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Original research article

Evaluation of the Bacteriological Profile of Surgical Site Infections: An Observational Study

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Abstract

Background: Healthcare associated infection (HAI) poses major problem for doctors as well as patients and community at large. Among health care associated infections, surgical site infections are the second most common after urinary tract infection.
Aim: The aim of the present study was to identify bacterial aetiology of surgical site infections.
Material and methods: The study was a prospective, observational study which was carried in the Department of Microbiology, MGM Medical College and LSK Hospital, Kishanganj, Bihar, India.from February 2019 July 2020. A total of 390 patients with clinically diagnosed surgical site infection were chosen for the study. Suitable specimens from all these patients were subjected to Gram staining and culture on suitable culture media, and isolates were identified by 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 390 samples, 200 samples yielded positive culture (51.28%). Out of the positive samples *Staphylococcus aureus* (27.5%) was the most common pathogen isolated followed by *Escherichia coli* (22%), *Citrobacter spp*. (15%) and *Pseudomonas aeruginosa* (12.5%).
Conclusion: We conclude that the surgical site infections caused by Gram positive and Gram negative bacteria continue to be a frequent complication of surgical interventions. As the increasing resistance to antimicrobials increases the risk of morbidity and mortality, there is an urgent need for implementation of measures to restrict the health care associated infections.

Introduction

Infections which occur during the time of hospital stay and were not present or in incubating stage, during the time of hospital admission are considered as health care associated infections (HAI). HAI poses major health problem for both doctors as well as patients. Health care associated infections prolong hospital stay which leads to financial burden to the patients and also increases the mortality and morbidity. It has been reported that in United States of America the annual mortality is about 88,000 despite the annual estimated cost of management of HAI of about 4.5 billion dollar.[1] Among the health care associated infections, Surgical Site Infections (SSI) are the second most common after Urinary Tract Infection

(UTI).[2] SSI are a common complication associated with surgery, with a reported incidence rates of 2-20%.[3] They are responsible for increasing the treatment cost, length of hospital stay, and significant morbidity and mortality. Despite the technical advances in infection control and surgical practices, SSI still continue to be a major problem, even in hospitals with most modern facilities.[4] These infections are usually caused by exogenous and/or endogenous microorganisms that enter the operative wound either during the surgery (primary infection) or after the surgery (secondary infection). Primary infections are usually more serious, appearing within five to seven days of surgery.[5] Majority of SSI are uncomplicated involving only skin and subcutaneous tissue but sometimes these can progress to necrotizing infections involving the deeper tissues. The usual presentation of infected surgical wound can be characterized by pain, tenderness, warmth, erythema, swelling and pus formation.[6] A number of patient related factors (old age, nutritional status, pre-existing infection, co-morbid illness) and procedure related factors (poor pre-operative part preparation and surgical technique, prolonged duration of surgery, inadequate sterilization of surgical instruments) can influence the risk of SSI significantly.[4] 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.[7]

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 broader spectrum antibiotics.[8]

SSI continues to be a threat to surgical 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 multidrug resistant bacteria.

In developing countries like India, where many hospitals have inadequate infrastructure, poor infection control practices, overcrowded wards and practice of irrational use of antimicrobials, the problem of SSI gets more convoluted. With this background present study was carried out to evaluate the bacteriological profile of surgical site infections in a rural medical college and tertiary care hospital in Northern Bihar.

Material and Methods

The study was a prospective, observational study which was carried in the Department of Microbiology, Mata Gujri Medical College and LSK Hospital, Kishanganj, Bihar, India. from February 2019 July 2020. Total 390 patients (204 males and 186 females) of all ages with clinical diagnosis of SSI were included in this study. Patients with cellulitis and suture abscess were excluded from this study.

Methodology

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 each plate was 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.[9] 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 (CLSI) guidelines.[10] Antibiotics used for susceptibility testing were: Amikacin, Ampicillin-Sulbactam, Ceftriaxone, Ciprofloxacin, Gentamicin, Piperacillin-Tazobactum, Imipenem, Azithromycin, Vancomycin, Linezolid, Ofloxacin, Cefoxitin.

Statistical Analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2010) and then exported to data editor page of SPSS version 19 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included computation of percentages and means.

Results

Out of 390 samples, 200 samples were culture positive (51.28%). Among 200 positive samples, 105 (52.5%) were males (Table 1). The age wise distribution of the patients with positive culture has been shown in the (Table 2). The maximum No. of culture positive samples were in the age group of 20-30 years (33%) followed by 30-40 years (17.5 %) and 40-50 years (14%) of age groups respectively. Out of the 200 culture positive samples, *Staphylococcus aureus* (27.5%) was the most common pathogen isolated followed by *Escherichia coli*. (22%), *Citrobacter spp*. (15%) and *Pseudomonas aeruginosa* (12.5%) (Table 3). Among Gram negative bacilli, isolates of *E. coli* were found to be most sensitive to Imipenem 93.18%) followed by Amikacin (81.81%) and Piperacillin+Tazobactam (77.27%). For *Citrobacter spp*., most of the isolates were sensitive to Imipenem (80%) followed by Gentamicin (50%) and Ciprofloxacin (46.67%). Maximum number of isolates of *Klebsiella spp*. were found sensitive to Imipenem (73.68%) followed by Gentamicin (47.37%) and Amikacin (47.37%). For *Pseudomonas aeruginosa*, 64% of the isolates were sensitive to Imipenem, followed by Piperacillin+Tazobactam (60%) amd Gentamicin (52%). For *Enterobacter spp.*, Imipenem (80%) followed by Amikacin (60%) and Piperacillin+Tazobactam (60%) showed maximum sensitivity (Table 4). Among the Gram positive organisms, isolates of *S .aureus* showed maximum antibiotic sensitivity to Linezolid (94.54%) followed by Vancomycin (92.72%) and Amikacin (81.82%). The isolates of Coagulase Negative Staphylococci (CONS) were found to be sensitive to Linezolid (100%) followed by Vancomycin (92.85%), and Gentamicin (85.71%) (Table 5).

Table 1: Gender-wise Distribution of Culture Positive Patients

Gender	**No of patients (%)**
Male	105 (52.5)
Female	95 (47.5)

Table 2: Age-wise Distribution of Culture Positive Patients

Age in year	**Culture Positive (%)**
$\leq$20	27 (13.5)
21-30	66 (33)
31-40	35 (17.5)
41-50	28 (14)
51-60	24 (12)
Above 60	20 (10)

Table 3: Distribution of Organisms Causing Surgical Site Infection

Organism	**No. of isolates (%)**
Staphylococcus aureus	55 (27.5)
Escherichia coli	44 (22)

Citrobacter spp.	30 (15)
Pseudomonas aeruginosa	25 (12.5)
Klebsiella spp.	19 (9.5)
CONS	14 (7)
Enterobacter spp.	10 (5)
Acinetobacter spp.	2 (1)
Proteus spp.	1 (0.5)
Total	200 (100)

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

Drugs	***Escherichia coli*** **(%) (n=44)**	***Citrobacter spp.*** **(%) (n=30)**	***Klebsiella spp.*** **(%) (n=19)**	***Pseudomonas aeruginosa*** **(%) (n=25)**	***Enterobacter spp.*** **(%) (n=10)**
Gentamicin	31 (70.45)	15 (50)	9 (47.37)	13 (52)	4(40)
Ciprofloxacin	12. (27.27)	14 (46.67)	7(36.84)	13 (52)	5(50)
Piperacillin/ Tazobactam	34 (77.27)	11 (36.67)	6 (31.57)	15 (60)	6 (60)
Amikacin	36 (81.81)	14 (46.67)	9 (47.37)	14 (56)	6 (60)
Ampicillin/ Sulbactam	15 (34.09)	8 (26.67)	5 (26.32)	8 (32)	2 (20)
Impinem	41 (93.18)	24 (80)	14 (73.68)	16 (64)	8 (80)
Ceftriaxone	11 (25)	9 (30)	4 (21.05)	11 (44)	2 (20)

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

Drugs	***Staphylococcus aureus*** **(%) (n=55)**	**CONS (%) (n=14)**
Azithromycin	33 (60)	9 (64.28)
Vancomycin	51 (92.72)	13 (92.85)
Linezolid	52 (94.54)	14 (100)
Gentamicin	43 (78.18)	12 (85.71)
Ofloxacin	44 (80)	11 (78.57)
Cefoxitin	37 (67.27)	8 (57.14)
Amikacin	45 (81.82)	10 (71.42)

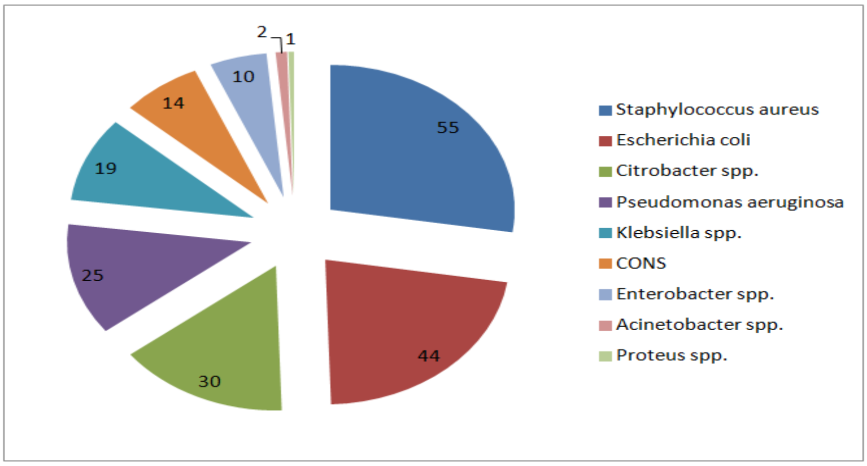

Figure 1: Distribution of Organisms Causing Surgical Site Infection

Discussion

Despite the advances in surgical techniques and better understanding of the pathogenesis of wound infection, management of SSI continues to be a significant concern for health care professionals. Patients admitted to a healthcare facility face additional exposure to microbial populations circulating in a hospital setup. The lowered immune status in the postoperative period adds up to the vulnerability of an individual patient. The unrestrained and rapidly spreading resistance to the available antimicrobial agents further contributes to the existing problem. Most of the organisms implicated in SSI are hospital acquired and vary considerably depending on the facilities provided in the particular hospital.

In the present study, the culture positive SSI rate was 51.28%. Various other studies from India have shown the rate of SSI to vary from 6.1% to 38.7%.[11-13] The main reason of high positive rate in the present study may be due to the lack of attention towards the infection control measures, inappropriate hand hygiene practices and overcrowded wards in the hospital. In our study, it was observed that rate of infection was higher in male patients (54.5%). The results were similar to a study by Vikrant Negi et al, who also reported that males (74.6%) were more commonly affected than females.[14] On the contrary, the study conducted by Gangania P et al revealed an almost equal distribution of male and female patients.[15]

The findings in the present study revealed that maximum culture positivity of the patients were within the age group of 20-30 years (33%) followed by 30-40 years (17.5%) age group. Similar results were observed by Gangania P et al who concluded that maximum No. of SSI was in patient in 16-45 years of age group (24%).[15] This may be due to increased physical activity, risk-taking behaviour and stress among other factors common in this age group.

Staphylococcus aureus (27.5%) was the most common pathogen isolated in the present study followed by *E. coli* (22%). This result is consistent with reports from other studies viz. Mulu W et al and Lilani SP et al.[6,12] *S. aureus* infection is most likely associated with endogenous source as it is a member of the skin and nasal flora and also results from contamination from environment, surgical instruments or from hands of health care workers.

In the present study, among Gram negative organisms, most f the isolates of *E. coli* were sensitive to Imipenem (93.18%), followed by Amikacin (81.81%) and Piperacillin+Tazobactam (77.27%). The findings are consistent with the study conducted by Saleem M et al who showed that *E. coli* exhibited high sensitivity to Imipenem.[16] In this study, *Citrobacter spp*. showed maximum sensitivity to Imipenem (80%) followed by Gentamicin (50%) and Ciprofloxacin (46.67%). For *Klebsiella spp*., Imipenem (73.68% of the isolates show positivity) was found to most effective agent followed by Gentamicin (47.37%) and Amikacin (47.37%). The findings are consistent with the study conducted by Sonawane J et al who also found that *Citrobacte*r and *Klebsiella* showed high sensitivity to Imipenem.[17]

In the present study, isolates of *Pseudomonas aeruginosa* showed a high sensitivity to, Imipenem (64%) followed by Piperacillin+Tazobactam (60%) and Gentamicin (52%). Similar results were shown by Sonawane J et al.[17] In the study conducted by them, Imipenem, Piperacillin+Tazobactum, Gentamicin and Amikacin were found to be more efficient antibiotics against Gram negative bacilli. Similar results were also observed by Saleem M et al in their study.[16]

Among the Gram positive organisms, most of the isolates of *S. aureus* were found to be sensitive to Linezolid (94.54%) followed by Vancomycin (92.72%) and Amikacin (81.82%). This is consistent with the study by Singh PP et al., who concluded that *S. aureus* isolates were sensitive to Vancomycin (100%), Linezolid (100%).[18] In our study, isolates of CONS were found to be sensitive to Linezolid (100%) followed by Vancomycin (92.85%), and Gentamicin (85.71%). These findings are in tandem with the study conducted by Negi V et al., who also reported that Vancomycin and Linezolid were the most efficient antibiotics against CONS.[14]

Conclusion

We conclude that despite the improvement in the aseptic practices and surgical techniques, SSI remains a formidable challenge to health care professionals. Widespread resistance to antimicrobials increases the risk of morbidity and mortality to a particular patient apart from increasing the cost of healthcare. Therefore there is urgent need of implementation of measures to restrict the health care associated infections by preventive measures such as rational use of antimicrobials, maintenance of proper hygiene, and strict asepsis.

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