ISSN: 0975-1556

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2021; 13(3); 404-410

Original Research Article

Susceptibility Pattern of Microorganisms Implicated in the Development of Surgical Site Infection to Antimicrobial Agents

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Received: 09-08-2021 / Revised: 04-09-2021 / Accepted: 20-09-2021
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Conflict of interest: Nil

Abstract

Aim: The aim of the present study to evaluate the antimicrobial susceptibility pattern of microorganisms involved in the pathogenesis of surgical site infection. **Methods:** The study was a cross sectional study, which was carried in the Department of Microbiology, Vardhman Institute of Medical Sciences Pawapuri Nalanda, Bihar India from August 2020 to June 2021. Using sterile cotton swabs, two pus swabs/ wound swabs were collected aseptically from each patient suspected of having SSI. Gram-stained preparations were made from one swab for provisional diagnosis. The other swab was inoculated on nutrient agar, 5% sheep blood agar (BA) and MacConkey agar (MA) plates and incubated at 37°C for 24-48 hours before being reported as sterile. Growth on culture plates was identified by its colony characters and the battery of standard biochemical tests. All the isolates were tested for antimicrobial susceptibility by Kirby Bauer disk diffusion technique on Muller Hinton Agar. **Results:** Out of 400 samples, 210 samples were culture positive (52.5%). Out of 210 culture positive samples S.aureus (23.80%) was the most common pathogen isolated followed by Escherichia coli. (23.80%), Citrobacter spp. (14.28%) and Pseudomonas aeruginosa (12.86%) respectively. Among gram negative bacilli, *E. coli* was most sensitive to Imipenem 90%) followed by Amikacin (78%) and Piperacillin Tazobactam (74%) whereas for Citrobacter spp., Imipenem (83.33%) followed by Gentamicin (53.33%), Ciprofloxacin (46.67%) was the drug of choice then for Klebsiella spp., Imipenem (75%) followed by Gentamicin (45%), Amikacin (45%) was the drug of choice. For Pseudomonas aeruginosa, Imipenem (62.96%) followed by Piperacillin Tazobactam (59.26%), Gentamicin (51.85%) was the drug of choice and for Enterobacter spp., Imipenem (80%) followed by Amikacin (70%), Piperacillin Tazobactam (80%) showed maximum sensitivity. Among gram positive organism, S.aureus showed maximum antibiotic sensitivity to Linezolid (94%) followed by Vancomycin (90%), Amikacin (82%) whereas CONS was sensitive to Linezolid (100%) followed by Vancomycin (93.75%), and Gentamicin (87.5%). **Conclusion:** The increasing resistance to antimicrobials increases the risk of morbidity and mortality; therefore, there is urgent need of implementation of measures to restrict the health care associated infection.

Keywords: antimicrobial, susceptibility, pattern

Introduction

As a part of innate immunity, the main function of intact skin in humans is to control the microbes that are resident on the skin surface and also it prevents the underlying tissues from colonization or invasion by pathogens. If due to any condition (wounds) where there is exposure of subcutaneous tissue due to loss of integrity of skin it provides good environment for colonization and proliferation of microorganisms and so any wound is at risk of developing infection.[1] Infections occurring in the wound are major barriers for healing which shows impact on patients, which may prolong the hospital stay and effects the quality of life[2] and wound healing requires a healthy environment which will result in normal healing process and also with minimal scar formation.[3] SSI which was previously termed as post operative wound infections was termed by US center for disease control in order to prevent the confusion between infection at site of surgical incision and infection at the site of traumatic wound[4] and SSI can be defined as proliferation of pathogenic microorganisms at the site of surgical incision which may involve skin and subcutaneous fat (superficial), Musculofacial layers (deep) in an organ/cavity.[5] Hospital acquired infections are common type of nosocomial infections in surgical patients[6] and SSI is the second most common hospital acquired infection.[7] Generally SSI occur within 30 days after the procedure but in cases of any added implants the duration of SSI may also extend upto one year from the operation procedure.[8] A number of patient related factors (old age, nutritional status, pre existing infection, co-morbid illness) and procedure related factors (poor surgical technique, prolonged duration of surgery, pre operative part preparation, inadequate sterilization of surgical instruments) can influence the risk of SSIs significantly.[5] In addition to these risk factors, the virulence and the invasiveness of the organism involved, physiological state of the wound tissue and the immunological integrity of the host are also the important factors that determine whether infection occurs or not.[9]

Surveillance data suggest that the types of causative organisms associated with SSI have not significantly changed over the past 10–15 years; however, the proportion of different types of causative organisms has changed. Antimicrobial resistant organisms are causing an increasing proportion of SSIs, and there has been a rise in the number of infections caused by atypical bacterial and fungal organisms. These changing proportions have been attributed to the increasing acuity of surgical patients, the increase in the number of immunocompromised patients, and the increasing use of broad-spectrum antibiotics.[10]

Surgical site infections are the second most common cause of Nosocomial infections.[11] Surgical site infections are still a threat to patients, in spite of the newer antibiotics available today. Although properly administered antibiotics can reduce postoperative surgical site infections secondary to bacterial contamination, widespread use of prophylactic antibiotics can lead to emergence of multi drug resistant bacteria. The higher rates of surgical site infections are associated with higher morbidity, mortality and increased medical expenses.[12]

In developing countries like India, where hospitals have inadequate infrastructure, poor infection control practices, overcrowded wards and practice of irrational use of antimicrobials, the problem of SSIs gets more convoluted. The aim of the present study to evaluate the antimicrobial susceptibility pattern of microorganisms involved in the pathogenesis of surgical site infection.

Material and Methods

The study was a cross sectional study which was carried in the Department of Microbiology, Vardhman Institute of Medical Sciences Pawapuri Nalanda, Bihar India from August 2020 to June 2021, after taking the approval of the protocol review committee and institutional ethics committee. Total 420 patients with SSIs either sex or any age, who had surgical wound pus, discharge, or signs of sepsis were include in this study. Patients with cellulitis and suture abscess were excluded from this study.

Using sterile cotton swabs, two pus swabs/ wound swabs were collected aseptically from each patient suspected of having SSI. Gram-stained preparations were made from one swab for provisional diagnosis. The other swab was inoculated on nutrient agar, 5% sheep blood agar (BA) and MacConkey agar (MA) plates and incubated at 37°C for 24-48 hours before being reported as sterile. Growth on culture plates was identified by its colony characters and the battery of standard biochemical tests.[13,14] All the isolates were tested for antimicrobial susceptibility by Kirby Bauer disk diffusion technique on Muller Hinton Agar and results were interpreted in accordance with Clinical Laboratory Standards Institute guidelines.[15] Antibiotics used for susceptibility testing were: Amikacin, Ampicillin / Sulbactam, Ceftriaxone, Ciprofloxacin, Gentamicin, Piperacillin-Tazobactum, Imipenem, Azithromycin, Vancomycin, Linezolid, Ofloxacin, Cefoxitin.

Statistical Analysis: Data was entered in Microsoft excel spreadsheet and analysed using appropriate statistical software application.

Results

Out of 400 samples, 210 samples were culture positive (52.5%) (Table 1). Among 210 positive samples 115 (54.76%) were males (Table 1). The age wise distribution of the gender has been shown in the (Table 2) with maximum no. of culture positive samples in age 20-30 years (30.95%) followed by 30-40 (18.08 %) and then followed by 40-50 (15.24%) of age group respectively. Out of 210 culture positive samples *S.aureus* (23.80%) was the most common pathogen isolated followed by *Escherichia coli*. (23.80%), *Citrobacter spp*. (14.28%) and *Pseudomonas aeruginosa* (12.86%) respectively (Table 3). Among gram negative bacilli, *E.coli* was most sensitive to Imipenem 90%) followed by Amikacin (78%) and Piperacillin Tazobactam (74%) whereas for *Citrobacter spp*., Imipenem (83.33%) followed by Gentamicin (53.33%), Ciprofloxacin (46.67%) was the drug of choice then for *Klebsiella spp*., Imipenem (75%) followed by Gentamicin (45%), Amikacin (45%) was the drug of choice. For *Pseudomonas aeruginosa*, Imipenem (62.96%) followed by Piperacillin Tazobactam (59.26%), Gentamicin (51.85%) was the drug of choice and for *Enterobacter spp.*, Imipenem (80%) followed by Amikacin (70%), Piperacillin Tazobactam (80%) showed maximum sensitivity (Table 4). Among gram positive organism, *S.aureus* showed maximum antibiotic sensitivity to Linezolid (94%) followed by Vancomycin (90%), Amikacin (82%) whereas *CONS* was sensitive to Linezolid (100%) followed by Vancomycin (93.75%), and Gentamicin (87.5%) (Table 5).

Table 1: Gender wise distribution of Culture positive Patients

Gender	**No of patients=210**
Male	115 (54.76%)
Female	95(45.24%)

Table 2: Age wise Distribution of Culture Positive Patients

Age in year	Culture Positive
Below 20	30 (14.28)
20-30	65 30.95)
30-40	38(18.09)
40-50	32 (15.24)
50-60	26(12.38)
Above 60	21 (10)

Table 3: Distribution of Organisms Causing Surgical Site Infection

Organism	No. of isolates (%)
Staphylococcus aureus	50(23.80)
Escherichia coli	50 (23.80)
Citrobacter spp.	30(14.28)
Pseudomonas aeruginosa	27(12.86)
Klebsiella spp.	20 (9.52)
CONS	16 (7.62)
Enterobacter spp.	10(4.76)
Acinetobacter spp.	4 (1.90)
Proteus spp.	3(1.43)
Total	210

Table 4: In-Vitro Antibiotic Sensitivity in Isolated Gram Negative Bacteria

Drugs	***Escherichia coli*** **(%)(n=50)**	***Citrobacter spp.*** **(%) (n=30)**	***Klebsiella spp.*** **(%) (n=20)**	***Pseudomonas aeruginosa*** **(%) (n=27)**	***Enterobacter spp.*** **(%) (n=10)**
	S	**S**	**S**	**S**	**S**
Gentamicin	33 (66)	16(53.33)	9 (45)	14 (51.85)	5(50)
Ciprofloxacin	15. (30)	14 (46.67)	7(35)	14(51.85)	5(50)
Piperacillin/Tazobactam	37 (74)	11 (36.67)	6 (30)	16 (59.26)	8(80)
Amikacin	39 (78)	14 (46.67)	9 (45)	15 (55.55)	7(70)
Ampicillin/ Sulbactam	18 (36)	9(30)	5 (25)	9 (33.33)	3 (30)
Impinem	45(90)	25 (83.33)	15 (75)	17 (62.96)	9(90)
Ceftriaxone	14 (28)	9 (30)	4 (20)	12 (44.44)	2 (20)

Table 5: In-Vitro Antibiotic Sensitivity in Isolated Gram Positive Bacteria

Drugs	***Staphylococcus aureus*** **(%) (n=50)**	**CONS (%) (n=16)**
	S	**S**
Azithromycin	30(30)	10 (62.5)
Vancomycin	45(90)	15(93.75)
Linezolid	47(94)	16 (100)
Gentamicin	39 (78)	14 (87.5)
Ofloxacin	40 (80)	12 (75)
Cefoxitin	34(68)	9 (56.25)
Amikacin	41 (82)	11(68.75)

Discussion

Despite the advances in surgical techniques and better understanding of the pathogenesis of wound infection, management of SSIs remains a significant concern for surgeons and physicians in a health care facility. Patients with SSIs face additional exposure to microbial populations circulating in a hospital set up which is always charged with microbial pathogens. The unrestrained and rapidly spreading resistance to the available array of antimicrobials further contributes to the existing problem. Most of the SSIs are hospital acquired and vary from hospital to hospital.

In the present study the Culture positive SSI rate was 52.5%. Whereas various other studies from India have shown the rate of SSI to vary from 6.1% to 38.7%.[16-19] The main Reason behind may be due to the lack of attention towards the infection control measures, inappropriate hand hygiene practices and overcrowded hospitals. In our study, it was observed that rate of infection was higher in male patients (54.76%). The results were similar to a study by Vikrant Negi et al, who reported that (74.6%) males were more commonly affected than females (25.5%).[20] In contrast to our study Gangania P et al reveals that 20% Females shows almost equal distribution of 19% of males.[21]

The findings in the study revealed that with maximum no. of culture positive samples in age 20-30 years (30.95%) followed by 30-40 (18.08 %) and then followed by 40-50 (15.24%) of age group respectively. Similar results were showed by Pooja Singh Gangania who concluded that maximum no of SSI was in 16-45years of age group (24%) patient. This may be due to heavy work load, stress at this age group and less number of patients.[21] *S.aureus* (23.80%) was the most common pathogen isolated followed by *E.coli* (23.80%). This result is consistent with reports from other studies SP Lilani, Mulu W.[17,22] *S. aureus* infection is most likely associated with endogenous source as it is a member of the skin and nasal flora and also with contamination from environment, surgical instruments or from hands of health care workers.[20]

In the present study among gram negative bacilli, *E.coli* was most sensitive to Imipenem 90%) followed by Amikacin (78%) and Piperacillin Tazobactam (74%). The findings are consistent with the previous study conducted by M. saleem et al who also showed that *E. coli* showed high sensitivity to Imipenem.[23] In this study *Citrobacter spp*., Imipenem (83.33%) followed by Gentamicin (53.33%), Ciprofloxacin (46.67%) was the drug of choice then for *Klebsiella spp*., Imipenem (75%) followed by Gentamicin (45%), Amikacin (45%) was the drug of choice The findings are consistent with the study conducted by Jyoti Sonawane et al who also showed that *Citrobacte*r and *Klebsiella* showed high sensitivity to Imipenem.[24]

Pseudomonas aeruginosa, Imipenem (62.96%) followed by Piperacillin Tazobactam (59.26%), Gentamicin (51.85%) was the drug of choice. Similar results were shown by Jyoti Sonawane et al.[24] Imipenem, Piperacillin/ Tazobactum, Gentamicin and Amikacin were found to be more efficient antibiotics against gram negative bacilli. Similar results were observed by M. saleem et alwho showed that Amikacin, Imipenem, Piperacillin/ Tazobactum, were found to be more efficient antibiotics against gram negative bacilli.[23] Among gram positive organism, *S.aureus* showed maximum antibiotic sensitivity to Linezolid (94%) followed by Vancomycin (90%), Amikacin (82%). This was in consistent with the study by Prem Prakash Singh et al., 2015 who also concluded that *S. aureus* was sensitive to Vancomycin (100%), Linezolid (100%).[25] Linezolid and Vancomycin were found to be more efficient antibiotics against gram positive cocci. This finding was in tandem with the study conducted by Vikrant Negi et al., 2015, who also reported that Vancomycin and Linezolid found to be more efficient antibiotics against gram positive cocci.[20]

Conclusion

The present study concluded that the increasing resistance to antimicrobials increases the risk of morbidity and mortality; therefore, there is urgent need of implementation of measures to restrict the health care associated infection. Rational use of antimicrobials, proper hygiene, and strict asepsis should be applied in all health care.

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