International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 31, Issue 5, May 2025 **ijppr.humanjournals.com** ISSN: 2349-7203

Study on the Impact of Culture Sensitivity Testing on Antibiotics Prescription in Wound Infected Surgical Patients

Dr. Junior Sundresh N[1], Sneha S.N[2], Reshma S[3]

[1] Professor, Department of General Surgery, Government Cuddalore Medical College and Hospital, Chidambaram, Tamil Nadu – 608002. India.
[2] Assistant Professor, Department of Pharmacy, FEAT, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu – 608002. India.
[3*] Pharm. D VI Year (INTG), Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu – 608002. India.
[4] Pharm. D VI Year (INTG), Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu – 608002. India.

Received: 2025-04-25 Revised: 2025-05-05 Accepted: 2025-05-10

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 at least 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 major function of intact skin is to manage bacteria on the skin's surface while also protecting beneath tissue from being colonized and invaded by hazardous diseases. When skin loses its integrity, such as in a wound, it produces a moist, warm, and nutritive environment that is ideal for microbial colonization and growth. Because wound colonization is predominantly polymicrobial, encompassing a wide range of potentially pathogenic microorganisms, any wound is susceptible to infection.[1]

Once the skin is injured, germs that penetrate the wound site multiply and become the primary cause of wound infection.White blood cells, damaged cells, and dead tissue are seen in the pus that forms as a result of regional inflammation. Wound infections are more likely to develop when a person is older, malnourished, obese, has endocrine or metabolic abnormalities, has a high microbial load, and has weak host defenses. Incidence of wound sepsis overall in India in 2015, varied between 10 and 33%. Pus discharge or painful spreading erythema around a wound are common local reactions of an infected wound, implying cellulitis. [3] When germs penetrate further into the wound bed and multiply quickly, an immune response occurs, resulting in local infection. As germs expand beyond the wound, infection may spread to deeper tissues, neighboring tissues, fascia, muscle, or local organs. Systemic infection, such as sepsis, can occur when microorganisms enter the body through vascular or lymphatic systems and affect the entire body. [4].Pathogenic bacteria that frequently cause wound infections include streptococcus pyogenes, proteus species, escherichia coli, pseudomonas aeruginosa, klebsiella pneumoniae, and streptococcus aureus.[3]

The majority of the time, clinical signs and symptoms such as heat, discomfort, swelling, suppuration, erythema, and fever are use d to diagnose wound infections visually.

International Journal of Pharmacy and Pharmaceutical Research (IJPPR)
Volume 31, Issue 5, May 2025 ijppr.humanjournals.com ISSN: 2349-7203

Acutelyinfected wound frequently exhibit pain, erythema, edema, heat, purulent discharge, and malodor. On the other hand, chroni c wounds can show indications of pocketing in granulation tissue, delayed healing, friable granulation, epithelial bridging, and sig nificant odor.[4]

Pus collection, tissue biopsy or wound swab, or debrided live tissue are used in the microbiological investigation of a wound culture specimen in order to identify the causal microorganisms and direct the antibiotic therapy. Since antibiotic resistance is becoming a serious concern in the modern world, testing microorganisms for sensitivity and culture at the first stage is crucial to providing the right therapy and preventing further complications [2]. Therefore, in our tertiary care center, this study was carried out to identify the various forms of Gram negative bacterial wound infections and their sensitivity profile to different antimicrobials.

2. Methodology:

This was a prospective study conducted from September 1, 2024 to February 29, 2025 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 on the impact of culture sensitivity testing on antibiotics prescription in wound infected during the given time period. In this study, a total of 100patients 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. Result:

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, emphasizing their dominance in generating wound infections.

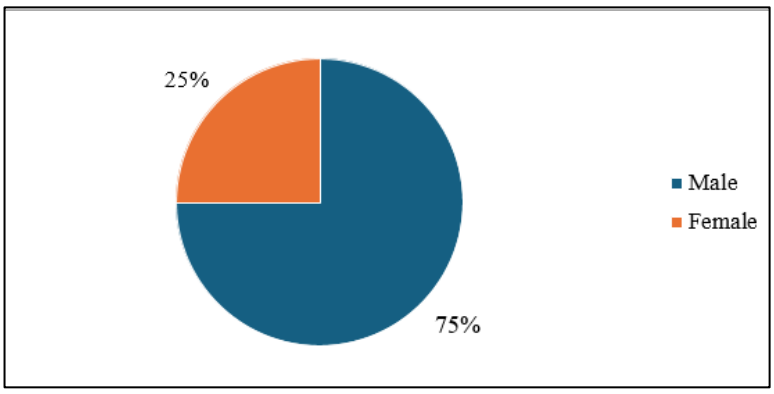

Figure 1. Gender wise distribution of patients with wound infections

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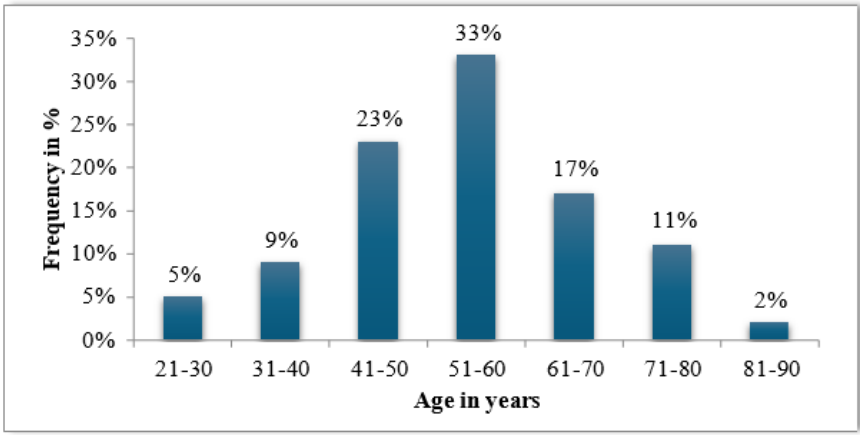

Figure 2. Age wise distribution of patients with wound infections

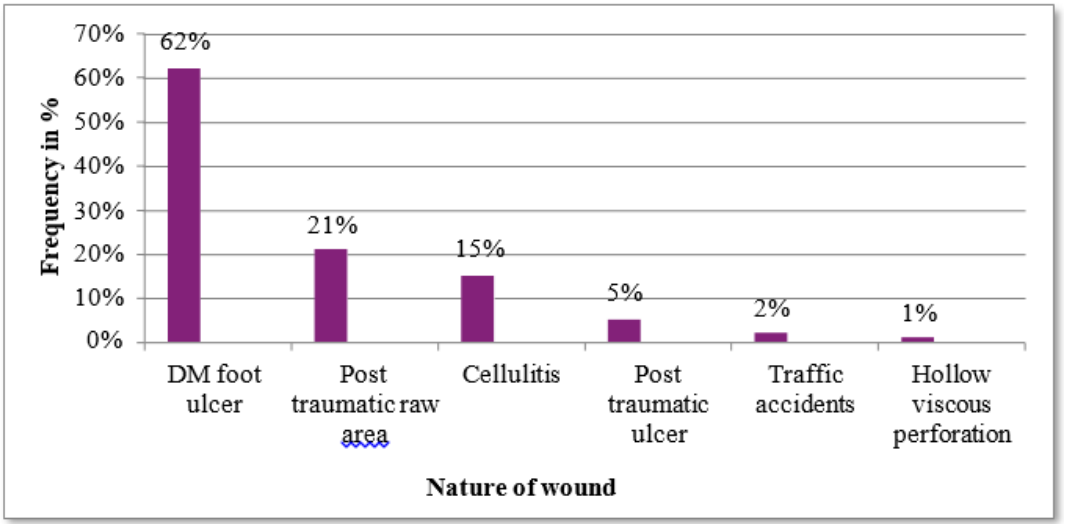

Figure 3. Distribution of infection based on wound nature

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*

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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 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 6. 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]

5. Conclusion:

The most common bacteria associated with wound infection in our study was Klebsiella along with a higher rate of isolation for gram negative wound pathogens compared to gram positives.Most gram negative pathogens were sensitive to broad spectrum antibiotics like Ciprofloxacin, tetracycline and Amikacin; while showing least sensitivity towards Norfloxacin, Ceftriaxone and Erythromycin . DM foot ulcer showed the highest wound infection rate, since open wounds are always at the risk of being infected. So proper wound care along with the continuous surveillance of the target pathogen's antibiotic susceptibility pattern should be practiced strictly to guide appropriate therapy for wound infections, and to prevent the emergence of MDR pathogens by promoting rational use of antimicrobial agents.

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How to cite this article:
Dr. Junior Sundresh N et al. Ijppr.Human, 2025; Vol. 31 (5): 180-185.
Conflict of Interest Statement: All authors have nothing else to disclose.