin	5 (3%)	2 (1.25%)	64 (58.18%)	2 (2.32%)	2 (5%)	13.22%
Meropenem	4 (2.3%)	4 (2.5%)	72 (65.45%)	3 (3.48%)	5 (12.5%)	15.52%
Netilmycin	4 (2.3%)	17 (10.62%)	74 (67.27%)	3 (3.48%)	2 (5%)	17.63%
Ceftazidime	3 (1.76%)	4 (2.5%)	66 (60%)	2 (2.32%)	2 (5%)	13.58%
Piperacillin	2 (1.17%)	-	-	-	-	0.35%
Ticarcillin	1 (0.5%)	3 (1.88%)	14 (12.72%)	1 (1.16%)	1 (2.5%)	3.52%
Cefixime	1 (0.50%)	-	-	-	-	0.17%
Cefazoline	1 (0.50%)	-	-	-	-	0.17%
Aztreonam	1 (0.50%)	-	1 (0.9%)	-	-	0.35%
Ticarcillin-clavulanate	1 (.50%)	-	7 (6.36%)	-	-	1.41%

[Table/Fig-4]: Antimicrobial susceptibility for gram negative bacilli.

S. No.	Antibiotic	*Staphylococcus aureus* (N=13)	*Staphylococcs haemolyticus* (N=7)	Other GPC (N=6)	Total
1	Penicillin G	1 (7.69%)	-	1 (16.66%)	2 (7.7%)
2	Erythromycin	2 (15.38%)	-	-	2 (7.7%)
3	Linezolid	13 (100%)	7 (100%)	3 (50%)	23 (88.5%)
4	Levofloxacin	1 (7.69%)	-	-	1 (3.8%)
5	Gentamicin	7 (53.84%)	-	-	7 (26.9%)
6	Vancomycin	12 (92.30%)	5 (71.45%)	3 (50%)	20 (76.9%)
7	Tetracycline	8 (66.66%)	6 (85.71%)	1 (16.66%)	15 (57.7%)
8	Tigecycline	13 (100%)	6 (85.71%)	3 (50%)	22 (84.6%)
9	Co-trimoxazole	9 (69.23%)	3 (42.85%)	-	12 (46.2%)
10	Teicoplanin	12 (92.30%)	7 (100%)	3 (50%)	22 (84.6%)

[Table/Fig-5]: Antimicrobial susceptibility for gram positive cocci.

DISCUSSION

In this study, LRTI cases are more common in male (81.14%) as compared to female (18.86%) which were similar to other studies done by Panda S et al., and Akingbade OA et al., [16,17]. Maximum cases of LRTI in this study has been encountered in the age group of 61-70 years (n=137/615) and minimum cases were found in 91-100 years (n=2/615). The findings are supported by studies done by Ahmed SM et al., [18]. In this study, overall culture confirmed cases were found to be 45.08% (n=615) of which ET aspirates 65.04% (n=400) showed higher positivity rate than sputum 32.03% (n=197). Study done by Mishra S et al., also showed greater positivity in ET aspirates than sputum samples [19].

This study shows isolation of gram positive organisms 4.23% (n=26) and gram negative 92.19% (n=567). Similar observations have been shown in other studies as Saha A, in (Tripura) [20]. Here, the most common organisms isolated were *Klebsiella pneumoniae* (30.15%) followed by *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Escherichia coli*. These findings were similar to other studies done by Tripathi Purti C and Kiran D showing *Klebsiella pneumoniae* as the major isolate causing LRTI [21].

In this study, gram negative bacteria showed high sensitivity against tigecycline (50.85%) and gentamicin (38.62%) which finds similarity to other studies done by Verma S, who also reported that tigecycline was highly sensitive in gram negative isolates [22]. Among gram-positive isolates, most commonly isolated bacteria were *Staphylococcus aureus* (50%) followed by *Staphylococcus haemolyticus* (26.92), *Enterococcus faecium* (19.23), *Enterococcus faecalis* 3.85% (n=1). In gram positive bacteria linezolid (100%) and tigecycline (100%) showed highest sensitivity. Present study was similar to other studies; Singh S et al., who also reported that linezolid is the most sensitive drug found in gram positive isolates [23].

Gram positive bacteria in this study also showed sensitivity to Vancomycin (76.92%), Tetracycline (57.7%) similar to study done by Regha IR and Sulekha B, [24]. The antimicrobial susceptibility pattern suggests that aminoglycosides like gentamicin can be a good choice as similar to study done by Ahmed SM et al., [18].

The study revealed that the changing antibiotic susceptibility patterns of bacterial pathogens are of great concern which leads to the emergence of resistant strains. The injudicious use of antibiotics is also considered as a direct cause of antibiotic resistance worldwide [25].

Hence, studies targeting formulation of local antibiogram of lower respiratory tract pathogens should be carried out at every centre which may guide the treating physicians to start empirical therapy. Specific antibiotic utilisation strategies like antibiotic restriction, combination therapy may also help to decrease or prevent the emergence of resistance.

Limitation(s)

Atypical pathogens like *Mycoplasma pneumoniae*, *Chlamydia trachomatis* etc., and viruses have not been reported in this study. For the detection of these atypical pathogens, advanced techniques like molecular assays are required which were not done in this study.

CONCLUSION(S)

Present study revealed the changing antibiotic susceptibility patterns of bacterial pathogens. The antimicrobial therapy should be based on the intensive diagnostic work up along with patients' risk factors so that it provides the clinician appropriate information required for choosing right antibiotics. Frequent campaigns should be carried out to create awareness about judicious use of antibiotics to reduce the emergence of antimicrobial drug resistant organisms.

REFERENCES

[1] Karen C. Carroll laboratory diagnosis of lower respiratory tract infections: Controversy and conundrums. J Clin Microbiol. 2002;40(9):3115-20.
[2] Woodhead M, Blasi F, Ewig S, Huchon G, Leven M, Schaberg T, et al. Guidelines for the management of adult lower respiratory tract infections. Eur Respir J. 2005;26:1138-80.
[3] Anderson H, Esmail A, Hollowell J, Littlejohns P, Strachen D. Epidemeologically based needs assessment, Lower respiratory diseases, DHA Project Research programme.1993; pp. 6-12.

[4] Sharma BB, Singh V. Indian pneumonia guidelines. Lung India. 2012;29(4):307-08.

[5] Chang AB, Chang CC, Grady KO, Torzillo PJ. Lower respiratory tract infections. Pediatr Clin N Am. 2009;56(6):1303-21.

[6] Boloursaz MR, Lotfian F, Aghahosseini F, Cheraghvandi A, Khalilzadeh S, Farjah A, et al. Epidemiology of lower respiratory tract infections in children. J Compr Ped. 2013;4(2):93-98.

[7] Zafar A, Hussain Z, Lomama E, Sibiie S, Irfan S, Khan E. Antibiotic susceptibility of pathogens isolated from patients with community acquired respiratory tract infections in Pakistan- The active study. J Ayub Med Coll Abbottabad. 2008;20(1):07-09.

[8] Practical Approach to Lung Health-World Health Organization. https://apps.who.int rest bitstreams retrieve. Assessed on: 15 february 2008.

[9] Disease burden and mortality estimates-WHO.https://www.who.int global_[9] burden_disease estimates. Assessed on: 15 April 2018.

[10] Editorial: Antibiotics and respiratory illness. Br Med J. 1974;3(5922):1.

[11] Macfarlane J. Community-acquired pneumonia. Br J Dis Chest. 1987;81(2):116-27.

[12] Ozyilmaz E, Akan OA, Gulhan M, Ahmed K, Nagatake T. Major bacteria of community-acquired respiratory tract infections in Turkey. Jpn J Infect Dis. 2005;58(1):50-52.

[13] Campbell S, Forbes BA. The clinical microbiology laboratory in the diagnosis of lower respiratory tract infections. J Clin Microbiol. 2011;49(9 Suppl):S30-33.

[14] Reimer LG, Carroll KC. Role of the microbiology laboratory in the diagnosis of lower respiratory tract infections. Clin Infect Dis. 1998;26(3):742-48.

[15] CLSI. Performance Standards for Antimicrobial Susceptibility Testing 29th ed. CLSI Standard M100. Wayne, PA: Clinical Laboratory Standards Institute; 2019.

[16] Panda S, Prema Nandini B, Ramani TV. Lower respiratory tract infection-bacteriological profile and antibiogram pattern. Int J Current Res Rev. 2012;4(21):149-55.

[17] Akingbade OA, Ogiogwa JI, Okerentugba PO, Innocent-Adiele HC, Onoh CC, et al. Prevalence and antibiotic susceptibility pattern of bacterial agents involved in lower respiratory tract infections in Abeokuta, Ogun State, Nigeria. Report Opinion. 2012;4(5):25-30.

[18] Ahmed SM, Jakribettu RP, Meletath SK, Arya B, Vpa S. Lower Respiratory Tract Infections (LTRIs): An insight into the prevalence and the antibiogram of the gram negative, respiratory, bacterial agents. J Clin Diagn Res. 2013;7(2):253-56. Doi: 10.7860/JCDR/2013/5308.2740

[19] Mishra S, Kattel H, Acharya J, Shah N, Shah A, Sherchand J, et al. Recent trend of bacterial aetiology of lower respiratory tract infection in a tertiary care centre of Nepal. Int J Infect Microbiol. 2012;1(1):03-08.

[20] Saha A. Clinico-bacteriological profile of lower respiratory tract infections in patients attending tripura medical college and dr. bram teaching hospital, tripura. Indian J Applied Res. 2018;8(6):39-40.

[21] Tripathi Purti C, Kiran D. Lower respiratory tract infections: Current etiological trends and antibiogram. J Pharmaceutical and Biomed Sci. 2014;04(03):249-55.

[22] Verma S. High rates of antibiotic drug resistance among gram-negative bacilli in lower respiratory tract infections in north India. Int J Current Res Rev. 2016;8(14):09-13.

[23] Singh S, Sharma A, Nag VL. Bacterial pathogens from lower respiratory tract infections: A study from Western Rajasthan. J Family Med Prim Care. 2020;9:1407-12.

[24] Regha R, Sulekha B. Bacteriological profile and antibiotic susceptibility patterns of lower respiratory tract infections in a tertiary care hospital, Central Kerala. Int J Med Microbiol Trop Dis. 2018;4(4):186-90.

[25] Vijay S, Dalela G. Prevalence of LRTI in patients presenting with productive cough and their antibiotic resistance pattern. J Clin Diagn Res. 2016;10(1):DC09-12. Doi: 10.7860/JCDR/2016/17855.7082.

PARTICULARS OF CONTRIBUTORS:

1. Associate Professor, Department of Microbiology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India.
2. Postgraduate Student, Department of Microbiology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India.
3. Resident, Department of Microbiology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India.
4. Professor and Head, Department of Microbiology, Mahatma Gandhi Medical College and Hospital, Jaipur, Rajasthan, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Ashina Singla,
Associate Professor, Department of Microbiology, MGUMST, Jaipur, Rajasthan, India.
E-mail: aashina14@gmail.com

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