Study on Antimicrobial Susceptibility Pattern of Bacterial Isolates from Infected Wounds in the General Surgery Ward

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Abstract

Background: *Wound infections are a major concern in the modern healthcare, representing one-third of the nosocomial infections among surgical patients and are responsible for 70% to 80% of mortality. Around 70% of bacteria responsible for causing wound infections are resistant to atleast one of the most frequently used antibiotics, thus stressing continuous surveillance. This study aimed to assess the antimicrobial susceptibility pattern of bacterial isolates from the infected wounds in the general surgery ward.*

Methods: *This was a prospective study of patients having wound infections admitted in the surgery ward at the Government Cuddalore Medical College and Hospital (GCMCH).*

Results: *In this study, a total of 100 patients with infected wounds were included. Wound infections were more prevalent among Males (75%) than Females (25%), with wound infection being more prevalent between 51-60 years of age (33%). A total of 131 micro-organisms were isolated from 100 patients with average of 1.31 organisms per patient. Among these 131 bacterial isolates, 107 (81.6%) were gram negative and 24 (18.4%) were gram positive. From this, Klebsiella sp. (26%) was the predominantly isolated pathogen followed by Pseudomonas sp. (23.7%), Escherichia coli (22.9%), MRSA (18.4%) and Proteus mirabilis (9.2%).*

Conclusion: *A high resistance rates to commonly used antibiotics such as third generation Cephalosporins and Aminoglycosides were reported. Continuous surveillance of antibiotic susceptibility pattern and rational use of antibiotics should be sought to prevent the emergence of resistant pathogens.*

Keywords: *Gram positive bacteria, Gram negative bacteria, MRSA, Antimicrobial resistance, Antimicrobial sensitivity, Wound infections*

1. Introduction:

The primary function of intact skin is to regulate microorganisms that are living on the skin surface and prevent harmful pathogens from colonizing and invading the underlying tissue. Compromised skin, such as in a wound provides a warm, moist and nutritive environment that encourages the colonization and growth of microorganisms. Since wound colonization is primarily polymicrobial and involves many potentially harmful microbes, any wound has a chance of getting infected.[1]

The main cause of wound infection is the growth of microorganisms that enter the wound site after the skin is injured. Pus that contains dead tissue, damaged cells and white blood cells is formed as a result of localized inflammation. Factors that contribute to the development of wound infection includes age, malnutrition, obesity, metabolic or endocrine disorders, microbial load and host defense mechanisms. In 2015, the overall prevalence of wound sepsis ranged from 10-33 % in India.[2]

Pus drainage or a painful spreading erythema surrounding a wound are typical local reactions of an infected wound that indicate cellulitis.[3] When bacteria infiltrate the wound bed and then proliferate widely it sets off an immunological reaction that leads to a local infection. If the bacterial spread advances beyond the initial wound site, the infection can progress to involve deeper structures, including nearby tissues, connective fascia, muscles or adjacent organs. Microbes can eventually infect the entire body through lymphatic or vascular systems resulting in systemic infections like sepsis.[4]

Bacterial pathogens such as *Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Streptococcus pyogenes, Proteus species, Streptococcus species,* and *Enterococcus species* are commonly responsible for wound infection.[5]

Wound infections are mostly diagnosed by visual examinations based on clinical signs and symptoms such as fever, erythema, suppuration, heat, pain and swelling. The following symptoms are frequently seen in acute infected wounds: pain, erythema, swelling, purulent drainage, heat and mal-odour. Chronic wounds on the other hand are frequently characterized by delayed healing, wound breakdown, friable granulation tissue, epithelial bridging and granulation tissue pocketing, with worsening pain and foul odour.[4]

In order to determine the microorganisms causing the infection and to direct the antimicrobial treatment, microbiological analysis of a wound culture specimen is carried out by using tissue biopsy, wound swabs, pus collection or debrided viable tissue.[4] Since antibiotic resistance is becoming a significant issue in the modern world, it is crucial to test microorganisms for culturing and sensitivity at the earliest stage to provide the appropriate treatment and to avoid further complications.[2]

Thus the purpose of this study was to determine the various kinds of bacterial wound infections at our tertiary care center as well as their susceptibility profile to different antimicrobials.

2. Methodology:

This was a prospective study conducted from September 1, 2023 to February 29, 2024 in the Department of Surgery, Government Cuddalore Medical College and Hospital (GCMCH), Tamilnadu, India. This study was conducted after obtaining the approval from Institutional Review Board and Ethics Committee. The primary objective of the study is to analyse the antibiotic susceptibility pattern of bacterial isolates from infected wounds during the given time period. In this study, a total of 100 patients with the present history of wound infections, irrespective of their age and gender were included. Patients without wound infections and patients who are unwilling to participate in the study were excluded from this study.

3. Results:

This study included a total of 100 patients with microbiologically confirmed wound infections enrolled over a six-month prospective observational period. From these patients, a total of 131 micro-organisms were isolated with an average of 1.31 organisms per patient.

Demographic Distribution and Wound Types:

The gender and age profile of the patients is presented in Figure 1 & 2. Wound infections were more common among Males (75%) than Females (25%),indicating a male-to-female ratio of 3:1. Similarly, patients aged between 51-60 years (33%) were mostly affected with wound infections.

Among all wound types, Diabetic foot ulcer (62%) was most frequently associated with bacterial infections, followed by Post Traumatic Raw Area (21%) and Cellulitis (15%).

Bacterial infections were most frequent with DM foot ulcer (62%), followed by Post Traumatic Raw Area (21%) and Cellulitis (15%).

Microbial Spectrum:

Out of the 131 bacterial isolates, 107 were Gram-negative (81.6%) and 24 were Gram-positive (18.4%). From this, *Klebsiella sp.* was the most predominant pathogen isolated from 34 (26%) samples followed by *Pseudomonas sp*. 31 (23.7%), *Escherichia coli* 30 (22.9%), *MRSA* 24 (18.4%), and *Proteus mirabilis* 12 (9.2%).

Collectively, 4 of the top 5 isolates were Gram-negative bacilli, emphasising their dominance in generating wound infections.

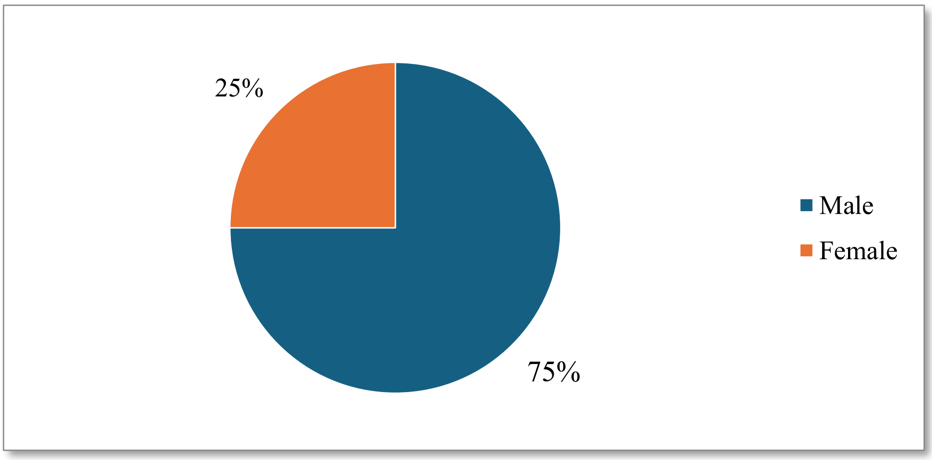

Figure 1. Gender wise distribution of patients with wound infections

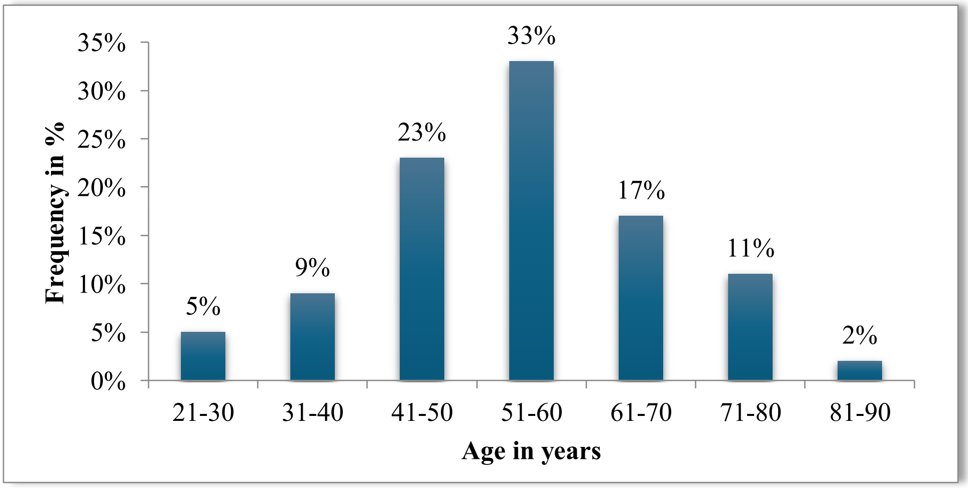

Figure 2. Age wise distribution of patients with wound infections

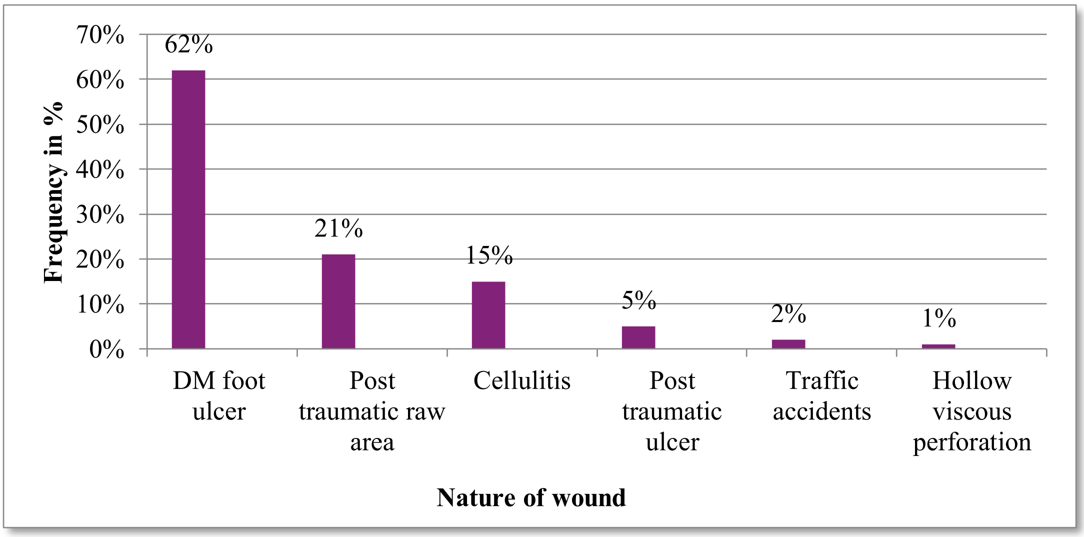

Figure 3. Distribution of infection based on wound nature

Table 1. Number of species isolated from the infected wounds

No. of species isolated	Frequency (n=131)	Percentage (%)
1	76	58
2	18	27.5
3	5	11.5
4	1	3

Table 2. Types of strain isolated from the infected wounds

Strain	Frequency (n=131)	Percentage (%)
Gram negative	107	81.6
Gram positive	24	18.4

Table 3. Types of bacteria isolated from the infected wounds

Gram negative isolates	Number (%)	Gram positive isolates	Number (%)
Klebsiella	34 (26)	*MRSA*	24 (18.4)
Pseudomonas	31 (23.7)		
Escherichia coli	30 (22.9)		
Proteus mirabilis	12 (9.2)		
Total isolates (%)	**107 (81.6)**	**Total isolates (%)**	**24 (18.4)**

* *MRSA: Methicillin Resistant Staphylococcus aureus*

Table 4. Antimicrobial sensitivity pattern of Gram Positive bacteria isolated from the Infected wounds

Bacterial isolates	Number of pathogens sensitive to antibiotics (%)								
	E	TE	AK	L	GEN	CIP	PIT	COT	C
MRSA	9 (37.5)	13 (54.5)	7 (29.2)	9 (37.5)	3 (12.5)	3 (12.5)	1 (4.2)	3 (12.5)	13 (54.2)

KEY: -: zero; E: Erythromycin; TE: Tetracycline; AK: Amikacin; L: Linezolid; GEN: Gentamicin; CIP: Ciprofloxacin; PIT: Piperacillin and Tazobactam; COT: Cotrimoxazole; C: Chloramphenicol

Table 5. Antimicrobial resistance pattern of Gram Positive bacteria isolated from the Infected wounds

Bacterial isolates	Number of pathogens resistance to antibiotics (%)															
	E	TE	CLO	AMP	AK	GEN	CD	C	CIP	COT	LZ	NIT	NOR	CUN	PIT	OX
MRSA	8 (33.3)	11 (45.8)	1 (4.2)	21 (87.5)	4 (16.7)	1 (4.2)	2 (8.3)	7 (29.2)	4 (16.7)	15 (65.2)	6 (25)	1 (4.2)	1 (4.2)	9 (37.5)	7 (29.2)	24 (100)

KEY: -: zero; E: Erythromycin; TE: Tetracycline; CLO: Cloxacillin; AMP: Ampicillin; AK: Amikacin; GEN: Gentamicin; CD: Clindamycin; C: Chloramphenicol; CIP: Ciprofloxacin; COT: Co-trimoxazole; LZ: Linezolid; NIT: Nitrofurantoin; NOR: Norfloxacin; CUN: Cundamycin; PIT: Piperacillin and Tazobactam; OX: Oxacillin.

Table 6. Antimicrobial sensitivity pattern of Gram Negative bacteria isolated from the infected wounds

Bacterial isolates	Number of pathogens sensitive to antibiotics (%)										
	GEN	PIT	AK	C	NOR	COT	CTR	TE	CIP	TOB	PB
Klebsiella (n = 34)	23 (67.6)	9 (26.5)	15 (44.1)	3 (8.8)	1 (2.9)	7 (20.6)	3 (8.8)	5 (14.7)	31 (91.2)	2 (5.9)	3 (8.8)
Pseudomonas (n = 31)	15 (48.4)	14 (45.2)	17 (54.8)	-	1 (3.2)	3 (9.7)	-	1 (3.2)	22 (71)	15 (48.4)	21 (67.7)
Escherichia coli (n = 30)	21 (70)	14 (46.7)	21 (70)	4 (13.3)	-	5 (16.7)	3 (10)	2 (6.7)	15 (50)	2 (6.7)	5 (16.7)
Proteus mirabilis (n = 12)	7 (58.3)	3 (25)	4 (33.3)	2 (16.7)	1 (8.3)	-	3 (25)	-	11 (91.7)	1 (8.3)	1 (8.3)
Total (n = 107)	**66 (61.6)**	**40 (37.4)**	**57 (53.2)**	**9 (8.4)**	**3 (2.8)**	**15 (14)**	**9 (8.4)**	**8 (7.4)**	**79 (73.8)**	**20 (18.7)**	**30 (28)**

KEY: - : zero; GEN: Gentamicin; PIT: Piperacillin and Tazobactam; AK: Amikacin; C: Chloramphenicol; NOR: Norfloxacin; COT: Cotrimoxazole; CTR: Ceftriaxone; TE: Tetracycline; CIP: Ciprofloxacin; TOB: Tobramycin; PB: Polymyxin B.

Table 7. Antimicrobial resistance pattern of Gram Negative bacteria isolated from the infected wounds

Bacterial isolates	Number of pathogens resistant to antibiotics (%)														
	GEN	AMC	PIT	AK	TOB	CTR	NOR	COT	CAZ	TE	AMP	PB	CIP	E	CPZ
Klebsiella (n = 34)	10 (29.4)	26 (76.5)	13 (38.2)	14 (41.2)	-	24 (70.6)	1 (2.9)	20 (58.8)	3 (8.8)	7 (20.6)	4 (11.8)	-	2 (5.9)	-	4 (11.8)
Pseudomonas (n = 31)	14 (45.2)	21 (67.7)	5 (16.1)	14 (45.2)	10 (32.3)	5 (16.1)	-	8 (25.8)	23 (74.2)	4 (12.9)	-	7 (22.6)	4 (12.9)	-	-
Escherichia coli (n = 30)	7 (23.3)	24 (80)	6 (20)	6 (20)	1 (3.3)	17 (56.7)	1 (3.3)	13 (43.3)	8 (26.7)	6 (20)	-	-	9 (30)	2 (6.7)	-
Proteus mirabilis (n = 12)	5 (41.7)	10 (83.3)	3 (25)	6 (50)	1 (8.3)	4 (33.3)	-	7 (58.3)	1 (8.3)	3 (25)	-	1 (8.3)	-	-	-
Total (n = 107)	**36 (33.6)**	**81 (75.7)**	**27 (25.2)**	**40 (37.3)**	**12 (11.2)**	**50 (46.7)**	**2 (1.8)**	**48 (44.8)**	**35 (32.7)**	**20 (18.7)**	**4 (3.7)**	**8 (7.5)**	**15 (14)**	**2 (1.8)**	**4 (3.7)**

KEY: - : zero; GEN: Gentamicin; AMC: Amoxicillin and Potassium clavulanate; PIT: Piperacillin and Tazobactam; AK: Amikacin; TOB: Tobramycin; CTR: Ceftriaxone; NOR: Norfloxacin; COT: Cotrimoxazole; CAZ: Ceftazidime; TE: Tetracycline; AMP: Ampicillin; PB: Polymyxin B; CIP: Ciprofloxacin; E: Erythromycin; CPZ: Cefoperazone

Table 8. Commonly prescribed antibiotics for treating wound infections

Antibiotics	No. of patients (n=100)	Percentage (%)
Cefotaxime	71	71
Piperacillin and Tazobactam	46	46
Ceftriaxone	3	3
Metronidazole	49	49
Amikacin	29	29
Gentamicin	42	42
Linezolid	21	21
Ciprofloxacin	68	68
Azithromycin	4	4
Ofloxacin	2	2
Cefixime	1	1
Ampicillin	5	5
Co-trimoxazole	4	4
Doxycycline	2	2

4. Discussion:

In this study, a total of 100 cases were included based on inclusion and exclusion criteria. Gender wise distribution showed that male (75%) were more prevalent to wound infections than female (25%), which is in line with the previous study done by Mama M *et al.*[1] This is consistent with occupational and lifestyle-related exposure patterns, especially in the Indian context.

Patients were divided into seven age groups. Wound infections were more prevalent between 51–60 years of age (33%), which is relevant to the study conducted by Sheeba PM *et al.*[9] This age-related trend is indicative of comorbid conditions such as diabetes mellitus and peripheral vascular diseases, both of which are prevalent in this age group and are known risk factors for wound infections.

Majority of the bacterial isolates from the infected wounds were gram-negative 107 (81.6%) followed by gram-positive 24 (18.4%). This higher rate of isolation of the gram-negative bacteria was also seen in previous studies from India by Biradar A *et al*, Basu S *et al* and Mantravadi HB *et al*.[6-8]

According to this study, 76 (58%) of the wound cultures showed mono-microbial growth; while the remaining 55 (42%) showed poly-microbial growth. This finding correlates with the study done by Mohammed A *et al*.[5]

This study reveals that among all the wound types, DM foot ulcer (62%) was the most common type of chronic wound associated with bacterial infections, which is similar to the study conducted by Guan H *et al*.[10] Diabetic foot ulcers are well-known for their poor healing ability and high infection rates due to compromised immunity, microvascular damage, and neuropathy. A total of 131 micro-organisms were isolated from 100 patients with an average of 1.31 organisms per patient. The pre-dominant isolate in this study was found to be *Klebsiella sp*. (26%), followed by *Pseudomonas sp.* (23.7%), *E. coli* (22.9%), *MRSA* (18.4%) and *Proteus sp.* (9.2%), which was also observed in a related study by Roopa C *et al*.[11]

Mostly used antibiotics for treating wound infections in the patients were Cefotaxime (71%), followed by Ciprofloxacin (68%), Metronidazole (49%), Piperacillin and Tazobactam (46%), Gentamicin (42%), Amikacin (29%) and Linezolid (21%) respectively. Although the bacterial isolates demonstrated a high level of resistance to third-generation cephalosporins, Cefotaxime remained the most commonly prescribed antibiotic for treating wound infections, suggesting a possible discrepancy between laboratory findings and empirical treatment strategies.

ANTIBIOTIC SENSITIVITY PATTERN OF BACTERIAL PATHOGENS:

In this study, *Klebsiella sp*. showed maximum sensitivity to Ciprofloxacin 31(91.2%) followed by Gentamicin 23(67.6%), Amikacin 15(44.1%), Piperacillin and Tazobactam 9(26.5%), Co-trimoxazole 7(20.6%), Tetracycline 5(14.7%), Polymyxin B 3(8.8%), Ceftriaxone 3(8.8%), Chloramphenicol 3(8.8%), Norfloxacin 1(2.9%), Erythromycin 1(2.9%), and Cefotaxim1(2.9%); similar findings were reported by Mohammed A *et al* [5] and Gangania PS *et al*.[13]

Pseudomonas sp. showed maximum sensitivity to Ciprofloxacin 22(71%) followed by Polymyxin B 21(67.7%), Amikacin 17(54.8%), Gentamicin 15(48.4%), Tobramycin 15(48.4%), Piperacillin and Tazobactam 14(45.2%), Co-trimoxazole 3(9.7%), Amoxicillin and Potassium clavulanate 1(3.2%) and Aztreonam 1(3.2%), which is similar to the studies done by Mohammed A *et al* [5] and Mwakalinga LK *et al*.[14]

Escherichia coli showed maximum sensitivity to Amikacin 21(70%), Gentamicin 21(70%) followed by Ciprofloxacin 15(50%), Piperacillin and Tazobactam 14(46.7%), Polymyxin B 5(16.7%%), Co-trimoxazole 5(16.7%), Chloramphenicol 4(13.3%), Ceftriaxone 3(10%), Tetracycline 2(6.7%) and Tobramycin 2(6.7%); these results are in line with study conducted by Gangania PS *et al* [13] and Mwakalinga LK *et al*.[14]

Proteus mirabilis shown maximum sensitivity to Ciprofloxacin 11(98.7%) followed by Gentamicin 7(58.3%), Amikacin 4(33.3%), Ceftriaxone 3(25%), Piperacillin and Tazobactam3(25%), Chloramphenicol 2(16.7%), Amoxicillin and Potassium clavulanate 1(8.3%), Polymyxin B 1(8.3%), Tobramycin 1(8.3%) and Cefotaxim 1(8.3%); these findings are similar to the results reported by Mwakalinga LK *et al*.[14]

MRSA showed maximum sensitivity to Tetracycline 13(54.2%), Chloramphenicol 13(54.2%) followed by Erythromycin 9(37.5%), Amikacin 7(29.2%), Linezolid 9(37.5%), Co-trimoxazole 3(12.5%), Ciprofloxacin 3(12.5%), Gentamicin 3(12.5%) and Piperacillin and Tazobactam 1(4.2%); these results are similar to the study done by Mohammed A *et al*.[5]

In this study, the gram negative pathogens showed maximum sensitivity towards Ciprofloxacin (76.5%), Gentamicin (63.8%) and Amikacin (61.7%).The gram positive bacterial pathogens showed maximum sensitivity to Tetracycline (54.2%), Chloramphenicol (54.2%), followed by Erythromycin (37.5%) and Amikacin (29.2%).

Pathogens like *Klebsiella* (92.9%), *Pseudomonas* (76.9%), and *Proteus sp.* (60%) shown higher sensitivity to Ciprofloxacin which was relevant to the study conducted by Goswami NN *et al.*[12]

ANTIBIOTIC RESISTANCE PATTERN OF BACTERIAL PATHOGENS:

In this study, *Klebsiella sp.* showed high resistance to Amoxicillin and Potassium clavulanate 26(76.5%) followed by Ceftriaxone 24(70.6%), Co-trimoxazole 20(58.8%), Amikacin 14(41.2%), Piperacillin and Tazobactam 13(38.2%), Gentamicin 10(29.4%), Tetracycline 7(20.6%), Ampicillin 4(11.8%), Cefoperazone 4(11.8%), Ceftazidime 3(8.8%), Ciprofloxacin 2(5.9%), Cefotaxim 1(2.9%) and Norfloxacin 1(2.9%); these findings correlates with studies done by Mohammed A *et al* [5], Mwakalinga LK *et al* [14] and Sheeba PM *et al.*[9]

Pseudomonas sp. showed high resistance to Ceftazidime 23(74.2%) followed by Amoxicillin and Potassium clavulanate 21(67.7%), Amikacin 14(45.2%), Gentamicin 14(45.2%), Tobramycin 10(32.3%), Co-trimoxazole 8(25.8%), Polymyxin B 7(22.6%), Piperacillin and Tazobactam 5(16.1%), Ceftriaxone 5(16.1%), Ciprofloxacin 4(12.9%), and Tetracycline 4(12.9%); which is similar to the study done by Bessa LJ *et al* [15] and Savanur SS *et al.*[16]

Escherichia coli exhibited high resistance to Amoxicillin and Potassium clavulanate 24(80.1%) followed by Ceftriaxone 17(56.7%), Co-trimoxazole 13(43.3%), Ciprofloxacin 9(30%), Ceftazidime 8(26.7%), Gentamicin 7(23.3%), Tetracycline 6(20%), Amikacin 6(20%), Piperacillin and Tazobactam 6(20%), Erythromycin 2(6.7%), Cundamycin 1(3.3%), Ofloxacin 1(3.3%), Norfloxacin 1 (3.3%), and Tobramycin 1(3.3%); these results are similar with the findings reported by Sheeba PM *et al* [9] and Savanur SS *et al.*[16]

Proteus mirabilis showed high resistance to Amoxicillin and Potassium clavulanate 10(80.3%) followed by Co-trimoxazole 7(58.3%), Amikacin 6(50%), Gentamicin 5(41.7%), Ceftriaxone 4(33.3%), Tetracycline 3(25%), Piperacillin and Tazobactam 3(25%), Tobramycin 1(8.3%), Ceftazidime 1(8.3%), Polymyxin B 1(8.3%) and Chloramphenicol 1(8.3%); these results correlates with the study conducted by Savanur SS *et al.*[16]

MRSA shown absolute resistance to Oxacillin 24(100%), followed by Ampicillin 21(87.5%), Co-trimoxazole 15(62.5%), Tetracycline 11(45.8%), Cundamycin 9(37.5%), Piperacillin and Tazobactam 7(29.2%), Chloramphenicol 7(29.2%), Linezolid 6(25%), Erythromycin 8(33.3%), Amikacin 4(16.7%), Ciprofloxacin 4(16.7%), Clindamycin 2(8.3%), Cloxacillin 1(4.2%), Gentamicin 1(4.2%), Nitrofurantoin 1(4.2%), and Norfloxacin 1(4.2%); this findings are in line with the results reported by Mohammed A *et al* [5] and Mulu W *et al.*[17]

The gram negative bacterial pathogens showed higher resistance towards Amoxicillin and Potassium clavulanate (75.7%), Ceftriaxone (46.7%) and Cotrimoxazole (44.8%).

The gram positive pathogens showed absolute resistance towards Oxacillin (100%), followed by Ampicillin (87.5%), Cotrimoxazole (62.5%) and Tetracycline (45.8%).

These findings highlight the urgent need for targeted therapy, as empirical regimens based on older resistance patterns may be ineffective.

5. Conclusion:

This study demonstrates the dominance of Gram-negative bacteria in infected wounds and displays concerning resistance patterns to commonly used antibiotics such as amoxicillin-clavulanate and ceftriaxone. While ciprofloxacin and gentamicin are still relatively effective, the disconnect between antibiotic susceptibility data and prescribing practices is concerning.

MRSA, which remained the predominant Gram-positive isolate, showed high resistance across multiple drug classes, raising concerns about the effectiveness of conventional empirical regimens.

The high proportion of diabetic foot ulcers among the patients emphasizes the significance of early healing by maintaining optimal blood glucose levels and treating vascular insufficiencies, thus minimizing the risk of infections.

Findings from this study strongly suggests the establishment of routine culture and sensitivity testing as well as appropriate usage of antibiotics by means of evidence based prescribing and antimicrobial stewardship. To prevent recurrent infections and to improve wound healing, concentrating on controllable risk factors such as glycemic control and wound hygiene, especially in diabetic patients, is equally essential.

In conclusion, this study emphasizes the necessity of a multidisciplinary approach that integrates clinical, microbiological and public health strategies for effective management of wound infections and for mitigating the threat of antimicrobial resistance.

6. References:

1. Mama M, Abdissa A, Sewunet T. Antimicrobial susceptibility pattern of bacterial isolates from wound infection and their sensitivity to alternative topical agents at Jimma University Specialized Hospital, South-West Ethiopia. *Ann Clin Microbiol Antimicrob.* 2014;13:14.
2. Roopashree S, Prathab AG, Sandeep T. Bacteriological profile and antibiotic susceptibility patterns of wound infections in a tertiary care hospital in South India. *Indian J Microbiol Res.* 2021;8(1):76–85.
3. Bowler PG, Duerden BI, Armstrong DG. Wound microbiology and associated approaches to wound management. *Clin Microbiol Rev.* 2001;14(2):244–269.
4. Hoang PN, Ghori MU, Ousey KJ, Conway BR. Current and advanced therapies for chronic wound infection. *Pharm J.* 2022;309(7963).
5. Mohammed A, Seid ME, Gebrecherkos T, Tiruneh M, Moges F. Bacterial isolates and their antimicrobial susceptibility patterns of wound infections among inpatients and outpatients attending the University of Gondar Referral Hospital, Northwest Ethiopia. *Int J Microbiol.* 2017;2017:8953829.
6. Biradar A, Farooqui F, Prakash R, Khaqri SY, Itagi I. Aerobic bacteriological profile with antibiogram of pus isolates. *Indian J Microbiol Res*. 2016;3(3):245–249.
7. Basu S, Ramchuran PT, Bali ST, Gulati AK, Shukla VK. A prospective, descriptive study to identify the microbiological profile of chronic wounds in outpatients. *Ostomy Wound Manage*. 2009;55(1):14–20.
8. Mantravadi HB, Chinthaparthi MR, Shravani V. Aerobic isolates in pus and their antibiotic sensitivity pattern: a study conducted in a teaching hospital in Andhra Pradesh. *Int J Med Sci Public Health*. 2015;4(8):1076–79.
9. Sheeba PM, Prathyusha K, Anila MA. Antibiotic susceptibility trends in bacterial isolates from wound infections. *MIR J.* 2024;11(1):1–9.
10. Guan H, Dong W, Lu Y, Jiang M, Zhang D, Aobuliaximu Y, et al. Distribution and antibiotic resistance patterns of pathogenic bacteria in patients with chronic cutaneous wounds in China. *Front Med (Lausanne).* 2021;8:609584.
11. Roopa C, Deepali VP. Pus culture isolates and their antibiotic sensitivity at a tertiary care hospital in Hyderabad, Karnataka. *IP Int J Med Microbiol Trop Dis*. 2017;3(4):140–145.
12. Goswami NN, Trivedi HR, Goswami AP, Patel TK, Tripathi CB. Antibiotic sensitivity profile of bacterial pathogens in postoperative wound infections at a tertiary care hospital in Gujarat. *India. J Pharmacol Pharmacother*. 2011;2(3):158–164.
13. Gangania PS, Singh VA, Ghimire SS. Bacterial isolation and their antibiotic susceptibility pattern from post-operative wound infected patients. *Indian J Microbiol Res*. 2015;2(4):231–235.
14. Mwakalinga LK, Temu RJ, Horumpende PG, Ngowi N, Pallangyo AJ. Bacterial isolates and their antibiotic susceptibility pattern among patients with infected wounds admitted in orthopaedic and trauma ward in tertiary care hospital, North Eastern Tanzania. *J Biosci Med*. 2022;10(7):83–96.
15. Bessa LJ, Fazii P, Di Giulio M, Cellini L. Bacterial isolates from infected wounds and their antibiotic susceptibility pattern: some remarks about wound infection. *Int Wound J*. 2015;12(1):47–52.
16. Savanur SS, Gururaj H. Study of antibiotic sensitivity and resistance pattern of bacterial isolates in intensive care unit setup of a tertiary care hospital. *Indian J Crit Care Med*. 2019;23(12):547–555.
17. Mulu W, Abera B, Yimer M et al. Bacterial agents and antibiotic resistance profiles of infections from different sites that occurred among patients at Debre Markos Referral Hospital, Ethiopia: a cross-sectional study. *BMC Res Notes*. 2017;10(1):254.
18. Liu YF, Ni PW, Huang Y, Xie T. Therapeutic strategies for chronic wound infection. *Chin J Traumatol*. 2022;25(1):11–16.