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Research Article

Microbiological Profile of Surgical Site Infections in Abdominal Surgeries: A Prospective Study.

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Abstract: ***Introduction:*** Surgical Site infections (SSIs) are one of the commonest postoperative complications worldwide especially in developing countries due to lack of resources, automation and modalities. They account for the second most frequently reported hospital acquired infections. More than one-third of postsurgical deaths, worldwide, are somewhere related to SSI. The study aimed to comprehensively investigate the prevalence , the microbiological profile and antimicrobial susceptibility pattern of surgical site infections (SSIs) in abdominal surgeries. **METHODS:** A prospective observational study conducted over a period of one year, involving patients who underwent abdominal surgeries. Pus samples were collected from wounds at surgical sites from post abdominal surgeries presenting with clinical signs of infection. Microbiological analysis was performed using standard laboratory techniques for bacterial identification. Antibiotic sensitivity patterns of the isolated microorganisms were determined using the Vitek-2 Compact instrument (automated method for Bacterial Identification & antimicrobial susceptibility testing).**RESULTS:** A total of 3358 patients were included in the study, with 53 (1.58%) patients exhibiting postoperative SSIs. The microbiological analysis revealed a diverse range of pathogens, including 56.6% E.coli, 15.1% Klebsiella pneumoniae, 11.3% Staphylococcus species, 5.7% Pseudomonas aeruginosa, 9.4% Acinetobacter species, 1.9% Enterobacter species. Notably, E. coli 56.6% was the most frequently isolated pathogen. Staphylococcus spp demonstrated lowest sensitivity to Erythromycin & Amoxycillin - clavulanicacid i.e,33.3%. E.coli showed fairly good sensitivity i.e, 70-76.6% to Carbapenems and 53.3 - 73.3% sensitivity towards Aminoglycosides. Klebsiella spp isolated showed very low to nil sensitivity (12.5% to 25%) to most antibiotic classes. The Pseudomonas spp showed low sensitivity to 3rd & 4th generation Cephalosporins (33.3%) comparatively to Aminoglycosides, Fluroquinolones & Carbapenems (100%). Majority of Klebsiella spp. 75% & Acinetobacter spp. 60% isolated in this study were Multi Drug Resistant (MDR). Characterized by the Centre for Disease Control (CDC) criteria, of the 53 cases; superficial SSI was found in 18 cases i.e. 33.96%, deep incisional SSI in 27 cases i.e. 50.94% whereas organ/space SSI in 8 cases (15.09%.)**CONCLUSION:** The occurance of SSI in abdominal surgery was 1.58% in this study with current preoperative protocol for SSI prevention, the SSI rate was very low. This study provides a comprehensive insight into the microbiological profile of SSIs following abdominal surgeries and underscores the importance of understanding local antibiotic resistance patterns. The antibiotic sensitivity patterns highlighted very low to nil sensitivity & varying degrees of resistance among the isolated microorganisms, emphasizing the need for targeted and judicious antibiotic therapy.

Keywords: Surgical Site Infections (SSI) Abdominal Surgery Microbiological Profile Bacterial Pathogens Antibiotic Resistance Nosocomial Infections

INTRODUCTION

The hospital-acquired infections (HAIs) encompass a range of infections acquired during hospitalization[1]. Among the HAIs, surgical site infections (SSIs) arise following surgical procedures are increasing world wide, that represent a substantial burden, posing challenges to patient care and healthcare resources [2]. Infections occurring up to 30 days after surgery or occurring up to an year after surgeries in patients receiving implants , affecting either the incision or deep tissue at the operating site often characterized by the invasion of body tissues by disease-causing agents are termed as Surgical site infections (SSIs) or "postoperative wound infections"[3,4,5]. Surgical site Infections (SSIs) remains a significant concern in healthcare settings worldwide. SSIs are often associated with increased stay in hospital, increased patient morbidity & mortality along with high healthcare costs, making them a critical focus of research and preventive efforts[6,7]. Despite advancements in medical practices and infection control

measures, SSIs persist as a formidable clinical challenge in most developing countries. The degree of characterization is based on their multifactorial etiology, stemming from factors such as surgical techniques, patient-specific variables (risk factors), vigilance criteria used, nature of data aggregation and healthcare practices. In most Instances the patient's own endogenous flora play a role in developing SSI in many surgeries. SSIs also contribute to operation-related mortality, despite occurring recurrently in cutaneous incisions [2,8]. SSI are influenced by factors such as inadequate hand hygiene, improper skin preparation, suboptimal antibiotic use and the nature of surgical procedures [9]. Patient - specific risks may include smoking, immunosuppressive drugs, anemia, advanced age, poor nutrition, diabetes, hypertension, tuberculosis and prolonged hospital stays [10,11,12] Disseminating timely data on surveillance , treatment cost & the impact of drug-resistant organisms to health care administrators, clinicians and other decision makers is an irreplaceable & effective tool for prevention and control of HAIs [13]. Understanding the intricate interplay of these factors is essential for devising effective strategies to reduce SSI incidence thereby to improve patient outcomes. Hence the present study aimed to determine the prevalence of SSI, its microbiological profile and antimicrobial susceptibility pattern in patients undergoing abdominal surgeries.

MATERIALS AND METHODS

A prospective hospital based observational study conducted over a period of one year, involving patients who underwent abdominal surgeries in Mahatma Gandhi Institute of Medical Sciences, Jaipur from April 2017 to April 2018 . The Pus samples / wound swabs were collected from wounds at surgical sites, post abdominal surgeries presenting with clinical signs of infection. The Pus Samples or wound swabs were aspirated with a sterile syringe from the wound or collected either on sterile cotton swab and subjected to routine microbiological investigations such as Microscopy : Grams staining and standard bacterial culture methods : following inoculation on to Blood agar, Chocolate agar & Mac conkey agar as per standard protocols and incubated for 24 -48 hours at 37°C aerobically for the isolation [13]. All the isolates were further processed for bacterial identification and antimicrobial susceptibility pattern following standard microbiological procedures using the Vitek-2 Compact instrument (automated method for Bacterial Identification & Antimicrobial susceptibility testing). The data was collected in a specially designed Case Recording Form [CRF] for recording the history and consolidating all the relevant data required.

Study Participants: Only adult patients of age group >18 yrs who underwent emergency or elective abdominal surgery at Mahatma Gandhi Hospital, Jaipur were included. All necessary baseline details regarding preoperative preparation, intra operative information & postoperative examination were recorded . All cases included were diagnosed for postoperative wounds as per CDC criteria & documented. Any Patient with repeat abdominal surgery at the same site within 30 days were excluded from the study.

RESULTS

A total of 3358 abdominal surgical cases were included this study based on the inclusion & exclusion criteria. Of these nearly 53 patients developed wounds at the surgery site, among those 36(67.9%) were males and 17(32.1%) were females. Among various abdominal surgeries SSI rate was found to be high in total abdominal Hysterectomy & X-LAP surgeries i.e, 4.0% & 3.7% respectively (CHART No.1). As per the CDC criteria, Out of 53 cases with SSI; nearly 18(33.96%) were of superficial incisional SSI type, deep incisional SSI was found in 27(50.94%) cases, whereas organ/space SSI was seen in 8(15.09%) cases (CHART No.2). The total incidence of SSI assessed by wound classification as: Clean – 22, Clean contaminated – 4, Contaminated – 27, Dirty – 0. Majority of patients with SSI i.e,(48 cases) 90% were anemic in this study, None of the patient was diabetic nor had h/o diabetes in this study. SSI was widely observed in age group between 40 – 70 years among the study participants. The microbiological analysis revealed a diverse range of pathogens, including 56.6% *E.coli, 15.1% Klebsiella pneumoniae, 11.3% Staphylococcus species, 5.7% Pseudomonas aeruginosa, 9.4% Acinetobacter species, 1.9% Enterobacter species.* Notably, *E. coli* 56.6% was the most frequently isolated pathogen (CHART No.3).

CHART No.1: SURGICAL SITE INFECTION RATES IN VARIOUS ABDOMINAL SURGERIES.

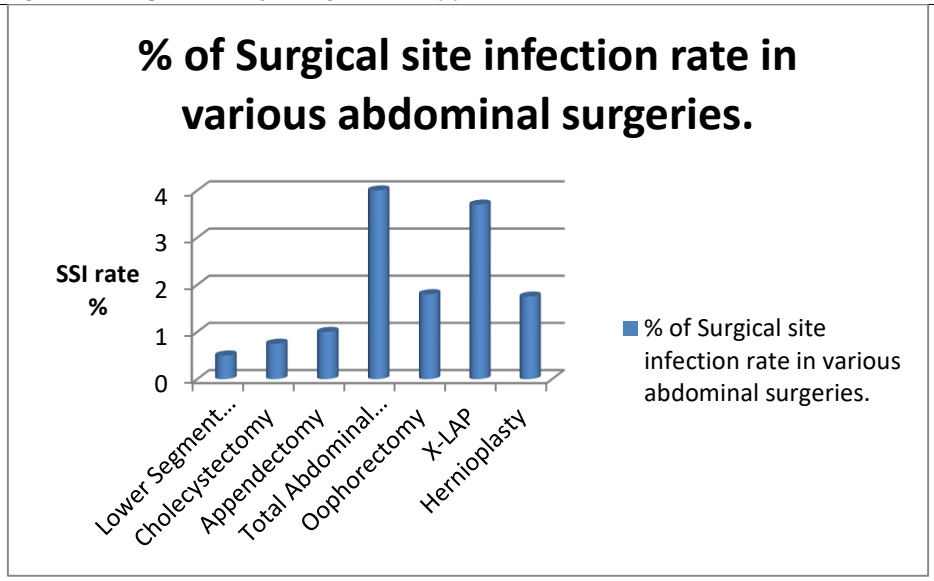

CHART No.2: DISTRIBUTION OF SSI TYPES IN ABDOMINAL SURGERIES.

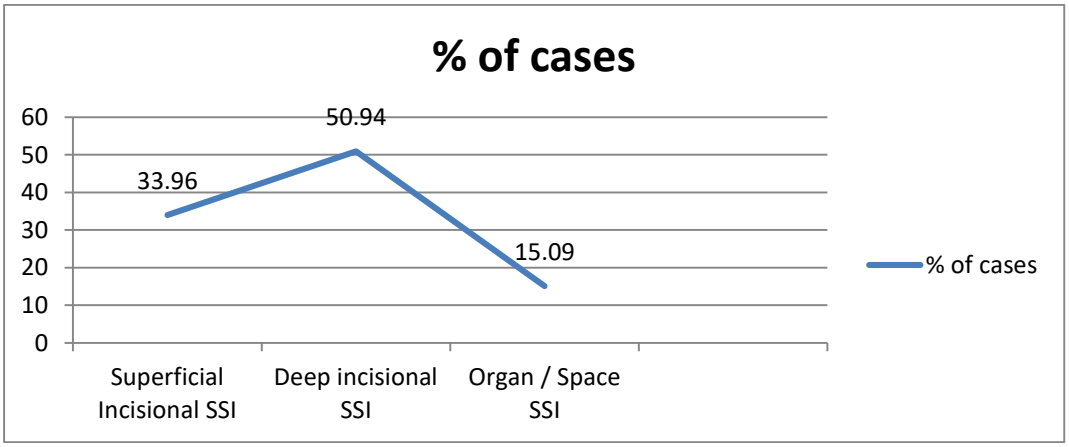

CHART No.3: DISTRIBUTION OF MICROORGANISMS ISOLATED FROM SSIS IN VARIOUS ABDOMINAL SURGERIES.

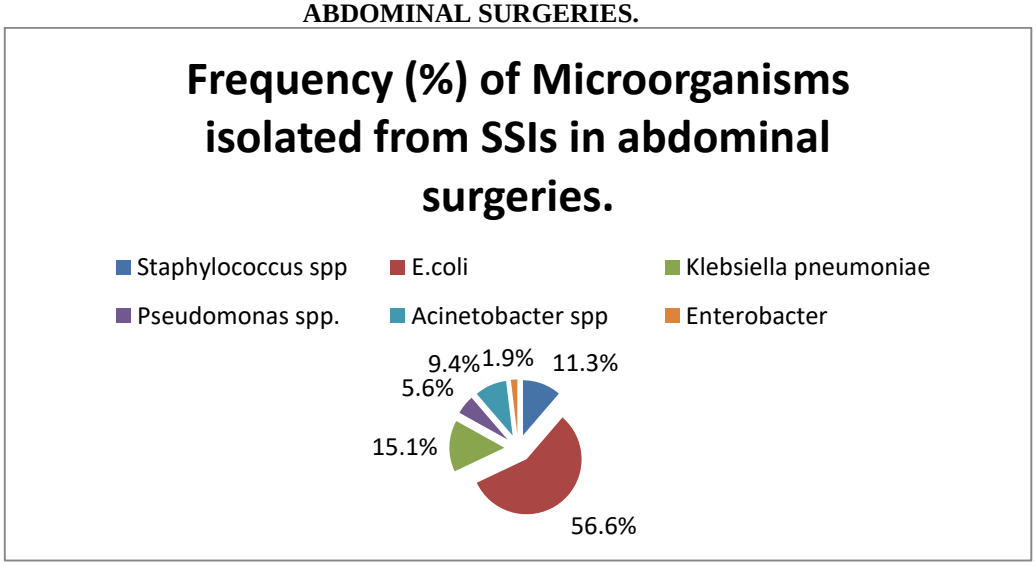

Table 1 & 2 : illustrates the drug sensitivity pattern to the commonly used antimicrobials against Gram Negative bacteria & Gram Positive bacteria respectively. *Staphylococcus spp* demonstrated lowest sensitivity to Erythromycin & Amoxycillin- clavulanic acid i.e, 33.3%. comparatively to Levofloxacin, Ciprofloxacin , Co-trimoxazole i.e, 66.6% &

Tetracycline (83.3%). The sensitivity of *Staphylococcus spp* isolated was fairly high to the broad spectrum antibiotics like Tetracyclines, Tigecycline and Teicoplanin. 100% sensitivity was recorded towards Gentamicin, Linezolid, Tigecycline & Teicoplanin. About 50% of the *staphylococcus spp* isolated were MRSA (Table No.2). *E.coli* isolates showed fairly good 70-76.6% sensitivity to Carbapenems and 53.3 -73.3% sensitivity to Aminoglycosides. The *Klebsiella spp* isolated showed very low to nil sensitivity to most antibiotic classes such as 3rd & 4th generation Cephalosporins, Aminoglycosides, Fluroquinolones & Carbapenems. Majority of *Klebsiella spp* i.e, 75% isolated in this study were MDR. The *Pseudomonas spp* showed low sensitivity to 3rd & 4th generation Cephalosporins (33.3%) comparatively to Aminoglycosides, Fluroquinolones & Carbapenems (100%). Sensitivity to the tested antibiotics was very low in *Acinetobacter spp*. ,only 20% of *Acinetobacter spp.* were found sensitive to Amikacin, Piperacillin tazobactum & Imipenem. Nearly 60% of *Acinetobacter spp* were MDR in this study. (Table No.2).

Table No.1 : DRUG SENSITIVITY PROFILE OF GRAM NEGATIVE ISOLATES (%)

.No.	**µ.org Antibiotics**	***E .coli* n=30(%)**	***Klebsiella pneumoniae*. n=8 (%)**	***Enterobacter spp*.n=1(%)**	***Pseudomonas spp.* n=3 (%)**	***Acinetobacter spp n* =5 (%)**
.	Amocillin Clavulanic acid	6(20)	-	1(100)	-	-
.	Cefotaxime	1(3.3)	1(12.5)	0	-	-
.	Cefatazidime	3(10)	1(12.5)	0	1(33.3)	0
.	Ceftriaxone	2(6.7)	1(12.5)	0	1(33.3)	0
.	Cefepime	12(40)	1(12.5)	1(100)	1(33.3)	0
.	Co-trimoxazole	4(13.3)	2 (25)	1(100)	1(33.3)	0
.	Aztreonam	12 (40)	2(25)	0	1(33.3)	0
.	Amikacin	22(73.3)	2(25)	1(100)	3(100)	1(20)
.	Gentamicin	16(53.3)	2(25)	0	3(100)	0
0.	Levofloxacin	2(6.7)	2(25)	1(100)	3(100)	0
1.	Ciproflox acin	2(6.7)	1(12.5)	1(100)	3(100)	0
2.	Piperacillin- tazobactam	12(40)	2(25)	1(100)	3(100)	1(20)
3.	Meropenem	21(70)	1(12.5)	1(100)	3(100)	1(20)
4.	Imipenem	23 (76.7)	1(12.5)	1(100)	3(100)	1(20)
5.	Tigecycline	21(76.7)	3(37.5)	1(100)	-	0
6.	Minocycline	4(13.3)	1(12.5)	1(100)	1(33.3)	2(40)
7.	MDROs*	Nil	6 (75)	Nil	Nil	3(60)

*- Multi Drug Resistant Organisms.

Table No.2 : DRUG SENSITIVITY PROFILE OF GRAM POSITIVE ISOLATES (%)

S.No.	List of Antibiotics	*Staphylococcus Spp.* n = 6 (%)
1.	Cefoxitin	3 (50)
2.	Clindamycin	3 (50)
3.	Erythromycin	2 (33.3)
4.	Gentamicin	6(100)
5.	Levofloxacin	4 (66.7)
6.	Ciprofloxacin	4(66.7)
7.	Amoxicillin-clavulanic acid	2(33.3)
8.	Co-Trimoxazole	4(66.7)
9.	Tetracycline	5(83.3)
10.	Tigecycline	6(100)
11.	Teicoplanin	6(100)
12.	Linezolid	6(100)
	Methicillin Resistant Staphylococcus	3(50)

DISCUSSION

The overall rate of SSI in abdominal surgery was 1.58%, with current preoperative protocol for SSI prevention , the SSI rate was very low. This correlates with the study done by Vikas Mishra et al from Kanpur i.e. 1.8% [14]. This is in agreement with two other Indian studies on surgical wounds conducted in Uttarakhand and Aurangabad, which showed almost similar infection incidences of 5% and 6%, respectively [15,16]. Studies has reported SSI in abdominal surgeries between 3.4 % and 36.1% in India [17,18,19,20]. In this study SSI rate was comparatively low i.e 1.58% compared to study by Maitreyee save et al, reported 19.3% in abdominal surgeries conducted between 2017 to 2019 in pune . A combination of bacterial, patient & local factors contribute to development of SSI, hence the difference in SSI rates [1]. Higher infection rate was observed in Male patients 67.92% than females 32.08%. Similar pattern was seen in the study by Victor Odhiambo Dinda, at Nairobi, 75.9% in males and 24.1% in females [21]. Older patients due to high levels of catabolic activity, weaker immune system , associated co-morbidities heal slowly and get more prone to develop SSI [22,23,24]. A number of factors contribute to SSI such as previous illness, patient's immune status, hypertension, diabetic status, anemia, pre & post operative care , infection control practices, duration of surgery etc.,[1]

Characterized by the CDC criteria, of the 53 cases; superficial SSI was found in 18 cases i.e. 33.96%, deep incisional SSI in 27 cases i.e. 50.94% whereas organ/space SSI in 8 cases 15.09%.The rates of clean, clean-contaminated and contaminated were 41.51%, 7.54 % and 50.94% respectively. Preoperative antibiotics were prescribed in most of the patients except few emergency surgical procedures. Third generation cephalosporin was used in surgeries that are clean, clean-contaminated, contaminated or dirty procedures as preoperative prophylaxis. Periodic assessment of antibiotic resistance patterns and the strategic dissemination of pertinent data are indispensable elements in addressing the rise of drug-resistant organisms. The colon contains a huge number of organisms, mainly anaerobes, Enterobacteriaceae and *Enterococci spp.* There is therefore a potential for infection if there is spillage of bowel contents during surgery. The duration of surgery also accelerates the wound susceptibility to microorganisms thereby increasing the exposure time and reduced antibiotics concentration in tissues. There is good evidence that single dose preoperative antibiotics, do reduce the incidence of wound infection, though there is still debate about the best regimes & re-administration recommended for prolonged surgeries[25,26]. Comparative review of pathogens isolated from SSI in from various studies is illustrated in (Table No.3). Microbiological analysis of SSI revealed a diverse range of pathogens, including 56.6% *E.coli, 15.1% Klebsiella pneumoniae, 11.3% Staphylococcus species, 5.7% Pseudomonas aeruginosa, 9.4% Acinetobacter species, 1.9% Enterobacter species.* Notably, *E. coli* was the most frequently isolated pathogen. 56.6%. The patients indigenous microbial flora to be blamed for the existence of enteric pathogens isolated from SSI or infection sites [13].

Table No.3: COMPARATIVE REVIEW OF PATHOGENS ISOLATED FROM SURGICAL SITE INFECTION .

VARIOUS STUDIES on SSI (Authors)	***Staphylococcus species***	***E.coli***	***Klebsiella pneumonae***	**Non-fermenters (*Acinetobacter spp & Pseudomonas spp)***
Victor Odhiambo Dinda et al [21]	46%	13%	9%	13%
Vikrant Negi et al [27]	50.4%	23.02%	2.9%	12.09%
Asif Zafar Malik & Qasim Ali[28]	37.5%	30.04%	1.8%	-
Vikas Mishra et al [14]	26.6%	6.6%	46.6%	20%
B Ramana et al [29]	23.2%	36.3%	6.06%	10.10%
Present Study	11.32%	56.6%	15.09%	15.09%

Antimicrobial sensitivity testing showed the most effective drugs against *Staphylococcus spp* were broad spectrum antibiotics like Tetracyclines, Tigecycline and Teicoplanin i.e, 100% sensitivity was recorded towards Gentamicin, Linezolid, Tigecycline & Teicoplanin. About 50% of the *Staphylococcus spp* isolated were MRSA and lowest sensitivity was observed towards Erythromycin & Amoxycillin- clavulanicacid i.e, 33.3%.This study had important clinical implication for our hospital decision making on antibiotic prescription towards Gram positive bacteria. The level of sensitivity was significantly low in Gram negative bacteria isolated in this study. Klebsiella spp isolated showed very low to nil sensitivity i.e,12.5% to 25% to most antibiotic classes. The Pseudomonas spp showed low sensitivity to 3rd & 4th generation Cephalosporins (33.3%) comparatively to Aminoglycosides, Fluroquinolones & Carbapenems (100%). Majority of Klebsiella spp (75%) & Acinetobacter spp. (60%) isolated in this study were MDR. E. coli showed (53.3% - 76.6%) sensitivity to Aminoglycosides & Carbapenems respectively. Several studies has observed decrease in sensitivity to wide class of routinely used antibiotics in gram negative bacteria. A larger issue on a worldwide is the emergence of antimicrobial resistance among bacteria, which is often attributed to the widespread prescription of antimicrobials, that creates strong selection pressure [13,30,31]. The limitation of the present study was that anaerobic culture on pus or wound swabs were not done, hence anaerobic pathogens responsible for SSI in abdominal surgeries couldnot be determined.

CONCLUSION

The prevalence of SSI in abdominal surgery was 1.58% in this study, This study provides a comprehensive insight into the microbiological profile of SSIs following abdominal surgeries and underscores the importance of understanding local antibiotic resistance patterns. Despite use of prophylactic antimicrobials and sterilizing surgical procedures, SSI remains a major clinical concern. Periodic assessment of the resistance patterns to the commonly used antibiotics is highly recommended. Inspection, documentation of infection actively & prospectively is an important tool for understanding the degree and distribution of nosocomial infections. Addressing the risk factors through strict infection control and personalized patient care is crucial for reducing SSIs and enhancing surgical outcomes. Implementing advancement of SSI prevention strategies ultimately increase patient safety in surgical settings. The antibiotic sensitivity patterns highlighted very low to nil sensitivity & varying degrees of resistance among the isolated microorganisms, emphasizing the need for targeted and judicious antibiotic therapy. Further research is warranted to explore strategies for infection prevention and control in this patient population. Healthcare system administrators and decision-makers play a pivotal role in prioritizing the actions such as ensuring infection control practices, the efficacy of antimicrobial stewardship programs , appropriate pre and post operative patient care which ultimately reduce the SSI burden and mitigate the impact of antibiotic resistance on patient care and healthcare costs.

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