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A Retrospective Analysis of Bacteriological Profile and Antimicrobial Susceptibility Trends of Pus Isolates from Outpatients Departments in a Tertiary Care Hospital

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ABSTRACT

Background: Traditionally, SSTIs have been caused by Staphylococcus aureus but increasing involvement of Gram-negative organisms and rising AMR, including MRSA and ESBL-producing Enterobacterales, have compromised the efficacy of empirical therapy highlighting the need for institution-specific surveillance data for appropriate antibiotic selection.
Methods: A retrospective study was conducted out in the Department of Microbiology of a tertiary care hospital in South India from January 2024 to December 2025. All culture-positive pus samples received from the outpatient departments were included. Bacterial isolates were identified using routine laboratory protocols, and antimicrobial susceptibility results were interpreted as per CLSI 2024 and 2025 guidelines. Year-wise organism distribution and susceptibility patterns were assessed to observe temporal trends.
Results: A total of 528 non-duplicate isolates were examined (Year 2024: 229 isolates; Year 2025: 299 isolates). Gram-negative organisms predominated (2024: 69%; 2025: 68%), with P. aeruginosa being the most common isolate followed by K. pneumoniae and E. coli; among Gram-positive isolates, S. aureus was the most common, with MRSA accounting for a substantial proportion (61% in 2024, 46% in 2025). Enterobacterales demonstrated poor and progressively declining susceptibility to several commonly used antimicrobial classes, whereas P.aeruginosa maintained relatively stable susceptibility to antipseudomonal agents and S.aureus showed reduced susceptibility to Ciprofloxacin.
Conclusion: The high prevalence of multidrug-resistant Gram-negative organisms and the substantial MRSA burden in outpatient SSTIs emphasize the requirement for periodic review of treatment strategies, along with routine OPD-based antibiogram surveillance to guide judicious antibiotic prescribing and reduce use AMR dissemination.

Keywords: Skin and Soft Tissue Infections (SSTIs), Antimicrobial Susceptibility, Outpatient Antibiogram, Pus Isolates, Antimicrobial Resistance (AMR).

INTRODUCTION

Skin and soft tissue infections (SSTIs) including abscesses, cellulitis and wound infections are among the most common infections in outpatient settings and Staphylococcus aureus has been the traditionally most common causative pathogen[1,2]. However, the microbiological landscape of SSTIs is rapidly changing with Gram-negative organisms such as Escherichia coli, Klebsiella pneumoniae and Pseudomonas aeruginosa becoming increasingly prevalent in tertiary care

settings. Methicillin-resistant Staphylococcus aureus (MRSA) and extended-spectrum β-lactamase (ESBL)-producing Enterobacterales and even early signals of carbapenem resistance are increasingly limiting the use of empiric antibiotics[1,3,4]. Antimicrobial susceptibility patterns differ significantly by geographic regions and healthcare settings. Reliance on external data can result in inappropriate empirical therapy which suggests that local antibiograms derived from institutional data are needed to guide treatment decisions.[5,6]

In this study we describe the bacteriological profile and the trends of year-wise antimicrobial susceptibility of pus isolates from the outpatient departments and evaluate the implications for empirical therapy.

MATERIALS AND METHODS

Study Design and Setting

A retrospective descriptive study was conducted in the Department of Microbiology at a tertiary care teaching hospital in South India, over a two-year period (January 2024–December 2025).

Inclusion Criteria

- Culture-positive pus or wound swab samples from outpatient departments
- First isolate per patient
- All age groups and both genders

Exclusion Criteria

- Duplicate isolates
- Contaminants or mixed growth without clinical significance
- Samples with incomplete data

Microbiological Methods

Standard microbiological techniques were used to process samples. Isolates were identified and tested for antimicrobial susceptibility testing (AST) using Vitek 2 compact. AST results were interpreted according to:
CLSI 2024 (for 2024 isolates)[7]
CLSI 2025 (for 2025 isolates)[8]

Data Analysis

Data were entered into Microsoft Excel and analyzed using descriptive statistics, expressed as frequencies and percentages, and comparisons were made between years to detect trends in susceptibility patterns.

RESULTS

Total Isolation Burden and Microbial Distribution

During the two-year study period, 612 OPD pus samples were received in 2024 and 668 samples in 2025 amounting to a total of 1280 samples. 528 non-duplicate bacterial isolates over two-years were recovered from clinically significant OPD pus samples. A temporal increase in the isolation burden (total number of pathogens), rising from 229 in 2024 to 299 in 2025 is noted, indicating a 30.5% increase in the number of isolates recovered during the study period. The overall bacteriological landscape was shifted towards Gram-negative organisms (68.6%, n=362), predominantly P.aeruginosa followed by E.coli and Gram-positive cocci (31.4%, n=166), predominantly Staphylococcus aureus.

Table 1: Organism distribution

Temporal Cohort	Total Pathogens	Gram-Positive (Count/%)	Gram-Negative (Count/%)
Year 2024	229	70 (30.6%)	159 (69.4%)
Year 2025	299	96 (32.1%)	203 (67.9%)
Cumulative	**528**	**166 (31.4%)**	**362 (68.6%)**

The Gram-negative profile was dominated by three specific organisms: *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Escherichia coli*.

Table 2: Spectrum of Gram-Negative Pathogens

Pathogen	Year 2024	Year 2025	Cumulative Total	% of Total Isolates
P. aeruginosa	67	92	159	30.1%
E. coli	42	61	103	19.5%
K. pneumoniae	50	50	100	18.9%

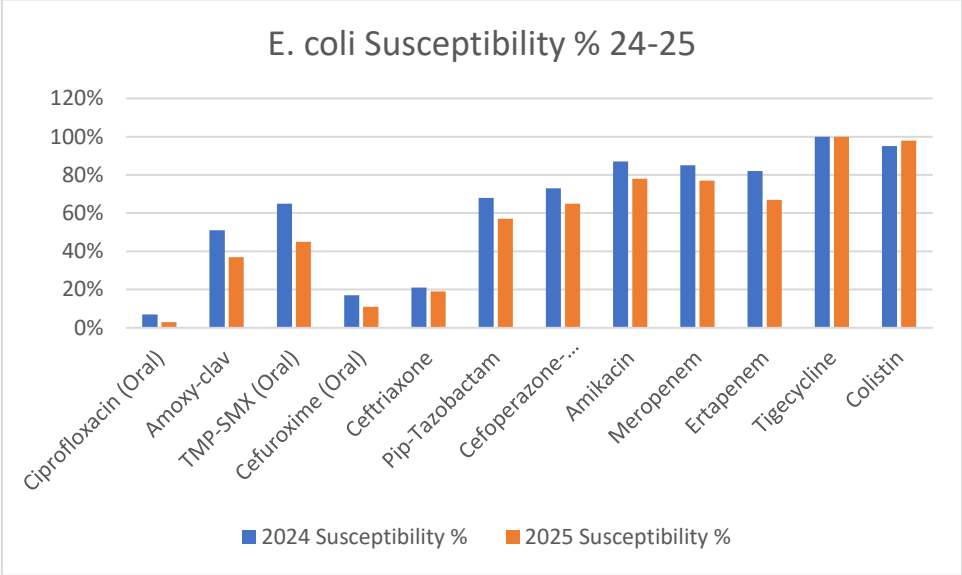
Staphylococcus aureus represented the entirety of Gram-positive isolates recovered during the study period. Within this group, the prevalence of methicillin resistance (MRSA) remained slightly high across both years.

Table 3: Spectrum of Gram-Positive Pathogens

Pathogen	Year 2024	Year 2025	Cumulative Total
MSSA	27	52	79
MRSA	43	44	87
Total S. aureus	**70**	**96**	**166**

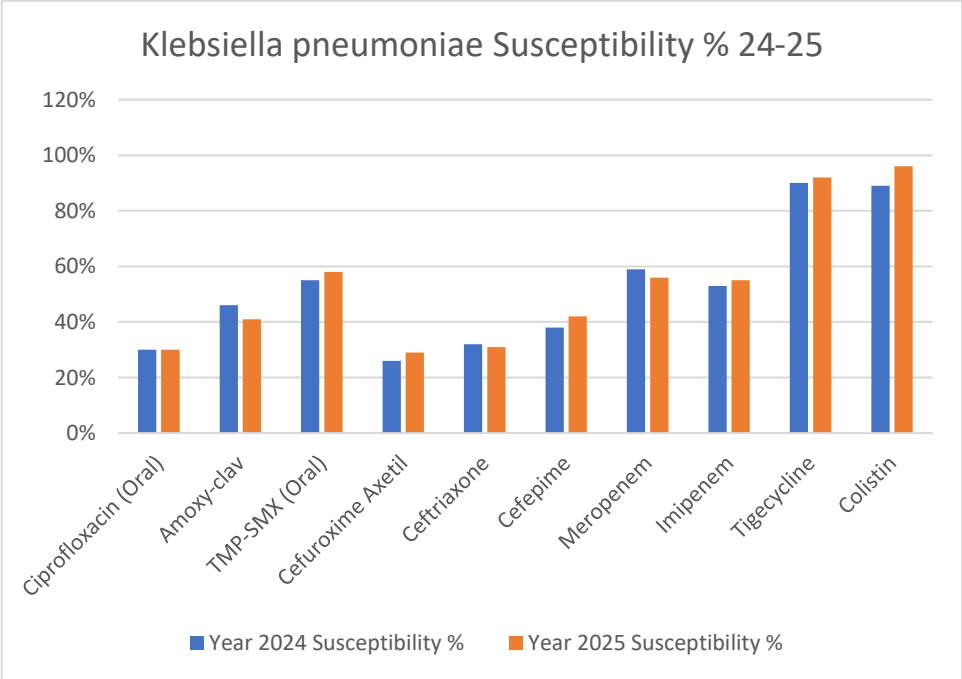
The study's most alarming resistance patterns were found in Escherichia coli isolates, especially with regard to common oral medications. Ciprofloxacin susceptibility was extremely low falling from 7% in 2024 to 3% in 2025. Amoxicillin-clavulanate and trimethoprim-sulfamethoxazole also showed notable declines.

Graph 1:Antimicrobial Susceptibility Profile: Escherichia coli



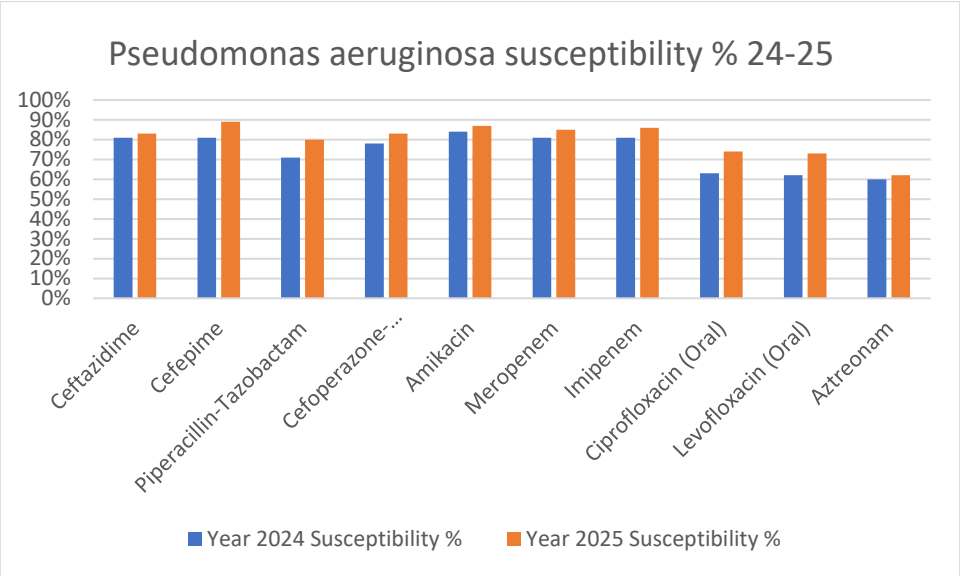
Klebsiella pneumoniae demonstrated relative temporal stability in antimicrobial susceptibility across the study period. Susceptibility to fluoroquinolones, cephalosporins and β-lactam/β-lactamase inhibitor combinations remained low to moderate with only minor variation. Carbapenem susceptibility showed a modest decline, whereas colistin susceptibility improved from 89% in 2024 to 96% in 2025. Tigecycline retained high activity throughout both years.

Graph 2:Antimicrobial Susceptibility Profile: Klebsiella pneumoniae



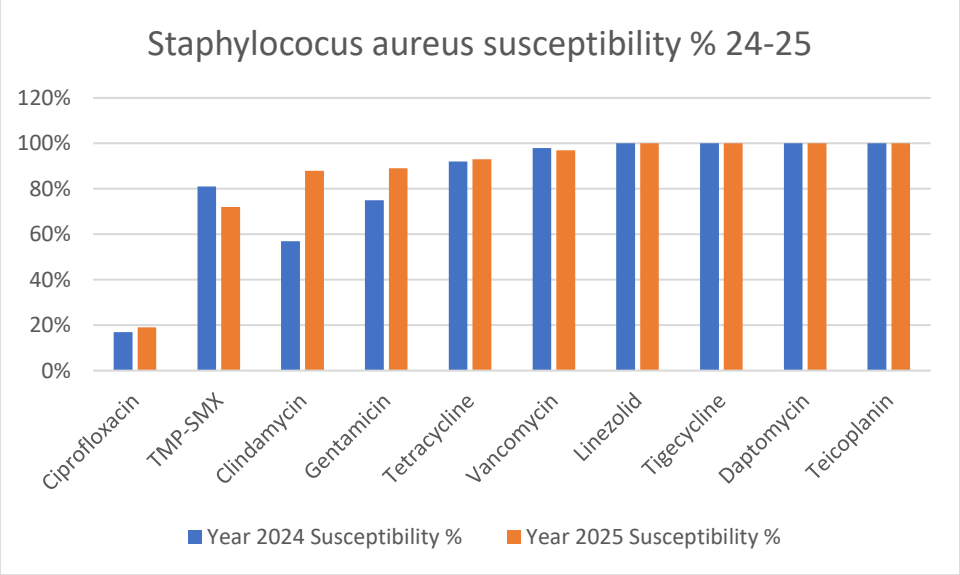
Pseudomonas aeruginosa demonstrated comparatively stable or even marginally improved susceptibility to numerous antipseudomonal agents throughout the study period, in contrast to the Enterobacterales.

Graph 3: Antimicrobial Susceptibility Profile: Pseudomonas aeruginosa



Staphylococcus aureus isolates demonstrated high overall susceptibility across both years, particularly to last-line and parenteral agents.

Graph 4: Antimicrobial Susceptibility Profile: Staphylococcus aureus



DISCUSSION

The Paradigm Shift toward Gram-Negative Dominance

There has been a dramatic change in the microbiological profile of outpatient pyogenic infections in our center. In our study, Gram-negative bacilli constituted 68.6% of isolates, indicating a shift in the etiological spectrum of pyogenic infections from the traditional understanding that localized pus-forming infections are predominantly due to Staphylococcus aureus as highlighted by Moran et al. 2006[1] and Mishra et al.[9] 2016 , towards increasing predominance of gram negative pathogens. This trend is also supported by other contemporary studies from India, such as Gill and Sharma (2019)[3], who reported 70.76% Gram-negative prevalence in a North Indian tertiary hospital, where E. coli was the most frequent isolate, and Sirisha et al. (2025)[10] who documented an even more pronounced Gram-negative shift in Kurnool with 81.4% of pus samples yielding Gram-negative organisms. This shift towards Gram-negative bacilli has important implications for empirical management, as treatment is often started with agents that are targeted at Gram-positive coverage and earlier more susceptible Gram-negative profiles were noted in the OPD setting. Of particular clinical interest was the predominance of Pseudomonas aeruginosa (30.1%), an organism that presents substantial therapeutic challenges because many commonly prescribed oral antibiotics (e.g., amoxicillin-clavulanate, cefuroxime, cefixime, doxycycline, trimethoprim-sulfamethoxazole) lack reliable activity against it, hence limiting empirical treatment options. The relatively high prevalence has important therapeutic implications as effective treatment frequently requires targeted antipseudomonal agents that are not routinely included in empirical outpatient regimens.

The Near-Total Collapse of Oral Fluoroquinolones and Cephalosporins

This two-year analysis has highlighted a key clinically significant finding regarding Enterobacterales: the number of empirical oral options has dwindled to critical levels. By 2025, susceptibility to ciprofloxacin had declined to a critical 3% for Escherichia coli, a significant loss of effectiveness for one of the most versatile classes of oral antibiotics used for community-acquired Gram-negative infections. Likewise, susceptibility to oral cephalosporins such as cefuroxime declined from 17% in 2024 to 11% in 2025 among E.coli isolates. These findings are in agreement with Trojan et al.[4] (2016), who also reported poor cefuroxime susceptibility among E.coli (5%), suggesting that oral second generation cephalosporins have limited value as empirical therapy for Gram-negative SSTIs. Trimethoprim-sulfamethoxazole susceptibility among E.coli isolates declined substantially from 65% in 2024 to 43% in 2025. Similar cotrimoxazole activity have been reported by Trojan et al.[4] (2016), who observed susceptibility of approximately 32% and Chaudhary et al.[11] (2023) reported 13% susceptibility among E.coli isolates, highlighting the diminishing reliability of this agent as an empirical oral treatment option. The clinical ripple effect of this decline in oral empirical therapy is significant. The infections that are not cleared with oral therapy become more likely to progress to systemic sepsis requiring acute hospitalization and high-end parenteral antibiotics, which further increases the mortality risk and economic burden on the patient.[12]

Temporal stability in Klebsiella pneumoniae:

The Klebsiella pneumoniae temporal data showed a small threshold shift. Most parameters were relatively stable, but colistin susceptibility increased from 89% in 2024 to 96% in 2025, which indicates relative stability of colistin susceptibility. Colistin is considered a last-line antibiotic for carbapenem-resistant Enterobacterales (CRE)[13,14]. These results are generally in line with an estimate in the 2021 ICMR annual report that demonstrated an overall colistin susceptibility of 97% among the bacterial species tested, indicating relatively low levels of colistin resistance[15].

The Staphylococcal Paradox and the Persistence of MRSA

MRSA prevalence remained slightly high, at 46% of S. aureus isolates in 2025, which is consistent with Indian data, where recent studies have shown variable MRSA prevalence, ranging from 13.26% (Kalita et al[16], 2019) to 52.2% (Singh et al[17], 2016). S. aureus isolates in our study were highly resistant to methicillin, but remained sensitive to linezolid, tigecycline, and daptomycin, and showed retained vancomycin activity; however, reports of linezolid-resistant S. aureus (Sangita et al.[18] 2024) and vancomycin-intermediate S. aureus (VISA) from India (Kaur et al.[3] 2019) and others have emphasized the need to use these agents prudently[19].

Pseudomonas aeruginosa: The Relative Stability of Antipseudomonal Susceptibility

The susceptibility profile for Pseudomonas aeruginosa was relatively stable and slightly better (11% increase in susceptibility to ciprofloxacin, 9% increase in sensitivity to Piperacillin-Tazobactam) over the 2024–2025 period. This is in agreement with the 2021 ICMR annual report that stated fluoroquinilone susceptibility in P. aeruginosa around 60%[15]. Ceftazidime susceptibility among P.aeruginosa isolates remained high in our centre, increasing slightly from 81% in 2024 to 83% in 2025, compared with only 38.7% susceptibility reported by Wajid et al.[20] in 2021. This finding suggests comparatively preserved activity of ceftazidime against P.aeruginosa in our setting. The causes for this pattern remain unclear and merit further investigation.

Clinical Relevance and Actionable Implications

The findings of this study indicate that existing empirical oral treatment guidelines may require periodic reassessment to ensure alignment with current antimicrobial susceptibility patterns. The 50% failure rate of ciprofloxacin and cefuroxime against community-acquired Gram-negative pathogens indicates that commonly used oral regimens may have limited effectiveness in our geographical area, emphasizing the importance of considering culture-guided therapy. In the setting of a 30% increase in isolate burden, empiric treatment without microbiological confirmation is less reliable, and early pus aspiration and sensitivity testing is now strongly recommended for effective outpatient wound management.

Although Gram-negative predominance has been reported across several Indian studies, the degree of antimicrobial resistance varies considerably between regions. In our study the overall meropenem susceptibility among Gram-negative was approximately 76%. In comparison, Sultana et al.[21] (2020) from Hyderabad reported 85.61% meropenem susceptibility, while Sirisha et al.[10] (2025) from Kurnool reported 87.4% susceptibility. These findings suggest a substantially higher burden of carbapenem resistance in our setting.

Study Limitations

Although this study has strong longitudinal data, it is a retrospective, single-center study that only reflected resistance patterns in an urban population that might not be generalizable to rural areas. Lack of molecular characterization of the genetic drivers of phenotypic resistance (e.g., PCR detection of mecA, bla_NDM, bla_OXA- 48-like, ESBL genes or mcr-1) limited the ability to correlate phenotypic resistance patterns with underlying resistance mechanisms and restricted detailed epidemiological analysis of resistance transmission. Our study focused only on aerobic bacterial pathogens and not on anaerobes or fungi in polymicrobial wound infections and has a risk of referral bias due to the fact that the hospital

is a tertiary care center and patients visiting the OPD may have already failed treatment at primary clinics thereby potentially overestimating community resistance rates.

CONCLUSION

These longitudinal data collected over a two-year period from pyogenic isolates in our tertiary care center suggest evolving antimicrobial resistance patterns characterized by increasing gram negative predominance and reduced susceptibility to commonly used oral agents. This can be combatted through aggressive local surveillance and commitment to evidence-based, rational use of antibiotics[22,23]. The data presented here provide the basic data to initiate that process in the South Indian outpatient setting.

DECLARATIONS

Funding
None.

Conflicts of Interest
The authors declare no conflicts of interest.

Ethical Approval
Ethical committee clearance was obtained for this study (Approval No: VIEC/2026/APP/19).

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