

Bacterial patterns and antibiotic susceptibility among pus culture in dr. Zainoel Abidin General Hospital, Banda Aceh



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Received: 07 February 2025

Revised: 12 March 2025

Accepted: 15 March 2025

Abstract. The collection of pus samples is crucial for identifying serious bacterial infections. Accurate identification of the pathogen and selection of the appropriate antibiotics are essential for effective treatment. This study used a descriptive retrospective method to investigate pus specimens' bacterial patterns and antibiotic susceptibility at dr. Zainoel Abidin General Hospital in Banda Aceh in 2023. Out of 1,274 examined pus specimens, 782 yielded positive cultures, revealing 61 bacterial species, predominantly *Escherichia coli* (22%), *Staphylococcus aureus* (16%), and *Pseudomonas aeruginosa* (9%). Gram-negative bacteria constituted 70.20% of the isolates. High antibiotic susceptibility rates were observed for Vancomycin (98%) and Linezolid (98%) in Gram-positive bacteria, while Amikacin (86%) and Meropenem (74.74%) were effective against Gram-negative bacteria. Notable resistance was found in Methicillin-resistant *S. aureus* (81%) and *E. coli* resistant to third-generation Cephalosporins (55%). These findings underscore the importance of monitoring bacterial patterns and antibiotic resistance for improved infection management at dr. Zainoel Abidin General Hospital, Banda Aceh.

Keywords: Antimicrobial susceptibility, bacteria, pus specimen, Gram-negative bacteria, bacterial identification

INTRODUCTION

Skin, mucous membranes, or environmental microorganisms commonly cause skin and soft tissue infections. These pathogens typically enter through external injuries or complications from surgery or spread through the bloodstream. Infections often involve significant bacteria, such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterobacteriaceae*, *beta-hemolytic streptococci*, and anaerobic bacteria, which are frequently detected in superficial wound samples or abscesses [1-4]. In clinical practice, pus samples are crucial for diagnosing severe bacterial infections. Comprehensive analysis of these samples aids in accurately identifying causative pathogens and informs the selection of appropriate antibiotic therapies, thereby mitigating the risk of complications from untreated infections [5, 6]. However, the increasing prevalence of

bacterial antibiotic resistance has significantly compromised the effectiveness of many treatments for bacterial infections [7, 8].

Based on data from dr. Zainoel Abidin Aceh General Hospital in 2023, there has been a significant decline in bacteria's susceptibility to various antibiotics. Therefore, antibiotic resistance is a significant challenge in treating bacterial infections today [9]. Most Gram-negative bacteria isolated from pus samples often resist commonly prescribed antimicrobial agents [7, 10]. This highlights the need for continuous monitoring and judicious use of antibiotics. Studies show that these resistance patterns can vary by geographic region and type of infection, underscoring the importance of proper local analysis [5, 11, 12]



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In addition to presenting the results of a systematic analysis of bacterial patterns found in pus specimens and their susceptibility to antibiotics, this study is expected to help understand the characteristics of microorganisms that cause infections and their response to therapy [12]. This information is essential for health practitioners, especially doctors and medical officers at dr. Zainoel Abidin General Hospital Banda Aceh, in determining appropriate clinical decisions in managing bacterial infections. The data presented in this study can be the basis for further research on the epidemiology of bacterial infections, especially in dr. Zainoel Abidin General Hospital Banda Aceh, and contribute to the scientific literature in clinical microbiology. In addition, this information could be used to develop more effective infection control policies. We hope that this information can be a source of education for the general public regarding the importance of understanding bacterial infections and the judicious use of antibiotics. This can help reduce the spread of bacterial infections and antibiotic resistance by better understanding prevention and treatment [13, 14].

METHODOLOGY

Data for this study were obtained from bacterial identification and antibiotic susceptibility tests conducted using the VITEK 2 Compact system at the Clinical Microbiology Laboratory of dr. Zainoel Abidin General Hospital Banda Aceh. One thousand two hundred seventy-four pus specimens collected from January to December 2023 were analyzed descriptively to determine bacterial patterns and their corresponding antibiotic sensitivities. The inclusion criteria encompassed all pus specimens that demonstrated bacterial growth. The exclusion criteria included "unidentified" results, duplicate tests from the same

patient, and cases where antibiotic susceptibility tests were not performed alongside bacterial identification.

The analysis primarily focused on descriptive data characteristics without additional statistical inference. The results were interpreted by the Clinical and Laboratory Standards Institute (CLSI) guidelines for bacterial identification and antibiotic susceptibility testing. The CLSI standards, recognized internationally, provide comprehensive protocols for interpreting results generated by systems such as VITEK 2 Compact, ensuring uniformity and consistency in clinical microbiological procedures. The VITEK 2 Compact is extensively used in microbiology laboratories, adhering to industry standards established by health authorities for reliable bacterial identification and susceptibility testing.

RESULTS AND DISCUSSION

Type of Bacteria

Seven hundred eighty-two positive cultures met the inclusion criteria, and 61 different bacterial species were identified. Gram-negative bacteria were the most prevalent, with 39 species totaling 549 isolates (70%) (Table 1), while Gram-positive bacteria consisted of 22 species totaling 233 isolates (30%) (Table 2). The top three bacteria identified were *Escherichia coli* (22%), *Staphylococcus aureus* (16%), and *Pseudomonas aeruginosa* (9%).

Throughout 2023, data collected from pus specimens at dr. Zainoel Abidin General Hospital in Banda Aceh provided valuable insights into bacterial patterns and antibiotic resistance. The analysis identified a range of Gram-negative and Gram-positive bacterial species. Bacterial identification and antimicrobial susceptibility testing (AST) were performed using the VITEK 2 Compact system, and appropriate antibiotics were selected based on the updated CLSI 2024 guidelines

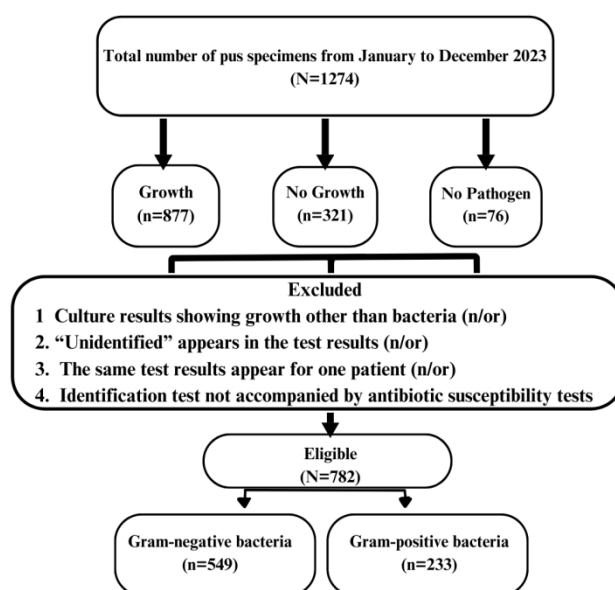


Figure 1. Study Criteria

Table 1. Gram-negative bacteria pattern

Organism Gram (-)	Number (Percentage)
<i>Escherichia coli</i>	170 (70.20)
<i>Pseudomonas aeruginosa</i>	71 (30.97)
<i>Klebsiella pneumoniae</i> subsp. <i>pneumoniae</i>	66 (12.93)
<i>Acinetobacter baumannii</i>	58 (12.02)
<i>Proteus mirabilis</i>	58 (10.56)
<i>Enterobacter cloacae</i> complex	18 (10.56)
<i>Morganella morganii</i> subsp. <i>morganii</i>	15 (3.28)
<i>Klebsiella pneumoniae</i>	11 (2.73)
<i>Enterobacter aerogenes</i>	11 (2.00)
<i>Citrobacter freundii</i>	10 (2.00)
<i>Sphingomonas paucimobilis</i>	7 (1.82)
<i>Stenotrophomonas maltophilia</i>	7 (1.28)
<i>Providencia stuartii</i>	5 (1.28)
<i>Morganella Morganii</i> subsp. <i>sibonii</i>	4 (0.91)
<i>Serratia marcescens</i>	3 (0.73)
<i>Citrobacter koseri</i>	3 (0.55)
<i>Pseudomonas fluorescens</i>	3 (0.55)
<i>Proteus hauseri</i>	3 (0.55)
<i>Aeromonas hydrophila</i>	2 (0.55)
<i>Klebsiella pneumoniae</i> subsp. <i>ozaenae</i>	2 (0.36)
<i>Acinetobacter baumannii</i> complex	2 (0.36)
<i>Pseudomonas luteola</i>	2 (0.36)
<i>Pantoea</i> spp	2 (0.36)
<i>Achromobacter xylosoxidans</i>	1 (0.36)
<i>Pseudomonas putida</i>	1 (0.18)
<i>Achromobacter denitrificans</i>	1 (0.18)
<i>Enterobacter cloacae</i>	1 (0.18)
<i>Aeromonas salmonicida</i>	1 (0.18)
<i>Klebsiella oxytoca</i>	1 (0.18)
<i>Salmonella</i> spp	1 (0.18)
<i>Serratia fonticola</i>	1 (0.18)
<i>Aeromonas veronii</i>	1 (0.18)
<i>Citrobacter amalonaticus</i>	1 (0.18)
<i>Pseudomonas alcaligenes</i>	1 (0.18)
<i>Cedecea lapagei</i>	1 (0.18)
<i>Citrobacter braakii</i>	1 (0.18)
<i>Escherichia coli</i> O157	1 (0.18)
<i>Kluyvera ascorbate</i>	1 (0.18)
<i>Serratia rubidaea</i>	1 (0.18)

Table 2. Gram-positive bacteria pattern

Organism Gram (+)	Number (Percentage)
<i>Staphylococcus aureus</i>	128 (54.94)
<i>Enterococcus faecalis</i>	32 (13.73)
<i>Staphylococcus haemolyticus</i>	24 (10.30)
<i>Staphylococcus epidermidis</i>	9 (3.86)
<i>Kocuria kristinae</i>	8 (3.43)
<i>Streptococcus agalactiae</i>	8 (3.43)
<i>Enterococcus faecium</i>	5 (2.15)
<i>Streptococcus pyogenes</i>	3 (1.29)
<i>Enterococcus</i> spp	2 (0.86)
<i>Staphylococcus warneri</i>	2 (0.86)
<i>Enterococcus raffinosus</i>	1 (0.43)
<i>Gemella morbillorum</i>	1 (0.43)
<i>Granulicatella elegans</i>	1 (0.43)
<i>Kocuria rosea</i>	1 (0.43)
<i>Pediococcus acidilactici</i>	1 (0.43)
<i>Staphylococcus cohnii</i> subsp <i>urealyticus</i>	1 (0.43)
<i>Staphylococcus lugdunensis</i>	1 (0.43)
<i>Staphylococcus pseudintermedius</i>	1 (0.43)
<i>Staphylococcus schleiferi</i>	1 (0.43)
<i>Staphylococcus xylosus</i>	1 (0.43)
<i>Streptococcus dysgalactiae</i> subsp <i>dysgalactiae</i>	1 (0.43)
<i>Streptococcus pseudoporcini</i>	1 (0.43)

(Figures 2 and 3). We examined the antibiotic sensitivity of the top five Gram-negative and three Gram-positive bacteria. The results showed a decline in bacterial sensitivity to antibiotics, reflecting increased antibiotic resistance within the hospital. Some identified bacteria

were listed among the WHO's 2024 priority pathogenic bacteria (Table 3).

Our findings showed that the five most commonly isolated Gram-negative bacterial species were *E. coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*,

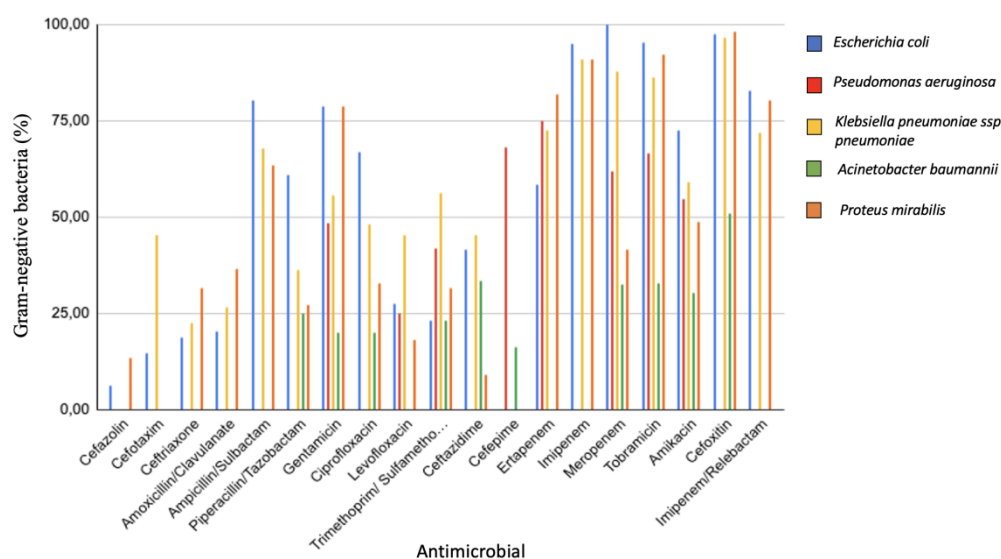


Figure 2. The sensitivity percentage of the top five Gram-negative bacteria based on CLSI 2024 [15]

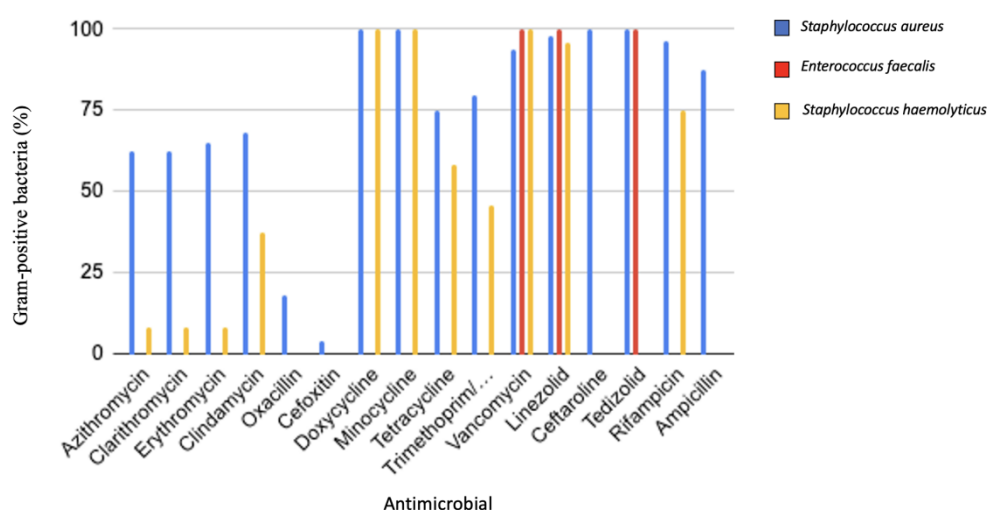


Figure 3. The sensitivity percentage of the top five Gram-positive bacteria based on CLSI 2024 [15]

Acinetobacter baumannii, and *Proteus mirabilis*. *E. coli* showed high resistance to Ampicillin with a sensitivity of 6.33%, followed by low sensitivity to Cefazolin (14.63%), Cefotaxime (18.80%), and Ceftriaxone (20.25%). In contrast, these bacteria were more sensitive to Meropenem (95.54%), Imipenem (100%), and Piperacillin-Tazobactam (78.85%). This suggests that these antibiotics are effective for the treatment of *E. coli*.

Pseudomonas aeruginosa showed high resistance to Gentamicin (48.44% of sensitivity) and Ciprofloxacin (25.00%). However, it showed a better response to Ceftazidime (68.18%), Cefepime (75.00%), and Meropenem (66.67%). The following result obtained was *Klebsiella pneumoniae*, which had significant resistance to Amoxicillin (45.45%) and Cefotaxime

(22.45%). However, the bacteria remained sensitive to Imipenem (87.75%) and Meropenem (86.44%).

Acinetobacter baumannii showed high antibiotic resistance and low sensitivity to Meropenem (32.73%) but complete sensitivity to Colistin (100%). In contrast, *Proteus mirabilis* had significant resistance to Amoxicillin, with a sensitivity level of only 13.46%. However, it showed high sensitivity to Meropenem (92.31%) and Imipenem (41.46%). These findings emphasize the importance of antimicrobial sensitivity testing in selecting appropriate therapy in clinical practice.

Table 3. Top Three Bacteria on the WHO Bacterial Priority Pathogen List, 2024

Critical group		High group	
<i>E. coli</i>	55%	<i>P. aeruginosa</i>	36%
third generation cephalosporin-resistant		carbapenem-resistant	
<i>E. coli</i>	6.33%	<i>S. aureus</i>	81%
carbapenem-resistant		methicillin resistant	

Critical group	High group	Medium group
• Enterobacterales carbapenem-resistant • Enterobacterales third-generation cephalosporin-resistant • <i>Acinetobacter baumannii</i> carbapenem-resistant	• <i>Salmonella typhi</i> fluoroquinolone-resistant • <i>Shigella spp</i> fluoroquinolone-resistant • <i>Enterococcus faecium</i> vancomycin-resistant • <i>Pseudomonas aeruginosa</i> carbapenem-resistant • Non typhoidal <i>Salmonella</i> Fluoroquinolone-resistant • <i>Neisseria gonorrhoeae</i> third-generation cephalosporin-resistant, and/or fluoroquinolone-resistant • <i>Staphylococcus aureus</i> methicillin-resistant	• Group A-Streptococci macrolide-resistant • <i>Streptococcus pneumoniae</i> macrolide-resistant • <i>Haemophilus influenzae</i> ampicillin-resistant • Group B-Streptococci penicillin-resistant

Figure 4. WHO Bacterial Priority Pathogen List, 2024 [16]

Resistance of Gram-Positive Bacteria

The Gram-positive bacteria isolated in this study included *Staphylococcus aureus*, *Enterococcus faecalis*, and *Staphylococcus haemolyticus*. *Staphylococcus aureus* showed high resistance to Oxacillin, with a sensitivity of only 17.97%, and Cefoxitin, with a sensitivity of 3.88%. These results indicate a high prevalence of *Methicillin-resistant Staphylococcus aureus* (MRSA). However, *S. aureus* remained sensitive to Linezolid (97.66%) and Vancomycin (93.75%), reliable therapeutic options for MRSA infections.

Enterococcus faecalis showed complete sensitivity to Linezolid (100%) and Tedizolid (100%), essential for treating serious infections caused by enterococci. Another finding in this study was that *Staphylococcus haemolyticus* resisted various antibiotics but was still sensitive to Linezolid (95.83%) and Vancomycin (100%). This number remains the mainstay in the therapy of infections involving this bacterium. The information obtained in this study emphasizes the importance of monitoring antibiotic resistance and the choice of therapy tailored to the results of sensitivity testing for effective treatment [17].

Clinical Implications and Recommendations

Based on the findings in this study, there are several important clinical implications, including routine monitoring of antibiotic resistance patterns, which is crucial to guide effective therapy selection. This can help reduce inappropriate antibiotic use and lower the risk of antimicrobial resistance development. Another implication is that antibiotic use should be based on specific sensitivity data from each healthcare facility to prevent overuse and inhibit the development of antimicrobial resistance [18]. Also, the culture and antimicrobial sensitivity testing results should be used as the basis for adjusting therapy so that the most appropriate antibiotics can be administered to ensure therapeutic effectiveness while minimizing resistance. These implications emphasize the importance of an evidence-based approach in managing infections to maintain the long-term effectiveness of antibiotics [18, 19].

Our finding showed pus samples' bacterial patterns and antibiotic susceptibility at dr. Zainoel Abidin General Hospital, Banda Aceh. The analysis showed that most bacteria isolated were Gram-negative, with the three primary pathogens being *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*. Antibiotics that still showed adequate susceptibility to

Gram-negative bacteria were Amikacin and Meropenem, while for Gram-positive bacteria were Vancomycin and Linezolid. However, the results of this study also showed the presence of resistance in several bacteria, which corresponds to WHO 2024 priority pathogens, including *S. aureus*, which is resistant to Methicillin; *E. coli*, which is resistant to third-generation Cephalosporins; *E. coli*, which is resistant to Carbapenems, and *P. aeruginosa* which is resistant to Carbapenems. These findings emphasize the importance of routine surveillance of bacterial patterns and antibiotic susceptibility to control resistance and strengthen infection prevention and control efforts in hospitals [20, 21].

CONCLUSION

This study highlights the importance of monitoring bacterial patterns and antibiotic resistance to improve infection management at dr. Zainoel Abidin General Hospital, Banda Aceh. The high prevalence of Gram-negative bacteria, especially *Escherichia coli*, and significant resistance in Methicillin-resistant *Staphylococcus aureus* and *E. coli* resistant to third-generation Cephalosporins emphasize better antibiotic control. The effectiveness of Vancomycin and Linezolid against Gram-positive bacteria, along with Amikacin and Meropenem for Gram-negative bacteria, provides valuable guidance for treatment. Strengthening antibiotic policies and resistance monitoring is essential to improve patient care and prevent the spread of resistant bacteria.

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How to cite this article:

MKeumalahayati, M., Hayati, Z., Maelani, I., Ridwan, A., Rahmawati, C.V., Muliana, D., Putri, F.D.A., Mahdani, W. (2025). Bacterial patterns and antibiotic susceptibility among pus culture in dr. Zainoel Abidin General Hospital, Banda Aceh. *Jurnal Natural*, 25(1), 41-47.