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Original Research Article

Aerobic Bacteriological Study of Surgical Site Infections and its Associated Factors

PriyankaPudoor[1], S. Uma Devi[2], V. O. Mahesh Babu[3]

[1]**Assistant Professor, Department of Microbiology, Government Medical College, Anantapur, Andhra Pradesh, India.**

[2]**Associate Professor, Department of Microbiology, Government Medical College, Anantapur, Andhra Pradesh, India.**

[3]**Assistant Professor, Department of Emergency Medicine, Government Medical College, Anantapur, Andhra Pradesh, India.**

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Corresponding Author: Dr. V. O. Mahesh Babu
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Abstract:

Introduction: Among nosocomial infections, SSI is the third most commonly reported infection and they account for approximately a quarter of all nosocomial infections. SSIs cause economic and social loss to the patients and family due to increase in length of stay and sometimes secondary surgery or re exploration may require. The aim of the study to analyze the risk factors and the pathogens responsible for surgical site infections.

Materials and Methods: This is a descriptive cross sectional study that was undertaken for a period of one year in the year 2023. Details were noted about each patient in a pre-structured questionnaire. All cases were monitored until discharge from the hospital. After discharge patients were followed through phone calls about their wound condition up to 30 days after surgery.

Results: Out of 272 total Elective surgeries, 5.14% had post op Surgical site infections & 31.7% of Emergency surgeries had SSI. Out of total 4.3% of 161 Clean surgeries; 5.7% of total 87 Clean contaminated;17.9% of total 67 contaminated & 21.8% of total 64 dirty wound types were infected ($p<0.001$). As the duration of surgery increased, SSI rate increase proportionately. The difference between the surgeries of <1 hr, 1-2 hr and 2 hours duration was highly significant statistically ($p<0.00001$). Out of 379 total operated patients who had Drains 10.8% showed SSI, and in no drain patients, 1.8% had SSI. 10.8% of abdominal surgeries & 1.8% of extra abdominal surgeries were showing SSI. 1.5% of total Laparoscopic abdominal surgeries, 11.08% of total Open Abdominal surgeries were showing surgical site infections. The difference of 9.58% was found to be statistically significant. In the present study, it was found that 5.2% of the total patients with preoperative stay >5 days showed postoperative infections. This was not statistically significant ($p>0.05$).

Conclusion: The Clinicians should have knowledge of the appropriate use of aseptic and antiseptic techniques, the proper use of prophylactic and therapeutic antibiotics, and adequate monitoring and support with novel surgical and pharmacological modalities as well as nonpharmacological aids.

Keywords: Surgical Site Infections, Risk Factors.

Introduction

Surgical site infection (SSI) is an infection that occurs after surgery in the part of the body where the surgery took place. An SSI typically occurs within 30 days after surgery or up to 90 days after surgery in patients receiving implants. The CDC describes 3 types of surgical site infections: Superficial incisional SSI, which involves only the skin, deep incisional SSI in which infections occur beneath the incision area in muscle and the tissues surrounding the muscles, organ or space SSI includes a body organ or space between organs.

Infection migration into surgical sites can occur either by endogenous spread of microorganisms which are already on or in the body or exogenous spread by direct or indirect contact from objects, or HCWs. The most common organisms responsible for SSI are S. aureus, CoNS, Enterococcus species and Escherichia coli [1].

Among nosocomial infections, SSI are the third most commonly reported infection and they account for approximately a quarter of all nosocomial infections [2]. SSIs cause economic and social loss to the patients and family due to increase in length of stay and sometimes secondary surgery or re exploration may require. Host factors, wound factors and surgery related factors are implicated in the causation of SSI [3].

SSIs are a major cause of morbidity and mortality worldwide, affecting 5.6% of surgical procedures in developing countries [4]. According to a World Health Organization (WHO) report, the incidence of SSIs ranges from 1.2 to 23.6 per 100 surgical procedures [5]. Worldwide, it has been reported that more than one-third of postoperative deaths are related to SSIs [6].

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 [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 [1].

Bacteriological studies have shown that SSIs are universal and the etiological agents involved may vary with geographical location, between various procedures, between surgeons, from hospital to hospital or even in different wards of the same hospital [1]. In recent years there has been a growing prevalence of gram negative organisms as a cause of serious infections in many hospitals [7]. Knowing the risk factors of SSI and prioritizing those to prevent will definitely help to reduce the SSI rate of health care clinics.

Here in this research work we would like to analyse the pathogens responsible for surgical site infections. We are also trying to present the associated factors of SSI noted in this community.

Materials and Methods

A total of 379 patients underwent surgery and were considered to study further about SSI and its associated risk factors. All these patients were admitted and operated in various surgical branches at the Government Medical College, Anantapur, Andhra Pradesh. A total of 48 patients satisfying the definition of SSI were considered as SSI cases and included in this study. This is a descriptive cross sectional study that was undertaken for a period of one year in the year 2023. Surgical site wounds were classified as clean, clean contaminated, contaminated and dirty wounds.

Inclusion Criteria: All adults (>15 years) operated patients (both elective and emergency) of either gender.

Exclusion Criteria: Patients with community-acquired infection were excluded from the study.

Data Collection: Details such as age, sex, sociodemographic, diagnosis, surgery, any implant, comorbidities, trauma, timing of surgery, duration of surgery, drain, site of surgery, any intraoperative events, antibiotic prophylaxis, history of previous surgeries or hospitalization, length of preoperative or postoperative stay, type of SSI, history of smoking, preoperative wound cleaning, post operative dressing details, clinical outcome were noted about each patient in a pre-structured questionnaire. All cases were monitored until discharge from the hospital. After discharge patients were followed through phone calls about their wound condition up to 30 days after surgery.

Microbiological Methods:

Culture specimens including pus swab, pus aspirate, drain fluid, tissue bits were obtained on the day of the event when the clinician suspected it was SSI. Specimens were obtained after thorough cleaning of the surface of the wound with saline, and followed by debridement of superficial tissue debris. Specimens were collected from the deeper portion of wound with a sterile swab or aspiration of pus with a sterile syringe or collecting drain fluid or pus or tissue bits into a leak proof screw capped sterile container. All the samples were promptly sent to the laboratory and processed for microbiological study at the department of Microbiology. Standard methods for isolation and identification of bacteria were used [8].

Antibiotic Susceptibility Testing (AST): AST of bacterial isolates was performed by the standard disc diffusion method as recommended by the CLSI guidelines. Method used for AST was a modified Kirby Bauer disc diffusion test. The test organism was subcultured into peptone water and incubated for 4-6 hours at 37^0C. The turbidity was standardized with 0.5 McFarland opacity standards and swabbed over 90 mm Mueller hinton agar plate. Antibiotic discs were placed 15mm from the edge of the plate. The discs were evenly placed so that they were no closer than 25mm from center to center. Places were incubated at 37 C for 18-24 hours. Zones of inhibition were measured and reported as sensitive, moderate sensitive and resistant.

Antibiotic disks used for Gram positive organisms testing were penicillin (10U), gentamicin (10µg), amoxyclav (30 µg), amikacin (30 µg), ciprofloxacin (5 µg), erythromycin (5µg), clindamycin (2µg), cotrimoxazole (1.25 µg/23.75 µg), cefoxitin (30 µg), linezolid (30 µg), vancomycin (30µg) and teicoplanin (30µg).

Gram negative isolates antibiotics were: amoxyclav (30 µg), piperacillin+tazobactum (100/10 µg), ceftazidime (30 µg), ceftriaxone (30 µg), cefipime (30 µg), Ceftazidime+clavulanic acid (30/10 µg), piperacillin+tazobactum (30/6 µg), levofloxacin (5 µg), meropenem (10 µg), amikacin (30 µg), tigecycline (15 µg) and colistin (50 µg). Standard Quality Control strains were used as a part of testing. Multi Drug testing was done for all strains isolated according to CLSI guidelines.

Statistical Analysis: All details were collected and entered into Microsoft excel sheet. All descriptive quantitative variables were expressed as numbers and percentages.

Results

Out of 379 operated patients in the General surgical department in our Hospital, 48 (12.6%) patients developed one or other postoperative infections. The SSI incidence observed was 12.6 % (48 SSI out of 379 surgeries). The mean age of infected patients was 44.7 years. Out of 276 males in our study, 14.8% patients showed post op infections & out of 96 total females, 7.29% were infected, the gender difference was statistically significant. Out of 57 Diabetics, 8.77% had post op infections & 13.35% of non-diabetics were infected. The difference of 4.58% was not statistically significant (Table 1).

Other chronic illnesses (HTN, anemia, neoplasms) were also not significant in getting infections (p>0.05). Out of 25 Traumatic cases operated, 20% were infected, and out of 354 non Traumatic cases operated 12.1% showed infection. This association was not significant (Table 1).

Out of 272 total Elective surgeries, 5.14% had post op Surgical site infections & 31.7% of Emergency surgeries had SSI. The difference of 26.56% was found to be highly significant statistically. Out of total 4.3% of 161 Clean surgeries; 5.7% of total 87 Clean contaminated; 17.9% of total 67 contaminated & 21.8% of total 64 dirty wound types were infected. When comparing the surgical site infection of clean & other than clean wound type, the difference was found to be highly significant statistically. (Corrected Chi square=14.6; p<0.001). As the duration of surgery increased, SSI rate increase proportionately. The difference between the surgeries of <1 hr, 1-2 hr and 2 hours duration was highly significant statistically (Corrected Chi square=32.2; p<0.00001; highly significant). Out of 379 total operated patients who had Drains 10.8% showed SSI, and in no drain patients, 1.8% had SSI. The difference was found to be statistically significant. 10.8% of abdominal surgeries & 1.8% of extra abdominal surgeries were showing SSI. It was found to be highly significant statistically. 1.5% of total Laparoscopic abdominal surgeries, 11.08% of total Open Abdominal surgeries were showing surgical site infections. The difference of 9.58% was found to be statistically significant. In the present study, it was found that 5.2% of the total patients with preoperative stay >5 days showed postoperative infections. This was not statistically significant (p>0.05) (Table 1).

Table 1. Analysis of SSI associated risk factors

Parameter	SSI present	SSI absent	Total	Chi Square	P value	Significance
Sex						
Males	41	235	276	4.4043	0.035	Significant
Females	07	96	103			
Diabetes						
Yes	5	52	57	0.9192	0.337	Not significant
No	43	279	322			
Trauma						
Yes	5	20	25	1.302	0.253	Not significant
No	43	311	354			
Timing of surgery						
Elective	14	258	272	49.229	<0.00001	Significant
Emergency	34	73	107			
Wound class						
Clean	7	154	161	51.187	<0.00001	Significant
Clean contaminated	5	82	87			
Contaminated	12	55	67			
Dirty	24	40	64			
Duration of surgery						
<1 hour	06	185	191	32.215	<0.00001	Significant
1-2 hours	13	53	66			
>2 hours	29	93	122			
Drain						
Present	41	223	264	6.458	0.011	Significant
Absent	7	108	115			
Site of surgery						

Abdominal	41	214	255	8.2106	0.004	Significant
Extra abdominal	7	117	124			
Type of surgery						
Laparoscopic	6	109	115	8.278	0.004	Significant
Open	42	222	264			
Preoperative Hospital stay						
<5 days	20	153	173	0.3509	0.553	Not significant
> 5 days	28	178	206			

50 isolates from SSI were obtained from 48 patients; the predominant isolate in SSI was Escherichia coli (46%) followed by Klebsiella pneumonia (40.4%), Proteus mirabilis (14.2%), Pseudomonas aeruginosa (2.3%), Acinetobacter haemolyticus (2.3%), Staphylococcus aureus (4.7%).

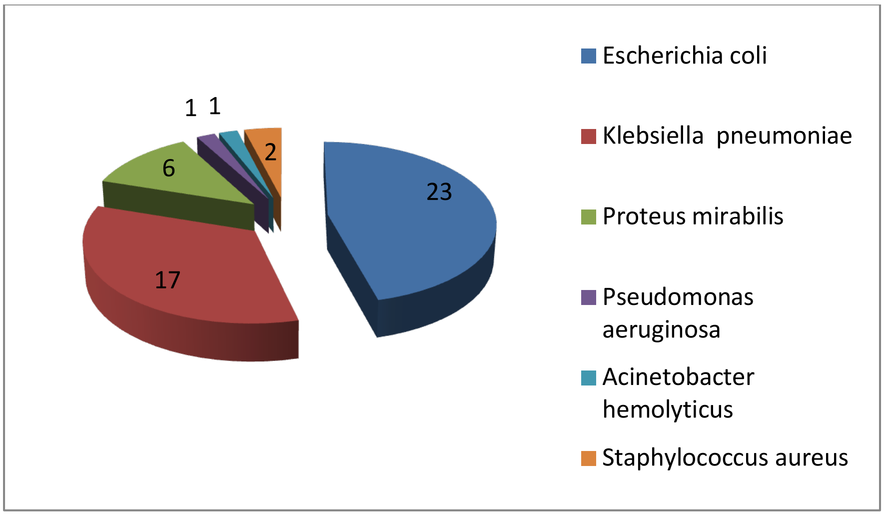

Table 2: Organisms isolated from SSI patients

Discussion

SSI incidence rate by various studies [6,9] was found to be around 6%. However the SSI incidence rate varies depending on financial status of patients, hospitals and its resources, from 20% to as high as 76.9% was reported [10,11]. The current status of SSIs identified in their hospital concurs with the studies of Golia et al. [12], and Iqbal et al. [3], who reported it as 4.3%, 5.4%, and 7.3%, respectively. On the contrary, Setty et al [14] reported it as 21.66% and 22.2%. The variation in incidence rate could be due to availability of resources, expertise personnel, adequate training skills to nurses and surveillance of SSI.

The mean age group affected in the present study was 44.7 years. This concurred with studies by Seyd Mansour Razavi et al from Iran stated 46.7 years as mean age of patients affected by SSI [15], Anusha S et al from Tamil nadu noted 41-50 years age group [16]. The study was found to be in contrast to the studies done by Patel Disha et al from Gujarat, > 60 years [17] and Narual H et al [18] also observed in >60 years. In the present study, age was not associated with the infection rate (p>0.05).

Mohan N et al [19] documented most of the cases of SSI were diagnosed in males (72%) (p=0.022). Most of the SSIs were diagnosed in emergency surgeries (81%) (p=0.025). Among the individuals with diabetes mellitus, about 55% of them developed SSI (p=0.0001). Among those who had a habit of smoking (p=0.526) or alcoholism (p=0.822), about 42% and 35% of them developed SSI, respectively. Similarly, of those who stayed more than seven days, 76.7% of them were diagnosed with SSI (p<0.0001). Among 2076 patients, 1307 underwent clean surgeries, and of these, 42 developed SSI (3.2%). The occurrence of SSIs among clean contaminated (n = 519), contaminated (n = 187), and dirty wounds (n = 63) were 5.2%, 11.2%, and 41.2% respectively. Narula H et al [18] stated that 29% of males and 10% of females developed SSI (P=0.896). They observed the change in SSI incidence in relation to preoperative hospital stay (P=0.000), diabetes mellitus (P=0.009), different wound classes (P=0.000). Tabiri et al. also reported that emergency cases had a higher number of SSIs (23.8%) as compared to elective cases (7.4%) [20]. In another study done by Dessie et al., SSIs were reported in 61.7% of emergency cases and 38.3% of elective cases [21]. The occurrence of SSIs among diabetics in the present study concurs with the study of Talbot [22], who reported that SSI among diabetics was 50%. Shiferaw et al [23] from Ethiopia observed the SSI factors relevance in relation to duration of surgery > 1 h (AOR = 1.78; 95% CI: 1.08–2.94), the operation > 1 h were nearly two times more at risk to acquire SSI which is also supported by other studies conducted in Tanzania [24], and Nigeria [25], diabetes mellitus (AOR = 3.25; 95% CI: 1.51–6.99) this is supported by Yemen [26], Nigeria [25], India [27], and Tanzania [24], American Society of Anaesthesiologists score > 1 (AOR = 2.51; 95% CI: 1.07–5.91), previous surgery (AOR = 2.5; 95% CI: 1.77–3.53), clean-contaminated wound (AOR = 2.15; 95% CI: 1.52–3.04), and preoperative hospital stay > 7 day (AOR = 5.76; 95% CI: 1.15–28.86), were significantly associated with SSI.

As per this study 50 isolates from SSI were obtained from 48 patients; the predominant isolate in SSI was Escherichia coli (46%) followed by Klebsiella pneumoniae (40.4%), Proteus mirabilis (14.2%), Pseudomonas aeruginosa (2.3%), Acinetobacter haemolyticus (2.3%), Staphylococcus aureus (4.7%). Gram-negative organisms were reported to be the predominant cause of postoperative wound infections in other studies as well in similar to this study [28,29]. Mohan N et al [19] did a study in Kerala observed Enterococci spp., Citrobacterspp., and Enterobacter spp. were isolated 100% from abdominal surgeries. Pseudomonas aeruginosa and Acinetobacter baumannii were the two organisms that were isolated from various surgical sites. Staphylococcus aureus was the most common organism accounting for 35.16% of total isolates [28,29].

Narul H et al [18] observed the Staphylococcus aureus was the most common organism isolated, accounting for 35.16% isolates followed by Klebsiella pneumoniae which accounted for 23.08% isolates) and Pseudomonas aeruginosa (16.48%). Other organisms isolated from postoperative wounds with their frequency of occurrence in decreasing percentage were Escherichia coli (12.09%), Proteus mirabilis (6.59%), Coagulase-negative Staphylococcus (5.49%), and Enterococcus sp. (1.10%). 4 (43.75%) out of 32 Staphylococcus aureus (43.75%) were screened as MRSA. Negi V et al [30] noted out of total 137 samples, 132 (96.4%) yielded bacterial growth and 139 bacterial isolates were obtained. Staphylococcus aureus (50.4%) was the commonest organism followed by Escherichia coli (23.02%), Pseudomonas aeruginosa (7.9%) and Citrobacter species (7.9%).

Conclusion

SSIs were more common in abdominal surgeries. Male patients, patient who underwent emergency surgery or open surgery or dirty surgery, duration of surgery > 1 hour has a higher risk of developing SSIs. The most common organisms encountered as SSI were Escherichia coli and Klebseilla pneumoniae. The clinicians should have knowledge of the appropriate use of aseptic and antiseptic techniques, the proper use of prophylactic and therapeutic antibiotics, and adequate monitoring and support with novel surgical and pharmacological modalities as well as nonpharmacological aids. Increase in nosocomial infections alerts the hospital infection control team to do active and periodic surveillance to find the root cause and mitigate it.

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