Antibiotics for bacterial infection in burned patients

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Abstract

Introduction:. Burn injuries serve as sites with the potential for colonization by pathogens originating from both within and outside the body. Information from patient records, including ages, extents of injuries, and burn depth, along with details on pathogens like their types, numbers, enzyme and toxin production, is crucial for assessing the risk of invasive infection in burn wounds. Infections in burns are influenced by factors such as the causative agent, depth of penetration, and response levels. Proper diagnostic and treatment protocols depend on a thorough understanding of burn pathophysiology and the relationship between pathogens and various infection types. Changes over time in the dominant microbial community in burns, shifting from Gram-positive to Gram-negative, mirror the history of burn infections. Regular clinical monitoring and follow-up in burn care enable early detection of conditions like gram-positive cellulitis, with the consistent response of beta-hemolytic streptococci to penicillin reducing the risk posed by common burn pathogens. On the flip side, the early emergence and evolution of natural and acquired mechanisms of disease resistance enhance susceptibility to attacks by drug-resistant strains such as Pseudomonas aeruginosa. Yet, effective topical antibacterial treatment and prompt burn excision play crucial roles in reducing the overall incidence of invasive burn infections. Patients with extensive burns and challenging wound management may face a spectrum of both bacterial and nonbacterial infections. Hence, it's imperative for the attending surgeon to conduct daily examinations of the entire burn site. Any changes in wound appearance or patient clinical parameters should be assessed through biopsies. While quantitative culture of biopsy samples can identify the most prevalent organisms, it is not effective in diagnosing invasive burn infections. Histological analysis of biopsied tissue from burn patients, which aids in determining the depth of invasion, stands as the sole dependable method to differentiate between merely wounded tissue and invasive infection. Studying the histological features of bacterial, viral, and fungal infections guides the selection of optimal treatment strategies.

Keywords: Infection, Burn wounds, Bacterial infection

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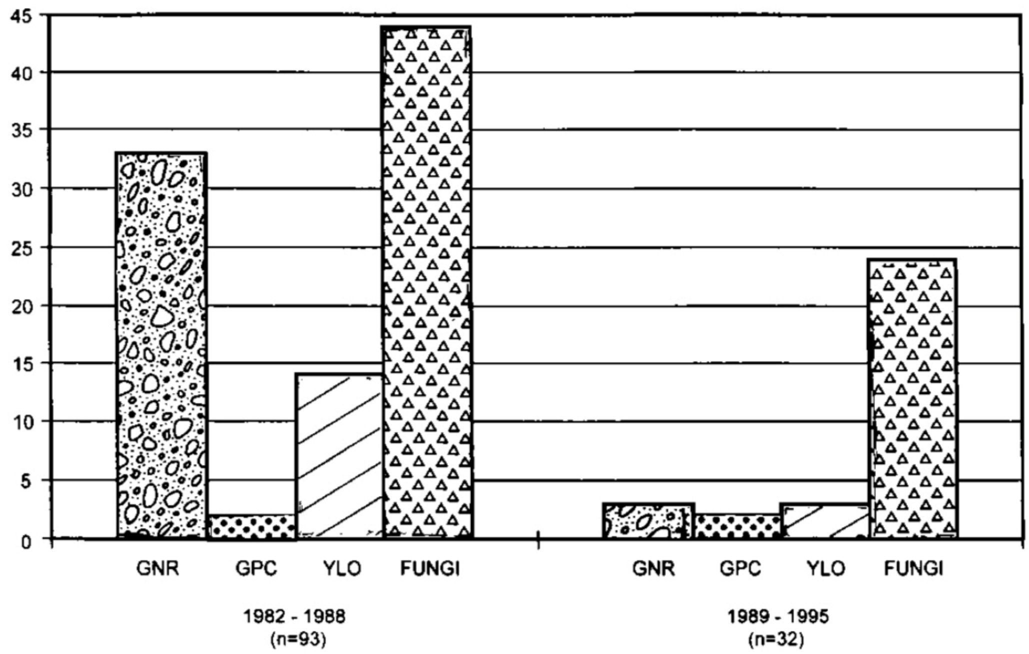
Chapter One

Introduction

1.1. Introduction

Literature view

Invasive burn wound infection is a critical issue characterized by the infiltration of microorganisms into burn wounds, potentially leading to pus formation and severe complications. Thanks to advancements in burn care techniques, the incidence of invasive burn infections has significantly decreased over time. These advancements have not only altered the types of microorganisms involved but also extended the time from injury to infection onset, consequently reducing the mortality rate associated with burn injuries caused by thermal energy. Prior to the introduction of topical antibacterial chemotherapeutic agents in the mid-1960s, invasive burn wound infection posed a significant threat, often resulting in fatal outcomes. The progress made in managing invasive burn wound infections is commendable and has undoubtedly improved patient outcomes in burn care. [1]. the severity of the burns depending on the rate of separation of burn infection also is determined by the stage of the burn and the age of the patient. Invasive burn infections rarely occur in partial-thickness wounds; they occur more frequently in children, with a more frequency in the elderly and decreased in young adults (15 to 40 years old) [2]. The susceptibility of burned surfaces to infection stems from the combination of coagulant proteins and microbial nutrients present in the wound. Additionally, the avascular nature of the scab hinders the transportation of immune-active cells, humoral factors, and antibiotics necessary for combating infections. This compromised delivery system contributes to the vulnerability of the wound to ulcer disease. [3The presence of flora in a burn area significantly impacts infection risk and invasiveness. Initially, post-burn wounds exhibit a low microbial population, primarily consisting of Gram-positive bacteria surviving in the skin adnexa. As time progresses, Gram-negative bacteria start to colonize the scab, becoming the predominant type in the burn wound after approximately one week. This transition underscores the importance of monitoring and managing microbial flora in burn injuries to mitigate infection risks effectively. [4]. group A hemolytic streptococcus b was the most common cause of burns and dangerous systemic infections, but after discovering of antibiotics treatment with penicillin essentially eliminated mortality .this [5]. After treatment with penicillin, Staphylococcus aureus was identified as the most frequently encountered early Gram-positive pathogen in burn wounds [6]. Pathogens have the capability to invaginate the squamous layer and infiltrate unburned subcutaneous tissue, forming multiple abscesses of varying sizes. While S. aureus typically does not cross tissue planes, it can lead to the development of thickened abscess walls, compromising the efficacy of both host defenses and antibiotic treatments. The discovery that staphylococci can potentially enter the bloodstream from an un-drained abscess highlights the importance of early diagnosis and timely drainage to reduce or prevent hematogenous invasion of staphylococcal infections post-burn. Before the identification of other primary causes, infection by burns was noted as the primary cause of mortality in 60% of burn patients. The utilization of mafenide acetate burn cream has been shown to lower the risk of death due to invasive burn infections by 29%, a reduction that was similarly observed with 0.5% silver nitrate immersion and sulfadiazine silver topical treatments [1]. Implementing burn debridement for the timely removal of necrotic tissue and prompt closure of burns has further decreased the incidence of fatal invasive burn infections to 7%. Additionally, severe sepsis following fungal infection poses an additional risk. [1]



[6]

Fig. 1. Marked changes in the epidemiology of invasive burn wound infection have been observed over the past two consecutive 7-year periods. Notably, there has been a significant decrease in the prevalence of gram-negative rods as the primary causative agents, with fungi now emerging as the predominant organisms responsible for invasive burn wound infections. This shift in etiology underscores the evolving nature of infectious agents in this context and highlights the importance of continued vigilance and research in the field of burn wound management.

GNR: gram-negative rods; GPC: gram-positive cocci; YLO: yeast-like organisms; Fungi: filamentous fungi.

1.2. Signs

General-signs

purplish discoloration dark brown or present on the wound may vary in localization, appearing as a singular spot, scattered areas, or spreading throughout the entire system. This alteration could signal a shift from a partial-thickness injury to complete tissue necrosis. The presence of discolored hemorrhage underneath the scab, as well as edema or purplish coloration at the margins of unburned skin surrounding the wound linked to Pseudomonas infection can also be noted. Additionally, a rapid and unexpected loss of the scab is typically associated with fungal infections.

Specific signs Bacterial infection

Seeing a green pigment /pyocyanin/ within the subcutaneous fat may indicate a Pseudomonas infection. Red nodular eruptions /ecthyma gangrenous/ appearing on areas beyond the skin affected by burns can progress to localized necrosis. Fungal infections can occur, characterized by the centrifugal advancement of edema leading to central ischemic necrosis, a common presentation seen in phycomycotic infections. saponification of subcutaneous fat may be indicative of a viral infection. Treatment involving vesicular lesions or partially healed deep burns should be considered.

1.3. Classification of Burn infections

The burned patients often named as a "generalized injury model," because the damage maybe affects a whole body . In other words, the burn is the central problem for the burn patient, and successful treatment and prompt closure of the burn is essential to survival. Preventing burn infection is definitely essential in this process. [11]. Patients commonly present with a specific Symptoms such as redness, swelling, and sensitivity of the no burned skin surrounding the burn or wound site can be observed. Without intervention, these symptoms may progressively spread, with some cases involving lymphatic involvement. An escalation in clear fluid discharge from the wound may be noted, and in instances where β-hemolytic streptococcal infection affects the skin graft, the graft could be rapidly compromised, sometimes deteriorating overnight.

(Cellulitis)

Cellulitis manifest as erythema, induration, warmth and pain in the tissues surrounding a burn or scaly wound and sometimes sepsis. Erythema only itself may not indicate cellulitis, topical application and systemic penicillin use to treat Progressively spreading cellulitis if caused by group A ß streptococcus or with B-lactam antibiotics.

An invasive infection includes concentrations of bacteria at an appropriate depth of the burn wound to cause suppurative separation of the eschar or graft loss .

In cases where sensitivity testing and culture assessments are unavailable, broad-spectrum antibiotics are typically employed to address cellulitis. Warm water baths are recommended for managing areas affected by cellulite. Additionally, applying Mafenide Acetate Burn Cream twice daily on the donor surface until the infection is under control is suggested. If the donor site remains unhealed, full-thickness lesions can undergo grafting, while biological dressings can be used for partial-thickness lesions to promote optimal conditions for bandage removal.

Invasive Infections

The important indicator of an invasiveness of the burn is the presence of a localized, multi localized , or generalized dark brown area. after while wound turns black or purple [12].unlucky , presence of these signs is little because subcutaneous tissue hemorrhage or burns following minor local trauma can give the same changes. shown below ,there is a time related change happening too fast like reliable local finding is the transfer from a partial-thickness lesion to full-thickness necrosis or necrosis of previously viable tissue in the excised wound bed

[11] (Figure 2). As. and intensity during infection by phycomycetes.another most important sign of complicated burn include hemorrhage discoloration of the tissue beneath the burn, blue discoloration also in the subcutaneous fat, purples pigmentation of unprotected skin or oedema . protect burn (or both) at the edge of the burn, initial erythema, and subsequent lesions. Black nodular necrotic dots (ecthyma gangrenous) on unburned skin. specific signs of fungal burns include rapid exfoliation of the crust, possibly due to liquefaction of fat, and fast contamination of subcutaneous edema with necrosis. central council (most specific of phycomycotic infection) [2].Skin exfoliation may be the first sign of midface mucositis and its presence suggests retrobulbar fat biopsy [13]. Heals vesicular lesions or heals second-degree burns as well as the presence of tooth edges and partial thickness crusts. Facial burns, particularly those affecting the nasolabial area, are indicative of burn infections attributed to herpes simplex virus type 1 [14] . Given that similar alterations in the wound can stem from various causes like wound desiccation, necrosis, pressure-induced necrosis, or hemorrhage due to local trauma, an infection diagnosis should be made carefully. Surface cultures, which serve as another confirming method, prove valuable in identifying organisms present on the burn as well as the prevalent bacterial species in the burn area. However, even quantitative culture methods may not differentiate between burn colonization and infection. A lower bacterial count generally indicates the absence of burn infection, but a quantitative count of 10 or more organisms per gram of tissue is often associated with histological signs pointing towards invasive infection, observed in less than half of samples [15]. histological examination of a

burn biopsy is the golden tool and important way to confirm the diagnosis of infected burned patients more than culture examination and its limitations . In cases of viral infection due to burns, diagnosis can also be Diagnosed by histological test of scratches resulting of skin lesions.

Using antibiotics for systemic prophylaxis is common in burn patients [19]. Resistant bacteria with intrinsic antibiotic resistance, longer survival in hospital environments, and hand-to-hand transmission of bacteria reflect their easy spread and cause epidemics [20, 21]. Extensively drug-resistant (XDR) and pan-drug-resistant (PDR) strains were classified as non-susceptible to at least one agent in all but two or fewer classes of antibiotics, and strains were non-susceptible to all antibiotics. agents in all antibiotics according to ECDC and CDC respectively. [22].

Fig. 2. invasive fungal (Aspergillus sp.) od previously burned patient cause necrosis.

Chapter Tow

Materials a Methods

Burn unit of Ba’aquba teaching Hospital which is located in in Diyala is the one of burn unit of local area with a capacity of 9 beds , it provides service approximately 35 patients per month from different government districts.

All medical records pertaining to burn patients admitted to the burn unit at Baquba Teaching Hospital from November 2023 to March 2024 were retrospectively examined. Data on patient age, gender, and infection outcomes were documented. Treatment protocols for burns aligned with established international standards, encompassing antibiotic , daily wound care involving topical antibiotic like sulfadiazine, fluid resuscitation, nutritional support, resuscitation procedures, and surgical interventions such as resection and pressure grafting for ulcers. Fundamental measures within the burn unit aimed at burn care and infection prevention encompass practices like staff hygiene, room isolation, periodic ward area cultures, and visitor restrictions. During wound exchanges, samples were directly inoculated onto 5% blood agar and Eosin Methylene blue agar. The agar plates were then incubated at 35 ± 2°C for 18 to 24 hours in aerobic conditions post-inoculation. Any observed bacterial growth patterns were meticulously documented, and the isolated bacteria were subsequently identified using conventional techniques.

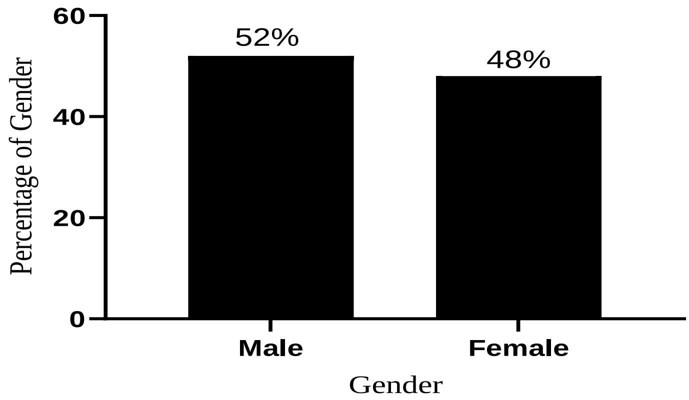
We took 100 burn patients(their culture was positive)[52 males and 48 females, mean age 29.5 years, range 16 to 54years] admitted to burn unit in Ba’aquba hospital were used for this study during the period from November 2023 to March 2024 . Mean total surface burned area was 18% [range 12- 83%].

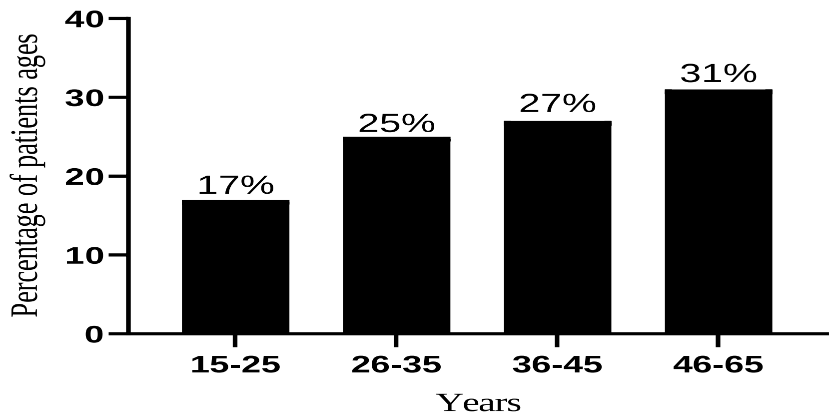
Results are presented as numbers and percentages. The average age of our patients is presented as mean plus/minus standard deviation. Data entrance and analyses were applicated using the statistical pack program SPSS (USA).

Chapter Three

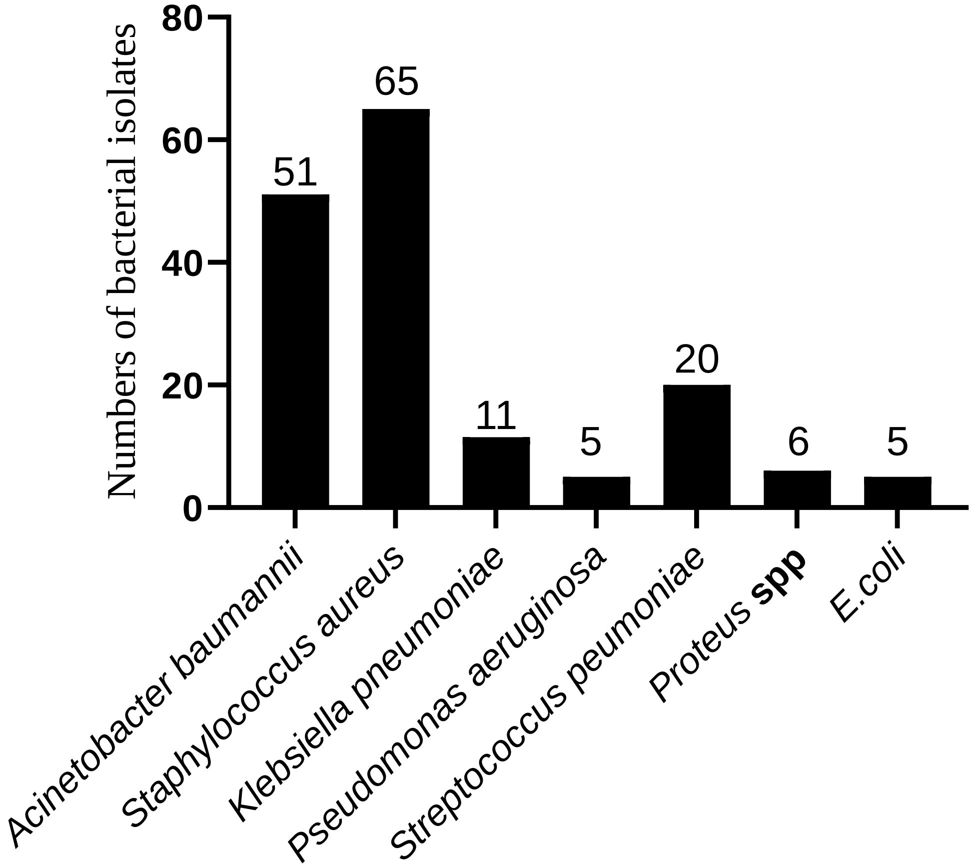
Result

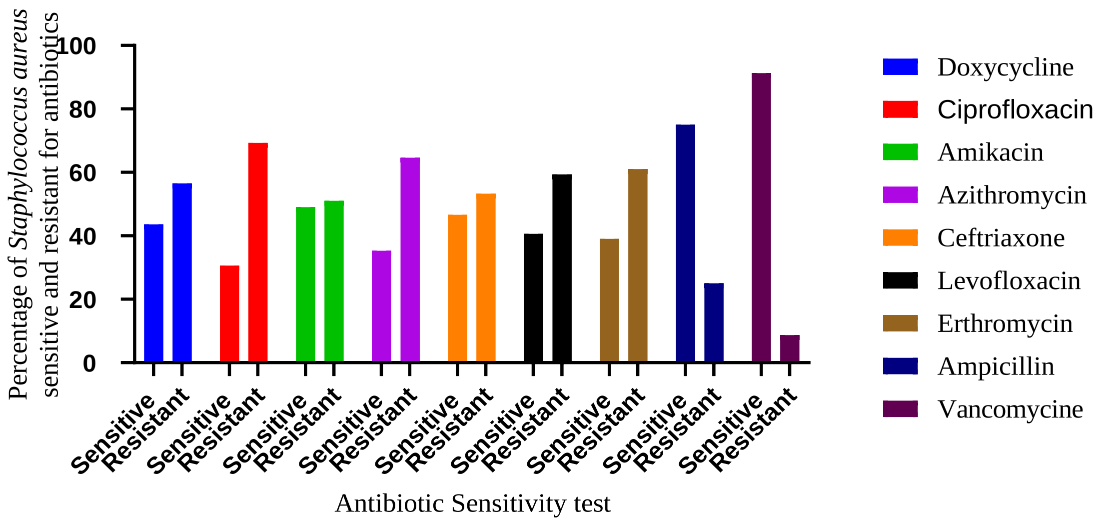
Our study comprised 100 participants, with 52 being male and 48 females. When analyzing the cultures, single isolates were detected. During the initial week, S. aureus predominated, closely followed by A. baumannii. The patients' ages ranged from 16 to 54 years, with the highest frequency of burns occurring within the 20-30 age bracket. The extent of body surface area affected by burns varied between 12% and 83%. The results displayed in Table (1) showcase the diverse array of bacteria isolated from the 100 wound swabs. Staphylococcus aureus, A. baumannii, and Klebsiella spp. stood out as the most commonly identified microorganisms, while Pseudomonas aeruginosa, Streptococcus pneumonia, and E. coli presented as less frequently isolated strains.

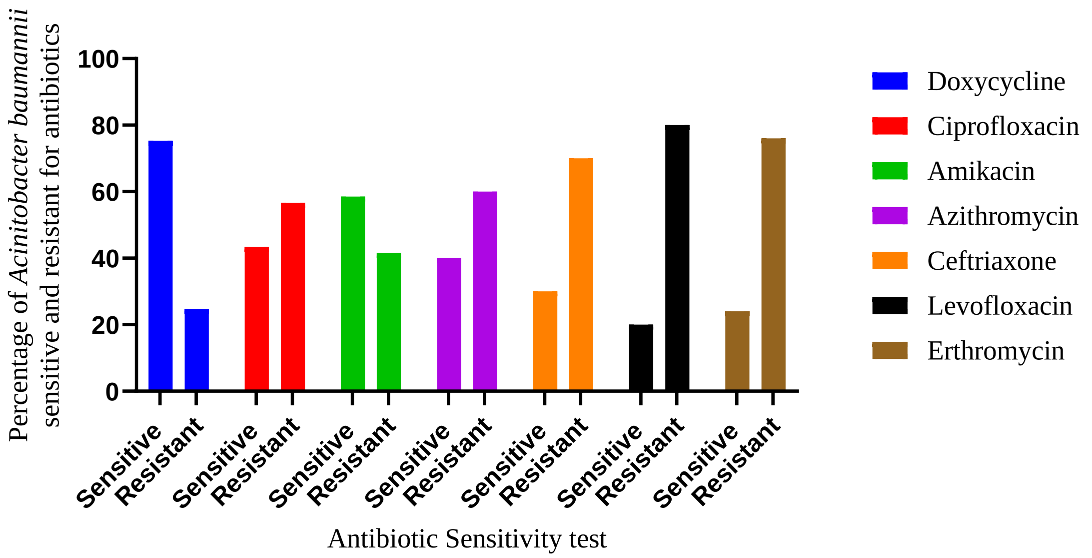


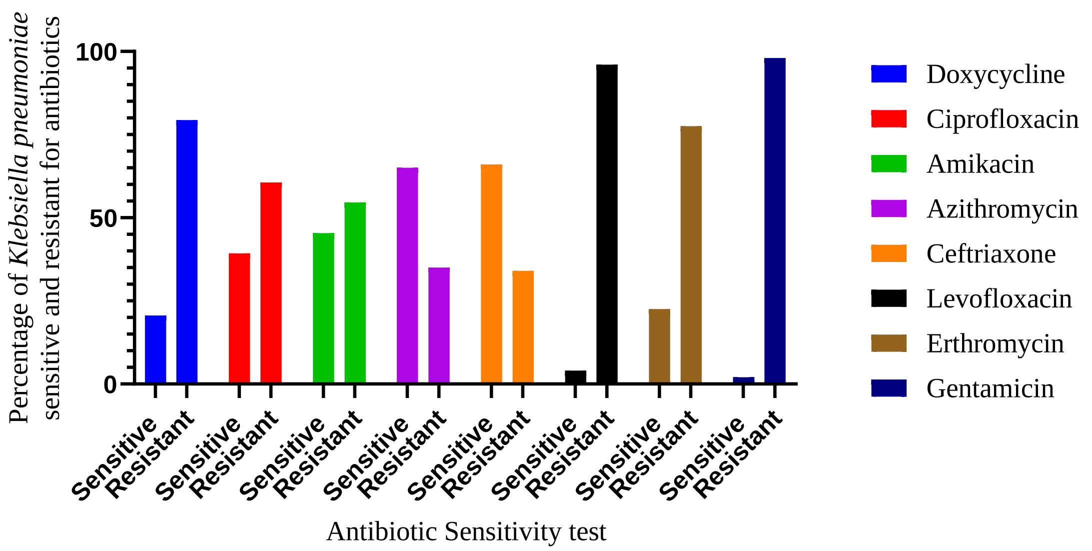


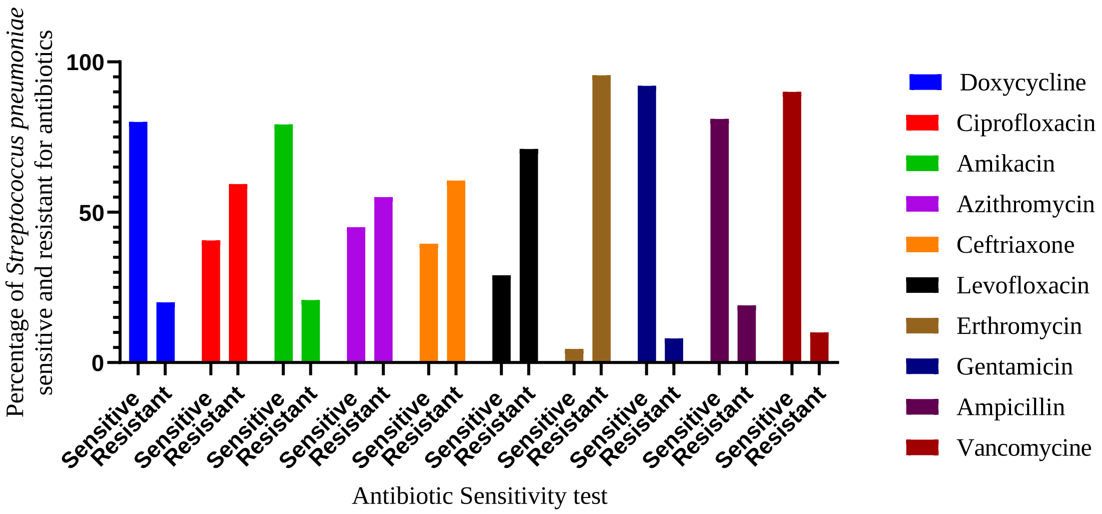
Various antibiotics were assessed concerning their effectiveness against gram-positive and gram-negative cocci. The susceptibility of microorganisms to antibiotics varied among different isolates. Staphylococcus aureus exhibited the highest sensitivity to vancomycin (75.25%), whereas a majority of the isolated Gram-negative bacterial strains displayed multidrug resistance. Resistance in S. aureus was noted at 40% to ciprofloxacin and 84% to erythromycin, with all strains being susceptible to vancomycin and Gemifloxacin in a minority of instances. Additionally, 40% of staphylococci obtained from samples were identified as MRSA (Methicillin-resistant Staphylococcus aureus). Table 2 presents the list of bacteria responsible for burn infections in burn patients, along with the antibiotics tested and their corresponding resistance profiles.

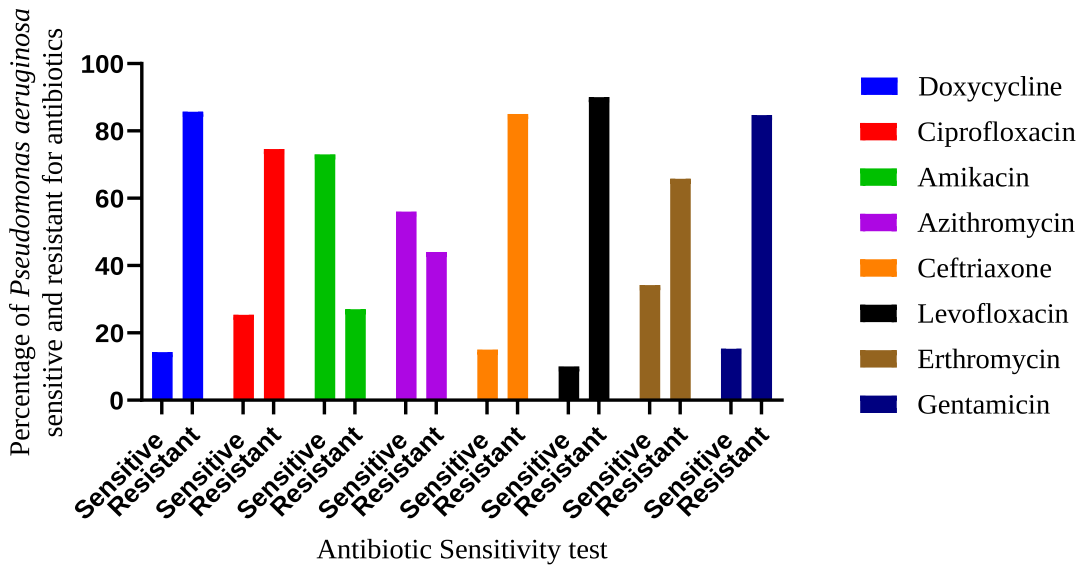


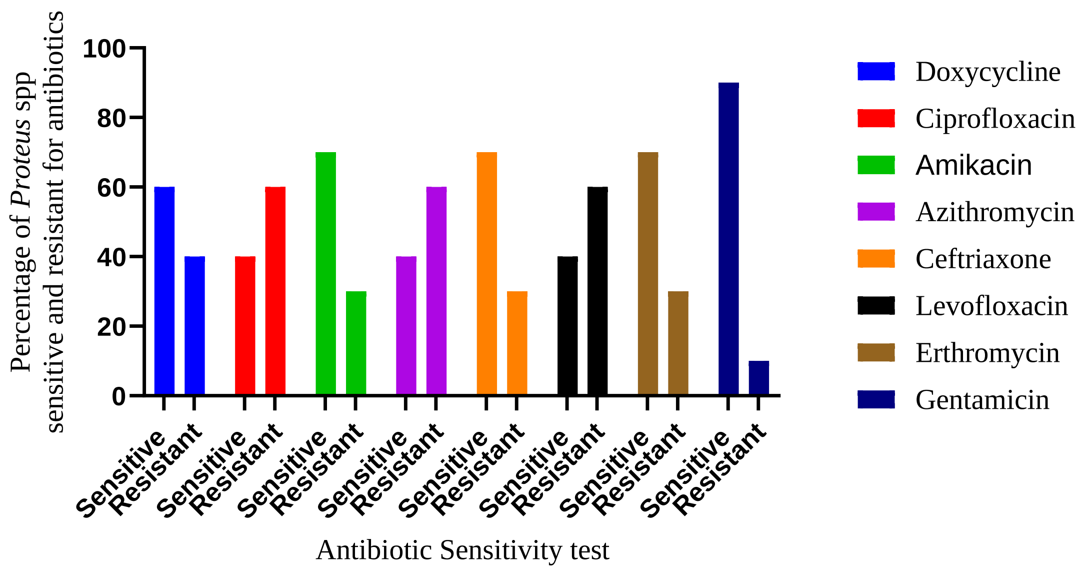

Percentage of Staphylococcus aureus sensitive and resistant for antibiotics
0
20
40
60
80
100
Sensitive
Resistant
Antibiotic Sensitivity test
Doxycycline
Ciprofloxacin
Amikacin
Azithromycin
Ceftriaxone
Levofloxacin
Erthromycin
Ampicillin
Vancomycine


Percentage of Acinitobacter baumannii sensitive and resistant for antibiotics
0
20
40
60
80
100
Sensitive
Resistant
Antibiotic Sensitivity test
Doxycycline
Ciprofloxacin
Amikacin
Azithromycin
Ceftriaxone
Levofloxacin
Erthromycin


Percentage of Klebsiella pneumoniae sensitive and resistant for antibiotics
0
50
100
Sensitive
Resistant
Antibiotic Sensitivity test
Doxycycline
Ciprofloxacin
Amikacin
Azithromycin
Ceftriaxone
Levofloxacin
Erthromycin
Gentamicin


Percentage of Streptococcus pneumoniae sensitive and resistant for antibiotics
100
50
0
Sensitive
Resistant
Antibiotic Sensitivity test
Doxycycline
Ciprofloxacin
Amikacin
Azithromycin
Ceftriaxone
Levofloxacin
Erthromycin
Gentamicin
Ampicillin
Vancomycine


Percentage of Pseudomonas aeruginosa sensitive and resistant for antibiotics
100
80
60
40
20
0
Sensitive
Resistant
Antibiotic Sensitivity test
Doxycycline
Ciprofloxacin
Amikacin
Azithromycin
Ceftriaxone
Levofloxacin
Erthromycin
Gentamicin


Percentage of Proteus spp sensitive and resistant for antibiotics
100
80
60
40
20
0
Sensitive
Resistant
Antibiotic Sensitivity test
Doxycycline
Ciprofloxacin
Amikacin
Azithromycin
Ceftriaxone
Levofloxacin
Erthromycin
Gentamicin

Chapter FOUR DISCUSSION AND RECOMMENDATION

Discussion

We studied the spectrum and drug resistance of pathogenic isolates from severely burned patients at our Diyala government hospital. We found that the number of NI per 100 hospitalizations in this population was 10.9, which is lower than previously reported for the same period. The low infection rate in our patients may be due to better environmental control, use of contact precautions, and strictly enforced surgical car. Although survival after burn injury has improved significantly with improved treatments4–6, control of infection remains a challenge. Several studies have sought to identify the most common multidrug-resistant pathogens, but the impact of MDROs on survival and other outcome parameters remains unclear. Our goal was to shed light on this issue by examining 100 infected burn patients admitted to our burn unit. Ansari Lair Metal, observed that the majority of patients fell within the 20-30 age range, aligning with our findings where individuals in the same age bracket exhibited the most severe burns. In the study by Nasser Setal., Gram-positive cocci were identified in 40.3% of cases, with gram-negative bacilli accounting for 55.7%. Pseudomonas emerged as the primary pathogen in our study, similar results from other research; however, it contrasts with studies, notably from developed nations, that pinpoint Staphylococcus aureus as the predominant organism. The prevalence of Pseudomonas infections in burn units may be attributed to its preference for humid environments. Staphylococcus aureus and A. baumannii were the most frequently isolated pathogens in burn wounds in our study, followed by Klebsiella spp., streptococcus, and E. coli. Proteus was present in 18.5% of cases, Antibiotic susceptibility profiles revealed widespread resistance to commonly used antibiotics due to indiscriminate usage over time. Staph. aureus displayed sensitivity to vancomycin and Gemifloxacin, while Pseudomonas and Klebsiella showed resistance to gentamicin and limited sensitivity to ciprofloxacin. In our research, amikacin, a second-generation aminoglycoside, demonstrated efficacy against Pseudomonas and Klebsiella.

The sensitivity of multiple pathogens to amikacin in our study has also been reported in other studies.

The high rate of multi-drug-resistant isolates may be because of the empiric use of broad-spectrum antibiotics and noncompliance with hospital antibiotic policies. Early discovering of isolates is also important to avoid treatment misuse , as the time required to isolate, identify and detect antibiotic susceptibility can take up to 48 hours from the time of infection. sample receiving point. This period of time may be sufficient to allow a subclinical infection to become a life-threatening disease. Second, in the case of burns, resulting from mixed infections, the potential virulence of one organism can affect another organism growing alongside it. Another factor that aggravates complications is multi-drug resistance (MDR). Once established in a hospital environment, MDR strains can persist for many months. Therefore, careful microbiological monitoring and in vitro testing before initiating antibiotic therapy and a restrictive antibiotic policy can be of great help in the prevention and treatment of MDR isolates. in burn medical units and thereby reduce the overall morbidity and mortality associated with infection. Overcrowding in burn units is a significant cause of cross-infection and should be avoided to control nosocomial infections.A superficial culture method was used, which does not provide database about the deeper layers of the burn or the actual condition of the wound. It does not differentiate between colonization and infection. The use of topical antibiotics such as silver sulfadiazine 1% affects the microbiological environment of the burn.

Conclusion

After finished Our study we found low rate of nosocomial infections and a reduced rate of isolates resistant to some drugs that are rarely used in hospitals. These results suggest that widespread antibiotic use in burn patients may lead to high rates of pathogens resistant to infection. Therefore, antibacterial drugs must be used with caution, depending on the isolate and its antibiotic profile. Staphylococcus aureus the main pathogen in burn wound infections. A. baumannii was the second commonest cause of infection in burned patients. These may indicate that burn patients gathering Nd hygiene problem are main causes of these infections.