Original Article

Microbiology of Lower Respiratory Tract Infections in Benin City, Nigeria

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Abstract

Background: **Lower respiratory tract infections are among the most common infectious diseases of humans worldwide and continue to be a major cause of morbidity in Nigeria. This study focused on determining the microbial agents of lower respiratory tract infections, the effect of age and gender on its prevalence, and the susceptibility profile of bacterial isolates.**

Methods: **Sputum specimens were collected from 1539 patients with symptoms of lower respiratory tract infections. The sputum specimens were processed to recover microbial aetiologic agents and susceptibility profiles of bacterial isolates were determined using standard techniques.**

Results**: An overall prevalence of 18.91% of lower respiratory tract infections was observed in this study. There is no difference in the prevalence of lower respiratory tract infection between the genders (*P* = 0.649). The prevalence of lower respiratory tract infections increases significantly with age (*P* < 0.001), with patients 71 years and older having the highest prevalence. *Klebsiella pneumoniae* was the most predominant isolate causing lower respiratory tract infection while *Acinetobacter* species were the least predominant isolate. The fluoroquinolones, β-lactams, and gentamicin showed moderate to high activity.**

Conclusion**: Gender did not affect the prevalence, but age did. β-lactams, fluoroquinolones, and gentamicin were the most active antibacterial agents and, therefore, the drugs of choice in treating lower respiratory tract infections in our setting.**

Keywords: *aetiology, antibacterial agents, clinical microbiology, Nigeria, prevalence, respiratory tract infections*

Introduction

Lower respiratory tract infections (LRTIs) are among the most common infectious diseases affecting humans worldwide (1). They are important causes of morbidity and mortality for all age groups, and each year approximately 7 million people die as a direct consequence of acute and chronic respiratory infections (2). In Nigeria, LRTIs continue to be the major cause of morbidity (3). Age, gender, and season are factors that have been implicated to affect the prevalence of LRTIs (4).

The aetiologic agents of LRTIs vary from area to area (2,5), so the susceptibility profile will also differ between geographical locations. Knowing the local susceptibility profile is important, as antimicrobial therapies for LRTIs are frequently empirical and presumptive (2). Current knowledge of the organisms that cause LRTIs and their antibiotic susceptibility profiles are therefore necessary for the prescription of appropriate therapy. This study was conducted to determine the microbial agents of human respiratory tract infections, the effect of age and gender on the prevalence of LRTIs, and the susceptibility pattern of bacterial isolates.

Subjects and Methods

Study population

A retrospective laboratory record review was undertaken. This study recruited a total of 1539 patients with symptoms of LRTIs who visited the chest clinic of the University of Benin Teaching Hospital, Benin City, Nigeria, between 1 February 2007 and 30 July 2010; 841 patients were men and 698, women. The age range of the patients was between 2 and 98 years. Exclusion criteria included antibiotic usage within 1 week prior to clinic visit, positive for HIV, or sputum smear positive for acid-fast bacilli. Verbal

informed consent was obtained from each patient or their parents/guardians (for children) prior to specimen collection. The Ethical Committee of University of Benin Teaching Hospital approved this study.

Specimen collection and processing

Early morning sputum specimens, or for children, transtracheal aspirates, were collected from each patient into wide-mouthed sterile containers and transported to the laboratory. Films were made from the sputum specimens and stained by Gram's method. The presence of numerous pus cells confirms true sputum and only such specimens were cultured. Each sputum sample was inoculated on chocolate, blood, and MacConkey agar plates. The plates were incubated at 37 °C for 24–48 hours. Emergent colonies were identified using standard methods (6). Susceptibility tests were performed on significant bacterial isolates using the British Society for Antimicrobial Chemotherapy (BSAC) standardized disc susceptibility testing method (7).

Statistical analysis

The data obtained were analyzed with chi-square (χ^2) test using the INSTAT® statistical software (GraphPad Software Inc, San Diego, CA, USA).

Result

A total of 291 (18.91%) out of 1539 sputum samples yielded significant growth. There were no significant differences in the prevalence of LRTIs (P = 0.649) and mixed infections (P = 0.196) between men and women (Table 1). The prevalence of LRTIs increased significantly (P < 0.001) with age, with the age group of 71 years and older having the highest prevalence, 48.57% (Table 2). Generally, *Klebsiella pneumoniae* (30.16%) was the predominant isolate recovered, followed by *Haemophilus influenzae* (17.05%), *Staphylococcus aureus* (15.41%), and *Acinetobacter species* (0.66%). *K. pneumoniae* was also the predominant isolate in both genders. *S. aureus* was the second most predominant isolate in women, whereas

Table 1: Effect of gender on the prevalence of lower respiratory tract infections

Gender	No. tested	No. positive growth (%)	No. with mixed growth (%)
Male	841	163 (19.38)	5 (3.07)
Female	698	128 (18.34)	9 (7.03)
Total	**1539**	**291 (18.91)**	**14 (4.81)**

Gender versus positive growth: χ^2= 0.207, P= 0.649
Gender versus mixed growth: χ^2= 1.670, P= 0.196

Table 2: Effect of age on the prevalence of lower respiratory tract infections

Age (years)	Male		Female		Total	
	No. tested	No. positive growth (%)	No. tested	No. positive growth (%)	No. tested	No. positive growth (%)
1–10	38	5 (13.16)	34	9 (26.49)	72	14 (19.44)
11–20	77	3 (3.90)	38	6 (15.79)	115	9 (7.88)
21-30	233	43 (18.45)	220	26 (11.82)	453	69 (15.23)
31-40	265	58 (21.89)	206	35 (16.99)	471	93 (19.75)
41-50	88	27 (30.68)	82	14 (17.07)	170	41 (24.12)
51-60	81	17 (20.99)	71	16 (22.54)	152	33 (21.71)
61–70	41	4 (9.76)	30	11 (36.67)	71	15 (21.13)
≥ 71	18	6 (33.33)	17	11 (64.71)	35	17 (48.57)

Age versus positive growth: χ2= 37.484, P < 0.001

Table 3: Aetiologic agents in lower respiratory tract infections

Organisms	Males (%)		Females (%)		Total (%)	
Escherichia coli	6	(3.60)	7	(5.12)	13	(4.26)
Klebsiella pneumoniae	47	(27.98)	45	(32.85)	92	(30.16)
Citrobacter species	5	(2.98)	4	(2.92)	9	(2.95)
Enterobacter species	2	(1.19)	1	(0.73)	3	(0.98)
Proteus species	18	(10.71)	5	(3.65)	23	(7.54)
Providencia species	5	(2.98)	5	(3.65)	10	(3.29)
Acinetobacter species	1	(0.60)	1	(0.73)	2	(0.66)
Alcaligenes species	6	(3.60)	6	(4.38)	12	(3.93)
Pseudomonas aeruginosa	9	(5.36)	5	(3.65)	14	(4.59)
Haemophilus influenza	31	(18.45)	21	(15.33)	52	(17.05)
Staphylococcus aureus	24	(14.29)	23	(16.79)	47	(15.41)
Streptococcus pneumoniae	1	(0.60)	5	(3.65)	6	(1.97)
Candida albicans	13	(7.74)	9	(6.57)	22	(7.21)
Total	**168**	**(55.08)**	**137**	**(44.92)**	**305**	**(100)**

H. influenzae was the second most predominant isolate in men (Table 3). *K. pneumoniae* and *Candida albicans* were isolated from 5 patients, making them the highest combination of mixed infection, while the followings were isolated from 1 patient each: *Proteus* species and *K. pneumoniae, K. pneumoniae* and *Enterobacter* species, *K. pneumoniae* and *Providencia* species, *Escherichia coli* and *C. albicans*, *E. coli* and *Proteus* species, *Citrobacter* species and *Alcaligenes* species, *Citrobacter* species and *Proteus* species, *H. influenzae* and *C. albicans*, and *H. influenzae* and *S. aureus*.

The susceptibility profile of bacterial isolates is shown in Table 4. The fluoroquinolones (ofloxacin, ciprofloxacin), β-lactams (amoxicillin-clavulanate, cefuroxime, cetazidime, ceftriaxone), and gentamicin showed moderate to high activity. Sulfamethoxazole-trimetroprim, tetracycline, erythromycin, and cloxacillin showed no activity against any bacterial isolates.

Discussion

The aetiologic agents of LRTIs vary from area to area, and the bacterial aetiology as well as their susceptibility pattern will be useful in the management of this infection. This study focused on determining the prevalence of microbial aetiology of LRTIs and their susceptibility profile.

A total of 291 (18.91%) of the 1539 sputum specimens yielded clinically significant pathogens. This prevalence is lower than the figures in previous reports: 59.4% (2), 47.2% (3), and 27.0% (8). Among children with diarrhea, prevalence of the infection varied with geographical locations, regions within the same country, and even over time in the same location and population (9). Indeed, the Ozyilmaz et al.'s study (2) was conducted in Turkey, the Egbagbe and Mordi's study (3) was conducted in University of Benin Teaching Hospital, Benin City, Nigeria, while the Okesola and Ige's study (8) was conducted in Ibadan in Nigeria.

Previous reports had also indicated higher prevalence of LRTIs in women than in men (3,8). However, in this study the prevalence of LRTIs did not differ significantly between men and women. The prevalence of LRTIs was significantly higher in patients 71 years and older. People within this age group may have lower immunity due to age (10) or other ailments that may compromise the immune system, which may explain the high prevalence observed in this study.

K. pneumoniae was the most predominant isolate recovered from patients with LRTIs. This is in agreement with previous studies (3,8); however, another study (2) reported *H. influenzae* as the most prevalent. *Acinetobacter* species have been associated with hospital-acquired pneumonia (1), but as our subjects were outpatients, the *Acinetobacter* species recovered

Table 4: Susceptibility profiles of bacterial agents of lower respiratory tract infections

Organisms	Antibacterial agents (µg/disc)											
	OFX (5)	CIP (5)	CN (10)	AUG (30)	SXT (25)	OB (5)	TE (10)	CXM (30)	C (10)	E (5)	CRO (30)	CAZ (30)
Escherichia coli (*n* = 13)	13 (100.0)	13 (100.0)	13 (100.0)	13 (100.0)	0 (0.0)	ND	0 (0.0)	11 (84.6)	0 (0.0)	ND	12 (92.3)	11 (84.6)
Klebsiella pneumonia (*n* = 92)	88 (95.6)	86 (93.5)	79 (85.9)	86 (95.6)	0 (0.0)	ND	0 (0.0)	86 (93.5)	0 (0.0)	ND	84 (91.3)	81 (88.0)
Citrobacter species (*n* = 9)	9 (100.0)	9 (100.0)	6 (66.7)	0 (0.0)	0 (0.0)	ND	0 (0.0)	9 (100.0)	0 (0.0)	ND	7 (77.8)	5 (55.6)
Enterobacter species (*n* = 3)	3 (100.0)	3 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	ND	0 (0.0)	3 (100.0)	0 (0.0)	ND	3 (100.0)	3 (100.0)
Proteus species (*n* = 23)	23 (100.0)	19 (82.6)	17 (73.9)	19 (82.6)	0 (0.0)	ND	0 (0.0)	19 (82.6)	0 (0.0)	ND	10 (43.5)	10 (43.5)
Providencia species (*n* = 10)	10 (100.0)	8 (80.0)	6 (60.0)	10 (100.0)	0 (0.0)	ND	0 (0.0)	8 (80.0)	3 (30.0)	ND	6 (60.0)	6 (60.0)
Acinetobacter species (*n* = 2)	2 (100.0)	2 (100.0)	1 (50.0)	10 (100.0)	0 (0.0)	ND	0 (0.0)	1 (50.0)	0 (0.0)	ND	1 (50.0)	0 (0.0)
Alcaligenes species (*n* = 12)	10 (83.3)	8 (66.7)	7 (58.3)	10 (83.3)	0 (0.0)	ND	0 (0.0)	8 (66.7)	0 (0.0)	ND	8 (66.7)	7 (58.3)
Pseudomonas aeruginosa (*n* = 14)	14 (100.0)	2 (85.7)	10 (71.4)	6 (42.9)	0 (0.0)	ND	0 (0.0)	0 (0.0)	0 (0.0)	ND	9 (64.3)	6 (42z.9)
Haemophilus influenzae (*n* = 52)	52 (100.0)	50 (96.2)	50 (96.2)	47 (90.3)	0 (0.0)	ND	0 (0.0)	45 (86.5)	0 (0.0)	ND	48 (92.3)	47 (90.4)
Staphylococcus aureus (*n* = 47)	47 (100.0)	43 (91.45)	39 (83.0)	41 (67.2)	0 (0.0)	0 (0.0)	0 (0.0)	44 (93.6)	0 (0.0)	0 (0.0)	43 (91.5)	40 (85.1)
Streptococcus pneumoniae (*n* = 6)	6 (100.0)	6 (100.0)	0 (0.0)	6 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	5 (83.3)	0 (0.0)	0 (0.0)	5 (83.3)	5 (83.3)

Data are expressed in number of susceptible isolates (percentage susceptibility).
Abbreviations: OFX = ofloxacin, CIP = ciprofloxacin, CN = gentamicin, AUG = amoxycillin/clavulanate, SXT = cotrimoxazole, OB = cloxacillin, TE = tetracycline, CXM = cefuroxime, ND = not done, C = chloramphenicol, E = erythromycin, CRO = ceftriaxone, CAZ = ceftazidime.

in this study may be associated with community-acquired LRTIs. Further investigation is required to verify this result, as many patients come to our centre after visiting either public hospitals or primary and secondary care hospitals. Other microbial agents recovered in this study have been reported to be associated with LRTIs (1–3,8).

The susceptibility pattern of the bacterial isolates revealed that β-lactams, gentamicin, and flouroquinolones were very active against the bacterial isolates. This is surprising as sales of antibiotics without prescriptions are rife in Nigeria (11,12). However, sulfamethoxazole-trimetroprim, tetracycline, cloxacillin, and

erythromycin were not active against any bacterial isolate, while only 30% of *Providencia* species were susceptible to chloramphenicol. This may indicate resistance has evolved due to long-term use of these quite affordable antibacterial agents in the community. The fluoroquinolones are contraindicated in children and pregnant women, while ceftriaxone, ceftazidime, and cefuroxine are very expensive. Gentamicin has toxic side effect in patients with renal impairment, so amoxicillin/clavulanate appears to be the drug of choice, depending on the bacterial isolates.

Conclusion

An overall prevalence of 18.91% of LRTIs was observed in this study. Gender did not affect the prevalence of LRTIs. Patients of 71 years and older have a significantly higher prevalence of LRTI compared with other age groups. *K. pneumoniae* is the most predominant bacteria isolates. β-lactams, fluoroquinolones, and gentamicin were the most active antibacterial agents. This study highlights the aetiology of LRTIs and the bacteria susceptibility profiles may be helpful for empiric therapy.

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