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Original Research Article

Microbiological Profile in Post-Surgical Wound Infections and Pattern of Antimicrobial Susceptibility at a Tertiary Care Teaching Hospital, Rajasthan, India

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Abstract:

Background: Post-surgical wound infections contribute substantially to the overall global burden of healthcare-associated infections (HAIs). These infections often lead to prolonged hospital stays, increased morbidity, and higher treatment costs, placing a strain on healthcare resources. The emergence of antimicrobial-resistant strains of bacteria in post-surgical wound infections poses a global threat. Hence to address the limited data on post-surgical wound infections, we conducted this research to determine the prevalence and antimicrobial susceptibility patterns of aerobic bacteria in post-surgical wound infected patients in Pacific Institute of Medical Sciences, Udaipur, Rajasthan, India.

Methods: Hospital based descriptive cross sectional study was carried-out in 693 patients who had undergone surgery in general surgery and showed symptoms of infection clinically from January to December 2023. Standard bacteriological methods were used for bacterial isolation and their antimicrobial susceptibility pattern.

Results: A total of 693 patients (435 males and 258 female) with clinical signs of post- surgical wound infections were enrolled. The age of the patients ranged from 11–80 years (with mean 33.24 ± 18.09 years). Out of the 693 wound swabs taken, 81 (11.68%) were culture positive. Out of these bacterial isolates, the predominant isolates were Pseudomonas aeruginosa (28) 28.39%, Coagulase negative staphylococci (CoNS) were 17 (20.98%), Escherichia coli (15) 18.51%, Staphylococcus aureus 13 (16.09%), Klebsiella species 08 (9.87%) and Proteus spp were 05 (9.17%). Bacterial isolates of 43/81 (53.08%) of Gram negative and 30/30 (100%) of Gram positive were sensitive to Gentamicin, Amikacin, carbapenems (100%), linezolid and Vancomycin, respectively. The cumulative incidence rate of post-surgical wound infection was 11.68%. The analysis defined four variables significantly associated with post-surgical wound infection i.e. middle or elderly age, male gender, diabetes mellitus, anemia, smoking, contaminated/dirty wound, hypertension and emergency surgery.

Conclusion: Preventing post-operative surgical site infections is a crucial aspect of patient care. Implementing effective control measures can significantly reduce the risk of infections. Implement proper postoperative wound care, including monitoring for signs of infection such as redness, swelling, warmth, and discharge. Follows the general infection control practices e.g. hand, environment hygiene, proper surgical instrument sterilization, staff as well as patient education.

Keywords: General surgery, Post-operative-surgical site infection, bacteriological agents, antimicrobial susceptibility, infection control measures.

Introduction

Surgical site infection or SSI refers to an infection that occurs in the area where a surgery was performed. Sources of SSIs include the patient's own normal flora, organisms present in the hospital environment that are introduced into the patient by medical procedures, specific underlying diseases, trauma, or burns that may cause a mucosal or skin surface interruption.[1] The system of classification for operative wounds, that was based on the degree of microbial contamination, was developed by the US National Research Council group in 1964. Postoperative wound infection is defined as an infection in the tissues of the incision and operative area that can commonly occurs between the fifth and 30th days after surgery. SSIs are more frequently reported in lower and middle-income countries. This may be attributed to various factors, including differences in healthcare infrastructure, resources, and access to preventive measures. The incidence of SSI is 11.8% in lower- and middle income countries. [1-2] many other studies have reported that SSIs rank third among common nosocomial infections, next to the urinary tract and respiratory tract infections. Recent studies reported that the SSI rate ranges from 19.4% to 36.5% all over the world. [3-4] In India, SSIs are one of the leading causes of morbidity and mortality [5-6] and also widely distributed by the depending on setting, it ranges from 1.6% to 38%. [7] this variability can be due to hospitalized patients characteristics, different clinical procedures, hospital environment, and infection control policies. A wound is the result of physical disruption of the skin, one of the major obstacles to the establishment of infections by bacterial pathogens in internal tissues. When bacteria breach this barrier, infection can occur. Post-operative wound infections are major global problem in the field of surgery leading to many complications, increased morbidity and mortality. Most of the post-surgical wound infections are hospital acquired and vary from one hospital to the other settings. [8-10]

The common causative bacteria in infections are *Staphylococcus aureus* (31.58%) followed by *Klebsiella pneumonia* (26.31%) and *Pseudomonas aeruginosa* (28.79%). [11] In another study S. aureus, Klebsiella species, E. coli, Proteus species, Streptococcus species, Enterobacter species, Pseudomonas species and Coagulase negative Staphylococci were reported as the most common pathogens present in post wound infection. [12-13] Some organisms are opportunistic nosocomial pathogens causes a wide spectrum of diseases in immunocompromised patients. The emergence of high antimicrobial resistance poses a growing challenge in the management and treatment of post-operative wound infections. Thus, bacterial pathogens are increasingly developing resistance to commonly used antibiotics. [14] The situation of resistance is worst in many developing countries due to use of antibiotics irrational and without doctor prescription. Therefore, present study is aimed to determine the prevalence and drug susceptibility pattern of microbiological pathogens in post-surgical wound infection in a tertiary care teaching hospital, Rajasthan, India.

Materials and Methods

Study design: Hospital based descriptive cross sectional study.

Study Setting and Duration: The present study was carried out over a period of 1 years from January 2023 to December 2023 in the department of General Surgery and Microbiology at Pacific Institute of Medical Sciences, Umarda, Udaipur, Rajasthan, India.

Data Collection Procedure:

Inclusion Criteria: The patients who undergone surgery both male and female, more than 10 years showed post-surgical wound infection diagnosed by physicians within 30 days of surgical procedure were included in the study.

Exclusion Criteria: The patients underwent laparoscopic surgery, received antibiotics for duration of >1 week before surgery, re-operative surgery, infection at surgical site, not come back for follow-up, receiving corticosteroids drugs, community-acquired pyogenic infections such as abscess, furuncle and carbuncles; patients with infection of an episiotomy; and patients with open fractures were excluded from the study.

Data were collected by using predesigned questionnaire form. The data were collected in the two phases. In first phase, data were collected during preoperative period, and in the second phase during the postoperative period, from the day after surgery to 30th day after the surgery. In the first phase all the information which included sociodemographic, biomedical characteristics of the patients, i.e. past medical history of diabetes, history of smoking tobacco, the body mass index, and anemia. Other information regarding surgery was also recorded, i.e. emergency or elective, surgery indication, class of ASA. Every patient was followed up from the time of surgery to until 30-day postoperative. During the follow-up of patients, surgical wound was inspected at the time of first dressing and weekly thereafter till 30th day of postoperatively.

Sample Collection and Processing

Sample was collected from infected site from each of the patients before cleaned using normal saline and sterile cotton gauze piece then, thereafter two wound swabs were collected using sterilized cotton swabs (Hi-Media) and immediately transported to the laboratory for further processing at department of microbiology within 1 hour.

The first swab was used to make Gram stain smears for direct detection by microscopy, while the second swab was inoculated into suitable culture media i.e. blood agar, MacConkey agar and nutrient agar, and incubated at 37°C for 18–24 hours. Further, bacteria growth was done by using Gram stain, motility, hemolysis on blood agar plates, lactose fermentation on MacConkey agar. Catalase and coagulase test for Gram-positive bacteria and other biochemical reactions for gram negative bacteria performed by nutrient agar culture plate.

Antimicrobial Susceptibility Testing

The antimicrobial susceptibility testing was done by in-vitro on Muller Hinton agar using Kirby Bauer disc diffusion method using 0.5 McFarland culture suspension of isolate as per Clinical and Laboratory Standard Institute (CLSI) recommendation [15]. The antibiotics used for testing were azithromycin (30mcg), amikacin (30 mcg), gentamicin (10 mcg), ampicillin (10 mcg), amoxicillin/ clavulanic acid (20/10 mcg), cefoxitin (30mcg), ceftriaxone (30 mcg), levofloxacin (5 mcg), Meropenem (10 mcg), Imipenem (10 mcg), ciprofloxacin (5mcg), cefoperazone/sulbactam (30mcg), cotrimoxazole (25mcg), Tetracycline (30 µg) and vancomycin (30 mcg) [16].

Quality Control: A standard procedure was followed to maintain the quality control in the laboratory test results. American Type Culture Collection (ATCC) control strains of Staphylococcus aureus (ATCC 25923), Escherichia coli (ATCC 25922) and Pseudomonas aeruginosa (ATCC 27853) were used for the quality control purpose [16,17].

Results

The results showing in the present study, the different characteristics with the post-surgical wound infections are listed in Table no 1. A total of 693 patients in the study, 435 were males (62.77%) and 258 were females (37.23%) in Figure 1. Age of the patients ranged from 14 to 87 years. The rate of post-surgical wound infection was higher in males (8.22%) than in females (3.46%). Mean age of male patients were 56.85 years while in female patients 42 years. Highest cases of post-surgical wound infection were recorded in age group of 41-50 years (14.91%), followed by 51-60 years (11.76%), in >60 years were 10.84%, 31-40 years were 9.16%, and in 11-20 years 9.09%. There is no significant difference among different age group in post-surgical wound infection rate (p value 0.401). The rate of post-surgical infection, was higher in contaminated surgeries (14.35%), compared to clean contaminated (8.87%) and clean surgeries (7.86%). There is significant difference between contaminated and clean surgeries (p value 0.0361). In the total 693 patients, 81 patients (11.68%) shows post-surgical wound infection and the most commonly isolated bacteria were *Staphylococcus aureus* (13/81, 16%), *E. coli* (15/81, 18.51%), *Pseudomonas aeruginosa* (23/81, 28.39%) and Klebsiella pneumoniae (8/81, 9.87%), and Coagulase Negative Staphylococci (CoNS) (17/81, 20.98%), and proteus species (05/81, 6.17%) in Table 2. Associated risk factors was also evaluated in both genders i.e. diabetes mellitus in 13.58%, hypertension in 27.6%, anaemia 24.69%, and smoking habits in 35.80% patients. In antimicrobial susceptibility testing pseudomonas aeruginosa was sensitive (100%) to carbapenems, and Piperacillin/Tazobactam, Amikacin 70 %, E.coli was 100% sensitive to Meropenem, Imipenem, and 90% sensitive to Amoxclav, Ampicillin/Sulbactam, Piperacillin/Tazobactum, less sensitive to other cephalosporins groups. Klebsiella spp sensitive to 100% of carbapenems and Piperacillin/Tazobactum. In gram positive bacterial isolates, Staphylococcus aureus was 100% sensitive to Amikacin, Gentamicin, Vancomycin, and linezolid. Coagulase negative Staphylococci was 100% sensitive to Gentamicin, Vancomycin, and linezolid. Details were showed in Table no 3.

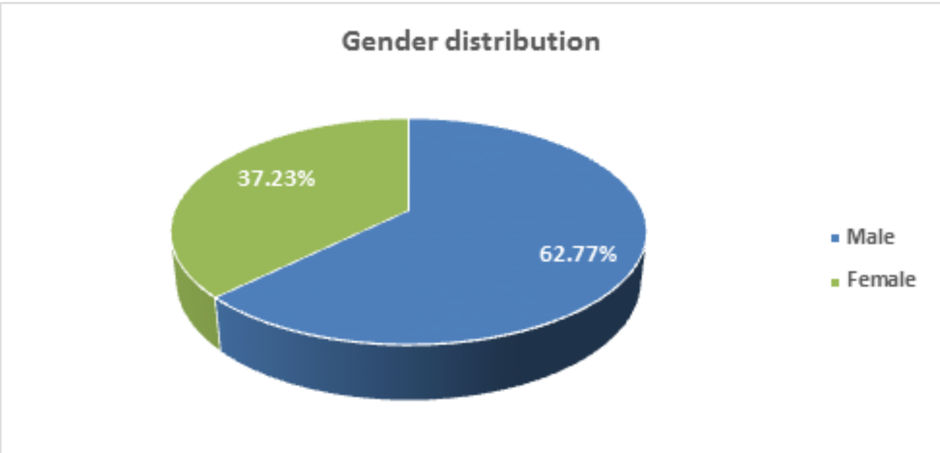

Figure 1: Gender distribution among post-surgical wound infection patients.

Table 1: Characteristics associated with post-surgical wound infection.

Characteristics of patients(n=693)		Post-surgical infection(n=81)	%	p-value
Gender	Male	57	8.72	0.166
	Female	24	6.07	
Age group	11-20 years(n=33)	03	9.09	0.401
	21-30 years(n=62)	05	8.06	
	31-40 years(n=131)	12	9.16	

	41-50 years(n=248)	37	14.91	
	51-60 years(n=136)	16	11.76	
	>60 years(n=83)	09	10.84	
Type of surgery	Clean(n=127)	09	7.86	0.0361
	Contaminated(n=397)	57	14.35	
	Clean contaminat-ed(n=169)	15	8.87	

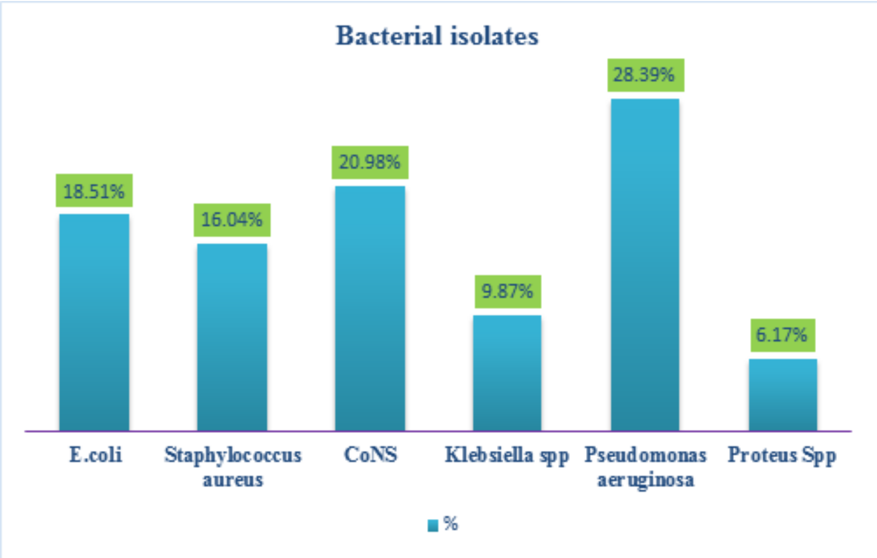

Figure 2: Bacterial isolates from post-operative wound infection patients.

Table 2: Associated risk factors in post-surgical wound infection patients

Risk factors (n=81)	**Gender distribution**	
	Male	**Female**
Diabetes mellitus(n=11)	09 (15.78%)	02 (8.33%)
Hypertension (n=22)	17 (29.82%)	05 (20.83%)
Anaemia (n=20)	07 (12.28%)	13 (54.16%)
Smokers (n=29)	28 (49.12%)	01 (4.16%)

Table 3: Antimicrobial susceptibility pattern of bacterial isolate in post-operative wound infection patients.

Name of antibiotics	**Bacterial isolates(n=81)**					
	Pseudomonas spp.(n=28)	**E.coli (n=15)**	**Klebsiella (n=8)**	**Staphylococcus aureus (n=13)**	**CoNS (n=17)**	**Proteus (5)**
Amikacin (30mcg)	70%	80%	90%	100%	90%	90%
Amoxclav (30mcg)	-	90%	70%	-	-	90%
Ampicillin+sulbactam(10mcg)	-	90%	80%	-	-	100%
Ciprofloxacin (5mcg)	60%	50%	50%	-	-	40%
Chloramphenicol (30mcg)	-	90%	70%	-	-	40%
Co-trimoxazole (25mcg)	-	50%	50%	-	-	50%
Cefepime (30mcg)	50%	40%	50%	-	-	50%
Ceftazidime (30mcg)	50%	50%	60%	-	-	50%
Cefuroxime (30mcg)	-	60%	60%	-	-	60%
Cefotaxime (30mcg)	-	50%	90%	-	-	50%
Doxycycline hydrochloride	-	80%	100%	100%	90%	80%
Imipenem (10mcg)	100%	100%	100%	-	-	90%
Levofloxacin (5mcg)	50%	60%	50%	-	-	70%
Meropenem (10mcg)	100%	100%	100%	-	-	100%
Piperacillin+Tazobactum	100%	90%	100%	-	-	100%
Gentamicin (10mcg)	50%	80%	100%	100%	100%	90%
Aztreonam (30mcg)	100%	80%	90%	-	-	90%

Tobramycin (10mcg)	50%	90%	90%	90%	90%	90%
Cefoxitin (10mcg)	60%	100%	100%	80%	80%	70%
Clindamycin	-	-	-	70%	60%	-
Vancomycin (10mcg)	-	-	-	100%	100%	-
Erythromycin (30mcg)	-	-	-	70%	60%	-
Azithromycin (10mcg)	-	-	-	70%	80%	-
Linezolid (10mcg)	-	-	-	100%	100%	-

(-* not applicable)

Discussion

Despite significant advances in surgical techniques, infection control measures, and a better understanding of wound healing, post-operative wound infections remain a significant concern in healthcare settings. The overall health and immune status of the patient play a crucial role in the development of post-operative infections. Patients with compromised immune systems or underlying medical conditions are at a higher risk. The rate of infection varies from different country, healthcare settings and even different areas. In our present study, overall infection rate was 11.68%, our similar but slightly higher rate was published by Addis Ababa 14.8% [18], whereas other studies showed higher rate of infection by Ahmad, Damani et al described 30% post-surgical infection rate [19-20] , reports from Niger 74.9% [21] and Nepal 80% [22] and rural tertiary hospital in Nigeria 70.1% [23], North Ethiopia 44.1% [24], Kenya 7% [25] and tertiary care hospital in Gujarat, India 68.85% [26]. The difference of prevalence in post-operative infection may be due to variation in common healthcare associated pathogens inhabitant, difference in making of policy of infection control and preventive measures between countries and hospitals,

In present study, most of the study subjects were in middle age group (30–60 years) and there was male predominance. Out of 693 surgery patients upon in the current study, 435 (62.77%) were males compared to 66% reported by others.

In our study, multiple infections among post-surgical wound infected patients was seen in 06 (7.40%) of patients where S. aureus and Proteus species was the most common organisms, where rest of are 75 (92.59%) have shown single bacterial infection. Pseudomonas aeruginosa followed by Coagulase Negative Staphylococci (CoNS), Escherichia coli was the predominant isolate which is in agreement to findings from Kenya [25] and Ethiopia [27]. Pseudomonas aeruginosa was the most prevalent isolates followed by CoNS. Pseudomonas is widely distributed in nature as an environment contamination while The normal flora nature of Staphylococci in the skin and anterior nares, which can enter to deep site during surgery of the natural barrier of the skin, could be the possible justification for its high prevalence. [28]

Bacterial growth was not seen in 612/693 (88.31%) patients, which could attribute to the normal healing process of the wound by host immune system, antimicrobial activity or appropriate use of antiseptics for cleaning the wounds. It could also be due to anaerobic bacteria or fungi infection which we could miss due to the use of culture media that only support the aerobic bacteria.

In our study, in vitro antimicrobial sensitivity test showed that isolated bacteria react differently to various antibiotics. Thirty (100%) of the isolated S.aureus and CoNS in our study were sensitive to Amikacin and Gentamicin similar to the report by Bowler PG and Mulu W et al [28-29] also from Nepal and Uganda [30]. All isolates of Staphylococci were sensitive to vancomycin and linezolid.

High resistance rate was seen in Klebsiella spp. to Ciprofloxacin, Levofloxacin, co-trimaxazole, ceftazidime, and Amoxicillin similar to the report by Anguzu JR et al [30] Pseudomonas aeruginosa were 50% resistant to Ceftazidime, cefepime, levofloxacin, and gentamicin similar resistance was reported by Singh A et al [31] although 100% sensitive to Meropenem, Imipenem, and Piperacillin/Tazobactum. Isolates of *Escherichia coli* were 100% sensitive to Imipenem, Meropenem followed by 90% sensitive to Amoxclav, Ampicillin/Sulbactam, Piperacillin/Tazobactum similar result were observed from Gupta M and Mulu W et al. [27,29]

All isolated bacteria were resistant to Cefepime, Ceftazidime, Cefuroxime, Ciprofloxacin, Co-trimaxazole, Clindamycin, and Erythromycin. This remarkably higher resistance may be due to their easily availability and indiscriminate use of the drugs without proper prescription. Vancomycin, Gentamicin, carbapenems and Linezolid in our study appear to be effective against post-surgical wound infection in the study area that can be used with caution.

Surgical wound classification has been the predictor of developing SSI. Previous studies have shown higher risk of SSI in contaminated and dirty wounds. [32] our findings are not well similar but showed some degree of SSI in this study. This is explained by the higher bacterial load in contaminated wounds (14.35%) as compared with clean (7.86%) and clean‑contaminated wounds

(8.87%). [33] There is significant difference between clean and contaminated surgeries (p value 0.0361). This can be due to patients with wound class III/contaminated (open, fresh, accidental wounds) and class IV/dirty-Infected (old traumatic wounds with retained devitalized tissue) and those that involve existing clinical infection or perforated viscera are at high risk to develop SSI.

Surgical site infection incurs heavy financial burden on patients and healthcare establishments. SSI surveillance system is present in most urban tertiary care setups, but data from other resource constrained health establishments is lacking. Efforts to reduce post-operative infections involve a combination of preventive measures, such as strict adherence to aseptic techniques, proper antibiotic use, preoperative screening and preparation, and ongoing surveillance and quality improvement initiatives in low-resource setting hospitals.

Conclusion

Surgical site wound infections are a major health associated infections (11.68%) based on this local institutional study. Incidence of post-operative wound infection is lower than the other studies reported in India. Diabetes mellitus, smoking, wound type, longer preoperative stay, type of operation, wound class and ward type, showed statistically significant association with postoperative wound infection. Better preoperative optimization of comorbidities, quality healthcare, and robust surveillance is needed for post-operative wound infection prevention and management in rural setting. Therefore, time to time surveillance of pathogens and antibiotic susceptibility is important to prevent further spread of multidrug resistant pathogens.

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