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Research Article

BACTERIOLOGICAL PROFILE OF SURGICAL SITE INFECTIONS AND THEIR ANTIBIOGRAM: A STUDY IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Objective: To ascertain the frequency of surgical site infection (SSI) occurrences and the prevalence of aerobic bacterial infections associated with their antibiogram.

Methods: For 1 year, a tertiary care hospital affiliated with Government Medical College, Amritsar, served as the site of this cross-sectional study. Pus aspirates were aseptically taken from 86 consecutive individuals suspected of having SSI using a sterile surgical syringe with a needle and sterile cotton surgical swabs. The specimens were cultivated and placed in an incubator at 37°C for 24 h. The individual strains were then identified using traditional techniques. The Kirby–Bauer's Disc Diffusion Method was employed to conduct antimicrobial susceptibility testing.

Results: Among 1021 patients, 86 were clinically suspected of SSI, and 64 were culture-positive. The incidence of SSI was 8.42%. The most common organisms were *Klebsiella pneumoniae* 34% (17/50) and *Escherichia coli* 32% (16/50), whereas *Staphylococcus aureus* 100% (14/14) was the only organism found among Gram-positive cocci. The antimicrobial Profile of Gram-positive isolates showed maximum sensitivity to linezolid (100%), followed by erythromycin (85.7%). The antimicrobial profile of lactose fermenters revealed maximum sensitivity to polymyxin (100%). Antibiogram of Proteus species showed maximum sensitivity to meropenem (100%) and ceftazidime tazobactam (100%). Non-fermenters showed 100% polymyxin and 80% sensitivity to aztreonam.

Conclusion: Our study has revealed significant findings. The incidence of SSI was found to vary between 8% and 12% in our tertiary care center. *K. pneumoniae* 26.5% (17/64) and *E. coli* 25% (16/64) were the most common organisms isolated. *S. aureus* 21.2% (14/64) was the only organism found among Gram-positive cocci. SSI below waist surgery was far more 75% (48/64) than above waist surgery of 25% (16/64).

Keywords: Post-operative wound, Antimicrobial resistance, Methicillin-resistant *Staphylococcus aureus*, Nosocomial infection.

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INTRODUCTION

A localized or systemic sickness that develops within 48 h of hospital admission due to an adverse response to the presence of an infectious agent is referred to as a hospital-acquired infection (HAI) [1]. Further classification of health-care-associated infections is as follows: (a) Ventilator-associated pneumonia, (b) bloodstream infections (central line and peripheral), (c) catheter-associated urinary tract infections, and (d) Surgical site infection (SSI) [1]. Infections that arise at the site of incision following surgery within 30 days or 90 days following cardiac, prosthetic implants, and breast surgery are also referred to as SSIs [2].

SSIs rank third among HAIs worldwide and the most prevalent (3–40%) HAIs in developing countries [3]. This rate ranges from 2% to 20% in developed countries [4]. S.S.Is further divided into (i) superficial SSI., (ii) deep SSI., and (iii) organ space SSI. The rate of SSI may be determined by the type of wound, which is (a) clean wound, (b) contaminated wound, (c) clean contaminated wound, and (d) dirty wound [2].

Skin is the first line of defense against bacterial invasion [3]. The intentional rupture of this defense system during a surgical incision leaves the surgical wound vulnerable to multi-source bacterial contamination from exogenous and endogenous sources. Certain variables associated with SSI are bacteria's inoculum, virulence factors, and the wound microenvironment [5]. Furthermore, fewer treatment choices are available because organisms that produce extended-spectrum B lactamases (ESBL) are resistant to a wide range of antibiotic classes [6,7]. Resistance to methicillin, one of the most common causes of HAIs, is methicillin-resistant *Staphylococcus aureus* infection, commonly associated with elevated rates of illness, mortality, duration of hospitalization, and financial burden [8,9].

Microorganisms form biofilms, diffuse, unorganized glycocalyx that adhere to solid surfaces such as surgical drains, prosthetic implants, and Foley catheters. This makes pathogens far more destructive due to: (1) Enzyme-mediated antibiotic resistance; (2) genetic adaptations; and (3) restricted antibacterial agent diffusion through the biofilm matrix [10,11].

The main goals of this investigation were the incidence of SSIs and the microbiological organisms that cause them, along with their antibiogram. These findings have practical implications for S.S.I prevention and control.

METHODS

This study was conducted using a cross-sectional design at a tertiary care facility affiliated with Government Medical College, Amritsar, India, for 1 year, from January 2023 to December 2023. The Institutional Ethical Committee gave its clearance before sample collection. The study population comprised 86 patients with SSIs from the hospital's orthopedic, general surgery, obstetrics, and gynecology wards. Eighty-six consecutive samples of patients, both sexes, over the age of 14, with surgical wounds, pus discharge (purulent, mucopurulent, bloody, or serious), and concurrent sepsis symptoms (erythema, tenderness, pain, fever, and wound dehiscence) were included in the study population.

The patients were divided into two groups based on the type of infection – superficial incisional SSI and deep incisional SSI. Each patient underwent a detailed clinical examination, and relevant investigations were carried out to confirm the diagnosis. Informed consent was obtained from all participants before their inclusion in the study. The data collected included demographic information, medical history, surgical details, and microbiological culture results. All patients were treated according to standard hospital protocols for SSI management, and their progress was closely monitored throughout the study period.

We collected comprehensive demographic information from the patients, including age, gender, address, kind of illness, diagnosis, surgical history, details of the procedure performed (type and length), timing of symptom onset, and any other existing medical conditions. Aspirates from pus were aseptically taken from 86 consecutive individuals suspected of having SSI using a sterile surgical syringe with a needle and sterile cotton surgical swabs. The specimens were cultivated on agar plates containing 5% sheep blood, MacConkey agar, and brain heart infusion (B.H.I.) broth. The samples were placed in an incubator set at a temperature of 37°C and thereafter inspected for signs of growth. The isolates were detected using traditional techniques. Direct microscopy was performed following Gram staining and conventional biochemical assays. Mueller Hinton Agar was subjected to an antimicrobial susceptibility test utilizing Kirby Bauer's disc diffusion method, with American Type Culture Collection strains serving as the controls [12]. The antibiotics ampicillin sulbactam (10/10 μg), penicillin (10 units), cefoxitin (30 units), tetracycline (30 μg), erythromycin (15 μg), clindamycin (2 μg), and linezolid (10 μg) were tested for Gram-positive bacteria suggestive of *S. aureus* and *Enterococci* species [13].

For Gram-negative bacteria, antibiotics tested for Enterobacterales were ampicillin (10 μg), ceftriaxone (30 μg), piperacillin-tazobactam (100/10 μg), levofloxacin (5 μg), tobramycin (10 μg), ceftazidime-tazobactam (30/10 μg), meropenem (10 μg), and polymyxin B (100/10 μg). At the same time, antibiotics tested for *Pseudomonas species* and *Acinetobacter species* were levofloxacin (5 μg), ceftazidime tazobactam (30/10 μg), piperacillin-tazobactam (100/10 μg), meropenem (10 ugs), polymyxin B (100/10 ug), and aztreonam (30 μg). The widths of the inhibition zones were measured and analyzed by the recommendations provided by the Clinical and Laboratory Standards Institute (CLSI) [13].

RESULTS

Out of 1021 surgical procedures in the obstetrics and gynecology, orthopedics, and surgery departments, 86 consecutive samples of SSIs were included. 64 samples cultured positive after 24 h of incubation with monomicrobial growth, giving an SSI incidence of 8.42%.

Gram-negative bacilli 78.12% (50/64) outnumbered Gram-positive cocci 21.8% (14/64) (Fig. 1). *S. aureus* 100% (14/14) was the only organism among Gram-positive cocci. Fifty of the Gram-negative bacillary isolates *Klebsiella pneumoniae* were 34% (17/50), and *Escherichia coli* was 32% (16/50), respectively.

Distribution of microorganisms based on Gram-staining variables (Fig. 1)

Gram-negative bacilli: 78.12% (50/64) outnumbered Gram-positive cocci: 21.8% (14/64). *S. aureus* 100% (14/14) was the only Gram-positive cocci cultured.

About 66% (36/50) of the Gram-negative organisms were *K. pneumoniae* and *E. coli,* whereas *Klebsiella oxytoca*, *Acinetobacter lwoffii*, and *Pseudomonas stutzeri* constituted only 4% each (2/50).

Lactose fermenters (Fig. 5) were 100% (35/35) resistant to ampicillin. Resistance in combination antibiotics, piperacillin-tazobactam, and ceftazidime tazobactam was 17.14% (6/35) and 40% (14/35), respectively.

- Meropenem was 88.9% (31/35), and polymyxin was 100% (35/35) sensitive

	GRAM POSITIVE COCCI 21.8% (14/64)
STAPHYLOCOCCUS AUREUS	100% (14/14)
	GRAM NEGATIVE BACILLI 78.1%(50/64)
KLEBSIELLLA PNEUMONIAE	34%(17/50)
ESCHERICHIA COLI	32%(16/50)
PSEUDOMONAS AERIGUNOSA	8%(4/50)
PROTEUS MIRABILIS	8%(4/50)
PROTEUS VULGARIS	6%(3/50)
PSEUDOMONAS STUTZERII	4%(2/50)
ACINETOBACTER LWOFII	4%(2/50)
KLEBSIELLA OXYTOCA	4%(2/50)

Fig. 1: Distribution of microorganisms based on Gram staining

- *Polymyxin B disks were used
- Proteus species were 100% (7/7) resistant to ampicillin
- Resistance to ceftriaxone and tobramycin was discovered to be 42.85% (3/7)
- Sensitivity to piperacillintazobactam 71% (5/7), ceftazidime tazobactam 100% (7/7), and meropenem 100% (7/7) was seen.
- Levofloxacin and piperacillin tazobactam were 50% (4/8) resistant in non-fermenters
- Tobramycin, ceftazidime, tazobactam, and aztreonam were 80% (6/8) sensitive. Polymyxin was found to be 100% (8/8) sensitive
- *Polymyxin B discs were used.

Antibiotic resistance pattern in *Staphylococcus aureus* (Fig. 4)

S. aureus was 78% (11/14) resistant to Ampicillin sulbactam.

Erythromycin and clindamycin were 85.8% (12/14) sensitive, and linezolid was 100% (14/14) sensitive.

Incidence of SSI below waist surgery and above waist surgery (Fig. 2)

Below: Waist surgery had a higher incidence of SSI 75% (48/64) than above waist surgery 25% (16/64).

Klebsiella species 29% (14/48) and *S. aureus* 25% (12/48) were the predominant organisms in below- waist surgery (Fig. 3).

Above waist surgery, *E. coli* 37.5% (6/16) and *Klebsiella* species 31% (5/16) were the predominant organisms.

DISCUSSION

The management of SSIs remains a prominent concern for surgeons and physicians in health-care institutions despite the progress made in surgical procedures and the increasing understanding of the causes of wound infection. The findings of this investigation offer a comprehensive analysis of the present microbiology, encompassing both the aerobic bacteriological profile and its susceptibility to antibiotics within our facility.

Our analysis indicates an 8.42% incidence of SSI. A study in the Department of Surgery at Government Medical College College, Amritsar, evaluated the rate of SSI at 12% in 2018 [14]. At the same time, the Department of Gynecology evaluated that the rate of SSI was 10% from June 2022 to June 2023. According to research by Narula *et al.*, the rate of SSIs in developing nations ranges from 2.5% to 41.9%, with Rajasthan being one of the states included [15]. Another study in Madhya Pradesh reported a 39% SSI rate at rural teaching hospitals in central India [16]. A study in a Mumbai-based private tertiary care hospital found that the overall SSI rate was 1.0% [17].

Rates of SSI below-waist surgery and above-waist surgery were discovered to be 75% (48/64) and 25% (16/64), respectively (Fig. 2). *S. aureus* 85.7% (12/14) and *Klebsiella* species 73% (14/19) were

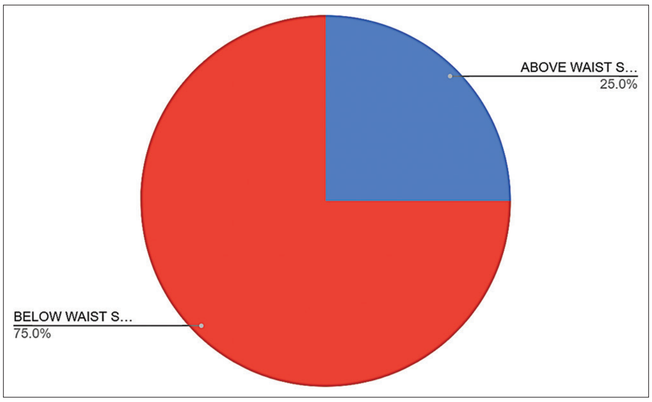

Fig. 2: Incidence of SSI based on above-waist surgery and below-waist surgery

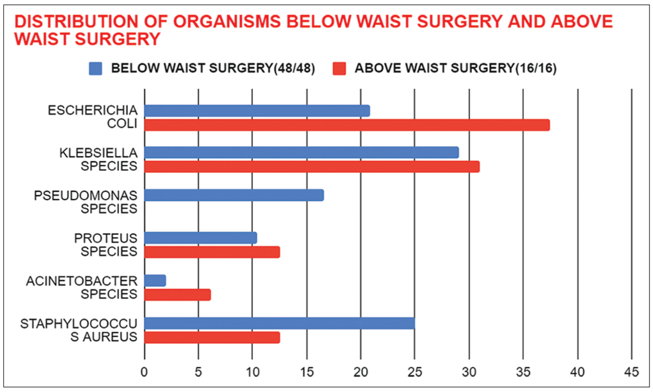

Fig. 3: Distribution of organisms below-waist surgery and above-waist surgery

predominant organisms found in below-waisted surgery (Fig. 3). *E. coli* 37.5% (6/16) and *Klebsiella* species 26.4% (5/19) were the predominant organisms found in above-waisted surgery (Fig. 3). Similar findings were found in a study done by Patel *et al.*; the prevalence of SSI was below waist surgery at 78.1% (25/32) and above waist surgery at 28.1% (7/32) [18]. In another study done in the General Surgery RIMS tertiary care center, the incidence of SSI was found below waist surgery at 89.9% and above waist surgery at 10.06% [19].

S. aureus (20.28%; 14/64) (Fig. 1) was the only isolate among Gram-positive cocci, and this discovery was in line with findings from earlier investigations (Mundhada and Tenpe, Bhave *et al.*) [7,20]. Methicillin resistance was seen in 42.8% (6/14) (Fig. 4) of *S. aureus* isolates. This finding is in line with the study conducted by Narula *et al.*, where 43.75% of *S. aureus* were methicillin-resistant [15]. In our study, *S. aureus* strains were sensitive to linezolid 100% (14/14), in concordance with Negi *et al.* [3].

Gram-negative bacilli (78%, 50/64) (Fig. 1) outnumbered Gram-positive cocci (21.2%, 14/64) in this investigation. Research that supported the findings were those of Panchalamarri and Renuka Devi [21] and Sikdar *et al.* [22], where Gram-negative bacteria were found at 74.2% and 58.72%, respectively. *K. pneumonia* and *E. coli* were the most predominant organisms, that is, 66% (33/50) (Fig. 1). In contrast, *K. oxytoca*, *A. lwoffii*, and *P. stutzeri* were only 4% (2/50) each (Fig. 1). Similar observations had also been reported by various other authors (Panchalamarri and Renuka Devi) [21].

The growing number of publications regarding the isolation of multidrug-resistant organisms from SSIs is worrisome. In this study, lactose fermenters were reported to be 100% (35/35) resistant to ampicillin (Fig. 5), ceftriaxone (54%; 19/35), and amikacin (37%; 13/35). Sensitivity to levofloxacin was 82.8% (29/35); piperacillin-tazobactam was 60% (21/35); ceftazidime tazobactam was 60% (21/35); and meropenem was 88.5% (31/35). Furthermore, Proteus species were 100% (7/7) resistant to ampicillin. Combinations such as piperacillin–tazobactam (71%), whereas ceftazidime tazobactam (7/7) and meropenem (7/7) are 100% sensitive. As stated, this study is in concordance with Negi *et al.*, Where regularly utilized medications were shown to have higher levels of resistance, ranging from 50% to 100% on average. Meropenem, piperacillin–tazobactam, and amikacin were found to be the most efficacious antibacterial drugs [3]. Another study by Khan *et al.* found Gram-negative organisms resistant to ampicillin, piperacillin, ceftazidime, and ceftriaxone (66–86%) [23].

The dissemination of these organisms, or their genes that confer resistance, within and beyond hospital settings is concerning. All isolates in this study were 100% susceptible to polymyxins (35/35). This finding is in concordance with Negi *et al.* [3] and Panchalamarri and Renuka Devi [21].

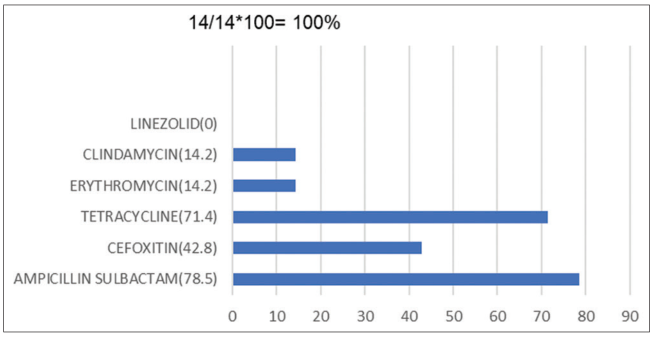

Fig. 4: Antibiotic pattern in *Staphylococcus aureus*

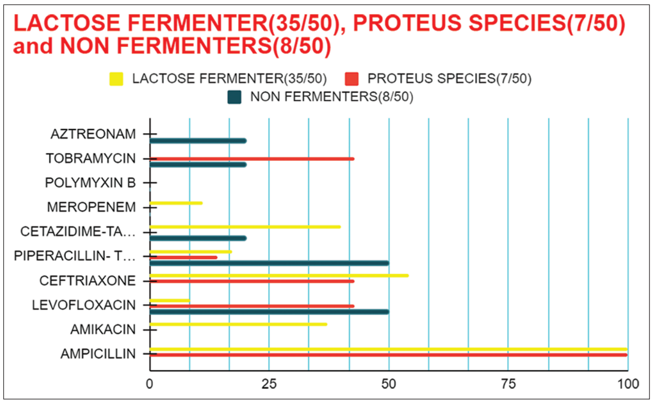

Fig. 5: Antibiotic resistance pattern in lactose- fermenters, Proteus species, and non-fermenters

Gram-negative bacteria that do not undergo fermentation bacilli are found everywhere and are well-known for their resistance to multiple drugs. In the present study, 50% (4/8) of non- fermenters (Fig. 5) were resistant to levofloxacin and piperacillin-tazobactam, while 100% (8/8) of non-fermenters were sensitive to meropenem, polymyxins, and 80% (6/8) of them were sensitive to aztreonam. Similar findings were found in a study done by Mythri *et al.* at KMHS Hospital [24]. The global issue of drug-resistant isolates is experiencing a rise in numbers.

CONCLUSION

The incidence of SSIs varied between 8% and 12% in our tertiary care center. *K. pneumoniae* 26.5% (17/64) and *E. coli* 25% (16/64) were the most common organisms isolated. *S. aureus* 21.2% (14/64) was the only organism found among Gram-positive cocci. SSI below waist surgery was far higher at 75% (48/64) than above waist surgery at 25% (16/64). These results underscore the need for targeted infection control measures, particularly for lower abdominal procedures. The high incidence of drug-resistant organisms highlights the importance of judicious antibiotic use and continuous surveillance to combat the growing challenge of antimicrobial resistance in health-care settings.

AUTHORS CONTRIBUTION

All authors contributed satisfactorily to the study.

CONFLICTS OF INTERESTS

The authors declare that they have no conflicts of interest.

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None.

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