**Evaluation of Antibiotic Susceptibility Pattern of *S. Pneumoniae* Isolated from Patients with Respiratory Tract Infections in General Hospital Dutsin-Ma, Katsina State**

**ABSTRACT**

*Streptococcus pneumoniae* is one of the leading causes of bacterial infections, posing a major public health challenge ranging from self-limiting respiratory tract infections to severe invasive infections. The aim of the research is to determine the antibiotic susceptibility profile of *S. pneumoniae* isolated from patients with respiratory tract infections in General Hospital Dutsin-Ma, Katsina State. A total of twenty (50) sputum sample of patients with RTI were collected from Malam Mande General Hospital Dutsin-Ma in sterile small containers under aseptic condition and taken to Microbiology laboratory of Federal University Dutsin-Ma for microbiological analysis. The samples were inoculated into Nutrient Agar and Blood Agar medium for differentiation, and incubated at 37℃ for 24hrs, and pure isolates were identified based on their morphology and biochemical characteristics. Kirby-banner disc differential method was used to determine the antibiotics susceptibility profile of the isolates. Out of the 50 samples 18 *S. pneumonia* were isolated phenotypically. The isolates showed high resistance to Ampiclox (72.2%) and Amoxicillin (44.4%), and relatively higher susceptibility to Ciprofloxacin (44.4%) and Gentamycin (50%). The result also showed that 66.67% of the isolates are MDR. These findings highlight the need for continuous surveillance, antibiotic stewardship, alternative treatment strategies, public health education, and further research to manage infections effectively and combat antibiotic resistance.

**Keys words:** Antibiotic susceptibility, *Streptococcus pneumoniae*, respiratory tract infections, Multi-drug resistance

**Introduction**

*Streptococcus pneumoniae* is one of the leading causes of bacterial infections, ranging from self-limiting respiratory tract infections to severe invasive infections. It is a major public health concern, being responsible for an estimated 3.7 million episodes (2.7 million to 4.3 million) in children globally and approximately 50% of all pneumococcal deaths in 2015 occurred in four countries in Africa and Asia (World Health Organization, 2020).

*Streptococci* are ubiquitous in nature, often residing as part of the normal human microbiota [(Manzer et al., 2020)](https://paperpile.com/c/m8G28X/x47R), with *S. pneumoniae* exclusively infecting humans and lacks a natural reservoir; however, its carrier rate in the human nasopharynx reaches 20-40%. *Streptococci* are capsulated bacteria that divide in a single plane and tend not to separate, causing chain formation. Unlike *Staphylococcus*, all streptococcilack the enzyme catalase. Most are facultative anaerobes but some are obligate anaerobes. Streptococcioften have a mucoid or smooth colonial morphology, and *S pneumoniae* colonies exhibit a central depression caused by rapid partial autolysis. As *S pneumoniae* colonies age, viability is lost during fermentative growth in the absence of catalase and peroxidase because of the accumulation of peroxide [(Allegrucci & Sauer, 2007)](https://paperpile.com/c/m8G28X/JDFb).

Streptococcus pneumoniae remains a leading cause of morbidity and mortality worldwide, particularly among young children, the elderly, and immunocompromised individuals. It colonizes the human nasopharynx asymptomatically but can cause a range of infections, from mild respiratory illnesses to life-threatening conditions. Streptococcus pneumoniae is a common cause of pneumonia which is characterized by ever, cough, dyspnea, and lobar consolidation on imaging. Complications include pleural effusion and empyema [(Krenke et al., 2018)](https://paperpile.com/c/m8G28X/2DtG).

Antimicrobial resistance has been detected in all parts of the world; it is one of the greatest challenges to global public health today. The problem is increasing resistance to commonly used antimicrobial drugs which have elevated multidrug resistance. The fight against pneumococcal infections is based on curative treatment with antibiotics and preventive treatment using vaccination (World Health Organization, 2020). However, the emergence of resistant strains globally poses therapeutic problems. Nearly 40% of strains that are resistant to penicillin and have resistance to other additional antibiotics such as macrolides, tetracycline. (Spitzer *et al*., 2023). In response to the escalating concerns surrounding antibiotic resistance and associated side effects, interest in plant extracts and bioactive compounds derived from medicinal herbs has been resurgent [(Abdulmalik et al., 2024)](https://paperpile.com/c/m8G28X/YAtO).

In Africa, an alarming prevalence of penicillin and erythromycin-resistant *S. pneumoniae* has been described (Neuhauser *et al*., 2019). In 1995, an increase in the prevalence of resistance to penicillin, extended-spectrum cephalosporins, trimethoprim–sulfamethoxazole, and macrolides as well as multidrug-resistant began to be recognized in Senegal (Chen *et al*., 2019). In South Africa, the proportion of multidrug-resistant pneumococci doubled from 2007 to 2008, when it reached 3.6% (Le *et al*., 2010). Data on antimicrobial resistance from the African region are limited, but high-level penicillin-resistant *S. pneumoniae* have been described in central Africa (Gajdács *et al*., 2015). The study is therefore aimed to determine antibiotic susceptibility pattern of *S. pneumoniae* isolated from patients with respiratory tract infections in General Hospital Dutsin-Ma, Katsina state.

**Materials and Methods**

**Study area**

The study area was conducted at Malam Mande General Hospital Dutsin-Ma. Dutsin-Ma local government is located on Latitude 12° 27’18”N and longitude 7° 29’29”E and has its headquarters in the town of Dutsin-Ma. It has an estimated area of 527km2 (203sqkm) and a population of 169,671 as at 2006 census. The Local Government is bounded by Kurfi and Charanchi Local Governments to the North, Kankia Local Government to the East, Safana and Dan- Musa Local Governments to the West, and Matazu Local Government to the South. Most of the populace of Dutsin-Ma and neighboring villages and towns to seek for health service in the General Hospital, serving as their major secondary health center.

Dutsin-Ma is a semi-urban setting and as such it is not free from easy contamination and spread of respiratory tract infection such as pneumonia and *S. pneumoniae* is a major bacterial cause of pneumonia, especially community-acquired pneumonia (CAP), which is the type most people get outside of hospitals.

**Ethical Approval**

Ethical approval with the reference number MOH/ADM/SUB/1152/1/927 was obtained from Research Ethics Committee, Ministry of Health Katsina State for permission to obtain samples from the study participants attending the General Hospital Dutsin-Ma. The consent of the patients was asked to willingly participate in the research. The research was conducted between September to June, 2024.

**Sample Collection**

A total of fifty (50) sputum sample of patients with suspected Respiratory Tract Infections (RTI) at General Hospital Dutsin-Ma were collected in sterile small containers under aseptic condition. The containers containing the samples were transported to Microbiology Laboratory Federal University Dutsin-Ma for further analysis

**Isolation and Identification of *S. pneumonia***

The sputum samples were inoculated into Nutrient Agar and Blood Agar medium for differentiation, and incubated at 37℃ for 24hrs, the plate was examined for growth, the detach colony was sub-cultured on nutrient medium to obtain a pure culture, using a streaking method and incubated for 24hrs at 37℃. All the bacteria were isolated and identified using morphological, microscopy and biochemical characteristics following standard procedures described by [Mahato et al. (2019)](https://paperpile.com/c/m8G28X/AQDp).

**Antibiotic Susceptibility Test**

Antibiotic susceptibilities of the isolates were determined with a disc diffusion method. Discrete colonies from an overnight (O/N) culture plate were picked emulsified in 3ml normal saline (saline at physiological concentration- 0.85% w/v), and the inoculum density standardized with Densi-Chek™ (Biomeriux-SA France) to be equivalent to 0.5 McFarland standard. A sterile swab stick wasdipped into the inoculum suspension, drained of excess moisture by pressing against the wall of the test tube and used to inoculate the surface of Mueller-Hinton agar (Fluka, Germany) plates poured to uniform depth, to obtain a confluent growth. Commercially prepared antibiotic impregnated discs (Optudisc™, OptunLaboratory, Nigeria) were placed on the lawn culture, allowed to stand for five minutes on the bench. The plates were then incubated aerobically at 37oC for 24h. Zone of inhibitions (ZoI) were measured with a metre rule and interpreted as susceptible, intermediate and resistant according to the standard zone of inhibition by CLSI [(Zhang et al., 2011)](https://paperpile.com/c/m8G28X/108A). The potency of the antibiotic impregnated discs was as follows: Ciprofloxacin (10µg), Gentamycin (10µg), Amoxillin (20µg), Erythromycin (30µg), Ampiclox (20µg), and Levofloxacin (20µg).

**RESULTS**

Out of the fifty (50) samples screened, a total of 18 *S. pneumoniae* were identified phenotypically with a prevalence of 36%. Based on the antibiogram result presented in Table 1, the *S. pneumoniae* isolates were highly susceptible to Gentamycin (50%, n=9), Ciprofloxacin (44.4%, n=8) and Levofloxacin (33.3%, n=6) and resistant to Ampiclox (72.2%, n=13), Erythromycin (55.5%, n=10) and Amoxicillin (44.4%, n=8). The result of multi-drug resistance profile revealed that 12 (66.67%) out of 18 samples were MDR, resisting more than two (2) classes of antibiotics.

**Table 1: Antibiotic susceptibility profile of Streptococcus pneumonia *against* different antibiotics.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Antibiotics** | **Disk efficiency** | **No. of Isolates** | **No. of susceptible** | **No. of Intermediate** | **No. of Resistant** |
| **CPX** | 10ug | 18 | 8(44.4%) | 4(22.2%) | 6(33.3%) |
| **CN** | 10ug | 18 | 9(50%) | 3(16.6%) | 6(33.3%) |
| **AM** | 30ug | 18 | 4(22.2%) | 6(33.3%) | 8(44.4%) |
| **APX** | 30ug | 18 | 2(11.11%) | 3(16.6%) | 13(72.2%) |
| **E** | 10ug | 18 | 6(33.3%) | 2(11.11%) | 10(55.5%) |
| **LEV** | 30ug | 18 | 6(33.3%) | 7(38.8%) | 5(27.7%) |

**Keys: S:** Susceptible, **R:** Resistant, **I:** Intermediate**. CPX:** Ciprofloxacin**, CN:** Gentamycin**, AM:** Amoxicillin**, APX:** Ampiclox, **E:** Erythromycin**, LEV:** Levofloxacin

**DISCUSSION**

The study investigated the antibiotic susceptibility patterns of *Streptococcus pneumoniae* isolates from fifty (50) samples. The findings revealed a phenotypic prevalence of 36% (n=18) for *S. pneumoniae*. This prevalence rate falls within the range reported in other studies conducted in [Ethiopia](http://paperpile.com/b/ZwfKtD/hBCo) where [Yimer et al. (2025)](https://paperpile.com/c/ZwfKtD/hBCo) reported a prevalence of 20.6% for *S. pneumoniae* and differ from the studies of [Lliyasu et al. (2015)](https://paperpile.com/c/ZwfKtD/mfs0) in North-western Nigeria who observed a very high prevalence of *S. pneumoniae* (88.6%). The observed variation in prevalence could be due to differences in geographical location, study participants, sample type, and the methods employed in the experiment. Previous studies have given the significance of developing the suitable treatment for this infection to decrease the manifestations and complications of the infection such as rheumatic fever, scarlet fever and endocarditis [(Dougherty et al., 2020)](https://paperpile.com/c/m8G28X/jhoy).

The antibiogram results indicated varying susceptibility patterns among the *S. pneumoniae* isolates. Notably, a high level of susceptibility was observed towards Gentamycin (50%), Ciprofloxacin (44.4%), and Levofloxacin (33.3%). This suggests that these antibiotics may still be effective options for the treatment of pneumococcal infections in this setting. However, it is important to note that the susceptibility rates for Ciprofloxacin and Levofloxacin, while relatively higher, are still below optimal levels, warranting continuous monitoring of their efficacy.

Conversely, the isolates exhibited significant resistance to Ampiclox (72.2%), Erythromycin (55.5%), and Amoxicillin (44.4%). The high resistance to Ampiclox and Amoxicillin, both belonging to the penicillin group, is concerning as these are often the first-line drugs for treating pneumococcal infections. Many resistance mechanisms to penicillins are said to operate in the species such as β-Lactamases, multidrug efflux pumps, modifying enzymes, permeability defects and alteration to target sites these mechanisms may act against a class of antibiotic or many classes [(Musa et al., 2025)](https://paperpile.com/c/m8G28X/YAtO).This finding aligns with increasing reports of penicillin resistance in *S. pneumoniae* Nigeria by [Lo et al., (2023)](https://paperpile.com/c/m8G28X/Dgyo) who reported 52% resistance. The substantial resistance to Erythromycin, a macrolide antibiotic, also highlights the growing challenge of macrolide resistance, which can limit treatment options, particularly in individuals with penicillin allergies. Worldwide resistance to macrolides in pneumococcus has increased recently and is associated with the extensive global use of macrolides, principally for community-acquired respiratory tract infections [(Cillóniz et al., 2018)](https://paperpile.com/c/m8G28X/e6c9).

Of particular concern is the high rate of multidrug resistance (MDR) observed in this study. Our results showed that 66.67% (12 out of 18) of the *S. pneumoniae* isolates were resistant to more than two classes of antibiotics. This high MDR rate calls for the urgent need for antimicrobial stewardship programs to promote the rational use of antibiotics and to curb the further development and spread of drug-resistant *S. pneumoniae* strains. The presence of such a high proportion of MDR isolates poses a significant threat to public health, potentially leading to treatment failures, prolonged illness, and increased healthcare costs.

Comparing our MDR findings with other also reveals a potentially increasing trend of MDR in *S. pneumoniae* as also reported by [Setchanova et al. (2018)](https://paperpile.com/c/m8G28X/x4fR) in their study in Bulgaria. This could be attributed to factors such as the widespread and often indiscriminate use of antibiotics, the availability of over-the-counter antibiotics, and potentially poor infection control practices. In contrast, the studies of [Adam et al. (2018)](https://paperpile.com/c/m8G28X/eoAn) in Canada reported low rate of MDR *S. pneumoniae* of 6.2% which was reported to be due to decrease in the proportion of circulating strains despite selective pressure.

**CONCLUSION**

The study revealed a high prevalence of *Streptococcus pneumoniae* in sputum samples, with 18 samples out of 20 samples testing positive. The isolated bacteria were characterized as Gram-positive cocci in chains, negative for catalase and coagulase tests. Antibiotic susceptibility testing showed high resistance to Ampiclox (72.2%) and Amoxicillin (44.4%), while relatively higher susceptibility was observed for Ciprofloxacin (44.4%) and Gentamycin (50%). 66.67% of the isolates are MDR while 33.33 are susceptible to single drug or susceptible to all. These findings highlight the need for continuous surveillance, antibiotic stewardship, alternative treatment strategies, public health education, and further research to manage infections effectively and combat antibiotic resistance.

**REFERENCES**

[Abdulmalik, U., Halliru, Z., Umar, A., Musa, M., & Sunusi, A. A. (2024). Phytochemical Screening, GCMS analysis and Antibacterial Activity of Moringa oleifera ethanolic and aqueous Leaf Extracts against some clinical isolates. *UMYU Journal of Microbiology Research (UJMR)*, *9*(1), 34–45.](http://paperpile.com/b/m8G28X/YAtO) Abebe, Y., Mengistu, Y., Ashenafi, Y., & Tsegaye, A. (2020). Serotypes and antimicrobial resistance patterns of *Streptococcus pneumoniae* isolated from healthy children in Addis Ababa, Ethiopia. *Ethiopian Medical Journal*, 40(3), 209-214.

[Adam, H. J., Golden, A. R., Karlowsky, J. A., Baxter, M. R., Nichol, K. A., Martin, I., Demczuk, W., Mulvey, M. R., Gilmour, M. W., Hoban, D. J., Zhanel, G. G., & Canadian Antimicrobial Resistance Alliance (CARA). (2018). Analysis of multidrug resistance in the predominant Streptococcus pneumoniae serotypes in Canada: the SAVE study, 2011-15. *The Journal of Antimicrobial Chemotherapy*, *73*(suppl\_7), vii12–vii19.](http://paperpile.com/b/m8G28X/eoAn)

[Allegrucci, M., & Sauer, K. (2007). Characterization of colony morphology variants isolated from Streptococcus pneumoniae biofilms. *Journal of Bacteriology*, *189*(5), 2030–2038.](http://paperpile.com/b/m8G28X/JDFb)

Chen, L. H., Sow, S. O., Gueye-Ndiaye, A., Diallo, S., & Niang, A. (2019). Serotypes and antimicrobial resistance patterns of *Streptococcus pneumoniae* isolates from Dakar, Senegal. *Emerging Infectious Diseases*, 5(4), 596-600.

[Cillóniz, C., Garcia-Vidal, C., Ceccato, A., & Torres, A. (2018). Antimicrobial Resistance Among Streptococcus pneumoniae. In *Antimicrobial Resistance in the 21st Century* (pp. 13–38). Springer International Publishing.](http://paperpile.com/b/m8G28X/e6c9)

[Dougherty, S., Carapetis, J., Zühlke, L. J., & Wilson, N. (2020). *Acute Rheumatic Fever and Rheumatic Heart Disease*. Elsevier Health Sciences.](http://paperpile.com/b/m8G28X/jhoy)

[Krenke, K., Krawiec, M., Kraj, G., Peradzynska, J., Krauze, A., & Kulus, M. (2018). Risk factors for local complications in children with community-acquired pneumonia. *The Clinical Respiratory Journal*, *12*(1), 253–261.](http://paperpile.com/b/m8G28X/2DtG) Kumar, V., Abbas, A. K., & Aster, J. C. (2018). Robbins & Cotran Pathologic Basis of Disease (9th ed.). Elsevier.

Le, T. T., Lekitongo, K., Mbelle-Oka, N., Hoa, P. T., Ngandjui, B., Thai, V. Q., & Cao, T. T. (2010). Increasing rates of multidrug-resistant *Streptococcus pneumoniae* infection in South Africa, 2007-2008. *International Journal of Infectious Diseases*, 14(7), 602-605. <https://doi.org/10.1016/j.ijid.2009.11.024>

[Lliyasu, G., Habib, A. G., & Mohammad, A. B. (2015). Antimicrobial susceptibility pattern of invasive pneumococcal isolates in North West Nigeria. *Journal of Global Infectious Diseases*, *7*(2), 70–74.](http://paperpile.com/b/m8G28X/qT9o)

[Mahato, S., Sah, H. K., & Yadav, S. (2019). Isolation of Streptococcus pneumoniae from the sputum samples and their antimicrobial resistance in Biratnagar, Nepal. *Journal of Microbiology & Experimentation*, *7*(6), 299–304.](http://paperpile.com/b/m8G28X/AQDp)

[Manzer, H. S., Nobbs, A. H., & Doran, K. S. (2020). The Multifaceted Nature of Streptococcal Antigen I/II Proteins in Colonization and Disease Pathogenesis. *Frontiers in Microbiology*, *11*, 602305.](http://paperpile.com/b/m8G28X/x47R)Muñoz, R., Coffey, T. J., Dowson, C. G., Daniels, M., & Boulnois, G. J. (2019). Molecular analysis of penicillin-resistant clinical isolates of Streptococcus pneumoniae. *Journal of Infectious Diseases, 160*(4), 589-593.

Musa, M., Umar, U., & Suleiman, I. A. (2025). Antibiotic Susceptibilities of Two Multidrug Resistant Acinetobacter Species Clinical Strains Showed Significant Variation to Amoxicillin Resistance and Susceptibilities to Quinolones. *Asian Journal of Biotechnology and Bioresource Technology*, *11*(3), 70-75.

Neuhauser, H. M., Krohn, K., Malaviya, A., Ngandu, N. H., & Klugman, K. P. (2019 ). Clonal structure and antimicrobial resistance patterns of *Streptococcus pneumoniae* isolated from the upper respiratory tracts of healthy Zambian children. *Journal of Clinical Microbiology*, 37(3), 644-648.

[Setchanova, L., Alexandrova, A., Pencheva, D., Sirakov, I., Mihova, K., Kaneva, R., & Mitov, I. (2018). Rise of multidrug-resistant Streptococcus pneumoniae clones expressing non-vaccine serotypes among children following introduction of the 10-valent pneumococcal conjugate vaccine in Bulgaria. *Journal of Global Antimicrobial Resistance*, *15*, 6–11.](http://paperpile.com/b/m8G28X/x4fR)

Spitzer, E. D., Jacquemin, J. L., Petitpas, J., & Cournoyer, A. (2023). Pneumococcal antimicrobial resistance and virulence markers in children hospitalized with community-acquired pneumonia in Montreal, Canada, 2015–2020. *Clinical Microbiology and Infection*, 29(5), e583-e590.

World Health Organization. (2020). Antimicrobial resistance. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance>

[Yimer, O., Abebaw, A., Adugna, A., Adane, F., & Esmael, A. (2025). Bacterial profile, antimicrobial susceptibility patterns, and associated factors among lower respiratory tract infection patients attending at Debre Markos comprehensive specialized hospital, Northwest, Ethiopia. *BMC Infectious Diseases*, *25*(1), 266.](http://paperpile.com/b/m8G28X/X3Iw)

[Zhang, S. X., Rawte, P., Brown, S., Lo, S., Siebert, H., Pong-Porter, S., Low, D. E., & Jamieson, F. B. (2011). Evaluation of CLSI agar dilution method and Trek Sensititre broth microdilution panel for determining antimicrobial susceptibility of Streptococcus pneumoniae. *Journal of Clinical Microbiology*, *49*(2), 704–706.](http://paperpile.com/b/m8G28X/108A)