

Prevalent Bacterial Infections and The Antibacterial Resistance Pattern of Their Causative Microorganisms

By

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A thesis submitted to the School of Pharmacy in partial fulfillment of the requirements for
the degree of Bachelor of Pharmacy (B. Pharm.)

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Declaration

It is hereby declared that

1. The thesis submitted is my own original work while completing degree at Brac University.
2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. I have acknowledged all main sources of help.

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Approval

The thesis titled “Prevalent Bacterial Infections and The Antibacterial Resistance Pattern of Their Causative Microorganisms” submitted by Tasfin Rasif (20146012), of Summer, 2025 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Pharmacy.

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Ethics Statement

This project does not involve any kind of animal and human trial.

Abstract/ Executive Summary

According to World Health Organization (WHO), in 21st century antibiotic resistance a serious risk for public health. To highlight the situation of antibiotic resistance in Jashore city, Bangladesh, a retrospective study was conducted using 48 isolates from Jashore Medical College (JMC). The isolates obtained from patient's blood, urine, stool, sputum, wound swab and throat swab involved bacterial species. The data was included according to age of patients, antibiotic susceptibility, distribution of microbial organisms, resistance and sensitive pattern was determined. *E. coli* was found to be the most prevalent microorganism responsible for antibiotic resistance at Jashore city in Bangladesh. Netilmicin showed greater resistance towards pathogenic bacteria in patients. Lack of proper knowledge, overuse and misuse of antibiotics, irrational use by healthcare providers contribute to increasing antimicrobial resistance. It is high time to made awareness and should be taken necessary steps should be taken to decreased antibiotic resistance rate.

Keywords: Antibiotic Resistance; Resistant pattern; *Escherichia coli*; Netilmicin; *Staphylococcus aureus*.

Dedication

This project is dedicated to my parents, for their endless love, support, encouragement and sacrifices made it possible for me and without it I would not be where I am today.

Acknowledgement

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List of Acronyms

WHO	World Health Organization
MDR	Multi Drug Resistance
XDR	Extensively Drug Resistance
AMR	Antimicrobial Resistance
UTIs	Urinary Tract Infections
GIIs	Gastrointestinal Infections
STIs	Sexually Transmitted infections
BSIs	Blood Stream Infections
GLASS	Global Antimicrobial Resistance and Use Surveillance System
E. Coli	Escherichia coli

Chapter 1

Introduction

Bacterial infections are the most rated causes of human disease (Belay Tafa Regassa, 2023). Historically, bacterial infections have been the most important cause of morbidity and mortality for centuries (Akova, 2016). The mid of 20th century introduction of antibiotics revolutionized health care by significantly reducing death rate from the bacterial infections (DorothyDavies, 2010). But the overuse of antibiotics and sometimes misuse of antibiotics has created a new problem, which known as antibiotic resistance. Nowadays, antibiotic resistance is the hard challenge for clinical health and public health problem in large population (Amin Talebi Bezmin Abadi, 2019). Hazard of antibiotic resistant bacteria is a health threat today which complicating the treatment of infection, which indicates more severe and longer lasting illnesses (DorothyDavies, 2010). This research aims to explore the prevalent bacterial infections and the resistance patterns of their causative microorganisms, addressing the critical state.

Antibacterial resistance is a most prominent problem that need to separate attention from the global scientific community (Belay Tafa Regassa, 2023). Antibiotic resistance threaten becomes a major public health crisis in this current situation (Belay Tafa Regassa, 2023). Antimicrobial resistance (AMR) is one of the top ten global public health threats facing humanity, according to the World Health Organization (WHO) (Belay Tafa Regassa, 2023). The World Health Organization (WHO) has long acknowledged the need for a more effective, which coordinated worldwide effort to prevent Antimicrobial resistance (AMR) (Belay Tafa Regassa, 2023).

The surfacing of multidrug resistant (MDR) and extensively drug-resistant (XDR) bacteria has made infections (Belay Tafa Regassa, 2023). Which once able to effectively treat via antibiotics

now much more difficult to treat that leads to increased healthcare expenses, extended hospital admissions, and elevated mortality rates (Belay Tafa Regassa, 2023).

Bacterial infections represent significant risks in healthcare environments (Emily R. M. Sydnor, 2011). That owing to their capacity to induce various diseases and consequences (WHO, 2015). So, infections can impact several bodily regions, resulting in diverse symptoms and health complications (Emily R. M. Sydnor, 2011). Prevalent bacterial infections cover urinary tract infections (UTIs), respiratory infections, dermal infections, gastrointestinal infections (GIIs), sexually transmitted infections (STIs) and bloodstream infections (BSIs) (Report signals increasing resistance to antibiotics in bacterial infections in humans and need for better data, 2022). Urinary tract infections impact on the urinary system, encompassing the kidneys, bladder, urethra and are frequently attributed to *Escherichia coli* (E. Coli) (Emily R. M. Sydnor, 2011). Respiratory infections effects on bacterial pneumonia, bronchitis and sinusitis are frequently induced by organisms, such as *Streptococcus pneumonia* (Emily R. M. Sydnor, 2011). Skin infections, like cellulitis, impetigo and boils are often attributed to *Staphylococcus aureus* (Emily R. M. Sydnor, 2011). Bloodstream infections which are potentially resulting in sepsis and frequently attributed to bacteria such *Staphylococcus aureus* and *Escherichia coli* (Emily R. M. Sydnor, 2011).

In the year of 2001, the WHO set a Global Strategy for Containment of Antimicrobial Resistance (Pittet, 2009). It mentioned a frame work of interventions aimed at minimizing the emergence and the dissemination of antimicrobial resistant microorganisms (Pittet, 2009). Investigating common infections caused by bacteria and their resistance patterns is essential for several reasons (WHO, 2015). That identifying the microorganisms that are most susceptible to developing resistance and the medications, they resist can assist healthcare personnel in effectively preparing for and managing the outbreaks (WHO, 2023). Ultimately, governments may leverage this knowledge to

establish successful antibiotic stewardship programs and restrict antibiotic usage in agriculture (Report signals increasing resistance to antibiotics in bacterial infections in humans and need for better data, 2022). It enhance public understanding regarding the significance of appropriate antibiotic application (WHO, 2023). In the year of 2012, WHO published “The Evolving Threat of Antimicrobial Resistance: Options for Action” (WHO, 2015). It proposed a multifaceted approach that includes enhancing health systems and surveillance, optimizing antimicrobial use in both hospitals and communities healthcare, implementing infection prevention (Rodríguez-Bano, 2004). It also control measures, promoting the development of suitable new drugs and vaccines, and ensuring political commitment (JI Alós, 2005). In the year of 2014, WHO published the inaugural global report on antimicrobial resistance surveillance (WHO, 2015). It compiled experiences from national and international surveillance networks in light of the proposed role of the surveillance system (Pittet, 2009). This report demonstrates that available surveillance data can inform treatment decisions that elucidate AMR trends, highlight priority intervention areas, and assess the effectiveness of measures (Pittet, 2009). It aimed at controlling resistance of antibiotics (Pittet, 2009). The insufficient surveillance in numerous regions globally results in considerable gaps in the current understanding of the distribution and magnitude of this phenomenon (JI Alós, 2005). In the year of 2017, the WHO published a list of 12 bacterial families that represent significant threats to human health (Report signals increasing resistance to antibiotics in bacterial infections in humans and need for better data, 2022). The WHO categorizes bacteria into three priority levels: critical, high, and medium, based on the necessity for new antibiotic development to address these pathogens (Report signals increasing resistance to antibiotics in bacterial infections in humans and need for better data, 2022). This is a challenge faced by every country,

at every level of development, and indeed poses a major obstacle to achieving universal health (Ana Monteiro, 2022).

This study provides insight into the most prevalent pathogens and their associated resistance pattern. Also consider a number of individual problematic bacteria responsible for massive health concerns, such as *Staphylococcus aureus*, *Escherichia coli*, *Staphylococcus spp.*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* (Rodríguez-Bano, 2004). Studying how these bacteria are resistant to common antibiotics will help us get a better sense of current antibacterial resistance.

Although there are several studies that have examined bacterial infections and antibiotic resistance, the majority of them have focused on particular geographic areas or healthcare facilities (S Kastner, 2006). Examining resistance patterns across many public and healthcare contexts from the South side of Bangladesh, this research seeks to provide a wider view. Research like these will help advance the discipline by shedding light on new resistance patterns, the effects of antibiotic combinations, and other related topics (JJ De Waele, 2018).

Regarding bacterial infections and antibiotic resistance, present studies have certain advantages. The vast volume of information gathered over years is one of the main assets and many bacterial pathogens have been found by researchers (JJ De Waele, 2018). Which along with their modes of infection, elements causing drug resistance and deeper understanding of the genetic foundation of resistance (Emily R. M. Sydnor, 2011). It made possible by advances in molecular biology and genomics has helped to create new diagnostic tools, which also focused on the treatments (Emily R. M. Sydnor, 2011).

Still, there are some major limits in present studies. One main restriction is the geographic emphasis of many investigations (Report signals increasing resistance to antibiotics in bacterial infections in humans and need for better data, 2022). Reason, most of the studies are focused on certain geographical locations and there is a dearth of thorough and worldwide data on resistance trends (Amin Talebi Bezmin Abadi, World Health Organization Report: Current Crisis of Antibiotic Resistance, 2019). Furthermore, the fast changing character of bacterial resistance makes results obsolete very fast (Amin Talebi Bezmin Abadi, World Health Organization Report: Current Crisis of Antibiotic Resistance, 2019). Which calls for ongoing data update and monitoring (Amin Talebi Bezmin Abadi, World Health Organization Report: Current Crisis of Antibiotic Resistance, 2019).

Yet, there are several limitations in the existing study. A significant constraint is the geographic concentration of several investigations and a significant portion of the study is focused on particular geographic regions (Ana Monteiro, 2022). Which resulting in an absence of extensive, worldwide data about resistance trends (Ana Monteiro, 2022). So, the fast progression of bacterial resistance deems findings potentially ineffective hence the requiring ongoing surveillance and the data updates (WHO, 2022). A further restriction is the excessive dependence on conventional antibiotics with little focus on alternative therapies such as phage therapy or antimicrobial peptides (Amin Talebi Bezmin Abadi, World Health Organization Report: Current Crisis of Antibiotic Resistance, 2019). Finally, there exists a gap in the translation of laboratory findings into clinical practice. Which leads to obstruct the practical implementation of research results (Ana Monteiro, 2022).

Antibiotic resistance is a well established phenomena that has been intensively explored in recent decades. Researchers have uncovered many bacterial infections resistant to widely used antibiotics including *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Staphylococcus spp.*, *Escherichia coli*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* (WHO, 2015). Data indicates that the improper use and excessive use of antibiotics in human healthcare and agriculture significantly contribute to this resistance (S Kastner, 2006). The World Health Organization (WHO) has pointed out the worldwide scope of this problem and noting significant resistance levels in bacteria (WHO, 2015). Which responsible for severe bloodstream infections and prevalent community-acquired illnesses. (Report signals increasing resistance to antibiotics in bacterial infections in humans and need for better data, 2022).

The results of research will give us greater insight by showing all the common bacterial infections and how they differ in terms of resistance across different areas and hospital settings. This method can help find patterns of resistance that are similar and different across regions that leading to a better global knowledge of the problem (Ana Monteiro, 2022). It also goes against the usual focus on antibiotics because it looks at new patterns in resistance as well as the effects of new drugs and combination treatments (Amin Talebi Bezmin Abadi, World Health Organization Report: Current Crisis of Antibiotic Resistance, 2019). It can also lead to new therapeutic methods that are less likely to fail because of resistance by looking into different treatment strategies and how well they might work (Amin Talebi Bezmin Abadi, World Health Organization Report: Current Crisis of Antibiotic Resistance, 2019). Since the 1940s penicillin's discovery, comprehension of antibiotic resistance has changed dramatically. Where antibiotics were first widely used as they seemed to be an incredible solution for bacterial diseases and researchers started to find (Devin Hunt and

Olivia S. Kates, 2024). Meanwhile the certain germs were developing resistance to these medications by 1950s and 1960s (Devin Hunt and Olivia S. Kates, 2024). New antibiotics showed up but the cycle of resistance persisted. According to developments, in molecular biology and genomics in recent year shows the horizontal gene transfer, mutation, and adaptation among other genetic processes driving resistance have clearer understanding (WHO, 2015). Global efforts to monitor and fight antibiotic resistance including the WHO launch of surveillance systems, such as Global Antimicrobial Resistance and Use Surveillance System (GLASS) (WHO, 2015). It have been spurred by the realization of this danger to public health that antibiotics present (WHO, 2015).

This research not only expands on what is already known but also highlights how crucial it is to apply innovations in clinical settings and attempts to close the gap between laboratory research and practical application by taking seriously the real life implications of resistance patterns and offering useful suggestions for hospitals and healthcare institutions (Ana Monteiro, 2022).

This study provides a conceptual framework for understanding the complexity of antibiotic resistance. That can help to guide the research on identifying and mitigating resistance mechanisms. It also provides a comprehensive understanding of AMR which can help to innovative solutions and public health strategies. Furthermore, this study offers practical approaches to tackling antibiotic resistance which can guide to developing new treatments and promoting responsible antibiotic use in publics (Md. Mahabubul Islam Majumder, 2022). Finally shows a foundation for understanding the mechanisms, prevalence, impact and use of antibiotic and their resistance. It highlight the need for proper solutions, improved surveillance and create public awareness (Eulambius M. Mlugu, 2023). This study can contribute to the development of effective strategies to combat antibiotic resistance and improve public health outcomes (Md. Mahabubul Islam Majumder, 2022).

Antibiotic resistance is one of the most urgent threats to public health worldwide (Devin Hunt and Olivia S. Kates, 2024). By investigating prevalent bacterial infections and their resistance patterns, this study addresses a critical aspect of this global crisis in Jashore side of Bangladesh. It contributing valuable data and insights that can inform public health policies and clinical practices. It can also help healthcare professionals make informed decisions about selection of antibiotics for the treatment by understanding which bacteria are most commonly resistant to certain antibiotics and can lead to more effective and targeted therapies (Devin Hunt and Olivia S. Kates, 2024). Ultimately improving the patient outcomes and reducing the spread of resistant of antibiotics (Devin Hunt and Olivia S. Kates, 2024).

Many studies on antibiotic resistance focus on specific regions or healthcare settings but not for Jashore region (Eulambius M. Mlugu, 2023). This approach includes data from these regions and healthcare environments which provides a broader perspective and fills gaps in the current knowledge. This study can be used to educate healthcare providers and the public about importance of responsible antibiotic use which ultimately promoting better health practices (Eulambius M. Mlugu, 2023). It not only looks at the prevalence of bacterial infections but also delves into the resistance pattern of antibiotic (Md. Mahabubul Islam Majumder, 2022). This approach offers a more detailed and cleared understanding of the problem. By emphasizing the practical implications of findings and providing actionable recommendations, it bridges the gap between laboratory research and clinical practice.

Chapter 2

Aim and Objective

The aims and objectives of this study are highlighted the alarming situation of antibiotics causes by bacterial infections in Bangladesh, especially in Jashore city. It highlighting the possible causes of antibiotics resistance which making publics aware of this context. According to World Health Organisation (WHO), the mid of 20th century introduction of antibiotics revolutionized health care by significantly reducing death rate from the bacterial infections. In developing country like Bangladesh, the rate of antibiotic resistance is growing day by day. It is a kind of irony that publics are not so much aware of this context. Even now children are suffering from this deadly diseases due to resistance of antibiotic therapy. If this cases are uncontrollable then the bacterial will slowly develop resistance against all antibiotics. This means no available antibiotics are can work against bacterial infections in upcoming time. It is important to create and raise awareness about this context among people.

Chapter 3

Methodology

A retrospective study was conducted using 48 individual's patient culture reports from Jashore Medical College (JMC) between 25/09/2023 and 27/12/2024 by maintaining ethical concerns. The results of antibiotic resistance and sensitivity tests contained patient information including patient's age and gender group. The isolates are collected from the patient's blood, urine, stool and sputum. That involves bacterial species, namely *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Escheria coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Proteus spp.*, *Citrobacter spp.* and *Staphylococcus spp.* After data collection, an excel sheet was prepared with the patient's age, gender, sample collection data and antibiotics resistance and susceptibility. Patients were divided into four groups based on their age: A (0-14 years old), B (15-30 years old), C (31-50 years old) and D (51-80 years old). Then the distribution of microorganisms and their resistance pattern were studied in the different age and gender groups. The resistance pattern of these microorganisms in percentage was also prepared. After that the common resistance pattern was analysed from the Excel sheet.

Chapter 4

Results and objective

Table 1: Percentage distribution of Bacterial organism

Name of Bacterial Organism	Number of Patients	Percentage
Escheria coli	23	48%
Staphylococcus aureus	16	34%
Staphylococcus spp.	3	6%
Streptococcus pneumoniae	2	4%
Proteus spp.	1	2%
Citrobacter spp.	1	2%
Pseudomonas aeruginosa	1	2%
Klebsiella pneumoniae	1	2%
	Total= 48	

This table provides a clear overview of the prevalence of different bacterial organisms among the patients with percentage. It shows that Escheria coli is the most commonly observed bacterial organism which affecting nearly half of the patients at 48%. Next second highest number of patients affected by Staphylococcus aureus at 34%. On the other hand, other organisms like Staphylococcus spp., Streptococcus pneumoniae, Proteus spp., Citrobacter spp., Pseudomonas aeruginosa, and Klebsiella pneumoniae have much lower prevalence rates in this context.

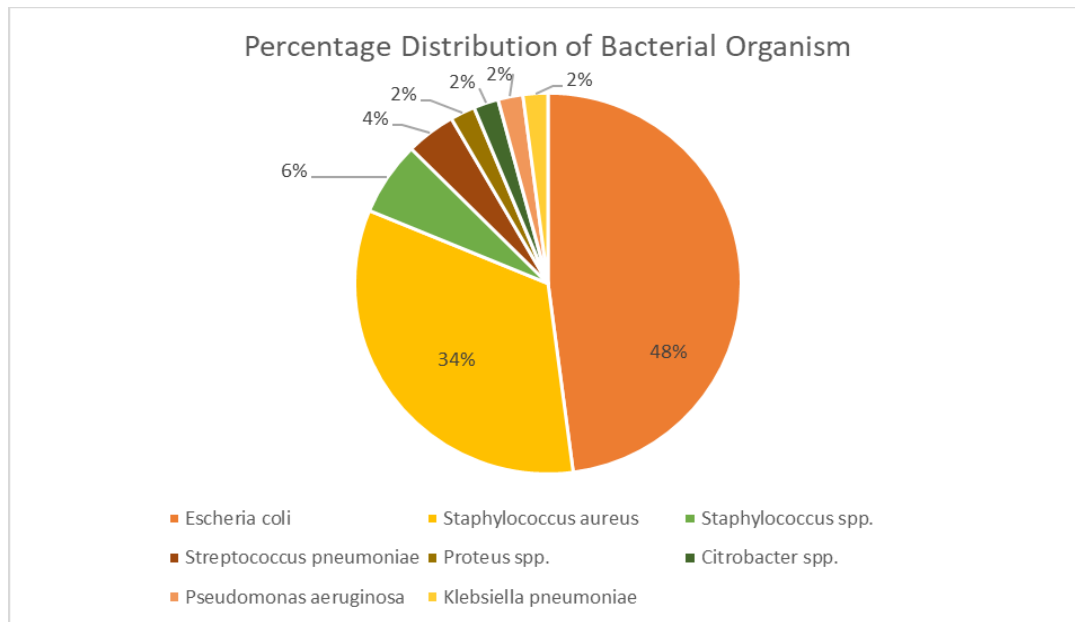


Figure: Percentage Distribution of Bacterial Organism

Table 2: Bacterial organism distribution according to age

Name of Bacterial Organism	A (0-14 years)	B (15-30 years)	C (31-50 years)	D (51-80 years)	Total
E. Coli	4 (17%)	4 (17%)	10 (44%)	5 (22%)	23
Staphylococcus aureus	1 (6%)	8 (50%)	6 (38%)	1 (6%)	16
Staphylococcus spp.	1 (34%)	00 (0%)	00 (0%)	2 (66%)	3
Streptococcus pneumoniae	1 (50%)	1 (50%)	00 (0%)	00 (0%)	2

Proteus spp.	00 (0%)	00 (0%)	1 (100%)	00 (0%)	1
Citrobacter spp.	00 (0%)	00 (0%)	1 (100%)	00 (0%)	1
Pseudomonas aeruginosa	00 (0%)	00 (0%)	00 (0%)	1 (100%)	1
Klebsiella pneumoniae	00 (0%)	00 (0%)	00 (0%)	1 (100%)	1

In this tablet, highlight the bacterial organism distribution according to patient's age by divided into four groups: A (0-14 years old), B (15-30 years old), C (31-50 years old) and D (51-80 years old). Here bacterial organism E.Coli affected most of the patients under 31-50 years old and most of the childrens are affected compaire to other organism.

- **E. coli** is most prevalent in the 31-50 years age group (44%), totaling 23 cases. Children affected rate is high in this organism.
- **Staphylococcus aureus** has the highest prevalence in the 15-30 years age group (50%), totaling 16 cases.
- **Staphylococcus spp.** shows the highest prevalence in the 51-80 years group (66%), totaling 3 cases.
- **Streptococcus pneumoniae** is equally present in the 0-14 and 15-30 years age groups (50% each). No cases in the older groups in total 2 cases.
- **Proteus spp.** and **Citrobacter spp.** each have a single case in the 31-50 years age group. No other presence in other age groups.
- **Pseudomonas aeruginosa** and **Klebsiella pneumoniae** each have a single case in the 51-80 years age group. No presence in other age groups.

This distribution helps identify age specific prevalence patterns of various bacterial organisms both male & female patients (Including childrens). Sample collected by patient's blood, urine, stool and sputum form hospitals.

Table 3: Resistance pattern of different classes of antibiotics against E.coli

Name of Antibiotic	Percentage of Resistance
Amoxicillin	53%
Azithromycin	47%
Ceftriaxone	57%
Ciprofloxacin	53%
Ceftazidime	61%
Gentamicin	53%
Levofloxacin	66%
Nalidixic acid	44%
Nitrofurantoin	61%
Netilmicin	66%

This table highlights the varying levels of resistance among different antibiotics against E.coli. Levofloxacin and Netilmicin showing the highest resistance at 66%, while Nalidixic Acid has the lowest resistance at 44%. So understanding that for Jashore city, the resistance patterns of

Levofloxacin and Netilmicin are most used and highly ineffective for treating bacterial infections whom affected by E.coli.

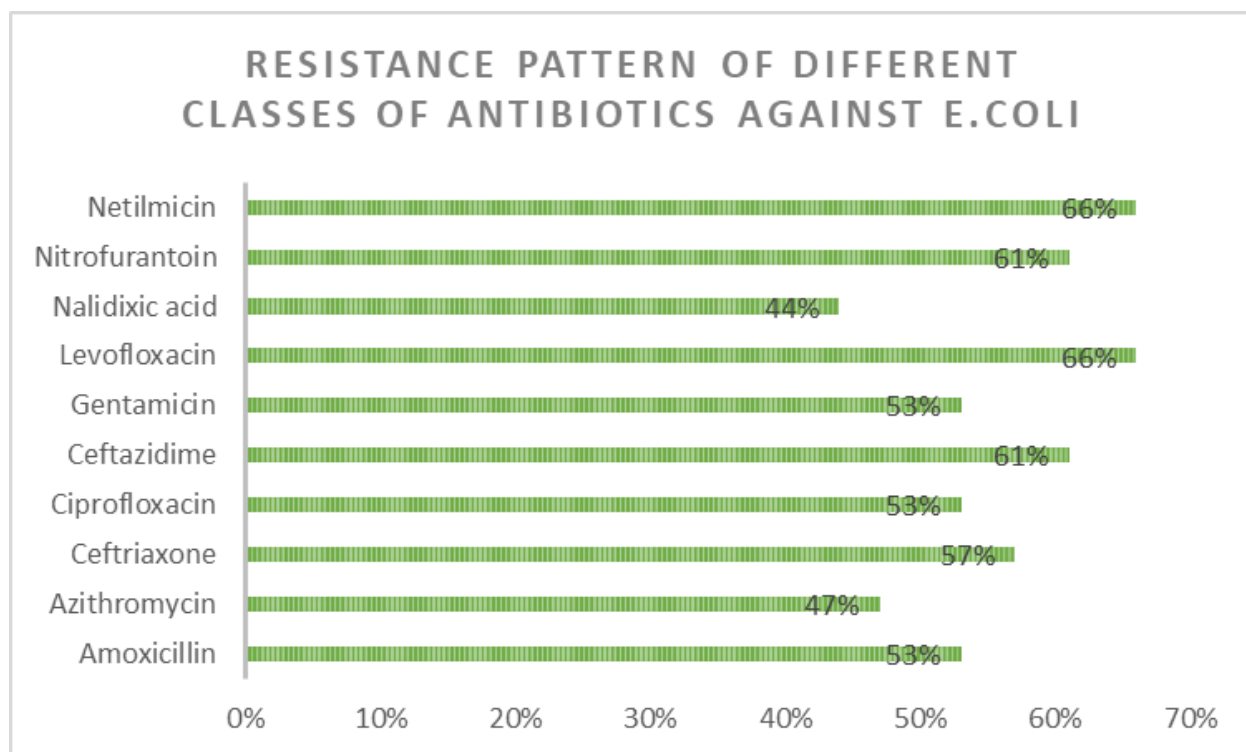


Figure: Resistance pattern of different classes of antibiotics against E.coli

Table 4: Sensitive pattern of different classes of antibiotics against E.coli

Name of Antibiotic	Percentage of Sensitive
Amoxicillin	47%
Azithromycin	52%
Ceftriaxone	43%
Ciprofloxacin	47%

Ceftazidime	39%
Gentamicin	47%
Levofloxacin	34%
Nalidixic acid	56%
Nitrofurantoin	39%
Netilmicin	34%

This table provides valuable information of different antibiotics in treating bacterial infections which causes by *E.coli*. Nalidixic Acid shows the highest sensitivity at 56%. On the other hand, Levofloxacin and Netilmicin show the lowest sensitivity at 34%. So understanding that for Jashore city, Nalidixic Acid is the most effective antibiotic for treating bacterial infections whom affected by *E.coli*.

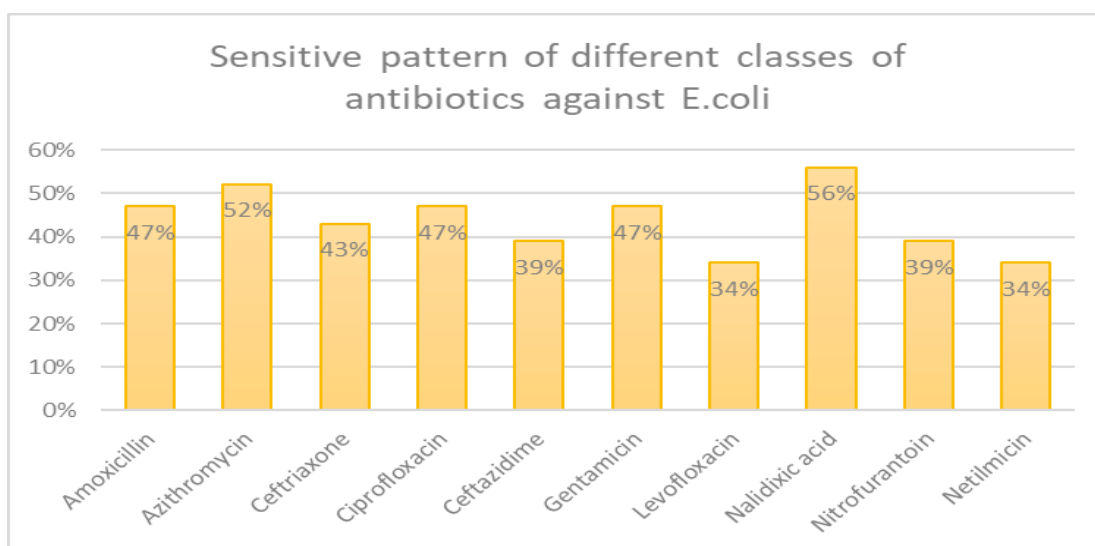


Figure: Sensitive pattern of different classes of antibiotics against *E.coli*

Table 5: Resistance pattern of different classes of antibiotics against Staphylococcus aureus.

Name of Antibiotic	Percentage of Resistance
Azithromycine	82%
Ceftazidime	94%
Ciprofloxacin	38%
Ceftriaxone	50%
Nalidixic acid	94%
Nitrofurantoin	50%
Levofloxacin	32%
Tetracycline	63%

This table provides data on the resistance patterns of different antibiotics when tested against Staphylococcus aureus. Ceftazidime and Nalidixic Acid show the highest resistance rates at 94%, while Levofloxacin shows the lowest resistance rate at 32%. So understanding that for Jashore city, Ceftazidime and Nalidixic Acid are more used and highly ineffective antibiotics for treating bacterial infections whom affected by Staphylococcus aureus.

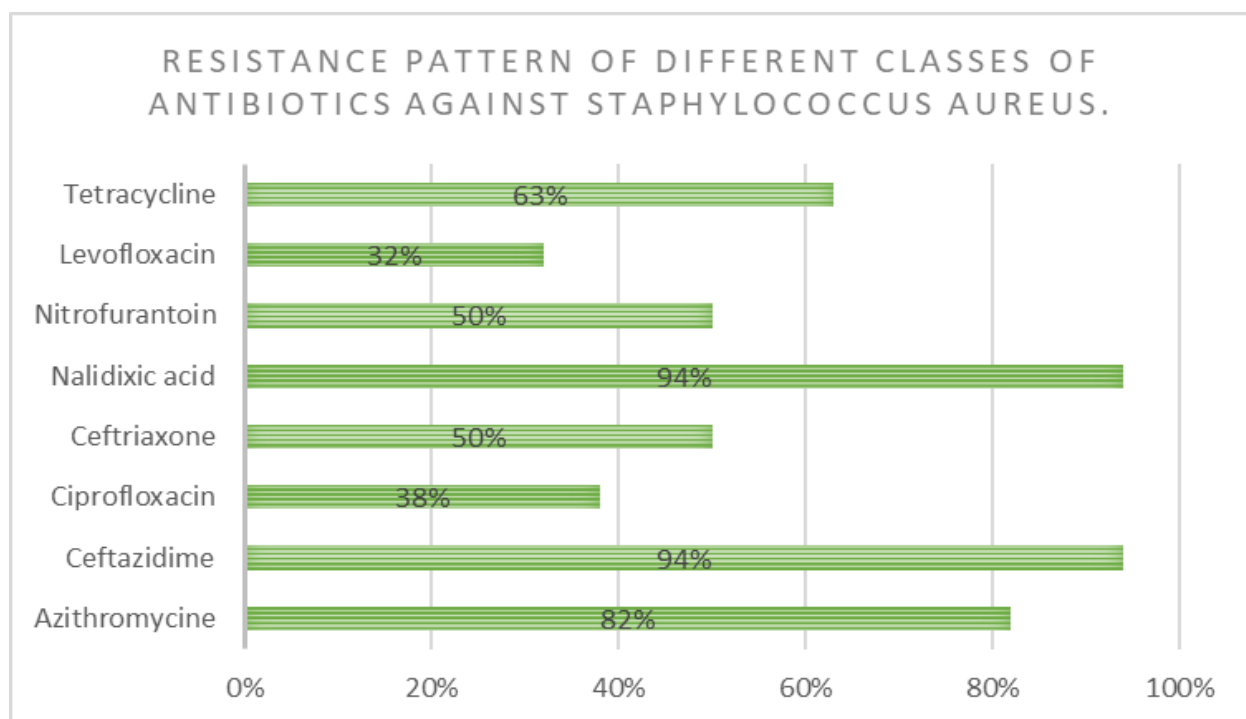


Figure: Resistance pattern of different classes of antibiotics against Staphylococcus aureus.

Table 6: Sensitive pattern of different classes of antibiotics against Staphylococcus aureus.

Name of Antibiotic	Percentage of Sensitive
Azithromycine	19%
Ceftazidime	7%
Ciprofloxacin	63%
Ceftriaxone	50%
Nalidixic acid	7%
Nitrofurantoin	50%

Levofloxacin	68%
Tetracycline	38%

The table presents data on the sensitivity of *Staphylococcus aureus* to various antibiotics. Levofloxacin shows the highest sensitivity rate at 68%. So suggesting them as less effective against bacterial strains tested. On the other hand Ceftazidime and Nalidixic Acid exhibit the lowest sensitivity rates at 7%. So understanding that for Jashore city, Levofloxacin is most used antibiotics for treating bacterial infections whom affected by *Staphylococcus aureus*.

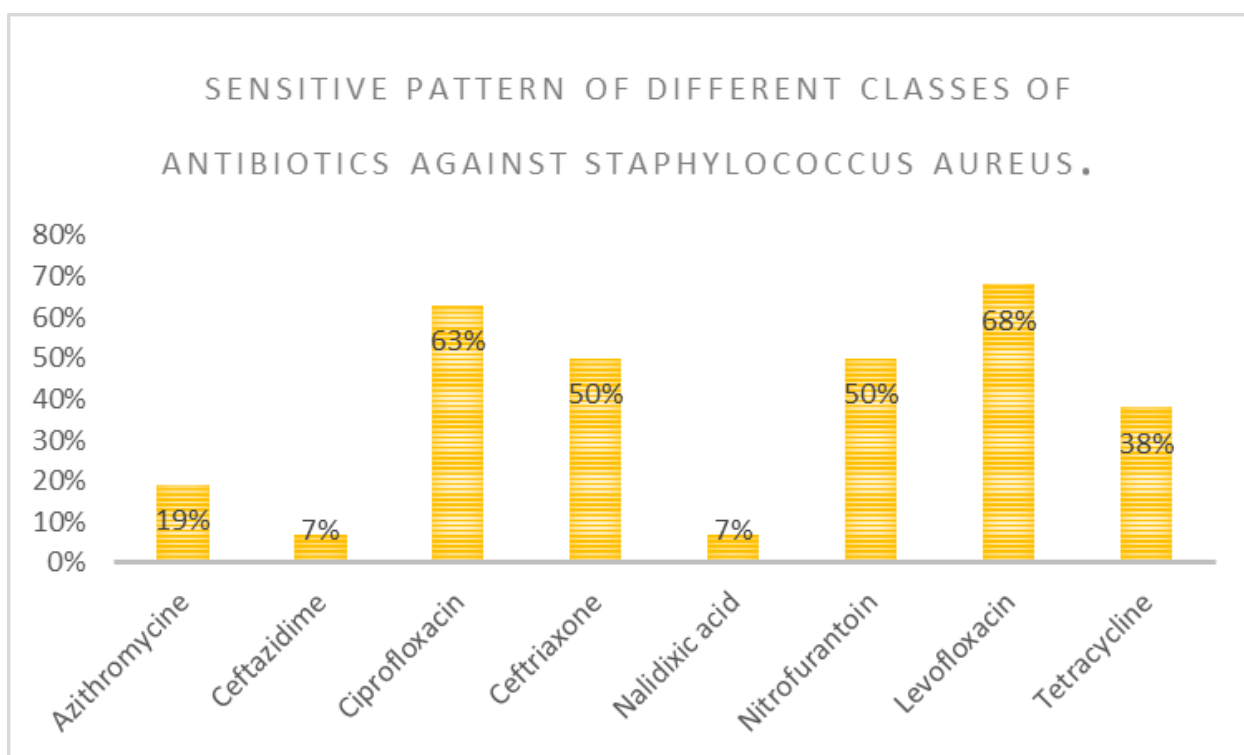


Figure: Sensitive pattern of different classes of antibiotics against *Staphylococcus aureus*.

Table 7: Resistance pattern of different classes of antibiotics against Staphylococcus spp.

Name of Antibiotic	Percentage of Resistance
Amoxicillin	65%
Azithromycin	66%
Cefepime	60%
Cefixime	66%
Nalidixic acid	98%
Tetracycline	34%

This table provides data on the resistance patterns of different antibiotics when tested against Staphylococcus spp. Nalidixic Acid shows the highest resistance rate at 98% and Tetracycline shows the lowest resistance rate at 34%. So understanding that for Jashore city, Nalidixic Acid is the most used antibiotics and highly ineffective for treating bacterial infections whom affected by Staphylococcus spp in this context.

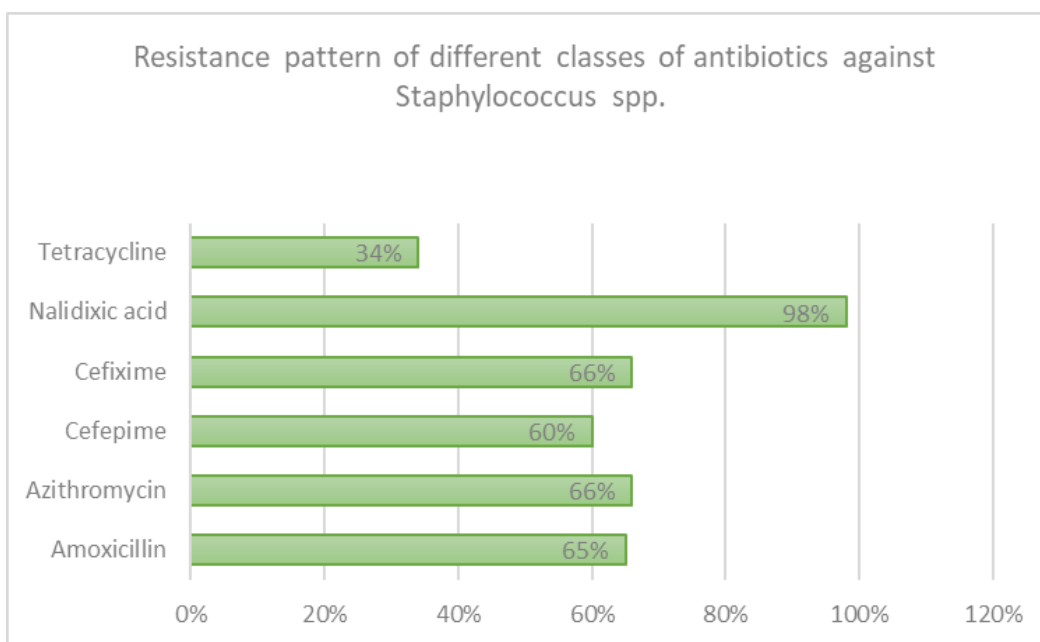


Figure: Resistance pattern of different classes of antibiotics against Staphylococcus spp.

Table 8: Sensitive pattern of different classes of antibiotics against Staphylococcus spp.

Name of Antibiotic	Percentage of Sensitive
Azithromycin	33%
Ceftriaxone	66%
Moxifloxacin	65%
Levofloxacin	65%
Netilmicin	99%
Imipenem	60%

The above table provides data on the sensitivity of *Staphylococcus* spp. to various antibiotics. Netilmicin shows the highest sensitivity rate at 99%. So understanding that for Jashore city, Netilmicin is highly effective against *Staphylococcus* spp in this context. On the other hand, Azithromycin shows the lowest sensitivity rate at 33%.

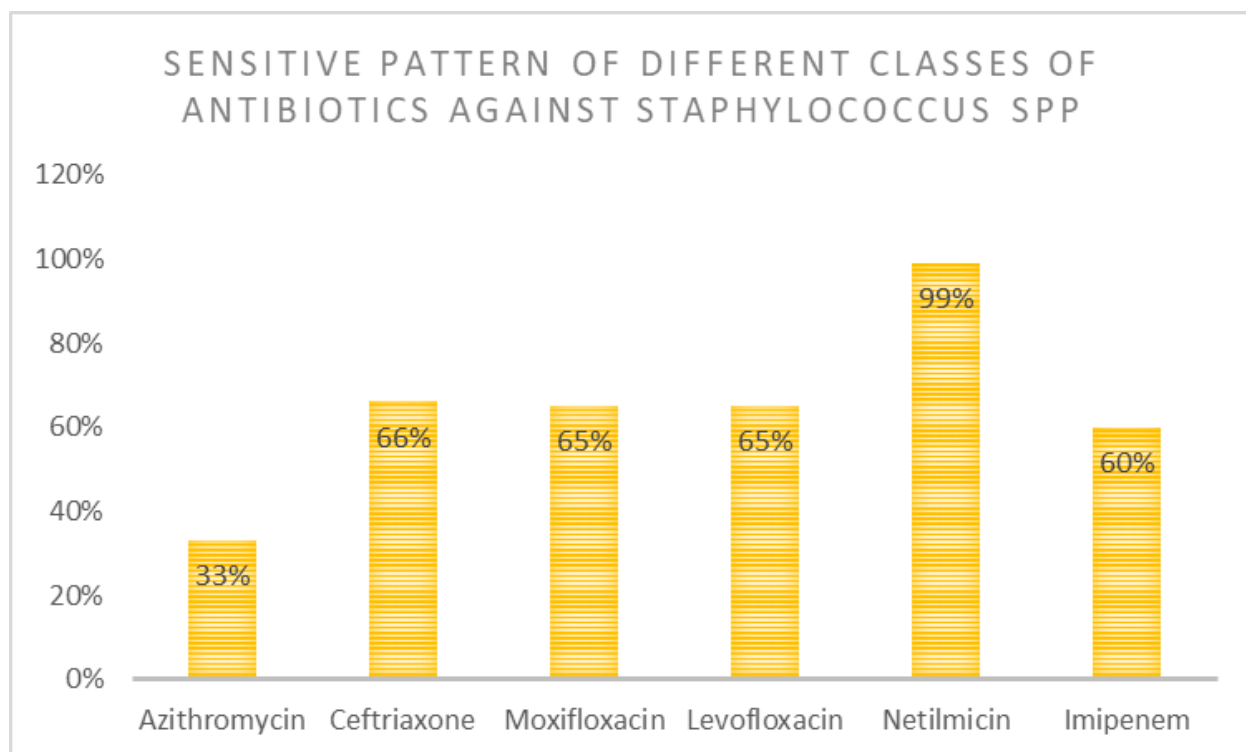


Figure: Sensitive pattern of different classes of antibiotics against *Staphylococcus* spp.

Table 9: Resistance pattern of different classes of antibiotics against *Streptococcus pneumoniae*

Name of Antibiotic	Percentage of Resistance
Azithromycin	99%
Aztreonam	50%
Ceftazidime	50%
Doxycycline	50%
Levofloxacin	50%
Nitrofurantoin	99%
Gentamicin	99%

This table presents data on the resistance patterns of different antibiotics when tested against *Streptococcus pneumoniae*. Azithromycin, Nitrofurantoin, and Gentamicin show the highest resistance rates at 99%. So understanding that for Jashore city, these antibiotics are most used and highly ineffective against *Streptococcus pneumoniae* in this context. On the other hand Aztreonam, Ceftazidime, Doxycycline, and Levofloxacin each show a 50% resistance rate.

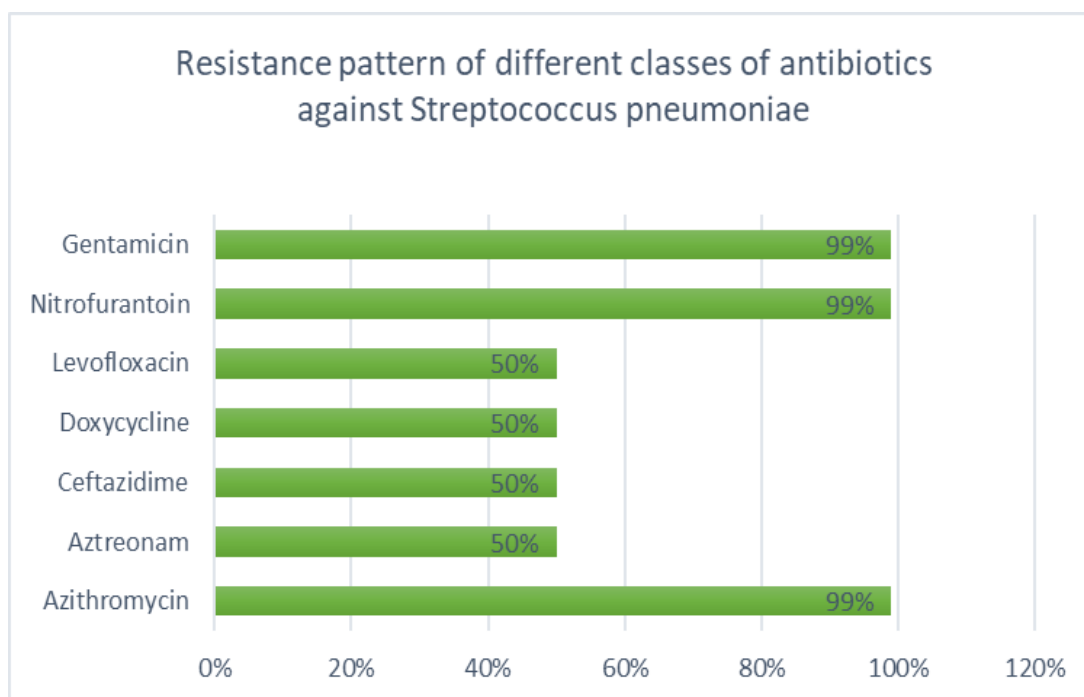


Figure: Resistance pattern of different classes of antibiotics against *Streptococcus pneumoniae*

Table 10: Sensitive pattern of different classes of antibiotics against *Streptococcus pneumoniae*

Name of Antibiotic	Percentage of Sensitive
Aztreonam	50%
Ceftazidime	50%
Cefepime	50%
Doxycycline	50%
Linezolid	99%
Vancomycin	99%

Netilmicin	99%
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This table indicates data on the sensitivity patterns of *Streptococcus pneumoniae* to various antibiotics. Linezolid, Vancomycin, and Netilmicin show the highest sensitivity rates at 99%. So understanding that for Jashore city, Linezolid, Vancomycin, and Netilmicin are highly effective against *Streptococcus pneumoniae* in this context. On the other hand, Aztreonam, Ceftazidime, Cefepime, and Doxycycline each show a 50% sensitivity rate.

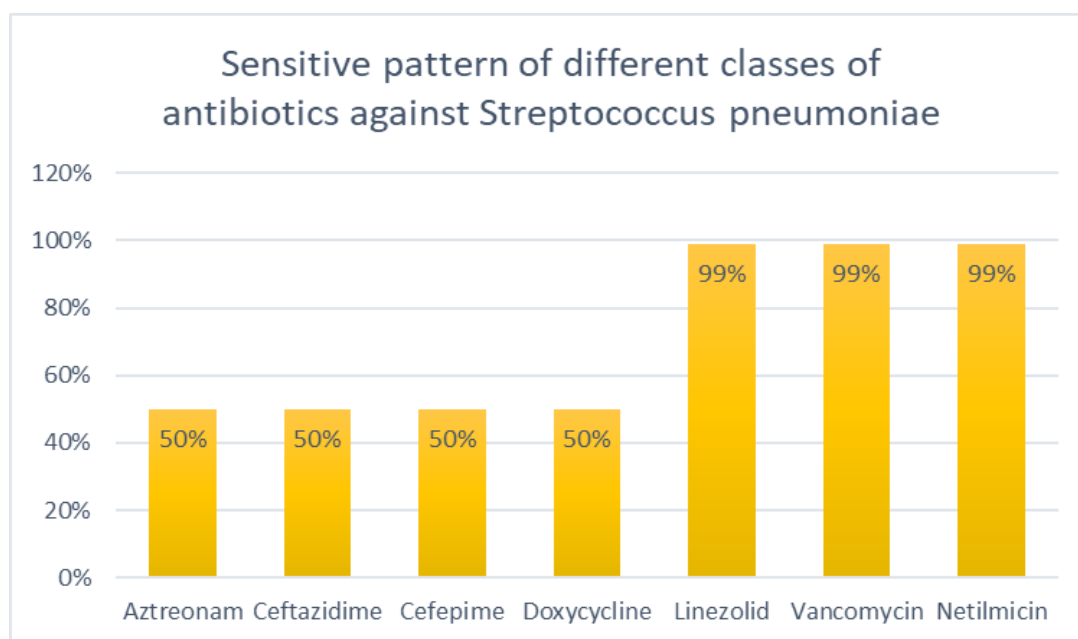


Figure: Sensitive pattern of different classes of antibiotics against *Streptococcus pneumoniae*

Chapter 5

Discussion

We observed the maximum patients are susceptible to E.coli. In table 1, we can see that 23 patients among 48 isolates are susceptible to E.coli. The second highest, about 16 patients among the rest are susceptible to Staphylococcus aureus. That means these two microorganisms are now top leading resistance causing pathogens nowadays in Jashore city. From table 2, we can observe that adult patients are most infected by Staphylococcus aureus and E.coli. Children patients are mostly affected by E.coli. If we thoroughly observe the resistance pattern of different classes of antibiotics, we can observe that Levofloxacin, Netilmicin, Ceftazidime and Nalidixic Acid are top leading antibiotics that have showed significant resistance towards E.coli, Staphylococcus aureus and Streptococcus pneumoniae in Jashore city. One of the highlighted reason behind this can be these antibiotics are very common and easily available. Other reasons behind this can be people's life style, food habits, misuse and overuse of antibiotics, lack of proper knowledge and guidelines, irrational use of antibiotics by health care providers and over the counter sales of antibiotics. Most of the people want to relief from disease fast, so they take high dose antibiotics. As soon as they get relief from these symptoms, they stop to taking antibiotics and do not complete the dosage properly. This can be another wild reason why adults patients are more susceptible to antibiotics resistance compared to children patients. If no steps is made as soon as possible and left uncontrolled the resistance of antibiotics resistance rate will increased and will be impossible to cure in upcoming days. So, this is the high time to made awareness and positive steps should be taken before antibiotics resistance becomes incurable.

Chapter 6

Conclusion

In this study it is found that E.coli is the most prevalent pathogen responsible for antibiotic resistance at Jashore city in Bangladesh. Netilmicin shows more resistance towards pathogenic bacteria in adult patients. Moreover Levofloxacin, Ceftazidime and Nalidixic Acid are top leading antibiotics that have showed significant resistance towards E.coli, Staphylococcus aureus and Streptococcus pneumonia. This is also alarming issue. The main reasons behind increased antibiotic resistance rate in developing country like Bangladesh are people's lifestyle and food habits, lack of knowledge, overuse and misuse of antibiotics, irrational use by healthcare providers, easy access and availability of antibiotics, over the counter sells of antibiotics etc (Report signals increasing resistance to antibiotics in bacterial infections in humans and need for better data, 2022). It is the high time to make awareness and take useful steps before antibiotic resistance becomes incurable.

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