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*Full Length Research Paper*

# Antimicrobial susceptibility of some respiratory tract pathogens to commonly used antibiotics at the Specialist Hospital, Yola, Adamawa State, Nigeria

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**The study was aimed at determining the prevalence and antibacterial susceptibility of bacterial strains isolated from the respiratory tract of patients attending the major hospital in Yola, Nigeria. The study was carried out between January, 2008 - June, 2009. Sputum, throat and mouth specimens were collected and cultured on the appropriate bacteriological media. Bacterial isolates were identified by standard biochemical tests. Antimicrobial susceptibility testing was performed according to Clinical and Laboratory Standard Institute (CLSI) guidelines. Of the samples analyzed, some 232 species of various bacteria were isolated, giving a prevalence rate of 92.8%. This consisted of 49.1% from male patients and 50.9% from females. The bacteria isolated from the samples included *Streptococcus pyogens* (22.4%), *Streptococcus pneumoniae* (21.6 %), *Staphylococcus aureus* (19.0%), *Klebsiella pneumoniae* (11.2%), and *Haemophilus influenza* (10.3%), *Proteus mirabilis* (8.6%) and *Pseudomonas aeruginosa* (6.9%) in order of ranking. All the isolates were susceptible to ciprofloxacin, ofloxacin and ceftriazone, moderately susceptible to chloramphenicol, erythromycin, colistin, nitrofurantoin and nalidixic acid and resistant to gentamycin, ampicillin, tetracycline, co-trimoxazole, streptomycin and penicillin. *S. aureus* was the most susceptible amongst the isolates. Penicillin had the highest resistance to all the isolates. Most of the isolates were displayed by multi-drug resistance with *P. aeruginosa and H. influenzae* showing the highest number of multi-drug resistance to most of the antibiotics except the fluoroquinolones. Although, multi-drug resistant strains of organisms were identified, ciprofloxacin, ofloxacin and ceftriazone are recommended as antibiotics of choice against the pathogens. These findings have clinical and epidemiological significance.**

**Key words:** Prevalence, susceptibility, antibiotic resistance, multi-drug resistance, fluoroquinolones, Yola.

## INTRODUCTION

The upper respiratory tract comprises of sinuses, nasal passages, pharynx and larynx, which serve as gateways to the trachea, bronchi and pulmonary alveolar spaces. Respiratory tract infections (RTIs) are amongst the most wide spread and serious infections that compel an individual to seek medical attention and prescription of antibiotics (Zafar et al., 2008). It represents one of the most common bacterial diseases encountered in medical practice today, affecting people of all ages, from the neonate to the geriatric age group (Kunin, 1994; Raju and Tiwari, 2004). This infection is the leading cause of morbidity and mortality in critically ill patients in developing countries (Jafari et al., 2009). The respiratory tract is a frequent site of infection because it comes in direct contact with the physical environment and is exposed to airborne microorganisms, including viruses,

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**Abbreviations: RTIs,** Respiratory tract infections; **CLSI,** clinical and laboratory standard institute; **URLs,** upper respiratory tract infections.

bacteria, fungi and parasites. Upper respiratory tract infections (URLs) involve direct invasion of the mucosa lining the upper airway (Imani et al., 2005).

It is a global problem accounting for over 50 million deaths of each year and occurs in both community and health care settings (Zafar et al., 2008). It accounts for reasonably high health care expenditure of more than 3.5 billion dollars per year in the United States alone. RTIs, such as sore throat, tuberculosis, whooping cough (pertusis), pneumonia, pharyngistis, bronchitis, emphysema, ear-ache, laryngitis, common cold, otitis media, mastoiditis amongst others are the most frequently-occurred infections of all human diseases and have been frequently documented (Ndip et al., 2008). Respiratory tract infections are usually contracted through air and by direct contact. This could be by inhalation of small infectious nucleii containing the pathogenic organisms, sharing cups and other eating materials with infected persons; it can also be transmitted directly by kissing, direct inhalation of the pathogens released by infected persons during sneezing, coughing or talking (Jafari et al., 2009).

Respiratory diseases have a significant economic impact on the sick individuals in terms of lost of productivity and also on physicians who most of the time has to give antibiotics even if the causative agents are not bacteria. In developing countries, infants and children under 4 years of age are at greater risk of developing lower RTIs, whereas, in developed countries, the severity and rate of mortality are greater in the elderly ones (Jafari et al., 2008).

The acquisition of antibiotic-resistant pathogens as commensals is the first step in the pathogenesis of resistant bacteria (Gazi et al., 2004). Colonization and infection with antibiotic resistant bacteria will make the therapeutic options for infection treatment extremely difficult, and virtually impossible in some cases. Pathogenesis of RTI involves complex interactions between an organism, the environment and the potential host (Grenet et al. (2004). Management of RTIs is based on information about the host, the organism, and the antimicrobial agent (Oh, 1995). There is a widespread agreement that viruses are the principal initiators of RTIs (Gazi et al., 2004).

Although, fungi and viruses are occasional etiological agents, RTIs are predominantly caused by facultative anaerobes. Most of the surfaces of the upper respiratory tract including nasal and oral passages, nasopharynx, oropharynx and trachea are colonized by normal flora, and these compete with pathogenic organisms for potential attachment sites, in addition of producing some antimicrobial substances to prevent infections. Temporary colonization of the eye, nose or pharynx by potential pathogens is very common and provides an important reservoir of infection. The most common bacteria implicated as causative agents of RTIs was included but not limited to *Pseudomonas* spp., *Streptococcus* spp., *Proteus* spp., *Klebsiella* spp., *Staphylococcus* spp., *Enterobacter* spp., *Acinetobacter* spp., and *Haemophilus influenza* (Gazi et al., 2004). Beta-lactam-resistant strains of the common pathogens are being isolated with increasing frequency in many countries, as well as macrolide- and fluoroquinolone-resistant strains. The range of species isolated has increased over the years, possibly as a result of changing medical interventions. RTIs are usually treated with antibiotics, and in most cases, there is need to start treatment before the final laboratory results are available. But of recent, emperic treatment has been complicated by the emergence of antimicrobial resistance among the principal pathogens and a definitive bacteriological diagnosis and susceptibility testing would, therefore, be required for effective management (Aydemir et al., 2006, Sahm et al., 2008). In the last three decades, there has been a lot of reports in the scientific literature on the inappropriate use of antimicrobial agents and the spread of bacterial resistance among microorganisms causing respiratory tract infections (Tenover and McGowan, 1996; Hryniewicz et al., 2001; Kurutepe et al., 2005). Nevertheless, the choice for antimicrobial therapy is usually straight forward when the etiologic agents and their susceptibility patterns are known (Zafar et al., 2008).

In Nigeria, just as in the other parts of the developing world, most RTIs are treated empirically, possibly because of higher cost of laboratory services where available. The emergence of antibiotic resistance in the management of RTIs is a serious public health issue, particularly in the developing world apart from high level of poverty, ignorance and poor hygienic practices; there is also high prevalence of fake and spurious drugs of questionable quality in circulation.

Antibiotic resistance often leads to therapeutic failures of empirical therapy, which is why knowledge of etiological gents of RTIs and their sensitivities to available drugs is of immense value to the selection and use of antimicrobial agents and to the development of appropriate prescribing policies (El-Astal, 2004). This study was conducted to determine the etiological agents of RTIs in the tertiary health care facility, the Specialist hospital, Yola, Nigeria and their antimicrobial susceptibility pattern to some commonly prescribed antibiotics at the hospital. It is hoped that the results will provide useful information which would be used in the formulation of policies for the rational and effective use of the antimicrobial agents in view of their reported effectiveness against a wide range of pathogens and propensity of bacteria to develop resistance to the drugs.

## MATERIALS AND METHODS

### Study population

The study population, were patients who attended the Specialist Hospital, Yola, Nigeria, either as inpatient or out patient with

symptoms suggestive of RTIs. All patients had clinical evidence of respiratory tract infections, as determined by the treating doctors. Only a single positive culture per patient was included in the analysis. These patients did not include those who were on antibiotics in a week before the samples were collected.

### Specimen collection

The sputum specimens were collected aseptically from 250 (125 males and 125 females) patients. All patients were instructed on how to collect the sputum samples aseptically and taken to the laboratory immediately for analysis. The sputum samples were collected into well-labeled sterile, wide mouthed glass bottles with screw cap tops as described by Kolawale et al. (2009). Using a sterile cotton wool swab moistened in peptone water, the inner surface of the infected nose, ear or eye was swabbed gently and then the swabs were transported to the laboratory in containers of Amies medium (Oxoid). On the labels were the name, age, sex, and time of collection. The study was carried out between January, 2008 - June, 2009. For collection of throat and mouth specimens, the handle of a spoon was used to depress the tongue to examine the mouth for the presence of inflamed membrane, exudates or pus. The mucous membrane of the mouth was rubbed with a sterile cotton wool swab taking enough care not to contaminate with saliva. Each of the swab samples was transported to laboratory in container of Amies medium (Oxoid TS003A)

### Bacteriology

In the hospital laboratory, each well mixed sample (5 µl) was inoculated on McConkey agar (Oxoid), Chocolate agar, and Blood agar (Oxoid). The inoculum on the plate was streaked out for discrete colonies with a sterile wire loop following standard procedures (Cheesborough, 2006; Inabo and Obanibi, 2006). The culture plates were incubated at 35 - 37°C for 24 h and observed for growth through formation of colonies. All the bacteria were isolated and identified using morphological, microscopy and biochemical tests following standard procedures described by Cowan and Steel (1974) and Cheesborough (2006).

### Standardization of microorganisms

Culture was standardized according to the methods described by Baker and Thornsberg (1983) and the Clinical and Laboratory Standard Institute (2006). Briefly, 0.2 ml of an 18 h culture of each organism was suspended into sterile universal bottles containing 5 ml nutrient broth and incubated for 5 h at 37°C. Normal saline was gradually added so as to compare its turbidity to McFarland Standard of 0.5 which corresponded to approximately 1.0 x $10^8$ cfu/ml. All the media used were supplied by Oxoid Ltd unless otherwise specified.

### Antibiotic susceptibility testing

The antibacterial susceptibility testing of the isolates was done using the Kirby-Bauer disk diffusion method (Bauer et al., 1966) following the definition of the Clinical and Laboratory Standards Institute (2006) using antibiotics containing discs (Boitech Laboratories Ltd). Briefly, 1 ml of an 18 h culture of each bacterium previously adjusted to turbidity Standard of 0.5 on McFarland Scale was seeded on sterile petri plates and then 20 ml of Mueller- Hinton agar (Difco Laboratories GmbH, Augsburg, Germany) were prepared and poured into the plates. The agar medium was allowed to solidify at room temperature on a flat bench. Then, some antibiotic discs were gently and firmly placed on the agar plates, which were then left at room temperature for 1 h to allow diffusion of the antibiotics into the agar medium. The plate were then incubated at 35 - 37°C for 24 h .The commercial antibiotics discs and the concentrations used were ampicillin (25 µg),ciprofloxacin (5 µg), ofloxacin (5 µg), co-trimoxazole (25 µg), streptomycin (25 µg), chloramphenicol (30 µg), erythromycin (25 µg), gentamycin (10 µg), penicillin (10 µg), nalidixic acid (30 µg), tetracycline (25 µg), ceftriaxone (10 µg), nitrofurantoin (200 µg), colistin (25 µg). Zones of growth inhibition were then measured to the nearest millimeter and recorded. The mean of triplicate results was taken as the zone diameter. Isolates were classified as either resistant or intermediate sensitive or sensitive based on the standard intermediate chart updated according to the standard of the Clinical and Laboratory Standard Institute (2006). Resistant and intermediately resistant isolates were grouped together for analysis in this study (Onanuga et al., 2005). An isolate was considered multi-drug resistant if it was resistant to at least three of the antibiotics tested (Santo et al., 2007). Interpretation of results was done using zone sizes. Those isolates that displayed diameter of zones of inhibition in antimicrobial susceptibility test less than or equal to six mm were considered resist ants, while those isolates with diameter of zones of inhibition more than or equal to 7 mm were considered susceptible (Gupta et al., 2004; Pfaller et al., 2001). Some laboratory strains of known sensitivity of *Staphylococcus aureus, Enterococcus faecalis, Escherichia coli* and *Pseudomonas aeruginosa* were used as quality control strains for the antimicrobial discs.

### Statistical analysis

All data were analyzed with SPSS for Windows, version 16.0 (SPSS Inc. Chicago III, USA). The trend $x^2$ test for statistical comparisons between the groups and a $p \leq 0.05$ was considered as statistically significant.

## RESULTS

A total of 500 patients were screened for having RTIs, out of which, a total number of 250 were included in the study. Of the samples analyzed, some 232 species of various bacteria were isolated, giving a prevalence rate of 92.8%. This consisted of 49.1% from male patients and 50.9% from females as detailed in Table 1. The bacteria isolated from the samples included *Streptococcus pyogens* (19.0%), *Streptococcus pneumoniae* (21.6%), *S. aureus* (19.0%), *Klebsiella pneumoniae* (11.2%),and H. influenza(10.3%), *Proteus mirabilis* (8.6%) and *P. aeruginosa* (6.9%) in order of ranking. There was no significant relationship between the occurrence of the isolates and gender at $p \leq 0.05$.

The susceptibility of the clinical isolates to routinely prescribed antibiotics in the hospital is depicted in Table 2. *S. pyogens was* the most prevalent bacteria with a susceptibility of 9.8% (nalidixic acid), 8.5% (nirofurantoin), 3.6% (colistin), 7.5% (chloramphenicol), 9.2% (erythromycin), 5.6% (gentamycin), 10.1% (ciprofloxacin), and 9.8% (ofloxacin), 7.2% (cotrimoxazole), 6.5% (streptomycin), 7.2% (ceftriaxone), 5.6% (penicillin), 5.2% (ampicillin) and 4.2% (tetracycline). The susceptibility profile of *P. aeruginosa* was 9.3% (nalidixic acid), 5.6%

**Table 1.** Prevalence of the isolates according to gender.

| Bacteria | Proportion | | Total number isolated |
|---|---|---|---|
| | Male | Female | |
| *S. aureus* | 20(17.5) | 24(20.3) | 44(19.0) |
| *S. pneumoniae* | 22(19.3) | 28(23.7) | 50(21.6) |
| *K. pneumoniae* | 15(13.2) | 11(9.3) | 26(11.2) |
| *P. mirabilis* | 8(7.1) | 12(10.2) | 20(8.6) |
| *S. pyogens* | 27(23.7) | 25(21.2) | 52(22.4) |
| *S. aeruginosa* | 9(7.9) | 7(5.9) | 16(6.9) |
| *H. influenza* | 13(11.4) | 11(9.3) | 24(10.3) |
| Total | 114 | 118 | 232 |

$X^2$ = 2.912; df = 6 and tabulated value = 12.592. Figures in brackets are percentages.

(nitrofurantoin), 11.1% (colistin), 5.6% (chloramphenicol), 7.4% (erythromycin), 3.7% (gentamycin), 14.8% (ciprofloxacin), 16.7% (ofloxacin), 5.6% (cotrimoxazole), 3.7% (streptomycin), 9.3% (ceftriaxone), 3.7% (penicillin), 1.9% (ampicillin) and 1.9% (tetracycline). *S. pneumoniae* had a susceptibility profile of 7.7% (nalidixic acid), 7.7% (nirofurantoin), 7.1% (colistin), 4.2% (chloramphenicol), 10.1% (erythromycin), 7.6% (gentamycin), 7.4% (cotrimoxazole), 4.8% (streptomycin), 9.5% (ciproxacin), 11.4% (ofloxacin), 7.4% (penicillin), 4.8% (ampicillin) and 3.7% (tetracycline). The susceptibility profile displayed by the other organisms followed similar patterns.

The proportions of the isolates showing multi-drug-resistance are given in Table 3. None of the isolates was sensitive to all the antibiotics tested. Some 40.9% of *S. aureus* isolates were sensitive to 1 - 3 different antibiotics, 59.1% were susceptible to more than 3 different antibiotics. A similar trend was observed for *K. pneumoniae, P. mirabilis,* and *S. pneumoniae, P. aeruginosa, S. pyogens* and *H. influenza.*

## DISCUSSION

A total of 500 patients were screened for having RTIs, out of which a total number of 250 were included in the study. Of the samples analyzed, some 232 species of various bacteria were isolated, giving a prevalence rate of 92.8%. This consisted of 49.1% from male patients and 50.9% from females as detailed in Table 1. Samples obtained from female subjects yielded more bacteria than those obtained from males, but the difference was not statistically significant ($p \leq 0.05$). The bacteria isolated from the samples included *K. pneumoniae* (11.2%), *P. mirabilis* (8.6 %), *S. pneumoniae* (21.6%), *S. aureus* (19.0%), *P. aeruginosa* (6.9%), *S. pyogens* (22.4%) and *H. influenza* (10.3%). These isolates clearly represented clinically significant pathogens, and are similar to the results obtained in other Nigerian cities of Ibadan and Lagos (Okeola and Oni, 2009; Nwanze et al., 2007) and also falls within the range of frequencies reported in other countries such as Cameroon (Ndip et al., 2008), South Africa (Liebowitz et al., 2003), Nepal (Gauchan et al., 2008), India (Kumari et al., 2007), China (Wang et al., 2001), Japan (Watanabe et al., 1995), Israel (Turner and Dagan, 2001), Egypt (ElKholy et al., 2003), Iran (Jafari et al., 2009) and Turkey (Aydemir et al.,2006).

Respiratory tract infections are frequently diagnosed and treated on clinical and radiological findings only (Aydemir et al., 2006). But however, in recent years, the increase in the rates of antibiotic resistance amongst the major pathogens has compromised the selection of empirical treatment for some respiratory tract pathogens with traditional agents and a definitive bacteriological diagnosis and susceptibility testing would, therefore, be required for effective management of RTI (Jafari et al., 2009). The increasing frequency of antibiotic resistance has been reported first at sites where penetration of the antimicrobial agent is restricted and the level of therapeutic concentrations is consequently more difficult to be achieved (Jafari et al., 2009).

Bacterial pathogens causing RTIs have a number of virulence mechanisms including the production of β-lactamases and exchange of resistance markers like plasmids and transposons (Aydemir et al., 2006; Jafari et al., 2009). Recognition of these resistance mechanisms allows them to be targeted, such as with β-lactamase inhibitors. The widespread and inappropriate use of antibiotics is recognized as a significant contributing factor to the spread of bacterial resistance to antimicrobial agents (Mincey and Parkulo, 2001). Bacterial resistance to commonly used antimicrobial agents in Nigeria was reported as far back as the 1970s and tetracycline, cotrimoxazole, chloramphenicol, streptomycin, and erythromycin were implicated in self-medication (Alausa and Montefiore, 1978; Montefiore et al., 1989; Abioye, 2002).

It has been suggested that the high prevalence of resistance to a particular antibiotic does not always reflect antibiotic consumption as previously suggested by Gaynes and Monnet (1997) in the United States and by Whitte et al. (2000) in German hospitals. Several researchers have argued that the prevalence of resistance to a particular antibiotic does not always reflect the antibiotic consumption in a given locality (Ako-Nai et al., 2005; Brown et al., 2005). In addition to the antibiotic stress, horizontal *gene* transfer is also considered as a factor in the occurrence of antibiotic resistance in clinical isolates (Brown et al., 2005).

All the isolates displayed variable sensitivity to the antibiotics tested as detailed as shown in Table 2. *S. pyogens* showed a susceptibility pattern of susceptibility of 9.8% (nalidixic acid), 8.5% (nirofurantoin), 3.6% (colistin), 7.5% (chloramphenicol), 9.2% (erythromycin), 5.6% (gentamycin), 10.1% (ciprofloxacin), 9.8% (ofloxacin), 7.2% (cotrimoxazole), 6.5% (streptomycin), 7.2% (ceftriaxone), 5.6% (penicillin), 5.2% (ampicillin) and 4.2% (tetracycline) and these fall within the range

**Table 2.** Susceptibility of the isolates to commonly used antibiotics.

| Bacteria | Total | Susceptibility to antibiotic | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Gen | Tet | Amp | Pen | Cot | Cip | Ofl | Col | Cef | Nit | Nal | Chl | Str | Ery |
| *S. aureus* | 357 | 26 | 18 | 25 | 28 | 27 | 38 | 40 | 24 | 21 | 10 | 16 | 25 | 30 | 29 |
| | | (7.3) | (5.0) | (7.0) | (7.8) | (7.6) | (10.6) | (11.2) | (6.7) | (5.9) | (3.6) | (4.5) | 7.0) | (8.4) | (8.1) |
| *S. pneumoniae* | 378 | 20 | 14 | 18 | 28 | 28 | 36 | 40 | 27 | 33 | 29 | 29 | 16 | 18 | 42 |
| | | (7.6) | (3.7) | (4.8) | (7.4) | (7.4) | (10.6) | (10.6) | (7.1) | (8.7) | (7.7) | (7.7) | (4.2) | (4.8) | (10.1) |
| *K. pneumoniae* | 202 | 16 | 7 | 6 | 18 | 8 | 22 | 23 | 17 | 14 | 18 | 8 | 6 | 14 | 19 |
| | | (7.9) | (3.5) | (3.0) | (8.9) | (4.0) | (10.9) | (11.4) | (8.4) | (6.9) | (8.9) | (4.0) | (3.0) | (6.9) | (9.4) |
| *P. mirabilis* | 149 | 16 | 4 | 8 | 4 | 12 | 16 | 14 | 11 | 16 | 11 | 10 | 8 | 6 | 13 |
| | | (10.7) | (2.7) | (5.4) | (2.7) | 8.1) | (10.7) | (9.4) | (7.4) | (10.7) | (7.4) | (6.7) | (5.4) | (4.0) | (8.7) |
| *S. pyogens* | 306 | 17 | 13 | 16 | 17 | 22 | 31 | 30 | 11 | 22 | 26 | 30 | 23 | 20 | 28 |
| | | (5.6) | (4.2) | (5.2) | (5.6) | (7.2) | (10.1) | (9.8) | (3.6) | (7.2) | (8.5) | (9.8) | (7.5) | (6.5) | (9.2) |
| *P. aeruginosa* | 54 | 2 | 1 | 1 | 2 | 3 | 8 | 9 | 6 | 5 | 3 | 5 | 3 | 2 | 4 |
| | | (3.7) | (1.9) | (1.9) | (3.7) | (5.6) | (14.8) | (16.7) | (11.1) | (9.3) | (5.6) | (9.3) | (5.6) | (3.7) | (7.4) |
| *H. influenzae* | 110 | 4 | 3 | 2 | 2 | 4 | 12 | 17 | 5 | 8 | 1 | 14 | 11 | 12 | 15 |
| | | 3.6) | (2.7) | (1.8) | (1.8) | (3.6) | (10.9) | (15.5) | (4.6) | (7.3) | (0.9) | (12.7) | (10.0) | (10.9) | (13.6) |
| Total | 1556 | 101 | 60 | 76 | 99 | 104 | 163 | 173 | 101 | 119 | 98 | 110 | 100 | 102 | 150 |

$X^2$ = 110.684; df = 78 and tabulated value = 2.389. Figures in brackets are percentages Gen = Gentamycin, Str = Streptomycin, Col = Colistin, Amp = Ampicilin, Nal = Nalidixic acid, Nit = Nitrofroitoin, Cip. = Ciprofloxacin, Ofl. = Ofloxacin, Tet = Tetracycline, Cef. = Ceftriaxone, Cot = Cotrimoxazole, Pen = Penicillin, Chl = Chloramphenicaol, Ery = Erythromycin.

obtained from other studies (Okesola and Ige, 2008) in Nigeria and in many other countries (Aydemir et al., 2006; Jafari et al., 2009). In the present study, *S. aureus* had similar susceptibility profile to that of *S. pyogens* and *Staphylococcus epidermidis.* Similar susceptibility profiles were presented among *S. epidermidis* in some hospitals in Turkey to be less susceptible to penicillin, ampicillin and tetracycline (Ang et al., 1985) and also in Cameroon (Ndip et al., 2008).

Our results showed the resistance rates of *S. pneumoniae* to ofloxacin (10.6%), ciprofloxacin (9.5%), ceftriaxone (8.7%) and erythromycin (7.7%), gentamicin (7.6%), ampicillin (4.8%), cotrimoxazole (7.4%), chloramphenicol (4.2%) and streptomycin (4.8%). The sensitivity of *K. pneumoniae* isolates followed similar pattern to that of *S. pneumoniae* and the results compared very well with the reports obtained from Japan (Watanabe et al., 1995), the United States (Doern et al., 1986; Jorgensen et al. (1990); Sahm et al., 2008), Turkey (Gonlugur et al., 2004; Aydemir et al. (2006); Pakistan (Jafari et al., 2009).

Only half of *P. aeruginosa* isolates were susceptible to ciprofloxacin and ofloxacin, while more than half were moderately susceptible to colistin, ceftriaxone, nalidixic acid and erythromycin. Majority of the isolates were either marginally or not susceptible to gentamicin, ampicillin, tetracycline, penicillin, co-trimoxazole, nitrofurantoin, chloramphenicol and streptomycin. The lower susceptibility rates compared very well to that of other studies conducted in other countries (Mazzulli et al., 2001l Gonlugur et al., 2003; Aydemir et al. (2006); Jafari et al. (2009). The isolation of *P. aeruginosa* strains that were highly susceptible to regularly used antibiotics have also been reported in a number of countries, which is contrary to the data obtained in the present study colistin (7.1%), nitrofurantoin (7.7%), nalidixic aid(10.1%), tetracycline (3.7%), penicillin (7.4%), Ferede et al., 2001) in Ethiopia reported the isolation of *P. aeruginosa* that was 84% sensitive to augmentin and 88% to gentamycin, but resistant to other drugs including co-trimoxazole, while Onyemelukwe et al. (2003) isolated *P. aeruginosa* that was 98.9% sensitive Similarly, Chah et al. (2003) also isolated some

**Table 3.** Proportion of the isolates susceptible to a number of antibiotics.

| Bacteria | Susceptibility to a number of antibiotic | | | |
|---|---|---|---|---|
| | N | All | ≤3 | ≥4 |
| *S. aureus* | 44 | 0(0.0) | 18(40.9) | 26(59.1) |
| *S. pneumoniae* | 50 | 0(0.0) | 19(38.0) | 31(62.0) |
| *K. pneumoniae* | 26 | 0(0.0) | 10(10.9) | 16(61.5) |
| *P. mirabilis* | 20 | 0(0.0) | 9(45.0) | 11(55.0) |
| *St. pyogens* | 52 | 0(0.0) | 23(44.2) | 29(55.8) |
| *P. aeruginosa* | 16 | 0(0.0) | 7(43.6) | 9(56.3) |
| *H. influenza* | 24 | 0(0.0) | (11(45.8) | 13(54.2) |
| Total | 232 | 0 | 97 | 135 |

$X^2$ = 0.924; df = 12 and tabulated value = 21.026. Figures in brackets are percentages.

*P. aeruginosa* resistance to cephalexin (80.0%), co-trimoxazole (80.0%), ampicillin (73%) and gentamycin (70.0%).

The high rate of resistance to ampicillin, tetracycline, gentamicin, streptomycin and co-trimoxazole observed in the present study may reflect the fact that these are the most commonly prescribed antibiotics in the hospital and also the most easily available community without prescription. Mazzulli et al. (2001) explained the higher resistance rates in tertiary hospitals especially where both inpatients and outpatients are used to collect data to be due to those patients having more complicated RTIs and thus exposed to more resistant flora, or may have failed previous therapy, all of which may account for the increased resistance observed. *P. aeruginosa* is important because of its prominence in multi-drug resistant nosocomial infections that are difficult to treat or control its propensity for incorporation of mobile elements and its ability to transfer resistance phenotypes to other pathogens in humans (La Plante et al., 2006; Shannon and French, 2004)

The antibacterial susceptibility of *P. mirabilis* data obtained in this study was also consistent with those obtained in similar studies (Moderres et al., 1997; Shrestha et al., 2005; Rai et al., 2006). More than 50% of the *H. influenza* isolates were only moderately susceptible to colistin, ofloxacin, nitrofurantoin and chloramphenicol, while more than 80% of the *H. influenza* isolates were not susceptible to gentamicin, ampicillin, tetracy-cline, penicillin, and co-trimoxazole. These results compared very well with the studies conducted in other countries (Jorgensen et al., 1990; Shannon and French, 2004; Aydemir et al., 2006; Imani et al., 2007; Jafari et al., 2009). Differences in the prevalence of antimicrobial susceptibility may be due to several factors, including different patterns of antimicrobial usages, which lead to selective pressure, as well as the distribution of specific serotypes and the spread of resistant clones within certain areas. Table 3 gives the resistance pattern of the various isolates to a number of antibiotics. The data shows that *S. aureus* (59.1%), *K. pneumonia* (61.5%), *P. mirabilis* (55.0%), *S. pneumoniae* (62.0%), *S. pyogens* (55.8%) and *H. influenza* (54.2 %) were resistant to more than 3 different antibiotics. In a similar study in Vietnam, some 90% of *S. aureus,* 68% *of H. influenzae* were resistant to at least one antibiotic *(*Larsson et al., 2000). These organisms were reported to be β-lactamase producers. The incidence of bacterial resistance media-ted by β-lactamases has been reported in several African countries including Nigeria and South Africa (Zeba, 2005; Onanuga et al., 2005; Nwanze et al., 2007). The clinical relevance of these enzymes is due to their ability of causing therapeutic failures. Studies in Lagos and Ibadan have reported that between 70 - 90% of strains of enterobacteriaceae including *E. coli, Klebsiella* sp. and *Proteus* sp. were resistant to many of the commonly available antibiotics, thus leading to the use of newer agents (Okesola and Oni, 2009).

In the present study, most of the isolates were sensitive to the quinolones (ciprofloxacin and ofloxacin), but poorly sensitive to ampicillin, naladixic acid, nitrofurantoin, tetracycline, gentamycin, streptomycin, colistin, cotrimoxazole, penicillin, chloramphenicol and erythromycin and these are in agreement to the study conducted in Algeria, where susceptibility to cotrimoxazole was particularly low (Ramdani-Bougessa and Rahal, 2003), but contradicts the reports of Larsson et al. (2000) in Vietnam. High antimicrobial resistance to ampicillin and penicillin have also been reported in Iran (Imani et al., 2007), Korea (Song et al., 1999), France, Germany and Japan (Schito et al., 2000). Data presented in this study indicate that some of the antibiotics commonly used to treat RTIs in the referral hospital are still effective. The results show that antibiotic resistance in this locality is relatively low compared with other countries and regions throughout the world as determined by the global surveillance studies conducted by Morrissey et al. (2005). But, it is still important to periodically monitor the prevalence and antimicrobial sensitivity pattern before empirical therapy is initiated in hospitals.

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