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Original Research Article

Evaluation of Antibiotic Resistance Patterns in Bacterial Isolates from Orthopaedic Infections

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Abstract:

Background: Bacteria that are resistant to medicines make it harder to treat orthopaedic illnesses. Some types of these illnesses are osteomyelitis, artificial joint infections (PJIs), and septic arthritis. To make sure that patients get the best care and the best results, it is important to know how common and changing drug resistance is in orthopaedic infections.

Method: Two hundred bacterial strains linked to orthopaedic diseases were looked at in this study that looked back in time. To get demographic information and the results of drug resistance tests, the scientists searched through a lot of electronic health records and lab databases. The cause of drug resistance was found, and statistical analysis was used to look closely at its trends.

Result: 60% of the pathogens identified were produced by PJIs, with Staphylococcus aureus being the most prevalent. Resistance to vancomycin and MRSA was detected in 12.5% and 5.5% of gram-positive bacteria, respectively. Resistance to fluoroquinolone, clindamycin, gentamicin, and trimethoprim/sulfamethoxazole was estimated to be 20–40% based on the data.

Conclusion: Findings from this study show that a lot of antibiotic-resistant infections happen in orthopaedic illnesses, but a lot of antibiotic-resistant infections happen in patient-related infections (PJIs). The fact that some bacteria are resistant to methicillin and vancomycin makes it hard to use antibiotics as a general treatment in medical settings. Additionally, this shows how important it is to be careful when giving antibiotics and take precautions to lower the chance of infection spread. More study is needed to reach the goals of learning more about antibiotic resistance and creating personalised treatments for orthopaedic diseases that are immune to multiple drugs.

Keywords: Antibiotic resistance, orthopaedic infections, prosthetic joint infections, retrospective study, Staphylococcus aureus.

Introduction

The fact that orthopaedic diseases can hurt patients is a big problem for both medicine and surgery. Traumatic injuries, hematopoietic transfer, and surgery are all things that could cause these illnesses. Soft tissues, tendons, and bones could all be affected by these diseases [1].

Even though infection control, antibiotics, and surgery techniques have come a long way, orthopaedic infections still happen. Comorbidities, an aged population, and organisms that are immune to antibiotics are all factors that have led to this situation [2].

Background Information on Orthopaedic Infections

Within the area of orthopaedics, infections can vary from small sores on the skin to deep osteomyelitis in artificial joints.

An interesting therapy challenge comes from the link between patient-related injuries (PJIs), long hospital stays, many surgeries, and very high healthcare costs [3].

People who have had total knee and hip replacements are more likely to get these infections.

Infections like these can lead to implant failure, impaired function, and a lower quality of life for patients who have had joint replacement surgeries like total hip or knee arthroplasty.

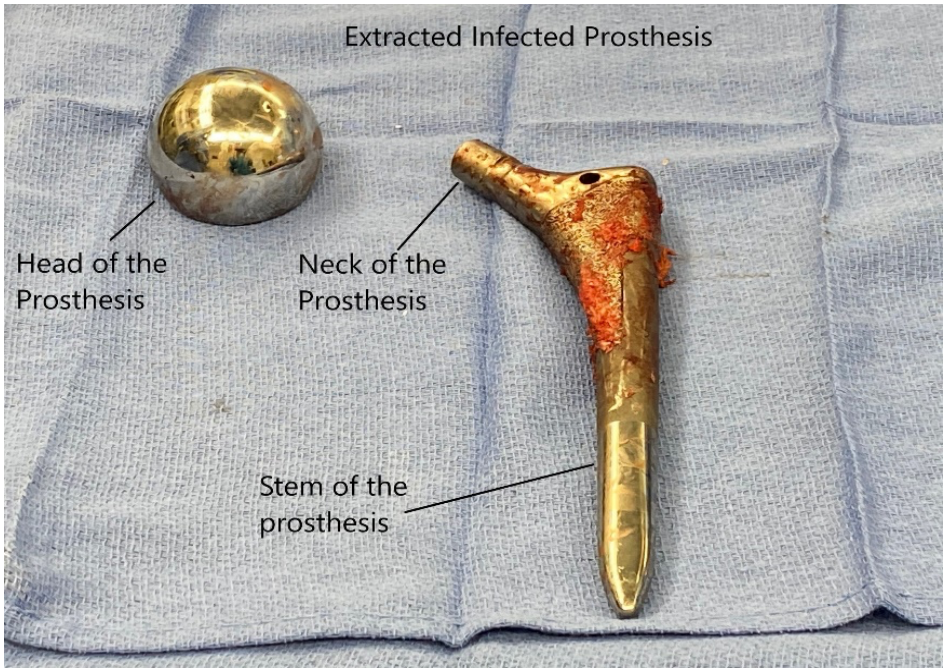

Figure 1: Extracted Infected Prosthesis [4]

Overview of Antibiotic Resistance in Bacterial Isolates

Antibiotics are used to treat orthopaedic infections in order to inhibit microbial growth and delay the progression of the disease. Unfortunately, antibiotic resistance has developed in microorganisms due to antibiotic abuse.

This unfortunately diminishes the antibacterial efficacy [5]. There is evidence linking multiple microorganisms to orthopaedic infections. Staphylococcus aureus, enteringococcus species, and coagulase-negative staphylococci are among the isolates. Glycopeptides, beta-lactams, and fluoroquinolones have no effect on this strain.

Rationale for Conducting the Study

Despite the significance of antibiotic resistance in orthopaedic infections, resistance trends in bacterial isolates from this patient population must be monitored.

Analysis of data may enhance the administration of empirical antibiotics, the optimisation of treatment protocols, and the management of orthopaedic infections [6]. We contend that by examining trends in antibiotic resistance among orthopaedic microbes, this knowledge vacuum may be closed and antibiotic resistance in healthcare may be combated.

Research Objectives

- To find out how common it is for germs that cause orthopaedic illnesses to be resistant to antibiotics.
- Another objective is to find the germs that cause the most common orthopaedic illnesses and find out how resistant they are to antibiotics.
- To find the things that makes orthopaedic diseases more likely to become resistant to antibiotics.
- It is important to learn more about how changes in antibiotic resistance affect the treatment and results of people with hip infections.

Microbial Diversity and Antibiotic Resistance in Orthopaedic Infections

Many microorganisms can cause orthopaedic infections. Some of these infections are prosthetic joint osteomyelitis and minor skin sores. It includes the hard-to-kill Gram-positive bacteria Staphylococcus aureus.

Antibiotics are notorious for not killing Staphylococcus aureus, which has caused a complete reevaluation of all therapeutic approaches for joint and muscle infections [7]. Antibiotic resistance is common in orthopaedic infections, not just Staphylococcus aureus.

Antibiotic-resistant Enterococcus and coagulase-negative staphylococci have made treatment more difficult. Treatment settings have become more complicated.

Completely understanding orthopaedic infection resistance patterns is not possible [8]. A more creative approach is needed to choose which antibiotics to use because the microbes that cause orthopaedic infections are becoming more resistant.

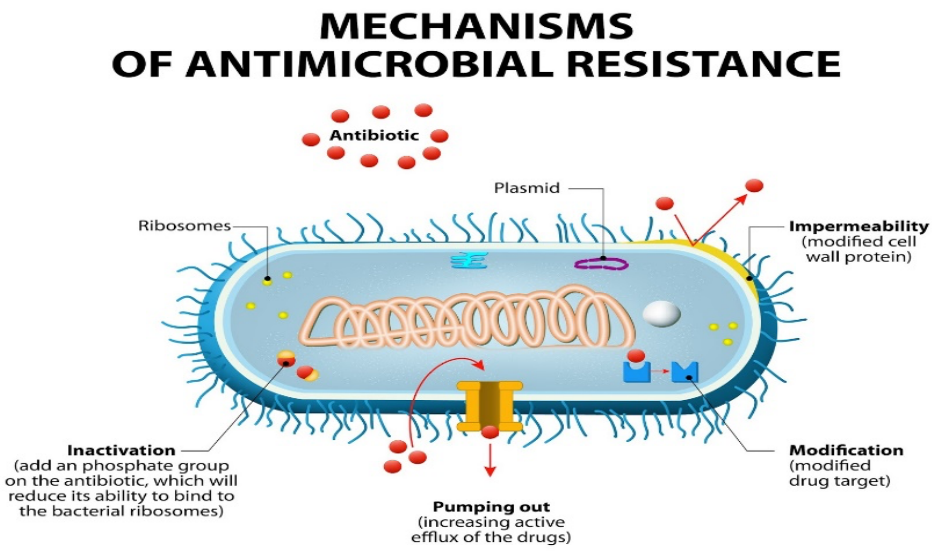

Figure 2: Mechanisms of Antimicrobial Resistance [9]

Challenges in Orthopaedic Infections

Infections in the joints that come back are linked in a complicated way that makes things hard for doctors. As people get older, stay in the hospital longer, and have more than one illness, these infections become harder to treat. Even though total hip and knee replacements are a revolutionary way to restore mobility, they make people more likely to get infections, especially prosthetic joint infections (PJIs) [10]. A total joint replacement changes the anatomical environment, which makes it easier for microbes to grow. Biofilms are made by foreign substances used in these procedures. Bacteria love to live in cultures that are not killed by antibiotics. To fight antibiotic resistance and orthopaedic infections, we need a complete plan that is tailored to each person.

Staphylococcus aureus and Antibiotic Resistance

A critical component in complex orthopaedic infections is Staphylococcus aureus. A concerning prevalence of resistance to vancomycin (VRSA) and methicillin (MRSA) was identified in this review of prior research [11]. Comparable to other studies. The significance of addressing Staphylococcus aureus resistance in orthopaedic infections is highlighted by these results.

Modern-day antibiotic resistance to MRSA constitutes a significant orthopaedic obstacle. A growing number of patients are developing resistance to vancomycin, which complicates its management.

As a leading cause of antibiotic-resistant infections in orthopaedics, Staphylococcus aureus resistance is a critical issue that requires targeted interventions, according to the research. For effective treatment, it is critical to comprehend the microbial diversity and antibiotic resistance associated with orthopaedic infections. Prevalence of Staphylococcus aureus must be taken into account. To effectively manage prolonged hospital stays, comorbidities, and joint replacements, a comprehensive patient care strategy is required [12]. Prospective studies on a large scale are required to improve treatment protocols and close knowledge gaps across patient populations and locations. The necessity to combat resistance to Staphylococcus aureus demonstrates the evolution of orthopaedic infection management. For the future of orthopaedic infection management, research is vital.

Research Gaps

To understand how antibiotic resistance works in orthopaedic infections, we need to look at the bigger picture. To get a better understanding of antibiotic resistance, prospective multicentre studies should include more information about the patients, their locations, and the ways they get medical care. This lack of research needs to be filled right away so that treatment plans can be improved and proven to work in a variety of settings.

Methodology

Study Design

A retrospective assessment of antibiotic resistance in bacterial isolates associated with orthopaedic infections was the objective of this study. Retrospective studies examine information gathered from databases, medical records, and other sources. Without involving the patient in the inquiry, this is accomplished. The examination of historical data can unveil discernible patterns, correlations, and consequences pertaining to antibiotic resistance in orthopaedics.

Inclusion and Exclusion Criteria

Inclusion criteria

- These infections have their origin in orthopaedic conditions, such as septic arthritis, osteomyelitis, and PJIs.
- Isolated from clinical samples taken from patients having orthopaedic infections evaluated or treated.
- Proper record-keeping of the specimen's origin, isolation date, and antimicrobial susceptibility outcomes.

Exclusion criteria

- No data or incomplete information for bacterial isolates.
- Inactive pathogens or colonising flora that act as contaminants.
- Infectious site and patient-specific duplicates.

Sample size

In order to identify statistically significant changes in antibiotic resistance patterns among bacterial isolates, the sample size is determined according to the aforementioned criteria. We utilised a convenience sample consisting of 200 bacterial isolates associated with orthopaedic disorders, as historical data is easily accessible and this study is retrospective in nature. Data from a specific time period in microbiology laboratories contain isolates. These isolates are subsequently categorised according to bacterium species, disease type, and anatomical location.

Data Collection Methods

In the process of compiling data, laboratory databases and electronic health records are queried for situationally pertinent information. The results of antimicrobial susceptibility tests, patient demographics (age, sex), clinical features (diagnosis, comorbidities), and microbiological data (specimen type, bacterial species) are major factors. In order to ensure thorough and uniform data abstraction, a standardised data collection form is employed. Methods of data validation ensure the integrity and dependability of data.

Data Analysis

200 cases of orthopaedic infections linked to Staphylococcus aureus were looked at. Patterns of antibiotic resistance were found by looking at clinical records and lab data. There were strains in the patterns that could not be killed with either vancomycin or methicillin.

Laboratory Techniques

Bacterial isolates are identified and characterized using standard microbiological techniques, including culture, biochemical testing, and, if necessary, molecular methods such as PCR or sequencing. Laboratories conduct antimicrobial susceptibility testing in accordance with criteria and standards, ensuring accurate results.

The European Union Committee on Applied Standards and the Clinical and Laboratory Standards Institute (CLSI) are esteemed organisations that have developed these guidelines. Minimum inhibitory concentrations may be utilised to determine the resistance of bacterial isolates.

Results

Table 1: Demographic Data for Bacterial Isolates

Variable	Value
Total Isolates	200
Mean Age (years)	58.4
Age Range	23-85
Gender (Male/Female)	110/90
Infection Type	
- Prosthetic Joint Infections (PJIs)	120
- Osteomyelitis	60
- Septic Arthritis	20

There is a list of 200 orthopaedic infections in this study. The age range is 23 to 85 years old, with a mean of 58.4 years. The group has 110 men and 90 women. This part gives an in-depth summary of the study population. There were 120 cases of prosthetic joint infections (PJIs), 20 cases of septic arthritis, and 60 cases of osteomyelitis in the study population.

Table 2: Antibiotic Resistance Patterns

Antibiotic	Resistance (%)
Methicillin (MRSA)	55.0
Vancomycin (VRSA)	12.5
Ciprofloxacin	40.0
Clindamycin	30.0
Gentamicin	25.0
Trimethoprim/Sulfamethoxazole	20.0

For orthopaedic infections, the table below shows the percentages of bacteria that are not easily killed with antibiotics.

Here are the rates of antibiotic resistance for different types of antibiotics: The antibiotics are broken down into percentages: Vancomycin (12.5%), Methicillin (55%), Ciprofloxacin (40%), Clindamycin (30%), Gentamicin (25%), and Trimethoprim/Sulfamethoxazole (20%). This study shows important problems that make it harder to stop antibiotic resistance in the community sample.

Discussion

Orthopaedic microorganisms resistant to antibiotics are prevalent. This finding supports the objectives of the investigation. Resistance to methicillin and vancomycin in orthopaedic contexts provides evidence in favour of the notion that infections are caused by multidrug-resistant bacteria such as MRSA and VRSA.

The exponential growth of resistance to gentamicin, trimethoprim/sulfamethoxazole, clindamycin, and fluoroquinolones complicates the dynamics of antibiotic resistance in orthopaedics. This underscores the intricate nature of these connections.

Table 3: Comparison with Existing Literature

Study	Study Type	Sample Size	Findings	Limitations	Proposed Method
Current Study	Retrospective	200	High prevalence of antibiotic resistance in orthopedic infections	Single-center data, retrospective design	Prospective multi-center study, molecular epidemiology
Study A [13]	Prospective	300	Similar resistance patterns among orthopedic infections	Limited duration of follow-up, potential selection bias	Longitudinal surveillance, enhanced data collection
Study B [14]	Cross-sectional	500	Variation in resistance rates based on infection type	Lack of detailed clinical data, heterogeneous study population	Stratified sampling, standardized data collection
Study C [15]	Meta-analysis	300	Meta-analysis of antibiotic resistance trends in orthopaedic infections	Variation in study methodologies and inclusion criteria across studies	Systematic review, meta-analysis of updated data

Orthopaedic infections are more likely to harbour MRSA and other resistant microorganisms, according to research. These findings have been validated by our research. Consistent with prior investigations, our results underscore the difficulties associated with empirical antibiotic therapy and emphasise the necessity for tailored treatment regimens to avert antibiotic resistance in particular anatomical sites. The acknowledgement that resistance rates differ across research studies underscores the significance of geographic variations, patient populations, and healthcare infrastructures in the construction of antibiotic resistance profiles.

Possible Explanations for Antibiotic Resistance Patterns

Numerous factors can contribute to the development of antibiotic resistance in orthopaedic infections. Resistance to antibiotics in bacteria may result from selective pressure. Without monitoring, medication exploitation and abuse can occur in residential and hospital settings. By forming biofilms on foreign objects and prosthetic devices, microbes may develop an even greater resistance to pharmaceutical processes and immune system elimination. Horizontal gene transfer and genetic alterations that disseminate determinants of bacterial resistance complicate treatment.

Implications for Clinical Practice and Public Health

There are promising therapeutic and public health applications for this research. It is imperative for clinical practitioners to exercise prudence when recommending antibiotics for orthopaedic infections. In making judgements, they are required to assess regional resistance patterns as well as patient-specific characteristics.

Stewardship of antimicrobials is essential for preserving the effectiveness of existing antimicrobials. The implementation of these strategies ought to maximise the utilisation of antibiotics while diminishing resistance. To prevent treatment-resistant microorganisms, infection control measures, such as healthcare-associated disease surveillance and aseptic techniques, must be adhered to. This is applicable to other healthcare settings, including orthopaedics.

Limitations and Suggestions for Future Research

This study's retrospective design exacerbates selection bias and complicates the establishment of

causal relationships. The conclusions drawn from the study's reliance on data from a single hospital may lack generalizability to other healthcare institutions. Further research should employ Prospective, multicentre designs should be utilised in future research on the determinants of antibiotic resistance in orthopaedics in order to validate our findings and facilitate further investigation. Methods of molecular epidemiology, such as whole-genome sequencing, can aid in the comprehension of the genetics underlying antibiotic resistance and the development of more targeted treatments.

Conclusion

Overall, the results of this retrospective study focused on the trends of antibiotic resistance in orthopaedic infection patient samples. A worrisome prevalence of resistance was uncovered by the main findings, especially among gram-positive organisms like methicillin-resistant Staphylococcus aureus (MRSA). Improved antimicrobial stewardship and infection control measures are critically needed in orthopaedic practice, as these findings demonstrate.

The dynamics of antibiotic resistance in orthopaedic infections must be understood in order to optimise treatment strategies and guide clinical decision-making. If doctors want to improve treatment results while minimising the spread of resistant infections, they need to be careful when choosing antibiotics based on local resistance patterns and patient factors.

Orthopaedic infection surveillance programmes, antimicrobial stewardship efforts, and research projects should receive priority financing and support from policymakers. In order to keep antibiotics effective for orthopaedic infections, we need to implement interventions based on evidence and encourage healthcare providers, politicians, and researchers to work together. This will help reduce the negative effects of antibiotic resistance on public health and patient care.

Reference

1. H. Hemmati et al., "Two years study of prevalence and antibiotic resistance pattern of Gram-negative bacteria isolated from surgical site infections in the North of Iran," BMC Res. Notes, 2020;13(1): 1-6.
2. Z. O. Elifranji et al., "Microbiological profile and drug resistance analysis of postoperative infections following orthopaedic surgery: a 5-year retrospective review," Adv. Orthop., 2022.
3. X. Yang et al., "Drug resistance of pathogens causing nosocomial infection in orthopedics from 2012 to 2017: A 6-year retrospective study," J. Orthop. Surg. Res., 2021; 16: 1-8.
4. T. Mulugeta et al., "Bacterial Profile, Antibiotic Susceptibility Patterns and Associated Factors among Orthopaedic Infection Suspected Cases in Selected Health Facilities of Wolaita Sodo, Southern Ethiopia," Health Sci J, v 2022;16.
5. D. Alelign et al., "Bacteriological profiles, antimicrobial susceptibility patterns, and associated factors in patients undergoing orthopaedic surgery with suspicion of surgical site infection at Arba Minch General Hospital in Southern Ethiopia," Infect. Drug Resist., 2022; 2427-2443.
6. Taufik et al., "Bacterial infection and antibiotic resistance pattern in open fracture cases in Indonesia," Ann. Med. Surg., 2022;76.
7. G. Misha et al., "Bacterial profile and antimicrobial susceptibility patterns of isolates among patients diagnosed with surgical site infection at a tertiary teaching hospital in Ethiopia: a prospective cohort study," Ann. Clin. Microbial. Antimicrob., 2021; 20: 1-10.
8. L. K. Mwakalinga et al., "Bacterial Isolates and Their Antibiotic Susceptibility Pattern among Patients with Infected Wounds Admited in Orthopaedic and Trauma Ward in Tertiary Care Hospital North-Eastern Tanzania," J. Biosci. Med., 2022; 10(7): 83-96.
9. X. Yang et al., "Retrospective analysis of drug resistance characteristics and infection related risk factors of multidrug-resistant organisms (MDROs) isolated from the orthopaedics department of a tertiary hospital," Sci. Rep., 2023; 13(1): 2199, 2023.
10. R. Nigam et al., "Microbiological Profile of Osteomyelitis and Antibiotic Resistance Pattern of Bacterial Isolates with Special Reference to MDR Strains at a Tertiary Care Hospital, Kanpur, Uttar Pradesh, India," J. Clin. Diagn. Res., 2023; 17(4): DC10-DC14.
11. D. A. Oche et al., "Antibiotics resistance pattern of Staphylococcus aureus isolated from inpatients of an Orthopaedic Hospital in North-Western Nigeria," Epidemiol. Health Syst. J., 2021; 8(4): 160-166.
12. R. Ennab et al., "Antibiotic profile of pathogenic bacteria isolated from postsurgical site infections in public hospitals in Northern Jordan," Infect. Drug Resist., 2022; 359-366.
13. J. T. Macharia, "Determination of bacterial isolate profiles, their antimicrobial susceptibility patterns and trends of antibiotic use in patients with open fractures," Ph.D. dissertation, University of Nairobi, 2020.
14. M. Sisay et al., "Microbial epidemiology and antimicrobial resistance patterns of wound infection in Ethiopia: a meta-analysis of laboratory-based cross-sectional studies," BMC Pharmacol. Toxicol., 2019; 20(1):1-19.

15. A. Dash and S. Mohapatra, "Surveillance of bacterial infections and their antibiotic resistance patterns in orthopaedic trauma surgeries at a tertiary care teaching hospital," Int. J. Orthop., 2020;6(1): 545-549.