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Surgical Site Infections – A Prospective Study in a Teaching Hospital of Semiurban Setup

KEYWORDS: Surgical Site Infections (SSIs), Postoperative Wound Infections, Antimicrobial Sensitivity, Staphylococcus aureus , Esch. coli.

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ABSTRACT *Background: Surgical site infection (SSI) or Surgical wound infection is a type of healthcare-associated infection in which a wound infection occurs after an invasive (surgical) procedure. Keeping in view the prevalence of the wound infections in our set up, this study was designed to evaluate the frequency, clinical presentation, different aerobic microorganisms which were involved in cases of clean and clean-contaminated, contaminated and dirty surgeries and their antimicrobial sensitivity pattern.*

Design and Duration: An observational prospective study from February 2014 to January 2016.

Setting: Surgical Units I, II and III of Gayatri Vidya Parishad Institute of Health Care and Medical Technology, Madhurawada, Visakhapatnam, Andhra Pradesh, India.

Patients: Nine hundred and thirty six patients who under-went clean and clean-contaminated, contaminated and dirty surgeries were included.

Methodology: The biodata of the patients, together with their clinical features, diagnosis, type of surgery which was performed and the development of any wound infections , the microorganisms isolated and their antimicrobial sensitivity pattern were noted . All the data was analyzed.

Results: Out of the 936 patients (544 males and 392 females) in the study, 674 belonged to the clean surgery group, 243 belonged to the clean-contaminated surgery group, 36 belonged to the contaminated surgery group and 21 belonged to the dirty surgery group. The overall incidence of surgical site infections (SSI) in this study was 7.59%; 32 (4.75%) cases in the clean surgical group, 21(8.64%) cases in the clean-contaminated group, 7(19.44%) cases in the contaminated group and 11(52.38) cases in the dirty group developed infections. The patients in the age group of more than 51-60 years were infected more than those in the younger age groups. The incidence of the wound infections was more in the male patients (11.63%) as compared to that in the female patients (7.65%). The common organisms involved in the SSIs were Staphylococcus aureus, Escherichia coli and Pseudomonas sps. Among Gram positive isolates, Linezolid was the most useful antimicrobial (96.30 to 100%) followed by Gentamicin and Amikacin. The least effective drug was Ciprofloxacin (0 to 44.44%) where as in Gram negative group, Gentamicin was the most effective antibiotic (91.67 to 100%) followed by Amikacin (77.78 to 100%) and the least effective was again ciprofloxacin (0 to 50%) .

Conclusion: Meticulous surgical techniques, the duration of the operation, proper sterilization, the judicious use of antibiotics, hygienic operation theatres and ward environments, the control of malnutrition and obesity and the treatment of infective foci and diseases like diabetes help in controlling the morbidity of the surgical wound infections.

INTRODUCTION

A wound is a breach in the skin and the exposure of subcutaneous tissue following loss of the skin integrity which provides a moist, warm and nutritive environment that is conductive to microbial colonization and proliferation[1]. Until the middle of the 19th century, when Ignaz Semmelweis and Joseph Lister became the pioneers of infection control by introducing anti-septic surgery, most of the wounds became infected. In cases of deep or extensive infections, this resulted in a mortality rate of 70-80% [2] . In 1992, the US Centers for Disease Control (CDC) revised its definition of 'wound infection', by creating the definition, 'surgical site infection' (SSI) [3], to prevent the confusion between the infection of a surgical incision and the infection of a traumatic wound. The CDC definition states that only the infections that occur within 30 days of a surgery (or within a year in the case of implants) should be classified as SSIs. The introduction of anti-septics has been considered to be an important milestone on the route to safe surgeries. The discovery of anti-microbial agents also enables us to perform surgeries in many conditions that were previously thought to be impossible in the pre-antibiotic era, due to the risk of infections [4] . The infection in a wound is a manifestation of the disturbed host-bacterial equilibrium that is in favour of the bacteria. This not only elicits a systemic septic response, but it also inhibits the multiple processes that are involved in the wound healing i.e. each of these processes is affected when the bacteria proliferate in a wound [5]. A 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 [6]. Four wound classes with an increasing risk of SSIs were described: clean, clean-contaminated, contaminated and dirty (Table-1). Surgical site infections (SSI) are important numerically and as a cause of morbidity and prolonged hospital stay. SSI accounts for 12.3% of hospital acquired infections [7]. A study shows surgical site infection rates in India to be between 4 to 30% [8]. The Center for Disease Control and Prevention guideline for the prevention of surgical site infection has recognized *Staphylococcus aureus, coagulase-negative Staphylococci, Enterococcus spp., Escherichia coli, P. aeruginosa,* and *Enterobacter spp.* as the most frequently isolated pathogens. Unfortunately, this view has been based on only two published reports that provided no indication of the inclusion of anaerobic bacteriology in the associated studies, and hence the data may have been biased in favour of aerobic and facultative microorganisms[9].

The control of surgical site infections has become more challenging due to widespread bacterial resistance to antibiotics very quickly and the knowledge of the causative agents and its antimicrobial sensitivity pattern of SSIs has therefore proved to be helpful in the selection of empiric antimicrobial therapy and on infection control measures in health care setups.

PATIENTS AND METHODS

This prospective study was carried out in the Surgical Units-I , II and III of Gayatri Vidya Parishad Institute of Health Care and Medical Technology, Madhurawada, Visakhapatnam, Andhra Pradesh, India from February 2014 to January 2016 on 936 cases that underwent clean, clean-contaminated, contaminated and dirty surgeries (Table -1) to (Table - 5).

Inclusion Criteria

1. Age >14 years.
2. Patients of either sex.
3. Patients who underwent clean and clean-contaminated surgeries electively and contaminated and dirty surgeries in an emergency. Prophylactic antibiotics were given for the groups of Class II , III and IV at the right time and duration.

Exclusion Criteria

1. Refusal to participate in the study.
2. Patients who were already receiving antibiotics for >1 week.
3. Patients undergoing re-operations.
4. Patients who were failing to come for a follow-up of up to 30days since the day of the operation.

The relevant information on all the patients was entered on a proforma which was especially designed for the study, which contained details on the biodata, clinical features, diagnosis, complications which included wound infections, the organisms which were isolated with their antibiograms.

Pus samples were collected under aseptic conditions with the help of 2 sterile disposable cotton swabs. One swab was used to make smear for detection of pus cells and microorganisms . Other swab was used to inoculate onto Blood agar and MacConkey agar media and incubated at 37°C for 24 hours. The same swab was subcultured in nutrient broth and subcultured again after 24 hrs. where no growths were observed. After incubation, identification of bacteria from positive cultures was performed using standard microbiological techniques which included Gram staining and biochemical reactions[10]. The antibiotic sensitivity test of all isolates was performed (according to CLSI guidelines) by modified Kirby Bauer's disc diffusion method on Mueller Hinton agar or Blood agar medium using antibiotic discs of Hi media Laboratories Pvt. Limited,, Mumbai, India[11].

RESULTS

The overall frequency of the surgical site infections was 7.59%; . The incidence amongst the clean surgical cases was 4.75% (32 out of 674) (Table - 2), among the clean-contaminated cases, it was 8.64% (21 out of 243) (Table - 3), among the contaminated cases, it was 19.44% (7 out of 36) (Table - 4) and among the dirty cases, it was 55.38% (11 out of 21) (Table - 5)

Out of a total of 544 male patients, 48(8.82%) had SSIs, whilst 23 (5.86%) out of 392 female patients had SSIs. Thus, it could be conferred that males were more prone to post-operative wound infections. Age of more than 60 years was found to be a risk factor for the Post-operative wound infections followed by 51-60 years as has been shown in (Table - 6).

The infective aerobic microbial flora was shown in (Table -7). The commonest organism was *Staphylococcus aureus* (32.93%) in Gram positive group followed by *Esch.coli* (29.27%) , Pseudomonas aeruginosa (14.63%) and Klebsiella Sps (10.98%) in Gram negative group .

Antimicrobial sensitivity pattern of bacterial isolates was shown in (Table - 8). Among Gram positive isolates, Linezolid was the most useful antimicrobial (96.30 to 100%) followed by Gentamicin and Amikacin. The least effective drug was Ciprofloxacin (0 to 44.44%) where as in Gram negative group, Gentamicin was the most effective antibiotic (91.67 to 100%) followed by Amikacin (77.78 to 100%) and the least effective was again ciprofloxacin (0 to 50%) in this group also.

DISCUSSION

Despite the advances in the operative techniques and a better understanding on the pathogenesis , etiology and invention of latest antimicrobials of the wound infections, SSIs continue to be a major source of morbidity and mortality for the patients who undergo operative procedures either electively or in emergency. Its rate varies in different countries, different areas and even in different hospitals within the same areas. Our overall incidence was 7.59%, whereas Ahmad M et al [12]. and Damani et al [13] described a 30% incidence of hospital-acquired infections .

Silom Jamulitrat et al[14] noted an overall infection rate of 6.5%. When categorized operation by traditional wound classification, infections occurred in 3.6% of the clean wounds, 8.4% of the clean-contaminated wounds, 11.8% of the contaminated wounds and in 31.0% of the dirty or the infected wounds,(Table -2 to 5) which was in accordance with our findings. Similar finding were observed in a study by Narasinga Rao Bandaru et al [15]. The post-operative wound infection rate in our study was 4.75% amongst the clean surgery cases, which was higher, as the usually reported rates varied from 1% to 4%, though most of the studies had documented a rate of less than 2% [16]. Our infection rate for the clean-contaminated cases was 8.64%. Different studies had shown a range of 5-30% in this class [17]. A study which was conducted at the Mayo Hospital, Lahore, report-

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ed an infection rate of 5.05% among the clean and a rate of 8.39% amongst the clean-contaminated cases [18].

The incidence of post operative infection was more common in males than in females. Out of a total of 544 male patients, 48(8.82%) had SSIs, whilst 23 (5.86%) out of 392 female patients had SSIs. Hence SSIs were more in in males than in females. A study carried out in three hospitals (Federal Medical Centre, Owerri, Imo State University Teaching Hospital, Orlu and General Hospital, Okigwe) by Ohalete et al also supported the result who reported that the males (59.3%) were more prone to wound infection than females (40.7%)[19].Similar findings were also noted in a study by Nitin GI et al [20]. Age of more than 60 years (12.07%) was found to be a risk factor for the Post-operative wound infections followed by 51-60 years(10.13%) (Table - 6). As age advances, the risk for SSIs will also increase. Similar findings were observed by Masood Ahmad et al [12] with 25% and 60%. Most commonly isolated organism was *Staphylococcus aureus* 27 (32.93%) followed by *Esch.coli* 24 (29.27 %) and *Pseudomonas species* 12 (14.63%). A similar study conducted by Nitin GI et al in accordance with our findings as *Staphylococcus aureus* was the most commonly isolated bacteria followed by Esch.coli [20]. In other studies by Aizza Zafar et al[22] also supported the findings.

Antimicrobial sensitivity pattern of bacterial isolates was shown in (Table - 8). Among Gram positive isolates, Linezolid was the most useful antimicrobial (96.30 to 100%) gentamicin and Amikacin. The least effective drug was Ciprofloxacin (0 to 44.44%) where as in Gram negative group, Gentamicin was the most effective antibiotic (91.67 to 100%) followed by Amikacin (77.78 to 100%) and the least effective was again ciprofloxacin (0 to 50%) in this group also. Similar findings were observed by Nitin GI et al 20, who reported that Linezolid was the most effective drug against Gram positive bacteria. A similar study conducted by Pappu et al [23], also in accordance with our findings and also by Meseret G et al in a Ethiopian Study [24].

CONCLUSION

In spite of the modern surgical and sterilization techniques and the use of prophylactic antibiotics, SSIs are still a real risk in surgeries and they represent a substantial burden of disease both for the patients and the healthcare services in terms of the morbidity, mortality and the economic costs. The changes in the definition have focused attention on the infection of the surgical incision, and the factors which have been associated with the SSIs are now being studied with a view to limiting the risk of the infection. The common correctable risk factors are malnutrition, obesity, the presence of infective foci, diabetes, hygienic conditions and the duration of the operation. These achievable preventive measures should be taken to save the economic burden on the patient, on the hospital and on the community as a whole. The improper and the prolonged use of antibiotics should be avoided, as this can lead to the development of resistant strains of micro-organisms, which can lead to nosocomial infections. This can be prevented by forming infection control committees and a drug policy. propylaxis had also a positive a positive impact after certain types of surgeries. Many other factors have been identified as having an effect on the potential for infection and healthcare professionals should consider these before, during and after surgeries. Thus, the incidence of post operative wound infection or SSIs should be minimized by taking into consideration the hygiene of the patient, the disinfection of the hospital environment including the wards and the operation theatres.

Table - 1: Classification of Surgical wounds based on degree of microbial contamination

Classification	Criteria
Class I/Clean	Elective, not emergency, non-traumatic, primarily closed; no acute inflammation; no break in technique; respiratory, gastrointestinal, biliary and genitourinary tracts not entered.
Class II/CleanNT-contaminated	Urgent or emergency case that is otherwise clean; elective opening of respiratory, gastrointestinal, biliary or genitourinary tract with minimal spillage (e.g. appendectomy) not encountering infected urine or bile; minor technique break.
Class III/ Contaminated	Non-purulent inflammation; gross spillage from gastrointestinal tract; entry into biliary or genitourinary tract in the presence of infected bile or urine; major break in technique; penetrating trauma <4 hours old; chronic open wounds to be grafted or covered.
Class IV/Dirty	Purulent inflammation (e.g. abscess); preoperative perforation of respiratory, gastrointestinal, biliary or genitourinary tract; penetrating trauma >4 hours old.

Table – 2 : Clean Surgeries performed

OPERATION	No.	Infected
Excision of Lipoma	87	3
Inguinal Hernia	165	8
Repair of other Hernias (Umbilical, Femoral, Congenital)	98	3
Hydrocele operations	167	11
Thyroidectomy	78	2
Excision of Breast lump	43	4
Fibroadenoma of Breast	36	1
Total	674	32 (4.75%)

Table – 3 : Clean contaminated Surgeries performed

Operation	No.	Infected
Cholecystectomies	68	4
Nephrectomies	2	1
Resection anastomosis of Intestines	36	3
Appendectomies	121	11
Gastrojejunostomy	10	2
Total	243	21 (8.64%)

Table – 4 : Contaminated Surgeries performed

Operation	No.	Infected
Duodenal Perforations	18	2
Gastric Perforation	7	1
Intestinal Perforations	9	3
Intestinal Gangrene	1	1
Total	36	7 (19.44%)

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Table - 5 : Dirty Surgeries performed

Operation	No.	Infected
Draining of Abscesses	8	4
Pyocoele	2	2
Intraabdominal abscess	4	1
Appendicular Abscess	5	3
Perinephric abscess	2	1
Total	21	11 (52.38%)

Table - 6 : Age Distribution & Surgical Site Infections

Age	Male	Female	Total	SSI	%
14 - 20 years	49	36	85	4	4.71
21- 30 years	130	84	214	17	7.94
31- 40 Years	126	78	204	14	6.86
41- 50 years	164	132	296	21	7.09
51- 60 years	41	38	79	8	10.13
>60 years	34	24	58	7	12.07
Total	544	392	936	71	7.59

Table - 7 : Etiological Organisms in the Surgical Site Infections

S.N0.	Gram Positive			Gram Negative		
	Organism	No.	%	Organism	No.	%
1	Staph.aureus	27	32.93	Esch.coli	24	29.27
2	S. pyogenes	3	4.88	Pseudomonas Sps.	12	14.63
3	Coagulase Negative Staph. (Cons)	3	4.88	Klebsiella Sps.	9	10.98
4	Enterococcus sps.	1	1.22	Enterobacter spp.	1	1.22
				Acinetobacter spp.	1	1.22
				Proteus Sps	1	1.22
Total		34	41.46		48	58.54

Table - 8: Antimicrobial Sensitivity Pattern of Bacterial Isolates of Surgical site infections

S.No.	Antimicrobial	Gram Positive (n=34)								Gram Negative (n=48)											
		S.aureus (27)		Coa.Neg. Staph. (Cons) (3)		S.pyogene (3)		Entero. Sps. (1)		Esch.coli (24)		Pseudomo. Sps. (12)		Klebsiella Sps. (9)		Enterobact. Sps.(1)		Acinetob. Sps.(1)		Proteus Sps.(1)	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
	Amikacin (30 mcg)	23	85.16	2	67.67	3	100.00	1	100.00	44	91.67	10	83.33	7	77.78	1	100.00	1	100.00	1	100.00
	Azithromycin (15 mcg)	15	55.56	1	33.33	1	33.33	0	0.00	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	Gentamycin (10 mcg)	24	88.89	3	100.00	3	100.00	1	100.00	45	98.75	11	91.67	8	88.89	1	100.00	1	100.00	1	100.00
	Lomefloxacin (10 mcg)	19	70.37	2	67.67	2	67.67	0	0.00	32	66.67	6	50.00	6	66.67	0	00.00	0	00.00	0	00.00
	Linezolid (30 mcg)	26	96.30	3	100.00	3	100.00	1	100.00	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	Ceftazidime (30 mcg)	15	55.56	1	33.33	1	33.33	0	0.00	21	43.75	3	25.00	4	44.44	0	00.00	0	00.00	0	00.00
	Cefoperazone (75 mcg)	14	51.85	1	33.33	2	67.67	0	0.00	31	64.58	7	58.33	4	44.44	0	00.00	0	00.00	0	00.00
	Cefotaxime (30 mcg)	16	59.26	2	67.67	2	67.67	1	100.00	38	79.16	8	66.67	7	77.78	1	100.00	1	100.00	1	100.00
	Ceftriaxone (30 mcg)	19	70.37	2	67.67	2	67.67	1	100.00	38	79.16	9	75.00	7	77.78	1	100.00	1	100.00	1	100.00
	Ciprofloxacin (5 mcg)	12	44.44	1	33.33	1	33.33	0	0.00	18	37.50	6	50.00	3	33.33	0	00.00	0	00.00	0	00.00
	Roxythromycin (15 mcg)	17	62.96	2	67.67	2	67.67	0	0.00	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT	NT
	Sparfloxacin (5 mcg)	19	70.37	2	67.67	2	67.67	0	0.00	24	50.00	6	50.00	4	44.44	1	100.00	1	100.00	0	00.00

NT = Not Tested, The content in the brackets of antimicrobial is the disc concentration

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