RESEARCH ARTICLE

pISSN: 0126-074X | eISSN: 2338-6223
https://doi.org/10.15395/mkb.v56.3422
Majalah Kedokteran Bandung. 2024;56(3):174–178

Majalah Kedokteran Bandung (MKB)

Received: July 1, 2023
Accepted: January 23, 2024
Available online: September 30, 2024

Microbial Diversity and Antimicrobial Susceptibility from Wound Dehiscence Isolates in an Indonesian Tertiary Referral Hospital

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Abstract

Healthcare-associated infections (HAIs) remain a critical issue for public health in Indonesia, with wound dehiscence associated with surgical site infections (SSIs) being one of them. Globally, SSIs are known as the most common postoperative complications with a heightened prevalence, particularly in low to middle-income countries. With its retrospective and descriptive design, this study aimed to illustrate the microbial patterns identified in Prof. Dr. I.G.N.G. Ngoerah General Hospital from 12 January 2020 to 12 December 2022. The study includes all patients who underwent surgery and were subsequently diagnosed with wound dehiscence and SSIs. Specimens were collected from patients and submitted to the Microbiology Laboratory at the hospital above. Bacterial identification and susceptibility testing to antimicrobials were performed using the Vitek 2 Compact System (bioMerieux, Marcy l'Etoile, France). Patient information was sourced from medical records. Out of 172 samples, 151 (87.8%) yielded positive cultures. Among these, 151 (87.8%) were found to be positive. Gram-negative bacteria were found to be most prevalent, with *Escherichia coli* (20.2%) and *Pseudomonas aeruginosa* (19.6%) being the most frequently isolated bacteria. The bacteria isolated were mostly susceptible to amikacin (72.1%), followed closely by meropenem (71.4%). This information could contribute to the development of an empirical antibiotic therapy protocol for wound dehiscence or SSI cases in this local context.

Keywords: Antibiotics, bacterial infection, postoperative complication, surgical site infection

Introduction

Wound dehiscence stands as a formidable complication that surgeons are often wary of. It raises significant alarm due to its potential for evisceration, the possibility of needing subsequent interventions, the risk of recurrence, surgical wound infection, and the formation of an incisional hernia.[1] Wound dehiscence entails the separation of the borders of a surgical incision that has been closed on the skin, irrespective of whether the underlying tissues, organs, or implants are exposed or protruding. This separation could occur at one or multiple points or involve the entire length of the incision, affecting several or all layers of tissue. Not all dehisced incisions will show clinical signs or symptoms of infection.[2] As defined by the CDC, wound dehiscence could either be a superficial or deep tissue injury and may be linked to SSIs[3]. SSIs are now placing substantial financial strain on healthcare systems[1]. They are the most commonly observed type of infection in low- and middle-income nations, with incidence rates ranging from 1.2 to 23.6 per 100 surgical procedures and a combined incidence of 11.8%. In comparison, in developed countries, the rates of SSIs fluctuate between 1.2% and 5.2%.[4] SSIs account for around 20% of all healthcare-associated infections (HAIs), and a minimum of 5% of patients who undergo a surgical procedure develop an SSI.[5]

In 2021, the annual National and State Healthcare-Associated Infections (HAIs) Progress Report highlighted an increase in the SSI Standardized Infection Ratio (SIR) related to all combined National Healthcare Safety Network (NHSN) operative procedure categories, roughly 3%. However, minor changes were reported in SIR associated with the Surgical Care Improvement Project (SCIP) NHSN operative procedure categories compared to the

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prior year.[6]

In hospital settings, antimicrobials are frequently employed as a preventative measure for all surgical procedures, with an inappropriateness rate of between 30% and 90%. Often, they are used at incorrect times, for extended periods, and with too broad a spectrum of coverage[7]. Overuse of prophylactic antimicrobials has the potential to modify the composition of normal flora or promote the spread of antimicrobial resistance.[7,8]

Hence, understanding bacterial etiology and the proper selection of antimicrobials is essential. This study sought to provide insights into bacterial identification and the pattern of antimicrobial susceptibility, particularly in patients with SSIs and wound dehiscence.

Methods

This descriptive study, using a retrospective approach, was carried out at Prof. Dr. I.G.N.G. Ngoerah General Hospital from 12 January 2020 through to 12 December 2022. Samples were gathered from patients suffering from wound dehiscence or SSIs and processed at the same hospital's Microbiology Laboratory. The Faculty of Medicine Udayana University Ethics Committee granted ethical approval for this study (No: 134/UN14.2.2.VII.14/LT/ 2023).

In total, 172 wound swabs, pus, and tissue samples were gathered from patients diagnosed with SSIs or wound dehiscence. Each specimen was transferred to the microbiology lab within 2 hours by placing the swab in Amies transport medium. The collected swabs were spread on sheep blood agar and MacConkey agar plates and then incubated at 37 degrees Celsius for a duration of 24 to 48 hours. Bacterial identification was conducted using the Vitek 2 Compact system (bioMerieux, Marcy l'Etoile, France).

Tests for antimicrobial susceptibility were also executed using the Vitek 2 Compact system (bioMerieux, Marcy l'Etoile, France). Bacterial suspension with a 0.5 McFarland standard was diluted to 1.5 × 107 CFU/ml in 0.45% saline solution. Testing was performed according to the manufacturer's instructions. The antimicrobial susceptibility tests were conducted for each bacterial species using susceptibility testing cards for *Staphylococcus spp., Enterococcus spp., and S. agalactiae* (AST-GP67 panel), for *S. pneumoniae, beta-hemolytic Streptococcus, and Viridans Streptococcus* (AST-ST03 panel), and a gram-negative (AST- GN93 panel). VITEK 2 results were read and analyzed automatically using the software provided by bioMerieux (version 9.02). For all the identification and antibiotic susceptibility test were performed, *Escherichia coli* (ATCC) 25922 and *Staphylococcus aureus* (ATCC) 29213 were used as reference strains for quality controls.

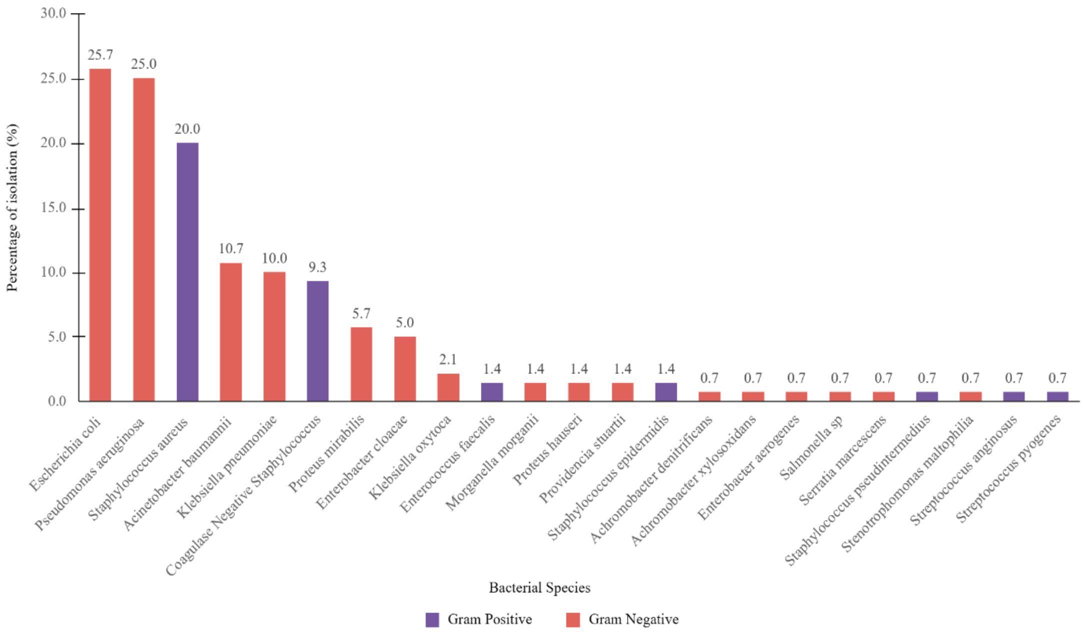

Figure 1 The Pattern of Isolated Bacteria from Wound Swabs, Pus, And Tissue Specimens in the Clinical Microbiology Laboratory, Prof. dr. I.G.N.G. Ngoerah Hospital

Table 1 Antibiotic Sensitivity Pattern Of Gram-Positive Isolates (n=29)

Antibiotics	Sensitivity n (%)
Linezolid	28 (96.6)
Tigecycline	28 (96.6)
Vancomycin	28 (96.6)
Erythromycin	25 (86.2)
Levofloxacin	25 (86.2)
Azithromycin	24 (82.8)
Ciprofloxacin	24 (82.8)
Clindamycin	24 (82.8)
Gentamycin	24 (82.8)
Moxifloxacin	24 (82.8)
Ampicillin/Sulbactam	20 (69.0)
Ceftriaxone	20 (69.0)
Trimethoprim/ Sulfamethoxazole	20 (69.0)
Cefepime	19 (65.5)
Cefuroxime	18 (62.1)
Piperacillin/Tazobactam	18 (62.1)
Tetracycline	18 (62.1)
Doxycycline	16 (55.2)
Amoxicillin/Clavulanate	15 (51.7)
Cefazolin	14 (48.3)
Amoxicillin	9 (31.0)
Ampicillin	2 (6.9)

All the data gathered were analyzed using descriptive statistics on SPSS version 22. Results were expressed as frequencies and percentages and presented in figures and tables.

Results

The study's findings indicated that of the 172 samples, 87.8% (151/172) were positive for bacterial growth, with the remaining being negative. Single-bacterial growth was observed in 82.1% (124/151) of the positive samples, and multi-bacterial growth was detected in 17.8% (27/151). As a result, the total number of bacterial isolates amounted to 178. Of these isolates, 78.6% (140/178) were identified as pathogenic bacteria, while 21.3% (38/178) were classified as colonization bacteria. Of the 178 bacterial isolates, Gram-negative bacteria were the most prevalent, comprising 73% (130/178) of the isolates, whereas Gram-positive bacteria comprised 26.9% (48/178). The detailed breakdown of bacteria extracted from patient samples is depicted in Figure 1. Altogether, 23 distinct bacterial species were identified. The most frequently isolated bacterium was

Table 2 Antibiotic Sensitivity Pattern of Gram-Negative Isolates (n=111)

Antibiotics	Sensitivity n (%)
Amikacin	101 (91.0)
Meropenem	100 (90.1)
Piperacillin/Tazobactam	74 (66.7)
Gentamycin	67 (60.4)
Cefepime	61 (55.0)
Tigecycline	60 (54.1)
Ceftazidime	57 (51.4)
Ciprofloxacin	54 (48.6)
Aztreonam	45 (40.5)
Trimethoprim/ Sulfamethoxazole	35 (31.5)
Levofloxacin	34 (30.6)
Cefoperazone/Sulbactam	32 (28.8)
Ampicillin/Sulbactam	22 (19.8)
Ceftriaxone	18 (16.2)
Cefixime	12 (10.8)
Cefoperazone	12 (10.8)
Ampicillin	6 (5.4)
Cefuroxime	2 (1.8)

Escherichia coli 20.2% (36/140), followed by *Pseudomonas aeruginosa* 19.6% (35/140) and *Staphylococcus aureus* 15.7% (28/140).

Regarding the 140 pathogenic bacterial isolates subjected to antimicrobial sensitivity testing, the antimicrobial susceptibility test results revealed that 72.1% of these isolates were susceptible to amikacin, closely followed by meropenem at 71.4%. The Gram-positive pathogenic bacteria showed the highest sensitivity towards linezolid, tigecycline, and vancomycin, each with a susceptibility rate of 96.6% (Table 1). In contrast, the Gram-negative pathogenic bacteria exhibited the greatest sensitivity to amikacin (91%) and meropenem (90.1%), as outlined in Table 2.

Discussion

In countries with low to medium income, surgical site infections (SSIs) are the most common type of healthcare-associated infections.[10] Despite numerous advancements in asepsis, antibiotics, sterilization, and surgical techniques, SSIs continue to pose a significant challenge across all surgical specialties in hospitals.[11] Wound dehiscence is the separation of skin edges and may vary from partial to complete separation.[12] The Centers for Disease Control and Prevention (CDC) states that wound dehiscence can result in superficial or deep tissue injury and can be linked to SSIs.[3] Furthermore, multidrug-resistant organisms (MDROs) have become a major challenge in the healthcare sector, posing a significant threat to patient outcomes.[13] MDROs that are well-recognized and cause significant global issues include Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant Enterococci (VRE), penicillin-resistant pneumococci, Extended-spectrum beta-lactamase (ESBL) producing *Klebsiella pneumoniae*, and carbapenem-resistant *Acinetobacter baumannii* (CRAB). The emergence of MDROs is influenced by several factors, with the most significant being the use of antibiotics and infection control practices. Therefore, the rational use of antibiotics is crucial.[14]

This retrospective study aimed to elucidate the distribution of microbial diversity and the patterns of antimicrobial susceptibility of bacteria isolated from specimens of patients with wound dehiscence at Prof. Dr. I.G.N.G. Ngoerah General Hospital from 12 January 2020 to 12 December 2022. Even though numerous studies have already described bacteria and their antimicrobial susceptibility patterns, regular and location-specific reports are crucial.

The most commonly identified bacteria in this study were *Escherichia coli*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. This finding aligned with a study conducted in Turkey by Isik et al.,[9] which showed that *Escherichia coli* was the most frequently detected microorganism in wound cultures (22.8%). other studies conducted in Indonesia have also reported *Escherichia coli* as the predominant microorganism in surgical wound infections (20%).[15] However, another study showed that *Staphylococcus aureus* (28.6%) was the leading causative microorganism of surgical site infection, followed by *Escherichia coli* (24.7%) and *Pseudomonas* spp. (23.7%). These differences could be attributed to variations in sample selections.[16]

The bacteria isolated in this study showed the highest susceptibility to amikacin (72.1%), followed by meropenem (71.4%) and piperacillin/tazobactam (65.7%). The Gram-positive bacteria in this study were found to be most sensitive to linezolid (96.6%), tigecycline (96.6%), and vancomycin (96.6%), aligning with findings from other studies like those by Singh et al.[17] The gram-negative bacteria in this study exhibited the highest sensitivity to amikacin (91%) and meropenem (90.1%), which is comparable to a study in Nepal, where gram-negative bacteria were most sensitive to amikacin (81.8%).[16] Another study in Nigeria reported similar findings, with most gram-negative isolates being susceptible to amikacin (72.7%) and imipenem (72.7%).[17]

This study had the limitation that the sample only included wound dehiscence and SSI cases from inpatients, potentially leading to an underestimation of the overall cases of wound dehiscence and SSIs.

In conclusion, the study found that *Escherichia coli* was the most common bacteria isolated from wound dehiscence cases, and most of the isolates showed susceptibility to amikacin and meropenem. These antibiogram data could provide a basis for selecting empirical therapy for wound dehiscence and SSI cases in local hospital settings, pending definitive culture results.

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