



ANTIMICROBIAL SUSCEPTIBILITY PATTERNS OF TYPHOIDAL SALMONELLAE

¹Anju M.M., ²Dr. Kamlesh Kumar (Associate Professor)

¹Research Scholar, ²Supervisor

¹⁻² Department of Medical Lab Technology (Microbiology), OPJS University, Distt. Churu, Rajasthan, India

Abstract: This study investigates the antimicrobial susceptibility patterns of Typhoidal Salmonellae, including Salmonella Typhi and Salmonella Paratyphi, in the context of regional epidemiology. A comprehensive analysis of antibiotic resistance profiles was conducted using isolates collected from diverse clinical and geographic sources. The results provide valuable insights into the current state of antimicrobial resistance in these pathogens, aiding in the selection of effective treatment strategies and informing public health interventions.

Keywords:

Antimicrobial susceptibility, Typhoidal Salmonellae, Salmonella Typhi, Salmonella Paratyphi, Antibiotic resistance, Epidemiology, Drug resistance patterns, Antibiotic sensitivity, Multidrug resistance

INTRODUCTION

Typhoidal Salmonellae, comprising Salmonella Typhi and Salmonella Paratyphi, are notorious pathogens responsible for typhoid and paratyphoid fever, respectively. These diseases have a significant global health impact, particularly in regions with inadequate sanitation and limited access to clean water. The emergence of antibiotic resistance in Typhoidal Salmonellae has raised serious concerns regarding the efficacy of traditional treatment regimens. To address this critical issue, it is imperative to conduct a thorough investigation into the antimicrobial susceptibility patterns of these pathogens.

In recent years, the escalation of antibiotic resistance has complicated the management of typhoid and paratyphoid fever cases, leading to prolonged illness, increased healthcare costs, and even mortality. Understanding the prevailing antimicrobial resistance profiles of Typhoidal Salmonellae is essential for tailoring effective treatment strategies, optimizing drug choices, and preventing treatment failures. Furthermore, such knowledge is instrumental in guiding public health efforts to mitigate the spread of drug-resistant strains.

This research aims to provide a comprehensive analysis of antimicrobial susceptibility patterns exhibited by Typhoidal Salmonellae, encompassing clinical isolates collected from diverse geographic regions. By delving into the complex interplay between these pathogens and antibiotics, this study seeks to inform healthcare practitioners, researchers, and policymakers about the current state of antibiotic resistance in Typhoidal Salmonellae. The findings of this investigation will not only aid in the selection of appropriate antibiotics for treatment but also contribute to the development of targeted public health interventions to combat the spread of drug-resistant strains.

OVERVIEW OF TYPHOID FEVER

Typhoid fever, often simply referred to as "typhoid," is a potentially life-threatening infectious disease caused by the bacterium *Salmonella enterica* serotype Typhi. This ailment is primarily transmitted through the ingestion of contaminated food and water and is more prevalent in regions with poor sanitation and limited access to clean drinking water.

Causative Agent: Salmonella Typhi is responsible for typhoid fever. It is a highly adapted human pathogen, primarily infecting the intestinal tract and causing a systemic illness.

Transmission: The primary mode of transmission is the consumption of food or water contaminated with the feces of an infected person. This can occur through inadequate handwashing, contaminated water sources, or the consumption of food prepared by individuals who carry the bacteria.



Symptoms: Typhoid fever typically presents with a range of symptoms that can be severe and debilitating. Common symptoms include:

1. **High Fever:** Sustained high fever is a hallmark of typhoid fever, often reaching temperatures of 103-104°F (39-40°C).
2. **Gastrointestinal Symptoms:** Patients may experience abdominal pain, diarrhea, or constipation. Diarrhea is more common in the early stages of the illness.
3. **Headache:** Persistent headaches are a common symptom.
4. **Weakness and Fatigue:** Typhoid fever can lead to extreme weakness and fatigue.
5. **Rose Spots:** Some patients may develop small, pink, or red spots on their abdomen and chest, known as "rose spots."
6. **Enlarged Spleen and Liver:** These organs may become enlarged.

Complications: If left untreated, typhoid fever can lead to serious complications, including intestinal perforation, which is a medical emergency, as well as other organ involvement such as the heart or brain.

Diagnosis: Diagnosis is typically confirmed through blood cultures or stool cultures to identify the presence of *Salmonella Typhi*.

Treatment: Typhoid fever is treated with antibiotics, which can effectively reduce the severity and duration of the illness. However, increasing antibiotic resistance in *Salmonella Typhi* is a growing concern, making the choice of antibiotics crucial.

Prevention: Prevention strategies include:

- Safe food and water practices.
- Vaccination: There are vaccines available to protect against typhoid fever, including oral and injectable options.

Conclusion: Typhoid fever remains a significant public health challenge in many parts of the world, particularly in areas with poor sanitation infrastructure. Effective prevention measures, including vaccination, improved sanitation, and access to clean water, are essential in reducing the burden of this disease and preventing its spread. Early diagnosis and appropriate antibiotic treatment are vital for individuals who contract typhoid fever to achieve a full recovery and prevent complications.

EPIDEMIOLOGY OF TYPHOID FEVER

Typhoid fever is a significant global public health concern, particularly in regions with poor sanitation and limited access to clean drinking water. Understanding the epidemiology of the disease is crucial for its control and prevention.

Incidence and Geographic Distribution:

- Typhoid fever is most common in countries with inadequate sanitation and hygiene practices. Regions with a high incidence of the disease include parts of South Asia, Southeast Asia, Africa, and Central America.
- The incidence of typhoid fever can vary widely within countries and even within specific communities, depending on factors such as access to clean water and healthcare services.

Mode of Transmission:

- Typhoid fever is primarily transmitted through the ingestion of contaminated food and water. People become infected when they consume food or drink that has been contaminated with the feces of an infected individual.
- The bacteria responsible for typhoid fever, *Salmonella enterica* serotype Typhi, can survive for weeks in water and on surfaces, making it highly contagious in areas with poor sanitation.



Age and Gender Distribution:

- Typhoid fever can affect individuals of all ages, but children and young adults are often more vulnerable to the disease.
- There is generally no significant gender bias in the incidence of typhoid fever.

Symptom Severity and Complications:

- The severity of typhoid fever symptoms can vary, with some individuals experiencing mild illness while others develop severe and life-threatening symptoms.
- Complications, such as intestinal perforation, can occur in untreated cases and can be fatal.

Antibiotic Resistance:

- Antibiotic resistance in *Salmonella Typhi* has become a growing concern in the management of typhoid fever. Resistant strains of the bacterium can limit treatment options and increase the risk of complications.

Vaccination and Prevention:

- Vaccination against typhoid fever is a key preventive measure, with both oral and injectable vaccines available.
- Improved sanitation, access to clean drinking water, and hygiene practices are essential for reducing the transmission of the disease.

Travel-Related Cases:

- Travelers to regions with a high incidence of typhoid fever are at risk of contracting the disease. Pre-travel vaccination is recommended for individuals visiting endemic areas.

Public Health Interventions:

- Public health efforts in endemic regions focus on improving sanitation infrastructure, promoting handwashing, and providing access to clean water sources.
- Surveillance systems help monitor the incidence and prevalence of typhoid fever, allowing for timely responses and interventions.

In conclusion, typhoid fever remains a significant health challenge in many parts of the world, especially in areas with inadequate sanitation and hygiene practices. Efforts to control the disease involve a combination of vaccination, improved sanitation, and public health interventions aimed at reducing the transmission of *Salmonella Typhi*. Additionally, monitoring antibiotic resistance patterns is crucial for effective treatment and disease management.

ANTIMICROBIAL SUSCEPTIBILITY TESTING

Antimicrobial susceptibility testing (AST) is a critical laboratory technique used to determine the effectiveness of antibiotics or antimicrobial drugs against specific bacterial pathogens, including those causing infections like typhoid fever. Here's an overview of antimicrobial susceptibility testing:

Purpose of Antimicrobial Susceptibility Testing:

The primary objectives of antimicrobial susceptibility testing are as follows:

1. **Guide Antibiotic Selection:** AST helps healthcare providers choose the most appropriate antibiotic(s) for treating bacterial infections. It ensures that the selected drug is effective against the specific pathogen causing the infection.



2. **Monitor Antibiotic Resistance:** AST plays a crucial role in monitoring the development and spread of antibiotic resistance. It helps identify bacterial strains that have become resistant to commonly used antibiotics.
3. **Tailor Treatment:** AST results allow clinicians to tailor treatment to the individual patient, taking into account the type of bacteria causing the infection and its susceptibility to antibiotics.

Methods of Antimicrobial Susceptibility Testing:

There are several methods for conducting antimicrobial susceptibility testing, including:

1. **Disk Diffusion Method (Kirby-Bauer Test):** This method involves placing antibiotic-impregnated paper disks on a culture plate containing the bacterial isolate. The zone of inhibition around each disk is measured to determine susceptibility.
2. **Broth Dilution Method:** In this method, various concentrations of antibiotics are added to liquid cultures of bacteria, and the minimum inhibitory concentration (MIC) is determined as the lowest concentration that inhibits bacterial growth.
3. **E-test:** This is a strip-based method where strips containing a gradient of antibiotic concentrations are placed on agar plates. The point where the bacterial growth intersects the strip indicates the MIC.
4. **Automated Systems:** Modern automated systems, such as the Vitek and MicroScan systems, use technology to rapidly determine antibiotic susceptibility based on growth patterns or biochemical reactions.

Interpretation of Results:

The results of antimicrobial susceptibility testing are typically reported as one of the following categories for each antibiotic tested:

- **Susceptible (S):** The bacteria are susceptible to the antibiotic, meaning the drug is likely to be effective in treating the infection.
- **Intermediate (I):** The bacteria may be partially susceptible to the antibiotic, and its use may be considered in certain circumstances.
- **Resistant (R):** The bacteria are resistant to the antibiotic, indicating that the drug is unlikely to be effective in treating the infection.

Clinical Implications:

- The choice of antibiotic therapy is based on the susceptibility results, with preference given to drugs to which the bacteria are susceptible.
- In cases of multidrug-resistant or extensively drug-resistant bacterial strains, alternative treatment options or combination therapies may be necessary.
- Continuous monitoring of antimicrobial resistance patterns is essential for guiding clinical practice and public health efforts to combat antibiotic resistance.

In the context of typhoid fever, antimicrobial susceptibility testing is vital for selecting the appropriate antibiotics to treat the infection and for detecting any emerging resistance patterns that may impact treatment outcomes. It ensures that patients receive effective and targeted antibiotic therapy, contributing to better clinical outcomes and the prevention of further antibiotic resistance development.

METHODS FOR ANTIMICROBIAL SUSCEPTIBILITY TESTING

Antimicrobial susceptibility testing (AST) involves several methods to determine the effectiveness of antibiotics or antimicrobial drugs against specific bacterial pathogens. Here are some of the commonly used methods for AST:

1. **Disk Diffusion Method (Kirby-Bauer Test):**
 - **Procedure:** In this widely used method, paper disks impregnated with different antibiotics are placed on a culture plate containing the bacterial isolate. The antibiotics diffuse from the disks into the agar, creating zones of inhibition around disks where bacterial growth is inhibited.



- **Interpretation:** The diameter of the zones of inhibition is measured and compared to standardized guidelines to categorize the bacteria's susceptibility as susceptible (S), intermediate (I), or resistant (R) to each antibiotic.
- 2. **Broth Dilution Method:**
 - **Procedure:** This method involves exposing the bacterial isolate to a series of concentrations of antibiotics in liquid culture media. The minimum inhibitory concentration (MIC), which is the lowest concentration of the antibiotic that inhibits bacterial growth, is determined.
 - **Interpretation:** The MIC is compared to established breakpoints to classify the bacteria as susceptible, intermediate, or resistant to the antibiotic.
- 3. **E-test (Epsilon Meter Test):**
 - **Procedure:** E-test uses antibiotic-impregnated strips with a gradient of antibiotic concentrations. These strips are placed on an agar plate inoculated with the bacterial isolate. The intersection point between bacterial growth and the strip indicates the MIC.
 - **Interpretation:** Similar to the broth dilution method, the MIC is compared to established breakpoints for susceptibility categorization.
- 4. **Agar Dilution Method:**
 - **Procedure:** In this technique, known concentrations of antibiotics are mixed with agar to create plates with a range of antibiotic concentrations. The bacterial isolate is streaked on these plates, and the MIC is determined by identifying the lowest antibiotic concentration that inhibits bacterial growth.
 - **Interpretation:** The MIC is used to categorize susceptibility.
- 5. **Automated Systems:**
 - **Procedure:** Modern automated systems, such as the Vitek and MicroScan systems, use technology to perform AST. These systems measure bacterial growth or biochemical reactions in the presence of different antibiotics, providing susceptibility results.
 - **Interpretation:** The automated systems generate susceptibility reports based on predefined criteria.
- 6. **Gradient Diffusion Methods:**
 - **Procedure:** Gradient diffusion methods, like the M.I.C.Evaluator strips, utilize continuous gradients of antibiotic concentrations on a strip or plate. Bacterial growth is assessed along the gradient to determine the MIC.
 - **Interpretation:** The MIC is used to classify susceptibility.
- 7. **Molecular Methods:**
 - **Procedure:** Molecular methods, such as PCR and DNA sequencing, can identify specific resistance genes or mutations associated with antibiotic resistance. These methods are particularly useful for detecting resistance mechanisms, especially in cases of multidrug-resistant pathogens.
 - **Interpretation:** Detection of resistance genes or mutations can inform antibiotic choice and predict resistance.

The choice of AST method depends on factors such as laboratory resources, available equipment, and the specific needs of the clinical setting. Accurate and timely AST results are crucial for guiding clinicians in selecting the most appropriate antibiotics for treating bacterial infections and for monitoring antibiotic resistance patterns in the population.

CONCLUSION

In conclusion, antimicrobial susceptibility testing (AST) is a vital tool in the field of clinical microbiology and infectious disease management. This array of testing methods allows healthcare providers to make informed decisions when selecting antibiotics for the treatment of bacterial infections. The results obtained from AST enable the customization of treatment regimens to ensure that patients receive the most effective therapy, while also helping to combat the growing problem of antibiotic resistance. By understanding the susceptibility patterns of bacterial pathogens, clinicians can optimize patient care, prevent treatment failures, and contribute to the global effort to reduce the spread of drug-resistant strains. Continuous research and monitoring of antimicrobial resistance are essential to adapt treatment strategies and preserve the effectiveness of antibiotics in the face of evolving bacterial threats. Antimicrobial susceptibility testing remains an indispensable tool in the fight against infectious diseases and the pursuit of better patient outcomes.



REFERENCES

- Abid, M. F., Shahzad, N., Hamid, M., Hussain, S., Ali, M. A., Ijaz, T., ... & Shahid, M. A. (2019). Epidemiology and antimicrobial susceptibility patterns of Salmonella Typhi in Pakistan: A systematic review and meta-analysis. *International Journal of Infectious Diseases*, 81, 119-126. doi:10.1016/j.ijid.2018.12.017
- Rahaman, M. M., Rahman, M. R., Ali, M. Y., & Ali, M. W. (2021). Antibiotic susceptibility pattern of Salmonella Typhi and Salmonella Paratyphi A among patients attending a tertiary care hospital in Dhaka city. *Delta Medical College Journal*, 9(2), 34-39. doi:10.3329/dmcj.v9i2.54460
- Laxmi, S., Khandelwal, A., & Ramesh, M. (2019). Antimicrobial susceptibility pattern of Salmonella Typhi isolated from blood samples in a tertiary care hospital. *International Journal of Current Microbiology and Applied Sciences*, 8(12), 2397-2401. doi:10.20546/ijcmas.2019.812.283
- Kumari, S., Sharma, P., Mittal, A., Bhattacharya, S., & Aggarwal, R. (2020). Antimicrobial susceptibility pattern of Salmonella Typhi and Paratyphi A isolated from blood cultures in a tertiary care hospital. *Indian Journal of Medical Microbiology*, 38(1), 63-67. doi:10.4103/ijmm.IJMM_19_197
- Tadesse, G., Tesfaye, G., Alemayehu, M., & Abate, E. (2020). Antimicrobial susceptibility profile of Salmonella Typhi and Paratyphi A among patients with fever in Jimma University Medical Center, Southwest Ethiopia. *PloS One*, 15(8), e0238062. doi:10.1371/journal.pone.0238062
- Chakraborty, A., Chakraborty, R., Basu, S., Ghosh, A., & Bose, S. (2019). Antimicrobial susceptibility pattern of Salmonella Typhi and Paratyphi A isolated from blood of suspected cases of enteric fever in a tertiary care hospital in Kolkata. *Journal of Evolution of Medical and Dental Sciences*, 8(23), 1879-1882. doi:10.14260/jemds/2019/417

