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Bacteriological Profile of Pus Samples and Their Antibiotic Susceptibility Pattern at A Tertiary Care Hospital, Jamnagar, Gujarat, India'

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Abstract

Background: *Pyogenic infections are a significant clinical concern, often caused by a variety of multidrug-resistant organisms, particularly in hospitalized patients.The increasing trend of resistance in P. aeruginosa and other Gram-negative organisms highlights the need for updated local susceptibility data to guide empirical therapy.*

Methods: *This retrospective observational study was conducted from September 2024 to February 2025 at M.P. Shah Government Medical College, Jamnagar. A total of 1000 pus samples were analyzed, of which 322 (32.2%) showed positive bacterial growth. The isolates were identified by standard microbiological methods and antibiotic susceptibility testing was performed using the Kirby-Bauer disk diffusion method, interpreted according to CLSI guidelines.*

Results: *Out of 322 culture-positive isolates, Gram-negative bacteria were predominant (52.5%), with P. aeruginosa being the most frequently isolated organism (35.4%), followed by E. coli (16.1%) and Proteus spp. (12.7%). Among Gram-positive organisms, Staphylococcus aureus was most common (12.7%), with nearly half (48.1%) identified as MRSA. Carbapenems (meropenem, imipenem) showed high sensitivity against Gram-negative isolates, while vancomycin and linezolid were most effective against Gram-positive isolates. ESBL production was observed in 61.2% of Gram-negative isolates.*

Conclusion: *The study emphasizes a high burden of multidrug-resistant pathogens in wound infections, particularly among Gram-negative organisms. Continued surveillance and strict antimicrobial stewardship are crucial to mitigate resistance. Carbapenems and beta-lactam/beta-lactamase inhibitor combinations remain the most effective empirical options. The findings support the need for hospital-specific antibiotic policies and infection control strategies.*

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I. Introduction

Pyogenic infections are a significant clinical concern, characterized by the accumulation of pus at sites of tissue inflammation.[1] Pus, typically a thick yellow or white exudate, consists of leukocytes, dead cells, and microbial debris, indicating an active immune response to microbial invasion. [2] These infections are often associated with wound sites and are driven by a complex interplay between microbial virulence, wound conditions, and the host immune defense mechanisms. [3]

Wound infections continue to pose a substantial burden on healthcare systems, particularly in developing countries like India, where the reported incidence of wound sepsis ranges from 10% to 33%.[4] The microbial etiology of these infections varies widely depending on geographical location, hospital environment, and patient demographics. [5] Moreover, the polymicrobial nature of many pyogenic infections, involving a mix of aerobic and anaerobic organisms, further complicates diagnosis and management. [6]

Among the pathogens implicated, Staphylococcus aureus remains the predominant organism, accounting for approximately 20–40% of cases. Pseudomonas aeruginosa, especially common in burn and post-operative

wounds, contributes to 5–15% of infections. Gram-negative bacilli such as Escherichia coli, Klebsiella spp., Proteus spp., and Enterococcus spp. are also frequently isolated in wound cultures. [7,8]

The choice of appropriate antimicrobial therapy is increasingly challenged by the rising prevalence of antibiotic resistance. The misuse and overuse of antibiotics have accelerated the emergence of multidrug-resistant (MDR) organisms, particularly among Gram-negative bacteria. [9,10] Alarmingly, such resistance is no longer confined to immunocompromised patients but is now being observed in otherwise healthy individuals, complicating treatment protocols and contributing to increased morbidity and healthcare costs. [11,12]

Accurate identification of the causative agents and their antibiotic susceptibility profiles is essential for guiding targeted therapy and mitigating the spread of resistant strains. Therefore, the present study aims to investigate the bacteriological spectrum of wound infections and evaluate the antimicrobial susceptibility patterns of the isolated organisms, with the goal of informing evidence-based therapeutic strategies and improving clinical outcomes. [13,14]

II. Materials and Methods

Study Design and Period:
This was a retrospective observational study conducted over six months, from September 2024 to February 2025.

Study Setting:
The study was conducted in the Bacteriology section of the Department of Microbiology at M.P. Shah Government Medical College, Jamnagar.

Inclusion Criteria:
- PUS sample were included in the study.
- All patient age groups and genders were included.

Exclusion Criteria:
- Duplicate samples from the same patient were excluded to prevent data redundancy.
- Samples that were not processed according to laboratory standards were also excluded.

Sample Processing:
All the pus sample of patients coming to the outpatient and in-patient department of
GGGH are collected for bacteriological culture into a wide-mouthed sterile containers or swab, transported to the laboratory and processed within two hours.
Gram's staining is a done for all the received samples and then inoculated onto Blood agar and MacConkey agar. Streaked culture plates were a incubated at 37°C overnight.
On the next day, the bacterial growth is observed, and further processed for identification.
Bacterial isolates are identified on the basis of colony characteristics, gram-staining, and a battery of biochemical tests.

Antimicrobial Susceptibility Testing:
Antibiotic susceptibility was tested using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar. Antimicrobial susceptibility was determined for Ceftazidime, Cefepime Piperacillin/Tazobactam(PTZ), Ciprofloxacin, Levofloxacin, ampicillin, 57 moxiclav, gentamicin, Tetracycline, Cotrimoxazole, Cefuroxime,Cefotaxime,Ceftriaxone,AmpicillinSulbactam,Ertapenam,Amikacin(AK),Meropenem(MP),Imipenem(IPM),Ceftazidime-avibactam,Aztreonam Minocycline and Doxycycline. For gram-positive isolates, Cotrimoxazole, Erythromycin, Clindamycin, Chloramphenicol, Tetracycline, Linezolid, Vancomycin.
Results were interpreted according to Latest CLSI guidelines.

Data Analysis:
Data were entered into Microsoft Excel and analyzed to determine prevalence rates and susceptibility patterns.

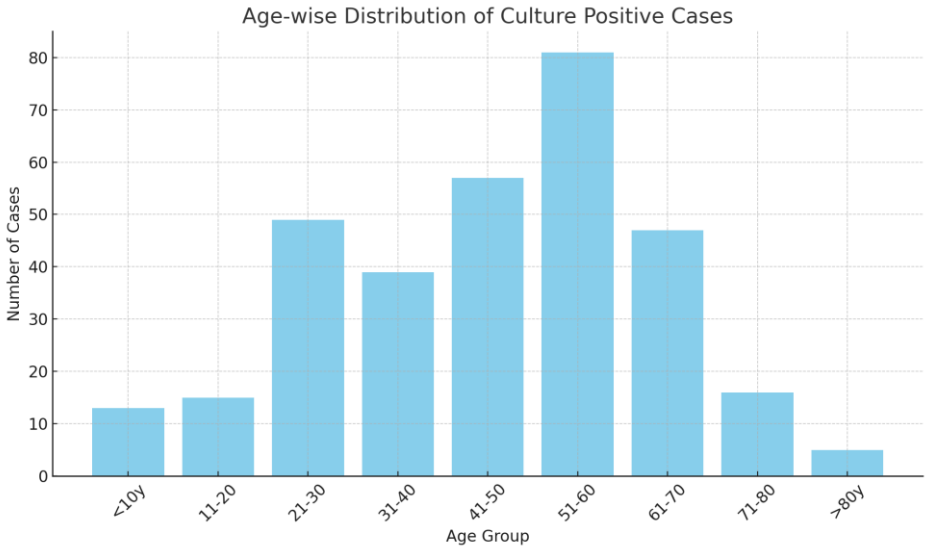
III. Results

Out of 1000 pus samples received for culture and sensitivity in the microbiology laboratory, 322 (32.20%) samples yielded positive culture and there was no growth in 678 (67.8%) samples.

Age and Gender Distribution:

The majority of isolates were from patients aged 51-60 and 61-70 years. Male patients accounted for 55.8% of the cases, with a male-to-female ratio of 1.80:1.

Age(years)	Number of cases	Percentage %
<10y	13	4.08%
11-20	15	4.65%
21-30	49	15.21%
31-40	39	12.11%
41-50	57	17.70%
51-60	81	25.15%
61-70	47	14.59%
71-80	16	4.96%
>80y	5	1.55%
Total:	322	100%



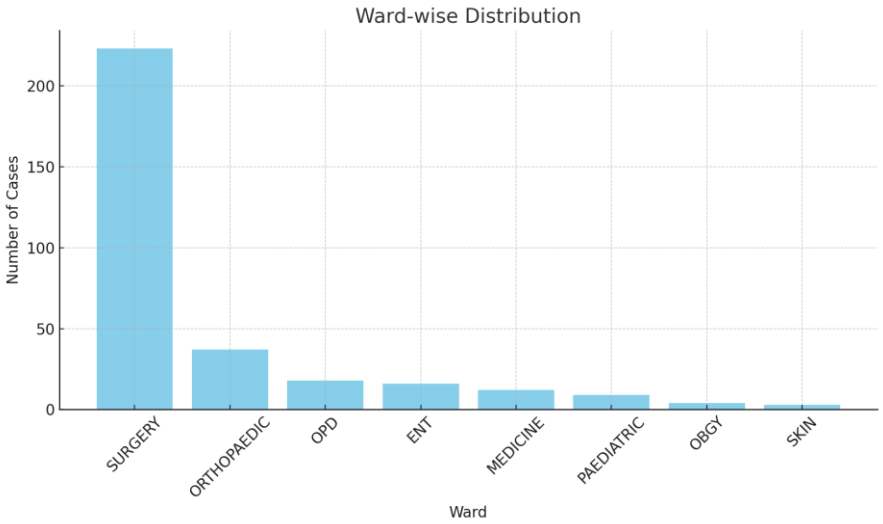
Age-Wise Distribution of Culture Positive Case.(Figure-1)

Sex	No. of cases	Percentage%
Male	207	64.28%
Female	115	35.72%
Total:	322	100%

Ward Wise Distribution:

Out of the 322 isolates, 94.41% were from the inpatient department, and 5.59 % were from the outpatient department.

Ward	No. Of Case	Percentage
SURGERY	223	69.25%
ORTHOPAEDIC	37	11.49%
OPD	18	5.59%
ENT	16	4.96%
MEDICINE	12	3.72%
PAEDIATRIC	9	2.79%
OBGY	4	1.24%
SKIN	3	0.96%
Total:	322	100%



Ward Wise Distribution(Figure-2)

Among the 322 culture positive samples, Pseudomonas aeruginosa was predominant bacterial isolate 114 (35.40 %) followed by Escherichia coli was 52 (16.14 %), Staphylococcus aureus was 41 (12.73%) Proteus species was 41 (12.73%), Klebsiella species was 38 (11.80%), Acinetobacter species was 36 (11.18%).

S.No.	Organism	Number(%)
1	Pseudomonas aeruginosa	114 (35.40 %)
2	Escherichia coli	52 (16.14 %)
3	Staphylococcus aureus	41 (12.74%)
4	Proteus species	41 (12.74%)
5	Klebsiella pneumoniae	38 (11.80%)
6	Acinetobacter species	36 (11.18%)
	Total:	322(100%)

Antimicrobial Susceptibility Patterns of Organism isolated

Antimicrobial Susceptibility Patterns of Pseudomonas aeruginosa(n-114).

Antibiotic	No.of isolates	Percentage%
Ceftazidime	49	42.98%
Cefepime	49	42.98%
Piperacillin/Tazobactam(PTZ)	88	77.19%

Ciprofloxacin	55	48.24%
Levofloxacin	55	48.24%
Meropenem(MP)	111	97.36%
Imipenem(IPM)	111	97.36%
Ceftazidime-avibactam	98	85.96%
Aztreonam	72	63.15%
TOTAL ISOLATE:114	114	

Pseudomonas aeruginosa were 77.19 % sensitive to Piperacillin tazobactum, 42.98 % sensitive to Ceftazidime, 48.24 % sensitive to Ciprofloxacin, 85.96% sensitive to Ceftazidime-avibactam acid and 97.36% sensitive to Imipenem.

Antimicrobial Susceptibility Patterns Of E. Coli(n-52)

Antibiotic	No.of isolates	Percentage%
Ampicillin	2	3.84%
Ceftriaxone	10	19.23%
Cefotaxime	10	19.23%
Amoxicillin-clavulanate	3	5.76%
Ampicillin-salbactam	29	55.76%
Piperacillin/Tazobactam (PTZ)	29	55.76%
Gentamicin	33	63.46%
Ciprofloxacin	13	25.00%
Levofloxacin	13	25.00%
Cotrimoxazole	16	30.76%
Cefuroxime	9	17.30%
Cefepime	10	19.23%
Ertapenem	51	98.07%
Meropenem(MP)	51	98.07%
Imipenem(IPM)	51	98.07%
Amikacin	35	67.30%
Cefoxitin	10	19.23%
Tetracycline	17	32.69%
Ceftazidime-avibactam	33	63.46%
Aztreonam	10	19.23%
Ceftazidime	10	19.23%
TOTAL ISOLATE:52	52	

Imipenem, meropenem and Ertapenem were most effective drugs observed in this study.

Antimicrobial Susceptibility Patterns Of S.aureus(n-41)

Antibiotic	No.of isolates	Percentage
Azithromycin	19	46.34%
Clindamycin	28	68.29%
Cefoxitin	20	48.10%
Doxycycline	40	97.56%
Minocycline	40	97.56%
Tetracycline	40	97.56%
Linezolid	39	95.12%
Ciprofloxacin	13	31.70%
Levofloxacin	13	31.70%
Gentamicin	18	43.90%
TOTAL ISOLATE:41	41	

Gram positive organisms mainly Staphylococcus aureus isolated were 97.56 % sensitive to Doxycycline, Minocycline and Tetracycline, 95.12% sensitive to Linezolid and 68.29 % sensitive to clindamycin. Methicillin resistant Staphylococcus aureus isolates were detected by cefoxitin disc diffusion method.

Antimicrobial Susceptibility Patterns Of Proteus spp.(n-41)

Antibiotic	No.of isolates	Percentage%
Ampicillin	4	20.00%
Ceftriaxone	13	31.70%
Cefotaxime	13	31.70%
Amoxicillin-clavulanate	7	17.07%
Ampicillin-salbactam	38	92.68%
Piperacillin/Tazobactam (PTZ)	38	92.68%
Gentamicin	18	43.90%
Ciprofloxacin	7	17.07%
Levofloxacin	7	17.07%
Cotrimoxazole	13	31.70%
Cefuroxime	7	35.00%
Cefepime	12	29.26%
Ertapenem	40	97.56%
Meropenem(MP)	40	97.56%
Imipenem(IPM)	40	97.56%

Amikacin	18	43.90%
Cefoxitin	13	31.70%
Ceftazidime-avibactam	40	97.56%
Aztreonam	12	29.26%
Ceftazidime	12	29.26%
TOTAL ISOLATE:41	41	

Proteus species isolated were susceptible to 97.56 % sensitive to
Ertapenem, Meropenem and Imipenem, 92.68 % sensitive to Ampicillin-sulbactam and piperacillin tazobactam.

Antimicrobial Susceptibility Patterns Of Klebsiella pneumoniae. (n-38)

Antibiotic	No.of isolates	Percentage%
Ceftriaxone	8	21.05%
Cefotaxime	8	21.05%
Amoxicillin-clavulanate	3	7.89%
Ampicillin-salbactam	16	42.10%
Piperacillin/Tazobactam (PTZ)	16	42.10%
Gentamicin	17	44.73%
Ciprofloxacin	12	31.57%
Levofloxacin	12	31.57%
Cotrimoxazole	11	28.94%
Cefuroxime	8	21.05%
Cefepime	8	21.05%
Ertapenem	32	84.21%
Meropenem(MP)	32	84.21%
Imipenem(IPM)	32	84.21%
Amikacin	17	44.73%
Cefoxitin	10	26.31%
Tetracycline	14	36.84%
Ceftazidime-avibactam	19	50.00%
Aztreonam	8	21.05%
Ceftazidime	8	21.05%
TOTAL ISOLATE:38	38	

Imipenem, meropenem and Ertapenem were most effective drugs observed in this study.

Antimicrobial Susceptibility Patterns of Acinetobacter sp. (n-36)

Antibiotic	No.of isolates	Percentage%
Ceftriaxone	0	-
Cefotaxime	0	-
Ampicillin-salbactam	7	19.44%
Piperacillin/Tazobactam (PTZ)	9	25.00%
Gentamicin	9	25.00%
Ciprofloxacin	13	36.11%
Levofloxacin	13	36.11%
Cotrimoxazole	5	13.88%
Minocycline	27	75.00%
Doxycycline	27	75.00%
Cefepime	0	-
Meropenem(MP)	13	36.11%
Imipenem(IPM)	13	36.11%
Amikacin	10	27.77%
Ceftazidime	0	-
TOTAL ISOLATE:36	36	

Acinetobacter sp were sensitive to 75 % sensitive to Minocycline and Doxycycline.

IV. Discussion

Pyogenic infections, characterized by pus formation, are commonly caused by both Gram-positive and Gram-negative bacteria. In the present study, Gram-negative organisms predominated (52.5%), aligning with findings from Duggal et al. [17] and Shama et al. [18], who reported a higher prevalence of Gram-negative pathogens in pus samples.

Bacteriological Profile

Table 1: Comparative Prevalence of Major Bacterial Isolates in Pus Samples

Organism	Present Study (%)	Duggal et al. (%)[17]	Shama et al. (%)[18]	Kumari PH et al. (%)[19]
Pseudomonas aeruginosa	35.4	29.1	31.3	27.2
Escherichia coli	16.1	18.5	20.6	15.8
Staphylococcus aureus	12.7	14.4	12.8	14.5
Proteus spp.	12.7	10.9	9.6	10.2
Klebsiella pneumoniae.	11.8	12.0	13.4	11.1
Acinetobacter spp.	11.1	9.5	10.2	8.6

Among the Gram-negative isolates, Pseudomonas aeruginosa was the most frequently isolated pathogen (35.4%), followed by E. coli (16.1%), Proteus spp. (12.7%), Klebsiella pneumoniae (11.8%), and Acinetobacter spp. (11.1%). These organisms are commonly present in hospital environments and are known to persist on surfaces, exhibiting resistance to disinfectants and multiple antibiotics.

On the Gram-positive side, Staphylococcus aureus was the most frequently isolated species (12.7%), echoing findings by Kumari PH et al. [19]. As S. aureus is a common skin commensal, its frequent involvement in wound and soft tissue infections is not unexpected[20].

Table 2: MRSA Prevalence in Indian Studies

Study/Region	MRSA Prevalence (%)	Notes
Present Study	48.1	Detected via cefoxitin disk method
Kumari PH et al.[19]	42.3	Pus samples
Verma P et al.[25]	45.0	Surgical infections
Shittu AO et al.[26]	47.0	Clinical MRSA

For Gram-positive organisms, methicillin resistance was detected in 48.1% of S. aureus isolates, indicating the presence of MRSA strains. This resistance is primarily mediated by the mecA gene, which encodes the penicillin-binding protein 2a (PBP2a), leading to resistance against most β-lactams [22,23]. Notably, all Gram-positive isolates were 97.56% sensitive to Minocycline, Doxycycline and 95.12% to linezolid, which is in accordance with findings by Verma P [25] and ShittuAO et al. [26].

Antibiotic Resistance Patterns

Table 3a: Escherichia coli

Antibiotic	Present (%)	Duggal [17] (%)	Gomatheswari [3] (%)	Kumari PH [19] (%)
Imipenem	98.07	91.0	92.3	89.6
Amikacin	67.30	62.0	60.5	64.8
Ciprofloxacin	25.00	30.1	31.0	27.4

Imipenem remains most effective against E. coli. Fluoroquinolone resistance is high across all regions.

Table 3b: Proteus spp.

Antibiotic	Present (%)	Duggal [17] (%)	Kumari PH [19] (%)
Imipenem	97.56	94.0	92.0
Piperacillin-Tazobactam	92.68	86.0	88.0

Proteus showed uniformly high sensitivity to carbapenems and PTZ, supporting their empirical use.

Table 3c: Klebsiella pneumoniae.

Antibiotic	Present (%)	Duggal [17] (%)	Kumari PH [19] (%)
Imipenem	84.21	83.0	80.0

Klebsiella isolates were carbapenem-sensitive across all centers, but resistance is rising.

Table 3d: Pseudomonas aeruginosa

Antibiotic	Present (%)	Duggal [17] (%)	Namita [8] (%)	Kumari PH [19] (%)
Imipenem	97.36	85.7	89.4	91.1
Piperacillin-Tazobactam	77.19	64.3	68.2	70.0
Ciprofloxacin	48.24	40.1	45.0	43.8

Imipenem shows highest efficacy for Pseudomonas. Ciprofloxacin resistance is consistent nationwide.

Table 3e: Acinetobacter spp.

Antibiotic	Present (%)	Kumari PH [19] (%)
Minocycline	75.00	70.0
Doxycycline	75.00	76.5

Tetracyclines offer an effective alternative for Acinetobacter, especially when carbapenems fail.

Table 3f: Staphylococcus aureus

Antibiotic	Present (%)	Kumari PH [19] (%)	Verma P [25] (%)
Linezolid	95.12	91.0	93.2
Doxycycline	97.56	90.3	92.1
Clindamycin	68.29	67.1	72.5

S. aureus isolates show excellent susceptibility to Linezolid and Doxycycline, reinforcing their importance in MRSA treatment.

The emergence of multidrug-resistant (MDR) pathogens significantly complicates the management of pyogenic infections. Carbapenems (imipenem and meropenem) and β-lactamase inhibitor combinations (like piperacillin/tazobactam) remained the most effective agents against Gram-negative isolates.

Regarding MRSA, a global meta-analysis indicated a pooled prevalence of 14.69% among residents of elderly care centers, with higher colonization rates associated with factors such as prior antibiotic use and hospitalization [PubMed ID: 36709300]. These findings underscore the importance of targeted screening and preventive measures in high-risk populations.

The high prevalence of MDR strains among both Gram-negative and Gram-positive organisms underlines the necessity for strict infection control practices and judicious use of antibiotics. As observed, E. coli, S. aureus, K. pneumoniae, and P. aeruginosa were frequently resistant to commonly prescribed antibiotics, highlighting the need for region-specific antibiotic policies.

V. Conclusion

The findings of this study reinforce the global concern surrounding antimicrobial resistance, particularly in nosocomial settings. Regular surveillance, appropriate antibiotic stewardship, and strict adherence to infection control protocols are crucial to curb the spread of MDR pathogens. Formulating targeted antibiotic policies based on local epidemiological data is now more essential than ever.

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