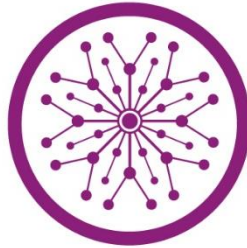


**Impact of Antibiotic Prophylaxis Protocol on an Incident of
Surgical Site Infection in Patients of Closed Fracture Treated with
Open Reduction and Internal Fixation**



SUPERIOR UNIVERSITY

**Thesis submitted to
The Superior University Lahore
In Partial Fulfillment of the
Requirement for the Degree of
Master of Science in Allied Health Sciences**

**By
Muhammad Mohsin Yar
Roll No. SU91-MSAHW-S23-080
Session 2023-2025
Faculty of Allied Health Sciences**

Author's Declaration

I hereby state that my MS thesis titled **“Impact of Antibiotic Prophylaxis Protocol on an Incident of Surgical Site Infection in Patients of Closed Fracture Treated with Open Reduction and Internal Fixation”** is my work and has not been submitted previously by me for taking any degree from this University,

The Superior University, Lahore, or anywhere else in the country/world.

At any time if my statement is found to be incorrect even after my graduation, the university has the right to withdraw my MS/M.Phil. degree.

Name of Student:

Muhammad Mohsin Yar

Date: _____

Plagiarism Undertaking

I solemnly declare that the research work presented in the thesis titled **“Impact of Antibiotic Prophylaxis Protocol on an Incident of Surgical Site Infection in Patients of Closed Fracture Treated with Open Reduction and Internal Fixation”** is solely my research work with no significant contribution from any other person. Small contribution/help wherever taken has been duly acknowledged and that complete thesis has been written by me.

I understand the zero-tolerance policy of the HEC and University,

The Superior University, Lahore,

towards plagiarism. Therefore, I as the author of the above-titled thesis declare that no portion of my thesis has been plagiarized and any material used as a reference is properly referred/cited. I undertake that if I am found guilty of any formal plagiarism in the above-titled thesis, even after awarding of MS/M.Phil. degree, the University reserves the rights to withdraw/revoke my MS/M.Phil. degree and that HEC and the University have the right to publish my name on the HEC/University website on which names of students are placed who submitted a plagiarized thesis.

Author Signature: _____

Name: **Muhammad Mohsin Yar**

Research Completion Certificate

This is to certify that the thesis entitled “**Impact of Antibiotic Prophylaxis Protocol on an Incident of Surgical Site Infection in Patients of Closed Fracture Treated with Open Reduction and Internal Fixation**” submitted by “**Muhammad Mohsin Yar**” has been accepted towards the partial fulfillment of the requirement for “**MS Allied Health Sciences**”. The quality of the work contained in this thesis is adequate for the award of a degree.

Signature: _____

Supervisor Name: **Dr. Muhammad Adnan Hafeez**

Designation: **Assistant Professor**

Certificate of Approval

This is to certify that the research work presented in this thesis, titled **“Impact of Antibiotic Prophylaxis Protocol on an Incident of Surgical Site Infection in Patients of Closed Fracture Treated with Open Reduction and Internal Fixation”** was conducted by **“Muhammad Mohsin Yar”** under the supervision of **“Dr. Muhammad Adnan Hafeez”**

No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Faculty of Allied Health Sciences, The Superior University, Lahore in partial fulfillment of the requirements for the degree of Master of Science in the field of **“Allied Health Sciences”** in the Faculty of Allied Health Sciences at The Superior University, Lahore.

Student Name: Muhammad Mohsin Yar

Signature: _____

Examination Committee:

Session Chair:

Signature: _____

a) External Examiner:

Signature: _____

b) Internal Examiner:

Signature: _____

c) Supervisor Name:

Signature: _____

d) PL/HOD: Dr. Muhammad Adnan Hafeez

Signature: _____

e) Dean: Prof. Dr. Muhammad Naveed Babur

Signature: _____

f) Contr. of Examination: Dr. Muhammad Haris

Signature: _____

DEDICATION

This humble research work of mine is hereby dedicated to my Parents, Supervisor Dr. Muhammad Adnan Hafeez, Co-supervisor, Dr Shakeel Basit, and all others who helped me throughout my research data collection. The dedication is all about their valuable drawings on my groundbreaking brain, my research behavior, and his very respectful, friendly dealing with me that I will never forget during my life.

ACKNOWLEDGEMENT

In the name of Allah, the most Gracious, the most Merciful. I am extremely thankful to Almighty Allah, the entire source of knowledge and wisdom endowed to mankind, for giving me the acumen and vision to complete this endeavor.

I want to express my profound gratitude to my supervisor for his/her wise counsel and encouraging attitude towards this study. I am extremely grateful to him/her for immensely facilitating me during my study period by ensuring the provision of favorable circumstances and a conducive environment. This project would not have been possible without his support and expert guidance.

In the end, I would like to extend my deepest gratitude to my family members. Without their encouragement, I would not have been able to complete this endeavor.

Student Name:

Muhammad Mohsin Yar

Table of Contents

Author's Declaration	ii
Plagiarism Undertaking.....	iii
Research Completion Certificate	iv
Certificate of Approval	v
DEDICATION	vi
List of Tables.....	x
List of Figures	xi
List of Abbreviations.....	xii
Abstract	1
Chapter 1	2
Introduction	2
Objectives.....	6
Chapter 2	7
Literature review	7
Chapter 3	13
Methodology	13
Study design	13
Clinical setting:	13
Study Duration:	13
Target Population	13
Study Population	13
Sample Size.....	13
Sampling Technique.....	14
Sample Selection.....	14
Data Collection Tools/Procedure	14
Data analysis	15
Ethical Considerations	15
Chapter 4	16
Results	16

Sociodemographic characteristics of the participants:	16
Clinical-related factors of the participants:	17
Descriptions of study variables:	20
Chapter 5	25
Discussion	25
Conclusion	29
Recommendations	30
References	31
Consent Form:	38
Appendix-I	40
Questionnaire	40

List of Tables

Table No. 4.1 Description Regarding Sociodemographic Characteristics.....	16
Table No. 4.2 Description of clinical related factors	18
Table No. 4. 3 Description of study variables.....	20
Table No. 4.4 Comparison of outcome with other independent variables.....	24

List of Figures

Figure No. 4. 1 Description of Diabetes Mellitus	18
Figure No. 4. 2 Description of Hypertension	18
Figure No. 4. 3 Description of BMI	19
Figure No. 4. 4 Description of Types of fractures	21
Figure No. 4. 5 Description of Pre-Op Antibiotics	22
Figure No. 4. 6 Description of Types of Implants	22

List of Abbreviations

American Society of Health-System Pharmacists (ASHP).....	4	osteosynthesis (MIPO)	2
Body Mass Index (BMI)	23	open reduction and internal fixation (ORIF)	1
Centers for Disease Control and Prevention (CDC).....	4	Plaster of Paris (POP)	13
C-reactive protein (CRP)	18	Randomized controlled trials (RCTs)	7
Erythrocyte sedimentation rate (ESR).....	18	Statistical Package for the Social Sciences (SPSS)	14
Health Belief Model (HBM).....	9	surgical site infections (SSIs)	1
International Business Machines (IBM)	14	White Blood Cells (WBCs).....	18
minimally invasive plate		World Health Organization (WHO).....	4

Abstract

Background: Orthopedic surgical site infections (SSIs) are common, increase morbidity, length of stay, and cost of care, and worsen patient trajectory. Despite all these, SSIs are still present thus reaffirming that improvement in the surgical skill and enhanced approaches to impeding infection complications are still significant. Closed fractures, including Open Reduction and Internal Fixation (ORIF) depend on the area, the level of complexity, and possible injuries. This provides evidence for current best practice in operative surgery that antibiotic prophylaxis does not need to be continued and should not be given for more than 24 hours after surgery.

Objectives: This study aimed to find out how antibiotics influence surgical site infection in a closed fracture patient which requires open reduction and internal fixation.

Methodology: This cross-sectional study was carried out at Gulab Devi Teaching Hospital. Data was collected using a convenient sampling technique. Samples were chosen due to the determined features, and a revised questionnaire was employed for data obtaining. Qualitative variables were described by using percentage and frequency, while mean and standard deviation were used for quantitative variables.

Results: This study established significant and non-significant effects of a range of independent variables. Diabetes mellitus had a significant association with wound infections or complications ($p = 0.039$). Body mass index was a highly significant predictor with an increase in BMI leading to complication ($p = 0.001$). The findings in the culture report revealed a relationship between bacterial type and risk of infection = 0.000. On the other hand, no statistically significant relation was observed between implant type ($p = 0.514$), the fracture site ($p = 0.580$), and preoperative antibiotics ($p = 0.482$).

Conclusion: The study revealed that ceftriaxone and cefazoline pre-surgery antibiotics lowered post-surgery infection rates by 1.9%, and aspects like chronic illness, Diabetes, hypertension and BMI affected the odds of infection.

Keywords: surgical site infections, Open Reduction and Internal Fixation, Prophylactic, antibiotic

Chapter 1

Introduction

After orthopedic surgeries, particularly those involving open reduction and internal fixation (ORIF) of closed fractures, surgical site infections (SSIs) are among the most frequent side effects. Morbidity, prolonged hospital stays, higher healthcare expenses, and worse patient outcomes are all greatly impacted by SSIs. Orthopedic surgeons around the world continue to face difficulties due to the prevalence of SSIs, even with improvements in surgical methods and infection control strategies. A crucial tactic in perioperative care is antibiotic prophylactic regimens, designed to lower the risk of infection (1).

With roots in the 18th century, orthopedic surgery has a long and illustrious history. Modern orthopedics was founded by the French physician Nicolas Andry, who first treated deformities in children before expanding to treat musculoskeletal disorders in adults as anesthetic and antiseptic techniques advanced (2). More accurate diagnosis and treatment planning were made possible by the advancement of surgical instruments and radiographic imaging by the early 20th century. In the latter half of the 20th century, orthopedic surgeons were able to undertake minimally invasive operations, such as arthroscopy, which improved patient outcomes and shortened recovery periods (3).

Orthopedic surgery is frequently used to repair fractures, especially closed fractures that need intervention like Open Reduction and Internal Fixation (ORIF). Fractures are classified according to their nature, location, and level of intricacy. In an open fracture, the bone protrudes through the skin, increasing the risk of infection. In a closed fracture, the bone breaks but does not puncture the skin (4).

In contrast to open or compound fractures, in which the bone penetrates the skin barrier, closed fractures, often referred to as simple fractures, are a form of bone injury in which the skin surrounding the fracture site is unbroken. Although low-energy processes can also produce these fractures in groups with reduced bone density, such as the elderly, they are common in orthopedic trauma and are frequently caused by high-energy events like falls, car accidents, or sports injuries (5). Closed fractures are divided into different categories based on the damaged bone, fracture pattern, and severity. Transverse, oblique, spiral or comminuted fractures are possible, and they can affect long bones like the femur, tibia, or

humerus. Classifying them is essential for choosing the best course of action, which usually entails conservative therapy with casting or surgical intervention, such as open reduction and internal fixation (ORIF), depending on the alignment and stability of the fracture (6).

A large percentage of musculoskeletal injuries globally are caused by closed fractures, which place a heavy strain on healthcare systems. According to studies, young persons who have experienced trauma had the highest incidence of fractures, while elderly adults who have osteoporosis-related fragility fractures have the highest frequency. Age, gender, degree of physical activity, and concomitant conditions like osteoporosis, diabetes, or long-term steroid usage are risk factors (7, 8).

For fractures that include articular surfaces, are unstable, or are displaced, ORIF is recommended. Closed fractures of the femur, tibia, and humerus, as well as intricate fractures of the ankle and wrist, are particular instances. Furthermore, ORIF is frequently utilized to repair fractures linked to osteoporosis or growth plate injuries in the geriatric and juvenile populations, respectively (9).

One of the most frequent and serious side effects of surgery is surgical site infection (SSI), which raises patient morbidity, lengthens hospital stays, and adds to medical expenses. These infections, which involve the surgical incision or deep tissues altered during surgery, appear 30 days after surgery or within a year if an implant is employed (10, 11).

In these situations, SSIs may result in unfavourable consequences such as osteomyelitis, implant failure, delayed healing, and even sepsis (12). The three types of SSIs include organ/space infections, deep incisional infections, and superficial incisional infections. *Staphylococcus aureus*, coagulase-negative staphylococci, and gram-negative bacilli are the main culprits. Together with the patient's inherent and extrinsic risk factors, the introduction of germs into the surgical site during or after the procedure promotes the development of infection (13).

Patient-related factors including diabetes, obesity, smoking, and malnutrition, as well as procedure-related factors like poor aseptic methods, lengthy surgical times, and inappropriate antibiotic prophylaxis, are important risk factors for surgical site infections (SSIs). Notably, the widespread use of internal fixation devices for closed fractures necessitates special attention since they might serve as a breeding ground for biofilms, decreasing the efficacy of conventional treatments (14, 15).

The perioperative administration of antimicrobial medicines to high-risk patients or operations to avoid infections is known as antibiotic prophylaxis (16). Prophylactic use, as opposed to therapeutic use, attempts to lower the microbial burden during the crucial period when surgical wounds are most vulnerable to contamination. Since most infections are caused by germs introduced during surgery rather than by hematogenous dissemination, the time-dependent character of SSIs serves as the foundation for the prophylactic argument (17).

A turning point in SSI preventive measures was reached in the 1970s when follow-up clinical trials confirmed the importance of prophylaxis, especially in clean-contaminated and contaminated operations (18).

Prophylactic antibiotics target the most likely microorganisms according to the type of surgery and the surgical location. Among their modes of action include disruption of nucleic acid synthesis (e.g., fluoroquinolones), interference with protein synthesis (e.g., aminoglycosides), and inhibition of bacterial cell wall formation (e.g., beta-lactams). The spectrum of activity, pharmacokinetics, and patterns of local resistance must all be taken into account when choosing an antibiotic (19).

The effectiveness of antibiotics in preventing SSIs depends on when they are administered. According to studies, to reach the best tissue concentrations at the moment of incision, antibiotics should be administered no later than one hour before the surgical procedure (20). Drugs with longer infusion durations, like fluoroquinolones or vancomycin, should be administered 120 minutes before incision (21). The importance of exact scheduling is highlighted by the fact that delayed administration, even by a few hours, is linked to higher SSI rates (22). To maintain therapeutic concentrations in tissues during the surgical operation, the antibiotic dosage must be adequate. Dosing needs are influenced by patient characteristics such as blood loss, obesity, and renal function. To guarantee proper distribution in fatty tissues, obese patients, for example, might need greater dosages(23).

Antibiotic usage that lasts longer than 24 hours after surgery raises the risk of antibiotic resistance and provides no further benefit in preventing SSI (23). With some high-risk surgeries being an exception, current guidelines recommend a single

preoperative dose or continuance for no more than 24 hours in the majority of procedures (24).

Prophylaxis is typically not recommended for clean procedures unless there are particular risk factors, like immunosuppression or implant use. Broad-spectrum antibiotics that target both gram-positive and gram-negative bacteria are advised in clean-contaminated processes (25).

This study explores if following antibiotic prophylaxis guidelines reduces infection rates in patients who receive ORIF treatment for closed fractures. ORIF surgeries for closed fractures risk infection because the procedures open the skin to allow access to bones and increase bacterial entry. Doctors tend to recommend pre-surgery antibiotics for infection prevention but experts still disagree about the best way to use these drugs. This project examines how well a particular approach to antibiotic prevention works to reduce infections in patients following ORIF surgery. This research examines ways to strengthen antibiotic protocols so patients receive better care through shorter hospitalizations and decreased healthcare spending on postoperative infections.

Objectives

The objectives of this study were:

- To determine the effect of antibiotics on surgical site infection in a patient of a closed fracture that is treated with open reduction and internal fixation.

Chapter 2

Literature review

Surgical prophylaxis refers to the use of antibiotics before operations to prevent infections. It is even more important in orthopedic surgeries in which implant stability and overall patient outcomes can be threatened by infection. The meta-analysis of various research has brought out the fact that the use of preventive antibiotics to the surgical site before making an incision or before death can minimize the development of SSIs (17).

It is well known that the time at which the antibiotic is administered has the potential to improve the effectiveness of the antibiotic. A review by Prakash (2021) showed that antibiotic prophylaxis within one hour before the surgical incision reduces SSI rate (26). Further, while choosing the appropriate antibiotics, normally first-generation cephalosporins like cefazoline is advised as their eminent effectiveness against the skin flora and optimal pharmacodynamics are considered (27).

The issue that has occasionally been contemplated is the duration of antibiotic prophylaxis. Intrapartum prophylaxis only until 24 hours post-surgery is usually encouraged in an attempt to reduce the instances of antibiotic resistance as well as side effects. However, a meta-analysis is in favor of short-term use, indicating no enhancement of SSI rates with prolonged prophylaxis (28).

Understanding the predictors of SSIs in ORIF patients benefits modifying the preventive measures for the patients. The use of duration of surgery, comorbid conditions, and the nutritional status of the patient have been used to explain increased infection rates. These are critical additional measures to antimicrobial prophylaxis measures such as adherence to strict aseptic principles during surgery and improvement of patients' medical status before the operation (29).

In the management of antibiotic prophylaxis, the basic aim is to have sufficient concentration of the drug in the serum and the tissues up to the time of the surgery. In the clean or clean-contaminated surgery procedures involving 2,847 patients, patients who received antibiotics administered within 2 hours before incision had a 0.6 percent rate of surgical site infection. Patients who received prophylactic antibiotics within more than three hours of the operation incision had a two-time increased risk of surgical site infection compared to the patients who

received antibiotics more than two hours before the operation incision had about six times increased risk of surgical site infection (30).

Surgical antibiotic prophylaxis started in the mid part of the twentieth century having undergone several changes to reduce risks resulting from post-surgical infections. These early works, by R. Sommerstein et al., 2023 have drawn a direct correlation between the timing of antibiotic prophylaxis and lowered odds of acquiring an infection. According to the WHO and the CDC, the early administration of antibiotics is required, which presumable is within an hour before the surgical cut.

Several kinds of literature regarding orthopedic procedures indicated that there is a profound decrease in SSIs in procedures involving the implantation of hardware through the administration of antibiotic prophylaxis. They pointed to the evidence, that patients administered prophylactic antibiotics had a lower infection rate than the patients who were not, thus, stressing on the protective effect of these protocols in terms of SSIs in orthopedic surgeries (31).

More recently, in a large meta-analysis of multiple Randomized controlled trials (RCTs) concerning antibiotic prophylaxis on orthopedic operation, including closed fracture, ORIF supported the use of antibiotic prophylaxis. It also validated the previous findings that the utilization of prophylactic antibiotics, given as a single preoperative dose within 60 minutes of surgical wound incision, decreases the incidence of SSIs by about 40-50%. They also discovered that the increased use of antibiotics for more than one week does not even enhance the outcome which becomes a yardstick to compliance with protocols (32).

A. Lakhani and colleagues tried to establish the connection between the use of antibiotics for prophylaxis and the emergence of antibiotic-resistant organisms in orthopedic surgeries. In their work, they proved that antibiotic prophylaxis dramatically lowered the incidence of SSIs although more usage and longer duration of the antibiotics contributed to resistance, particularly in a hospital setting. This study reminded me of the importance not to overuse antibiotics for patients because infections could be prevented, but resistance could happen at the same time (33).

C. A. Lin and O'Hara designed their literature review to compare the postoperative infection rate of different antibiotic protocols for patients who underwent ORIF for closed fractures. The studies they did show that cefazolin was both the most frequently used antibiotic and the best at preventing infection, reducing infection rates below that of clindamycin or vancomycin. They also

indicated the seriousness of protocol timing adherence as timely antibiotic administration is related to lower rates of infection (34).

The work carried out by Seidelman et al., offered credence to the subsequent emergence of the national guidelines on SSI. This particular guideline was about orthopedic procedures, which embraced ORIF, not to mention the standardized approach concerning the drug used in antibiotic prophylaxis. The guidelines highlighted the early use of antibiotics as it counted that, patients such as patients with ORIF closed fractures were likely to experience fewer infections if they received antibiotics before the operation (17).

In A two-arm parallel group randomized control trial Uçkay et al aimed to compare the efficacy of various antibiotics for preventing SSIs in patients undergoing fracture fixation. Participants in the study were patients with closed fractures who underwent ORIF. A careful study of the results pointed to the fact that the use of prophylactic antibiotics leads to a decrease in the number of infections, especially where antibiotics are administered within the recommended time before surgery. The same study also found that single doses of antibiotics do help but that a second dose should be given to high-risk patients (35).

In their study, Flores and colleagues evaluate the efficacy of antibiotic prophylaxis in the evaluation of trauma patients who have undergone orthopedic surgeries including ORIF on closed fractures. This made them conclude that the use of antibiotics within one hour before the operation reduced by a greater margin the chances of a patient developing SSIs, especially the high-risk trauma patients. The study also showed that timely selection of the right antibiotics also has a direct bearing on the rate of infection (36).

Garrigós et al., examined the effects of antibiotic prophylaxis in the rate of developing infections in patients with Orthopedic fracture fixation. In their study, they showed that correct antibiotic therapy decreased the risk of SSIs in closed fractures treated with ORIF with a special focus on the correct choice of the antibiotic and the correct time of its application. The study found that compliance for protocol was the key significant factor in determining efficiency in the results obtained (37).

The Health Belief Model (HBM) is one of the common theoretical models used in healthcare explorations, especially in antibiotic prophylaxis that affects the

development of SSIs in ORIF for closed fractures, for example. Therefore the HBM assists in understanding how the perceptions of healthcare providers and patients, affect the decision to follow antibiotic prophylaxis protocols. The model is therefore anchored on several factors as described below. Biases exist in the minds of the healthcare provider as well as the patient with regard to the probability of a post-operative infection following ORIF surgery. In the present case, due to considering the risk of SSIs very high, applicable antibiotic prophylaxis protocols are likely to be set. The perception of how severe SSIs can be affects the probability of initiation of prophylactic measures such as antibiotic prophylaxis. In the aspect of ORIF, should they know SSIs might be severe and if they align with the recommended antibiotic regimens, they will reduce the infection probability (38).

A study is one of the significant sources that could be quoted in connection with antibiotic prophylaxis in ORIF procedures, which states the importance of antibiotic prophylaxis in eradicating SSIs after orthopedic surgeries. From the research we see that antibiotic prophylaxis when given appropriately and in the recommended protocol will reduce infection rates of closed fracture surgeries managed with ORIF. In their study, Borbely et al. observed that the use of a standardized calendar of things to do leads to reduced infection rates, post-surgery, particularly in high-risk patients. If an ORIF surgery means a surgical treatment of a fracture with traumatic plates, screws, or rods, an infection risk is unavoidable because the bone and the tissues around it have been violated. The prophylactic administration of antibiotics within one hour before surgery is aimed at prevention of SSIs due to decrease of bacterial load (39).

Further, while works like Liu et al. (2024) also indicates that overall, antibiotic prophylaxis is successful in prevention of SSIs, various aspects like timing of administration of Antibiotics, selection of Antibiotics and status of the patient has a direct impact in controlling/ occurrence of SSIs in orthopedic surgeries such as ORIF (40).

In the following study, the antibiotic prophylaxis protocol is a key independent variable. This involves the type of antibiotics used, time the antibiotics were given (before surgery) and the length of antibiotic therapy given. Several research has shown that compliance in appropriate antibiotic procedure lessens the incidence of SSIs in orthopedic surgeries particularly in operations such as ORIF. A combination of antibiotic prophylaxis given within one hour before incision and

choice of the right antibiotic has been recommended to lower incidence of infections (41).

There is compelling evidence that the type of fracture i.e. closed or opened, determines the risk of SSIs. Closed fractures, although performing slightly less exposure to the exterior environment, inherently have the risks that accompany all operations. However, open fractures are far more critically dangerous as the wound site of the fracture is exposed to infections. Nevertheless, the issue of SSI cannot be overemphasized, especially in patients with closed fracture receiving ORIF, adequate antibiotic prophylaxis should be employed to reduce SSI (41).

As has been explored in ORIF that we perform on patients to manipulate the bone, the use of a scalpel to open the skin like a wound and the use of internal fixation devices such as screws and plates to fix the affected region could affect the probability of infection. Although ORIF has become a gold-standard procedure in the management of fractures, its open nature provides a route for bacterial accession & it is against this background that antibiotic prophylaxis becomes even more essential. Several authors have found that compliance with infection control practices including the correct technique in the handling of instruments and equipment, and proper sterilization procedures can help to reduce SSIs (42).

Centre surgical site infections as the main dependent variable in this study. It is customarily divided into three subtypes: SSI of a superficial layer, of a deep layer, or involving an organ/ space. This work would compare the rate of such sort of infections post-ORIF surgery among patients who are administered antibiotic prophylaxis and those who are not. A large number of researchers suggest that if appropriate antibiotics are used for prophylactic purposes, the rate of SSIs can be decreased (43).

The lack of personalization in the management of bacterial infections triggers antibiotic failure as explained by Sharma et al., when describing the implications of modulating the regimens of antibiotics in patients with a high prevalence of susceptibility to infections because of underlying diseases such as diabetes or obesity. Prescribing might be more effective in offering foreseeable best practicable interventions for the patient as well as minimizing antibiotic resistance (44).

The evaluation of the effectiveness of antibiotic protocols that are used during SSIs requires monitoring of the surgical site infections post-surgery. Ballhause, Krause (45) proposed that in order to improve SSI detectability and

perfect preventive measures, there should be follow-up appointments as well as patient reporting systems.

The assumption that the additional assessment of antibiotic steward programs in orthopedic facilities could help diminish SSIs without increasing the potential for antibiotic resistance (46).

Chapter 3

Methodology

Study design

It was a cross-sectional study.

Clinical setting:

The clinical setting of this study was Gulab Devi Teaching Hospital, Lahore.

Study Duration:

The duration of the study was four months after the approval of the synopsis.

Target Population

The target population of this study included patients of closed fracture treated with open reduction and internal fixation at Gulab Devi Teaching Hospital, Lahore.

Study Population

Patients with closed fractures treated with open reduction and internal fixation were included.

Sample Size

The sample size was calculated by Slovincs formula

$$n = N / 1 + N (e^2).$$

Whereas:

n = no. of samples

N = total population (60)

e = margin of error (.05)

Calculated Sample size = 52

Sampling Technique

Non-randomized simple convenient sampling method was used to collect data from all participants.

Sample Selection

Inclusion Criteria:

Patients were included with the following characteristics:

- 1) Accidental trauma patients.
- 2) Both Male and Female.
- 3) Patients of closed fracture

Exclusion Criteria:

There were excluded following patients:

- 1) Amputated patients.
- 2) Patients of open fracture.
- 3) Plaster of Paris (POP).
- 4) Needle Biopsy.

Data Collection Tools/Procedure

After the approval of the synopsis by the review committee, the suggested patients were able to participate according to specific inclusion and exclusion criteria. A non-probability sampling technique was used to collect the data. The purpose of the study was explained to the participants, and a written informed consent form (Appendix II) was used to obtain prior permission to participate in this study. Confidentiality was ensured to protect the ethical rights of the participants.

A modified questionnaire (Appendix I), discussed with the allocated supervisor, was used as a tool for data collection. The questionnaire consists of two sections. 1) Demographic Data 2) Study variables.

After obtaining responses from the participants, the completed questionnaire was

returned to the data collector. The provided response was allowed to be operated by the researcher or any other person, and each section, it will be considered final.

Subsequently the data collection, data was entered into SPSS software version IBM-26 for storage and appropriate analysis.

Data analysis

Data analysis is the most important part of a study to depict the real picture of information. The data was analysed by Statistical Package for the Social Sciences (SPSS) Software version International Business Machines (IBM)-26 for its proper analysis. The data was presented in the form of percentages, frequencies, mean & standard deviation for qualitative variables. Mean with standard deviation was calculated for quantitative variables. This chi-square was applied to participants the relationship between the two variables.

Ethical Considerations

The study received ethical approval from the Superior University Lahore Board of Study and Advanced Research Committee, and data collection permission from Gulab Devi Teaching Hospital's ethical committee. Participants provided verbal informed consent, and confidentiality was maintained by avoiding personal identifiers and locking questionnaire forms.

Chapter 4

Results

Sociodemographic characteristics of the participants:

In this study recruitment 52 patients were used to determine the effects of antibiotic prophylaxis on the rate of SSIs among closed fracture patients who were treated by ORIF. This pattern showed that 16 of the participants that is 30.8% were in the age range of 15-30 years demonstrating that a relatively large proportion of the study participants was young. The biggest age range constituted 21 subjects (40%) aged between 30-45 years, and 9 subjects (28%) were above 45 years of age; therefore, participants were fairly distributed across various ages. However, in terms of gender distribution, it was observed that 37 (71.2%) out of the 52 participants were males while 15 (28.8%) were females, signifying those male participants were more numerous in this kind of healthcare setting. The above gender divide may warrant causality with risks at the workplace or other life aspects that trigger fractures. As for marital status, 37 (71.2%) of the participants were married and 15 (28.8%) were single. These married participants could have a better support system at home and this could influence recovery and adherence to recommended medical procedures. Using sociodemographic characteristics helps elucidate the understanding of surgical site infection based on data from this study. Displayed in Table 4.1.

Table No. 4.1 Description Regarding Sociodemographic Characteristics

Variables	Number%
Age (Years)	
15-30 Years	16 (30.8%)
30-45 years	21 (40.4%)
> 45 years	15 (28.8%)
Gender	
Male	37 (71.2%)
Female	15 (28.8%)
Marital Status	
Single	15 (28.8%)
Married	37 (71.2%)

Clinical-related factors of the participants:

Concerning the presence of other diseases, 10 (19.2%) participants had diabetes mellitus; this is a condition that complicates the immune system and delays the process of healing of the affected area and, therefore, can increase the risk of postoperative wound infections. A total of 52 respondents (80.8%) did not have diabetes. Likewise, hypertension was reported in 16 (30.8%) of the participants as hypertension presents a complication in blood flow and impaired wound healing thus influencing recovery. On the other hand, thirty-six participants (69.2%) did not present with hypertension. The BMI classification delivered into the ideal nutritional and health status of the participants. Severely malnourished and weak participants were six (11.5%), a situation that makes them prone to common infections, and poor healing among other complications. As shown into Table No. 4.2 and Figure No. 4.1, 4.2, 4.3

A majority of the 27 participants (27/52) = 51.9% had a healthy weight indicating that participants had better nutritional status for enhanced recovery. Sixteen individuals were considered overweight (30.8%) and 3 participants were obese (5.8%), diseases that predispose the patient to more surgical complications including infections because of issues to do with immunity compromise and poor wound healing. These clinical characteristics help to convey the flavor of the health risks experienced by the surveyed subjects and point to the significance of understanding comorbidities and BMI surrounding surgical site infections. It is very useful to overview such aspects to define further risk factors, which might interest the outcomes of antibiotic prophylaxis in infection prevention after surgery.

Variables	Number%
Diabetes Mellitus	
Yes	10 (19.2%)
No	42 (80.8%)
Hypertension	
Yes	16 (30.8%)
No	36 (69.2%)
BMI	
Underweight	6 (11.5%)
Healthy Weight	27 (51.9%)
Overweight	16 (30.8%)

Obesity	3 (5.8%)	Table
----------------	-----------------	--------------

No. 4.2 Description of clinical related factors

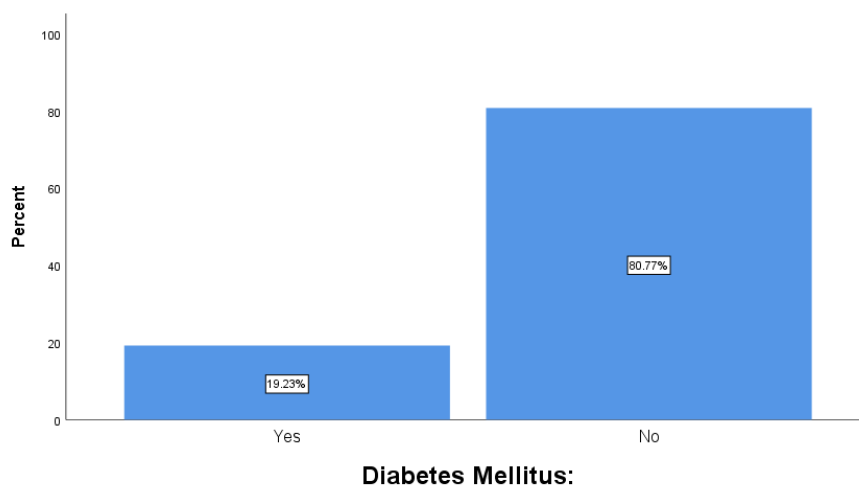


Figure No. 4. 1 Description of Diabetes Mellitus

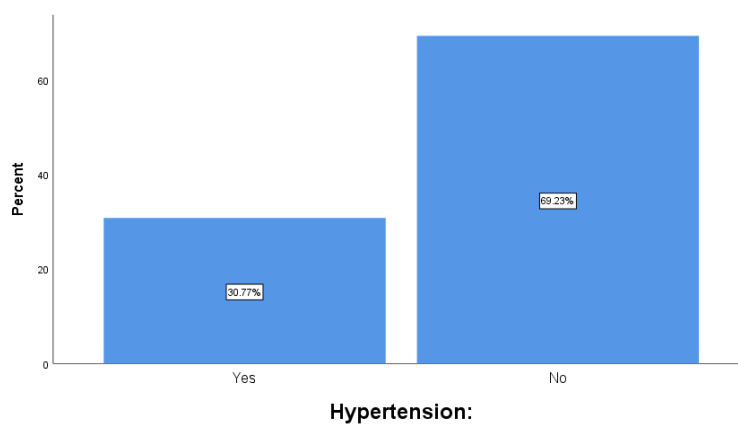


Figure No. 4. 2 Description of Hypertension

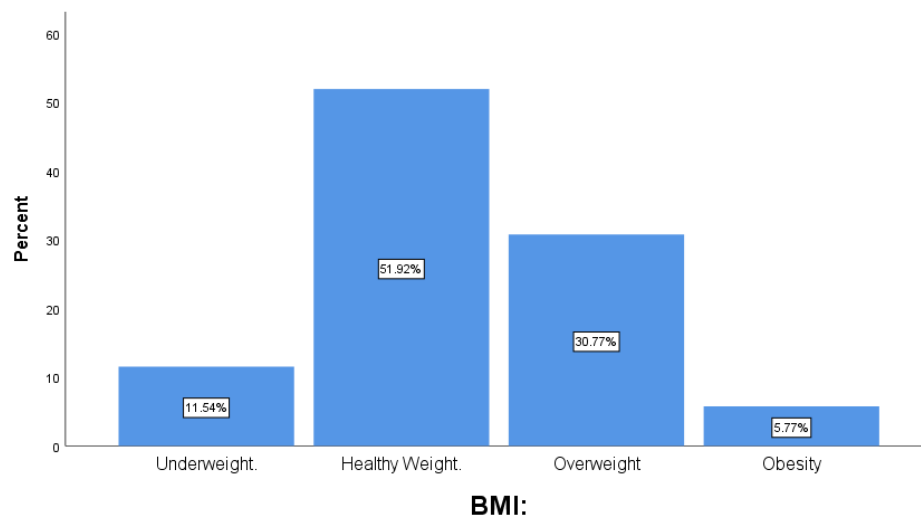


Figure No. 4. 3 Description of BMI

Descriptions of study variables:

Out of the total 52 patients, 20 were male and 32 were female, in antimicrobial stewardship 35 patients got ceftriaxone which is 67.3% and 17 patients got cefazolin which is 32.7% so ceftriaxone is the preferred preoperative antibiotic in this study. Among them, 98.1% (51 patients) received implants during the surgery, and 1.9% (1 patient) did not have the implants inserted during surgery. An incredibly low prevalence of wound infection was observed in the present study with 98.1% (51) of the patients without any infection and only 1.9% (1) getting a wound infection postoperatively. Likewise, the results for inflammatory markers comprising White Blood Cells (WBCs), Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) test were abnormal in only 1.9 % (1) of the patients showing very mild post-surgical inflammation. As shown into Table No. 4.3 and Figure No. 4.4

Table No. 4. 3 Description of study variables

Variables	Number%
Does the patient is given pre-op antibiotics (ceftriaxone or cefazolin)	
ceftriaxone	35 (67.3%)
cefazolin	17 (32.7%)
Does the patient have any implant inside the body?	
Yes	51(98.1%)
No	1 (1.9%)
Does the patient have any wound infection?	
Yes	1 (1.9%)
No	51(98.1%)
Which type of implant?	
Plate	18 (34.6%)
Nail	16 (30.8%)
Screw	17 (32.7%)
No implant	1(1.9%)
What are types Fracture sites?	
Upper limb	12 (23.1%)
Lower Limb	40(76.9%)
Culture report	
Positive	1 (1.9%)
Negative	51(98.1%)

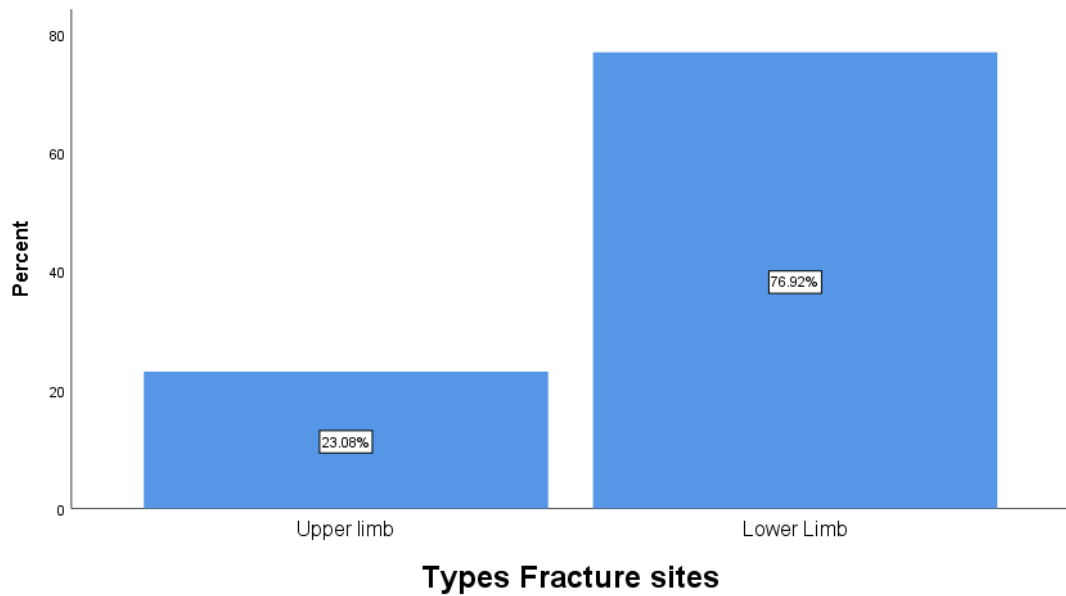


Figure No. 4. 4 Description of Types of fractures

Concerning the implant type, 18 (34.6%) of the patients wore a plate while 16 (30.8%) wore a nail, the 17 (32.7%) wore a screw and 1(1.9%) were without implant. The most affected sites were the lower limb with 76.9% (40) cases, and upper limb with 23.1% (12) cases. The culture result indicated that 98.1% of the cases grew gram negative bacilli and only 1.9% of the cases were positive for bacterial organisms. In conclusion, the study showed that, within the context of the antibiotic prophylaxis protocol for clean surgery, ceftriaxone and cefazolin in particular, contributed to a decrease of the frequency of SSIs, most of which ended with good outcomes for the patient. Shown into Table No. 4.3 and Figure No. 4.5, 4.6 & 4.7.

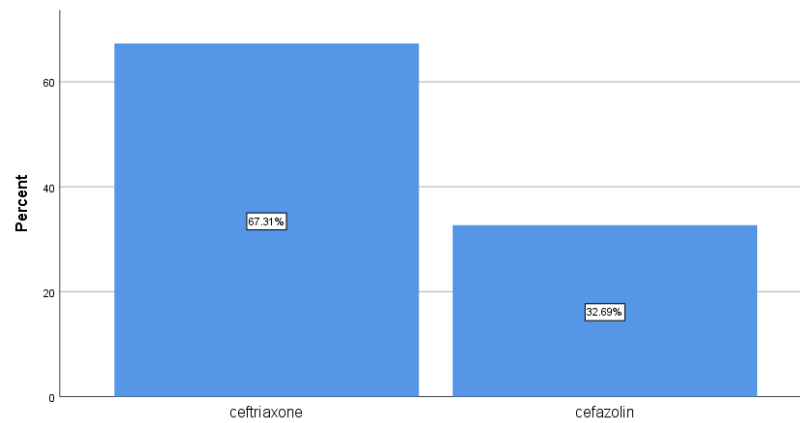


Figure No. 4. 5 Description of Pre-Op Antibiotics

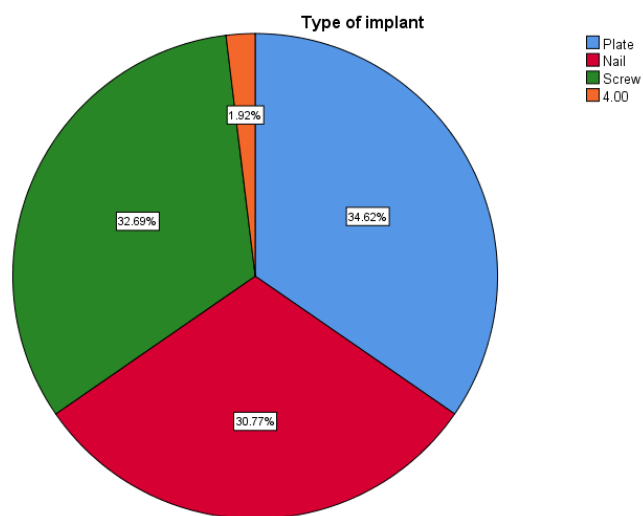


Figure No. 4. 6 Description of Types of Implants

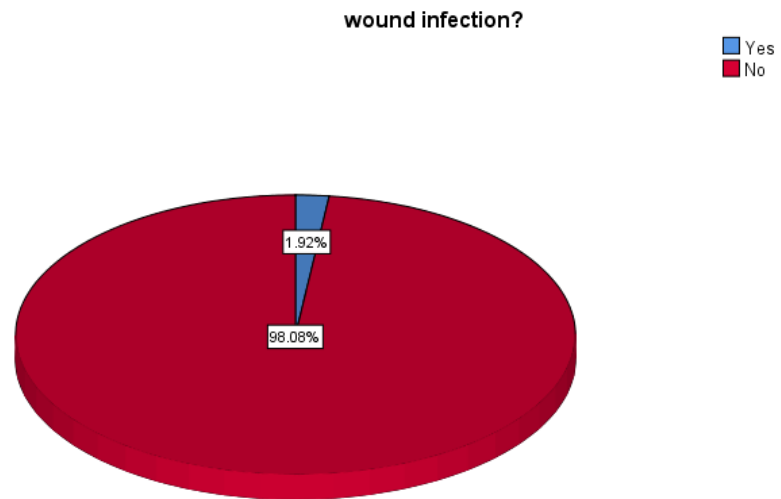


Figure No. 4.7 Description of Wound Infection

The results of this study suggest several independent variables measuring significance and non-significance impacts on the results of the study. A statistically significant association was noted with the variable diabetes mellitus ($p = 0.039$), affecting results for parameters such as wound infections or complications. The main effects of BMI ($p = 0.001$) revealed the fact that being overweight may increase the risk of complications. The culture report ($p = 0.000$) pointed to the fact between the relationships between the type of bacteria – gram positive or negative – and the outcome, putting much stress on the culture report as to infection risk. However, it became clear that ($p = 0.113$) and ($p = 0.501$), type of implant ($p = 0.350$), and fracture site ($p = 0.580$) did not correlate with the outcomes. Also, the use of pre-operative antibiotics, either ceftriaxone or cefazolin, had no statistically significant difference from each other; the p-value was 0.482. displayed in Table No. 4.4

Table No. 4.4 Comparison of outcome with other independent variables

Categories	Variables	Does the patient have any wound infection?		Total	P-Values
		Yes	No		
Does the patient is given pre-op antibiotics (ceftriaxone or cefazolin)	ceftriaxone	1	34	35	0.482
	cefazolin	0	17	17	
	Total	1	51	52	
Gender	Male	0	37	37	0.113
	Female	1	14	15	
	Total	1	51	52	
Diabetes Mellitus:	Yes	1	9	10	0.039
	No	0	42	42	
	Total	1	51	52	
Hypertension:	Yes	0	16	16	0.501
	No	1	35	36	
	Total	1	51	52	
BMI:	Underweight.	0	6	6	0.001
	Healthy Weight.	0	27	27	
	Overweight	0	16	16	
	Obesity	1	2	3	
	Total	1	51	52	
Which type of implant?	Plate	0	18	18	0.514
	Nail	1	15	16	
	Screw	0	17	17	
	No implant	0	1	1	
	Total	1	51	52	
What are types Fracture sites?	Upper limb	0	12	12	0.580
	Lower Limb	1	39	40	
	Total	1	51	52	
Culture report	Positive	1	0	1	0.000
	Negative	0	51	51	
	Total	1	51	52	

Chapter 5

Discussion

Concerning age, the distribution of the study sample can be deemed fairly even across all age groups. The majority of the patients were of the working age group with the majority (40%) in the 30-45 years age group followed by those in the 15-30 years age group (30.8%). The procedures above-described age distributions are consistent with the typical patterns of fractures, young people (from 15 to 30 years) participate in activities that may lead to fractures for a long time. Patients more than 45 years old might have spurs formation or degenerative changes that predispose them to fractures or falls. This demographic pattern draws out nicely in the previous studies that reveal age as a significant risk determinant of surgical infections. For example, knowledge about the surgical patient population often includes the characteristic of older age being associated with impaired immune response and slower rate of wound healing, factors that may contribute to SSIs (47).

Another demographic analysis shown herein indicated that more males participated in this research by 71.2%. This male dominance is in agreement with other studies that have indicated that males are more prone to fracture injuries than females especially due to workplace and accidents. Literature has established that men are more likely to develop fractures in their lifetime than women perhaps, an indication that all the Patients in this study are male (48). However, in the current study, gender was not shown to be a predictor of the occurrence of SSIs or the rate of fracture healing despite having a reputation for being related to fracture risk and rate of rehabilitation.

Compared with the general population, these patients have a high prevalence of married status – 71.2%, and this marital status can affect the patient's recovery. Earlier research has shown that married persons enjoy better psychological and emotional support which in turn reduces dropping-out rates on treatments, early recovery and so on. The findings of this study did not have the marital status as a statistically significant predictor which indicates that while marital status may affect the outcomes in overarching health, it still was not shown to single-handedly protect from SSIs when it came to closed fractures treated through ORIF (49).

Another area of focus in this work involved the analysis of multiple diseases that may coexist with the disease under study, including diabetes and hypertension as well as their effects on infection risk. The findings showed a difference in wound infections in patients with diabetes mellitus, statistically significant at $p = 0.039$, which is consistent with the conclusion of prior research that diabetes is a predictor of SSIs. Diabetes affects the immune system and delays the body's recovery from an infection, which raises postoperative infection rates (50). This is in concordance with the publications that reviewed the literature, proving that patients with diabetes in orthopedic surgeries were more prone to SSIs than patients without diabetes (51).

On the other hand, hypertension whose prevalence in the study population was 30.8% did not raise the risk of SSIs in any statistically significant manner ($p = 0.113$). This is different from other studies that have indicated that hypertension could delay wound healing as a result of its impacts on blood flow and oxygen supply. But other scholars have not seen these correlations: hypertension to infection rate where Guerra et al., found no correlation between the variables as was discovered in the present research (52).

Indeed, the study revealed that Body Mass Index (BMI) is closely related to postoperative complications: overweight patients possess an increased risk of developing SSIs ($p = 0.001$). This is in parallel with many studies that have pointed out obesity as a major cause of surgical risks including infections. Reduced immunity, higher fat stores that affect blood flow and poor wound healing due to tissue oxygen deficiency are other effects of obesity. Further exacerbating this risk of deterioration is obesity-related comorbidity including diabetes and hypertension. The research outcome on the subject corroborates the view held by many people that good health is important, especially in a bid to avoid operations and contracting diseases (53).

The study therefore focused on two classes of antibiotics; ceftriaxone with a frequency of 67.3% and cefazolin with a frequency of 32.7% on SSI rates. The findings, however, showed a negligible incidence of infection (1.9%) in the entire sample, which implies readiness of both antibiotics in minimizing SSIs. Earlier, a review of the literature has shown that both ceftriaxone and cefazolin have been employed in specific types of orthopedic surgeries to minimize the incidences of

SSIs, including those procedures involving implant placement like ORIF (54). This renders the result that there was no significant difference between ceftriaxone and cefazolin ($p = 0.482$) in this work compatible with earlier studies showing that both drugs are equally effective in controlling infection in clean orthopedic surgeries.

It also looked at the effect the type of implant fabricated (plate, screw or nail) had on infection end results. Nevertheless, the chi-square revealed a statistically not significant difference concerning implant type and SSIs with $p = 0.514$. This finding is contrary to some past recommendations by other authors on the subject that hold implant type to be a factor in the infection occurrence. For instance, La Porta et al (2023) highlighted that there is risk factor for infection since the areas for bacterial colonization is greater for implants that have greater surfaces such as plates. On the contrary, the findings of this study suggest that, for SSIs, the kind of implant does not play a crucial role so long as the right antibiotic prophylaxis and surgical procedures are in place (54).

The other variable considered in this study is fracture site. Majority of the fractures were open fractures in the lower limbs (76.9%) while few were in the upper limbs (23.1%). The present work did not note any change in the distribution of the fractures along the patients' body as well as the occurrence of SSIs that would indicate the vulnerability of particular regions to infection ($p = 0.580$). It is in harmony with other studies which indicated that among the multiple aspects contributing effect on system infection outcome, the fracture site does not play a major role compared to aspects such as the presence of system comorbidities and kind of antibiotic prophylaxis to be used (55).

Concerning microbiological characteristics, negative reports accounted for 98.1% of cases and only 1.9% of cases had positive reports of bacteria. The high prevalence of gram-negative bacteria in postoperative infections is evident in orthopedic surgeries because these bacteria are easily acquired in clinical settings and present on the skin and fabric surfaces. The overall low rate of gram-positive infections in this study is also in line with benchmark studies that note an increase in gram-negative organisms in the SSIs post-orthopedic surgery (56).

LIMITATIONS OF THIS STUDY:

The study on antibiotic prophylaxis in closed fracture patients treated with ORIF has several limitations. The small sample size of 52 patients, conducted at a single center, limits the statistical power and ability to detect subtle differences between groups. The observational nature of the study does not allow for the establishment of causal relationships, and the study did not control for all possible confounders, such as variations in surgical techniques, postoperative care, or patient adherence to post-surgical protocols. The lack of a control group also limits the ability to compare the effectiveness of the antibiotic prophylaxis protocol against other treatment protocols or no treatment at all.

The study focused on ceftriaxone and cefazolin, but did not explore other potential antibiotics or combinations of antibiotics, limiting the understanding of the most effective antibiotic regimen for preventing SSIs in this patient population. The study did not investigate long-term outcomes, such as the recurrence of infections or the impact on patient recovery and quality of life. Additionally, there is a potential for reporting bias in the collection of data, as the results rely on accurate documentation of clinical events. Despite these limitations, the study provides valuable insights into the role of antibiotic prophylaxis in preventing SSIs in closed fracture patients treated with ORIF. Future research with larger sample sizes, control groups, and multi-center approaches is needed to validate and extend these results.

Conclusion

The study aimed to evaluate the impact of antibiotic use on preventing post-operative wound infections (SSIs) in patients with closed fractures who underwent Open Reduction and Internal Fixation (ORIF). Results showed that preoperative antibiotics, such as ceftriaxone and cefazoline, had a minimal infection rate of 1.9%. Factors such as surgical prognosis, chronic illness, and BMI were found to have significant relationships with infections and complications. Most infections were caused by gram-negative organisms, but differences in microbial information limit understanding of antibiotic prophylaxis. The study found no significant impact of implant type or fracture location on SSI rates. Both ceftriaxone and cefazolin showed similar effectiveness in reducing SSIs in this population. The study suggests further research with more participants and multi-center investigations to identify improved antibiotic regimens for ORIF patients.

Recommendations

The study suggests several tactics to enhance patient care and surgical site infection (SSI) prevention in orthopedic surgery.

Larger sample sizes, multi-center studies, randomized controlled trials, investigating alternative antibiotics, long-term follow-up, personalized antibiotic prophylaxis, enhanced care protocols, continuing education and training initiatives, cost-effectiveness analyses, ongoing surveillance of infection rates and patterns of antibiotic resistance, and cooperation among infectious disease specialists, surgeons, and microbiologists are some of these.

Reducing SSIs, improving patient outcomes, and raising the standard of care in orthopedic surgery are the goals of these recommendations.

References

1. Mengistu DA, Alemu A, Abdukadir AA, Mohammed Husen A, Ahmed F, Mohammed B, et al. Global incidence of surgical site infection among patients: systematic review and meta-analysis. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing*. 2023;60:00469580231162549.
2. Cheers GM, Weimer LP, Neuerburg C, Arnholdt J, Gilbert F, Thorwächter C, et al. Advances in implants and bone graft types for lumbar spinal fusion surgery. *Biomaterials Science*. 2024;12(19):4875-902.
3. Schwabe MT, Hannon CP. The evolution, current indications and outcomes of cementless total knee arthroplasty. *Journal of Clinical Medicine*. 2022;11(22):6608.
4. Panagopoulos A, Solou K, Tatani I, Triantafyllopoulos IK, Lakoumentas J, Kouzelis A, et al. What is the optimal surgical treatment for Neer type IIB (IIC) distal clavicle fractures? A systematic review and meta-analysis. *Journal of Orthopaedic Surgery and Research*. 2022;17(1):215.
5. Zhang J, Bradshaw F, Hussain I, Karamatzanis I, Duchniewicz M, Krkovic M. The Epidemiology of Lower Limb Fractures: A Major United Kingdom (UK) Trauma Centre Study. *Cureus*. 2024;16(3).
6. Sahoo B, Malik A. *Elemental Fracture Classifications*: Notion Press; 2024.
7. Ma L. *Ex situ analysis of bone mineral density and cellular activity in type 1 diabetes mellitus*: Staats-und Universitätsbibliothek Hamburg Carl von Ossietzky; 2020.
8. Lorentzon M, Johansson H, Harvey N, Liu E, Vandenput L, McCloskey E, et al. Osteoporosis and fractures in women: the burden of disease. *Climacteric*. 2022;25(1):4-10.
9. Rasmussen CG, Jørgensen SB, Larsen P, Horodyskyy M, Kjær IL, Elsoe R. Population-based incidence and epidemiology of 5912 foot fractures. *Foot*

and ankle surgery. 2021;27(2):181-5.

10. Kumar P, Kumar R, Kumar R, Kumar R. Evaluation of Surgical Site Infections: An Institutional Based Study. *Emergency*. 9(20):45.
11. Ofuruma NN, Abasi IJ, Ikeanyi EM. Surgical Site Infection after Caesarean Section: Epidemiology, Microbiology, Management and Prevention in a Tertiary Health Facility in Niger Delta Region, Nigeria. *Journal of Advances in Medicine and Medical Research*. 2021;33(5):82-95.
12. Calderwood MS, Anderson DJ, Bratzler DW, Dellinger EP, Garcia-Houchins S, Maragakis LL, et al. Strategies to prevent surgical site infections in acute-care hospitals: 2022 Update. *Infection Control & Hospital Epidemiology*. 2023;44(5):695-720.
13. Eibeck A, Shaocong Z, Mei Qi L, Kraft M. Research data supporting" A Simple and Efficient Approach to Unsupervised Instance Matching and its Application to Linked Data of Power Plants". 2024.
14. Jamali DM, Rahman IU, Ijazulhaq HM, Manzoor J, Liaqat K, Naz F. Effect of Supplemental Oxygen on Risk of Surgical Wound Infection. *Pakistan Journal of Medical & Health Sciences*. 2022;16(09):804-.
15. Zimmerli W. Bone and joint infections: from microbiology to diagnostics and treatment: John Wiley & Sons; 2021.
16. De Guzman Jr VL. Surgical Site Infection Rates After Implementation of the Surgical Care Improvement Project Initiative: Walden University; 2021.
17. Seidelman JL, Mantyh CR, Anderson DJ. Surgical site infection prevention: a review. *Jama*. 2023;329(3):244-52.
18. Pereira LB, Feliciano CS, Siqueira DS, Bellissimo-Rodrigues F, Pereira LRL. Surgical antibiotic prophylaxis: is the clinical practice based on evidence? *Einstein (Sao Paulo)*. 2020;18:eAO5427.
19. Rai S, Gupta T, Kashid M, Sirohi B, Kale A, Sharma R. Does a Gentamicin-coated intramedullary nail prevent postoperative infection in Gustilo Type I

and II tibial open fractures? A comparative study and retrospective analysis. 2024.

20. Zelenitsky SA. Effective Antimicrobial Prophylaxis in Surgery: The Relevance and Role of Pharmacokinetics-Pharmacodynamics. *Antibiotics*. 2023;12(12):1738.
21. Duell CH, O'Sullivan DM, Bilinskaya A, Linder KE. Evaluation of Timing of Antimicrobial Surgical Prophylaxis on Rates of Surgical Site Infections. *Surgical Infections*. 2024.
22. Sommerstein R, Troillet N, Harbarth S, de Kraker ME, Vuichard-Gysin D, Kuster SP, et al. Timing of cefuroxime surgical antimicrobial prophylaxis and its association with surgical site infections. *JAMA Network Open*. 2023;6(6):e2317370-e.
23. Ryan RL, Jackson D, Hopkins G, Eley V, Christensen R, Van Zundert AA, et al. Plasma and interstitial fluid pharmacokinetics of prophylactic cefazolin in elective bariatric surgery patients. *Antimicrobial Agents and Chemotherapy*. 2022;66(7):e00419-22.
24. Gupta KK, Vatish D, Xavier V, Maliyil J, Manu M. Comparing surgeon adherence with World Health Organization antiseptic guidelines for surgical site preparation in the United Kingdom and India. *Surgical Infections*. 2020;21(7):634-8.
25. Anvesh A, Manohar C, Shivakumar V, Keshavamurthy R. Abstracts-USICON 2020. *Indian Journal of Urology*. 2020;36(Suppl 1):S1-S56.
26. Prakash O. A systematic review on Prophylactic use of antibiotics in the context of orthopedic surgery.
27. Karapetyan K, Mei S, Choudhury A, Cottreau J. Overview of antibiotic prophylaxis in orthopaedic and cardiac procedures. *Orthopaedic Nursing*. 2023;42(5):312-6.
28. Kruse C, Axelrod D, Al-Mohrej OA, Daniel R, Johal H. Effect of local

antibiotic prophylaxis on postoperative deep infection in fracture surgery: a systematic review and meta-analysis. *Journal of Orthopaedic Trauma*. 2023;37(1):e28-e35.

29. Al Qarawi NHA. Prevalence Rates and Risk Factors Analysis of Surgical Site Infections Following Spinal Surgeries; A 10 Years Retrospective Case-Control Study: Alfaisal University (Saudi Arabia); 2022.
30. Oprins E. SURGICAL SITE INFECTION SURVEILLANCE IN HIP AND KNEE ARTHROPLASTY: Ghent University; 2024.
31. Opri F, Bianchini S, Nicoletti L, Monaco S, Opri R, Di Pietro M, et al. Surgical Antimicrobial Prophylaxis in Patients of Neonatal and Pediatric Age Undergoing Orthopedic and Hand Surgery: A RAND/UCLA Appropriateness Method Consensus Study. *Antibiotics*. 2022;11(3):289.
32. Rohrer F, Maurer A, Noetzli H, Gahl B, Limacher A, Hermann T, et al. Prolonged antibiotic prophylaxis use in elective orthopaedic surgery—a cross-sectional analysis. *BMC musculoskeletal disorders*. 2021;22(1):420.
33. Lakhani A, Jindal K, Khatri K. Antimicrobial resistance (AMR) in orthopaedic surgeries: A complex issue and global threat. *Journal of Orthopaedic Reports*. 2024:100466.
34. Lin CA, O'Hara NN, Sprague S, O'Toole RV, Joshi M, Harris AD, et al. Low adherence to recommended guidelines for open fracture antibiotic prophylaxis. *JBJS*. 2021;103(7):609-17.
35. Uçkay I, Wirth S, Zörner B, Fucentese S, Wieser K, Schweizer A, et al. Study protocol: short against long antibiotic therapy for infected orthopedic sites—the randomized-controlled SALATIO trials. *Trials*. 2023;24(1):117.
36. Flores MJ, Brown KE, Morshed S, Shearer DW. Evidence for local antibiotics in the prevention of infection in orthopaedic trauma. *Journal of Clinical Medicine*. 2022;11(24):7461.
37. Garrigós C, Rosso-Fernández CM, Borreguero I, Rodríguez P, García-Albea

- R, Bravo-Ferrer JM, et al. Efficacy and safety of different antimicrobial DURATions for the treatment of Infections associated with Osteosynthesis Material implanted after long bone fractures (DURATIOM): Protocol for a randomized, pragmatic trial. *Plos one*. 2023;18(5):e0286094.
38. Al-Tahitah AN, Al-Sharafi MA, Abdulrab M. How COVID-19 pandemic is accelerating the transformation of higher education institutes: a health belief model view. *Emerging technologies during the era of COVID-19 pandemic*. 2021:333-47.
 39. Torrent J, Baduell A, Vega J, Malagelada F, Luna R, Rabat E. Open vs minimally invasive scarf osteotomy for hallux valgus correction: a randomized controlled trial. *Foot & Ankle International*. 2021;42(8):982-93.
 40. Liu H, Wang Y, Xing H, Chang Z, Pan J. Risk factors for deep surgical site infections following orthopedic trauma surgery: a meta-analysis and systematic review. *Journal of orthopaedic surgery and research*. 2024;19(1):811.
 41. Navarro-Martínez S, Sebastián-Tomás JC, Díez Ares JA, Peris Tomas N, Perianez Gomez MD, Martinez Mas E, et al. Enhanced recovery after bariatric surgery (ERABS) protocol implementation in a laparoscopic center. *Minimally Invasive Therapy & Allied Technologies*. 2022;31(2):269-75.
 42. Huang JI, Miller EA. Malunions and Nonunions in the Forearm, Wrist, and Hand, An Issue of Hand Clinics, E-Book: Malunions and Nonunions in the Forearm, Wrist, and Hand, An Issue of Hand Clinics, E-Book: Elsevier Health Sciences; 2023.
 43. Kim K, Zhu M, Coleman B, Munro JT, Young SW. Differing Microorganism Profile in Early and Late Prosthetic Joint Infections Following Primary Total Knee Arthroplasty—Implications for Empiric Antibiotic Treatment. *The Journal of Arthroplasty*. 2022;37(9):1858-64. e1.
 44. Sharma A, Badea M, Tiwari S, Marty JL. Wearable biosensors: an alternative and practical approach in healthcare and disease monitoring. *Molecules*.

2021;26(3):748.

45. Ballhause TM, Krause M, Roß J, Rueger JM, Frosch K-H, Klatte TO. Third day laboratory follow-up: mandatory for surgical site infections of tibial plateau fractures. *European Journal of Trauma and Emergency Surgery*. 2021;47:581-7.
46. CA C. 73rd Annual Meeting Abstracts. *Can Urol Assoc J*. 2021;15(9S4):S179-244.
47. Monteil M, Chenouard A, Roussey G, Bernardon R, Gaultier A, Porcheret F. Haemodynamic effect of dexmedetomidine during paediatric kidney transplantation. *Pediatric Nephrology*. 2025;40(1):213-21.
48. Ovesen SH, Clausen AH, Kirkegaard H, Løfgren B, Aagaard R, Skaarup SH, et al. Point-of-care lung ultrasound in emergency medicine: A scoping review with an interactive database. *Chest*. 2024.
49. Fiorindi C, Giudici F, Testa GD, Foti L, Romanazzo S, Tognozzi C, et al. Multimodal Prehabilitation for Patients with Crohn's Disease Scheduled for Major Surgery: A Narrative Review. *Nutrients*. 2024;16(11):1783.
50. Shambhu S, Gordon AS, Liu Y, Pany M, Padula WV, Pronovost PJ, et al. The Burden of Health Care Utilization, Cost, and Mortality Associated with Select Surgical Site Infections. *The Joint Commission Journal on Quality and Patient Safety*. 2024;50(12):857-66.
51. Yang L, Rong G-C, Wu Q-N. Diabetic foot ulcer: Challenges and future. *World journal of diabetes*. 2022;13(12):1014.
52. Guerra JV, Dias MM, Brilhante AJ, Terra MF, Garcia-Arevalo M, Figueira ACM. Multifactorial basis and therapeutic strategies in metabolism-related diseases. *Nutrients*. 2021;13(8):2830.
53. Chisari A, Golán I, Campisano S, Gélabert C, Moustakas A, Sancho P, et al. Glucose and amino acid metabolic dependencies linked to stemness and metastasis in different aggressive cancer types. *Frontiers in Pharmacology*.

2021;12:723798.

54. Rungelrath V, DeLeo FR. Staphylococcus aureus, antibiotic resistance, and the interaction with human neutrophils. *Antioxidants & redox signaling*. 2021;34(6):452-70.
55. Ahn J. *Insights in orthopedic surgery*: 2021: Frontiers Media SA; 2023.
56. Whittle E, Yonkus JA, Jeraldo P, Alva-Ruiz R, Nelson H, Kendrick ML, et al. Optimizing nanopore sequencing for rapid detection of microbial species and antimicrobial resistance in patients at risk of surgical site infections. *Msphere*. 2022;7(1):e00964-21.

Consent Form:

IMPACT OF ANTIBIOTIC PROPHYLAXIS PROTOCOL ON AN INCIDENT OF SURGICAL SITE INFECTION IN PATIENTS OF CLOSED FRACTURE TREATED WITH ORIF.

Participant Satisfaction:

This research does not concern the harm of any kind. There is no risk and discomfort to participant in this study.

Potential Benefits:

This study will provide information about the Impact of antibiotic prophylaxis protocol on an incident of surgical site infection in patients of closed fracture treated with orif.

Privacy Protection:

We will do everything we can to protect your information. All information collected during the investigation will be kept strictly confidential. All information about you that may identify you during the data entry and experience will be deleted.

Volunteer Involvement:

Your participation in this research study is voluntary. You have the option of not participating and leaving this research at any time without giving any reason. No action will be taken against you if you refuse to participate.

The following information is taken by those who are involved in the research and list them in the answer given:

I understand the information sheet and I was given the opportunity to ask research questions. I understand that my participation is voluntary, and I may change my mind at any time. I understand that my answers will be shown in secret. I allow researchers to test the answer. I understand that numbers will be saved instead of my name. So that I can't be identified in any way while publishing results. I agree that the information I receive is used in research. I agree to be included in the research described above and will notify researchers if any address changes.

I have read the license and I am given the opportunity to ask questions. I am willing to participate in this research.

Name of Participant: _____ Signature: _____ Date: _____

تحقیقی مطالعہ میں شرکت کا اجازت نامہ

نقصانات اور تکالیف:

اس تحقیق سے کسی قسم کے نقصانات کا اندیشہ نہیں ہے۔

مکمل فوائد:

یہ ایک اہم تحقیق م حصہ لینے کا موقع ہے۔

رازداری کا تحفظ:

ہم آپ کی معلومات کے تحفظ کیلئے وہ سب کچھ کریں گے جو ہم کر سکتے ہیں۔ تحقیق کے دوران اکٹھی کی گئی تمام معلومات کو انتہائی خفیہ رکھا جائے گا۔ ڈیٹا انٹری اور تجربے کے دوران آپ کے متعلق تمام معلومات جن سے آپ کی شناخت ہو سکتی ہو اس کو ختم کر دیا جائے گا۔ اس تحقیق کے نتیجے میں شائع ہونے والی اشاعت میں آپ کی شناخت کو ظاہر نہیں کیا جائے گا۔

رضاکارانہ شمولیت:

تحقیقی مطالعہ میں آپ کی شرکت رضاکارانہ ہے۔ آپ کو شرکت نہ کرنے اور کسی بھی وقت بغیر وجہ بتائے اس تحقیق کو چھوڑنے کا اختیار ہے۔

شرکت نہ کرنے میں شمولیت کو چھوڑنے کی صورت میں آپ کے خلاف کوئی کاروائی نہیں کی جائے گی۔

درج ذیل معلومات تحقیق میں شامل ہونے والوں کے لئے پڑھیں اور ان کا جواب دیئے گئے خانوں میں درج کریں۔

- ☐ میں نے معلوماتی شیٹ کو سمجھ لیا ہے اور مجھے تحقیق کے سوالات کرنے کا موقع دیا گیا تھا۔
- ☐ میں سمجھ گیا/گئی ہوں کہ میری شرکت رضاکارانہ ہے اور میں کسی بھی وقت اپنا ارادہ بدل سکتا/سکتی ہوں۔
- ☐ میں سمجھ گیا/گئی ہوں کہ میرے جوابات خفیہ رکھے جائیں گے۔ میں محققین کو اس بات کی اجازت دیتا/دیتی ہوں کہ وہ جوابات کو جانچ سکیں۔
- ☐ میں سمجھ گیا/گئی ہوں کہ میرے نام کے بجائے نمبر کی صورت میں محفوظ کی جائیں گی۔ تاکہ مینٹننس کی اشاعت کے دوران کسی بھی طرح سے شناخت نہ کیا جاسکوں۔
- ☐ میں اس بات سے رضامند ہوں کہ جو معلومات مجھ سے کجائیں وہ تحقیق میں استعمال ہوں۔ میں اوپر بتائی گئی تحقیق میں شامل ہونے کے لیے رضامند ہوں اور محققین کو اپنا پتہ تبدیل ہونے کی صورت میں مطلع کروں گا/گی۔

رضامندی: میں نے یہ اجازت نامہ پڑھا ہے۔ اور مجھے سوال پوچھنے کا موقع دیا گیا ہے۔ میں اس تحقیق میں شرکت کے لئے راضی ہوں۔

شرکت کنندہ کا نام: _____ دستخط _____

تاریخ _____

اجازت لینے والے کا نام: _____ دستخط _____

تاریخ _____

Appendix-I

Questionnaire

Impact of Antibiotic Prophylaxis Protocol on An Incident of Surgical Site Infection in Patients of Closed Fracture Treated With Open Reduction And Internal Fixation.

DEMOGRAPHIC DATA			
1. Age			
a) 15-30 Years	b) 30-45 years	c) > 45 years	
2. Gender			
a) Male		b) Female	
3. Marital Status			
a) Single		b) Married	
4. Diabetes Mellitus:			
Yes		No	
5. Hypertension:			
Yes		No	
6. BMI:			
a) Underweight.	b) Healthy Weight.	c) Overweight	d) Obesity

Study Variables			Yes	No
1. Does the patient is given pre-op antibiotics (ceftriaxone or cefazolin)				
2. Does the patient have any implant inside the body?				
3. Does the patient have any wound infection?				
4. Does the patient have elevated WBCs, ESR and CRP?				
5. Which type of implant?		Plate	Nail	Screw
6. Which type of patient’s admission		Emergency	Elective	
7. What are types of Fracture sites?		Upper limb	Lower Limb	
Follow-Up Study Variables				
Early surgical site infection (within 2 weeks)				
8. Wound discharge?		Yes	No	
9. Colour	Reddish	Yellow	White	
10. Amount		Only dressing Soaked	Flank	
11. Smell		Yes	No	
Late surgical site infection (After 2 weeks)				
12. Wound discharge?		Yes	No	
13. Colour	Reddish	Yellow	White	
14. Amount		Only dressing Soaked	Flank	
15. Smell		Yes	No	
16. Culture report		Positive	Negative	