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KEY WORDS: Surgical site infections (SSI), Risk factors, Southampton wound scoring system.

A STUDY OF INCIDENCE OF SURGICAL SITE INFECTION AND ASSOCIATED RISK FACTORS AT A TERTIARY CARE HOSPITAL IN MUMBAI, INDIA.

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ABSTRACT

Objectives: To determine the incidence of Surgical Site Infections (SSI) and risk factors affecting SSI at a tertiary care hospital in Mumbai, India.

Methods: This study includes 1000 patients who underwent various surgeries and the risk factors were studied. Southampton wound scoring is used to identify SSIs and data collection. Swabs obtained from wounds were processed using standard microbiological methods.

Results: Overall SSI rate is 9.6% (96/1000). Age >50 years, low immunity, diabetes mellitus, emergency surgery, presence of drain, surgical wound class, longer duration of surgery are associated with increase in SSI rates. The most common organism isolated is S.aureus (22/96) followed by E.coli (20/96). A standard wound scoring system helps in identifying and surveillance of SSIs. It aids in data collection and feedback to surgeons who can take appropriate steps to reduce SSIs.

INTRODUCTION:

Surgical Site Infection (SSI) is a type of Hospital Acquired Infection (HAI) and refers to an infection that occurs after operation within 30 days if no implant is used or within one year if implant is used. According to National Nosocomial Infection Surveillance (NNIS) system and Centres for Disease Control and Prevention (CDC), SSI accounted for 14% to 16% of all nosocomial infections and was the most common health care associated infections among surgical patients in USA.[1] The incidence of SSIs has been estimated to be about 3% in the United States, although the incidence varies greatly from less than 5% for clean surgery to more than 20% for emergency colon surgery, which is often performed in a dirty field. Incidence of SSI may vary from hospital to hospital in different countries.[2]

Developed countries, such as USA, UK and Sweden have lower incidence of SSI ranging from 2% to 6.4 %.[3,4,5] In developing countries, such as India, Pakistan, Nepal, Turkey and Iran, the incidence of SSI is higher ranging from [5].5% to 25%.[6,7,8,9]

SSI can increase the length of time a patient stays in hospital and thereby increase the costs of health care. The main additional costs are related to re-operation, extra nursing care and interventions, and drug treatment costs. The indirect costs, due to loss of productivity, patient dissatisfaction and litigation, and reduced quality of life, have been studied less extensively.[10] To reduce the risk of SSI, a methodical but realistic approach must be applied with the awareness that characteristics of the patient, operation, personnel, and hospital influence this risk.[11]

The Southampton scoring system was designed for use in the postoperative assessment of hernia wounds. It is much simpler than other scoring system with wounds being categorized depending on any complications and their extent.[12]

AIMS AND OBJECTIVES:

1. To identify the incidence of surgical site infection in postoperative patients in our hospital during defined period using Southampton Wound Scoring System,
2. To identify the risk factors responsible for surgical site infection.
3. To identify microorganisms causing SSI in our hospital.

MATERIALS AND METHODS:

Type of study: Prospective Observational Study
Setting: General surgical units of J.J Hospital in Mumbai
Study period: January 2015 – October 2016
Sample size: 1000 patients

Ethics: Study was approved by the ethics committee before commencing.
Consent: Informed, valid, written consent is taken.

Inclusion criteria:

1. All patients admitted in general surgical ward or surgical ICU and had undergone surgical interventions in J.J Hospital from January 2015 to October 2016 were included in this study.
2. Males and females of age >14 years.

Exclusion criteria:

1. Infections occurring after laparoscopic surgery were excluded from our study.
2. Deep incisional surgical site infections.
3. Organ space surgical site infections.
4. Males and females of age <14 years

Procedure:

All units have followed the protocol of shaving before surgery. Preoperative antibiotic was given to all cases within half an hour of incision and postoperative antibiotics were given according to type of surgeries. Three days for clean and clean contaminated cases and five days for contaminated and dirty cases. First check dressing was done after two days of surgery in all units. Only superficial surgical site infections were included in our study. . In our study, infection is defined using Southampton Wound Scoring System. Wound infection which includes grade IV and V is considered as SSI in our study. Superficial surgical site infection includes infection occurs within 30 days after the operation, *and* infection involves only skin or subcutaneous tissue of the incisions, *and* at least *one* of the following:

1. Purulent drainage, with or without laboratory confirmation, from the superficial incision.
2. Organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision.
3. At least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat; *and* superficial incision is deliberately opened by surgeon, *unless* incision is culture negative.
4. Diagnosis of superficial incisional SSI by the surgeon or attending physician.

Following conditions were not included as SSI in our study:

1. Stitch abscess (minimal inflammation and discharge confined to the points of suture penetration).
2. Infection of an episiotomy or new-born circumcision site.
3. Infected burn wound.

4. Incisional SSI that extends into the facial and muscle layers (see deep incisional SSI).

In case major infection detected, wound swab or pus were collected for culture. Daily dressing was done according to standard aseptic practices. Patients were followed up till wound healed recording any additional treatment were given like antibiotics according to sensitivity or debridement of wound.

Low immunity criteria include seropositive status, patients on steroids and patients on chemotherapy. Data was collected on preformed proforma.

Statistical analysis:
The data was entered using MS-Excel and analysed. Descriptive analysis for numerical data consists of mean with standard deviation (SD) and for categorical data consists of frequencies & percentage for various parameters. Chi square test is used for comparison of proportions between two groups. The P value less than 0.05 were taken as statistically significant.

Table 1: Southampton wound grading system

Grade		Appearance
0		Normal healing
I		Normal healing with mild bruising or eryth ema
	Ia	Some bruising
	Ib	Considerable bruising
	Ic	Mild erythema
II		Erythema plus other signs of inflammation
	IIa	At one point
	IIb	Around sutures
	IIc	Along wound
	IId	Around wound
III		Clear or hemoserous discharge
	IIIa	At one point only (<2 cm)
	IIIb	Along wound (> 2 cm)
	IIIc	Large volume
	IIId	Prolonged (> 3 days)
Major complication		
IV		Pus
	IVa	At one point only (< 2 cm)
	IVb	Along wound (> 2 cm)
V		Deep or severe wound infection with or withouttissue breakdown; hemato ma requiring aspiration

RESULTS:
In our study, incidence of surgical site infection is found to be 9.6%. Incidence of SSI in group of age >50 years was more than younger age group [16.7% v/s 7.5%]. Incidence of SSI is more in female [10.9%] than male [8.7%] which is statistically insignificant.. Higher incidence of surgical site infection is found in patients suffering from diabetes mellitus [25.3%] and patients of low immunity group [43.4%]. Surgeries performed in emergency have higher incidence of SSI (17.6%) as compared to elective surgeries (7.2%). Depending upon type of wounds, highest incidence of SSI is seen in dirty cases (33.33%) and lowest in clean wounds (5.6%). Incidence of SSI is 26.7% in patients with drain and 3.5% in patients without drain. Multilayer closure of wound has higher incidence of infection than monolayer closure (11.3% v/s 4.2% respectively). Depending upon duration of surgery, 5 hours surgery had 57.1% infection rate, 4 hours duration had 35.3% infection rate, 3 hours surgery had 18.4% infection rate, 2 hours surgery had 12.5% infection rate while duration of 1hr had 3.7% infection rate. Clean surgeries had an infection rate of 5.6%, clean-contaminated surgeries had an infection rate of 10.9%, contaminated surgeries had an infection rate of 26.8% and dirty surgeries had an infection rate of 33.33%.

Table 2: Incidence of SSI among significant risk factors

RISK FACTORS	Incidence of SSI		
	Total	Infected cases	Incidence
AGE>50 years	227	38	16.7%
H/O DM	186	47	25.3%
H/O LOW IMMUNITY	53	23	43.4%
Emergency	227	40	17.6%
Drain	262	70	26.7%
Duration of surgery >4hrs	24	10	41.66%
Multilayer closure of wound	761	86	11.3%

Table 3: Risk factors and their significance

RISK FACTORS		INCIDENCE OF SSI		
		Infection	No infection	P value
Age	<50	58 [7.51%]	715 [92.49%]	<0.001(S)
	>50	38 [16.7%]	189 [83.3%]	
H/O DM	YES	47 [25.3%]	139 [74.7%]	<0.001(S)
	NO	49 [6%]	765 [94%]	
Low immunity	YES	30 [56.6%]	23 [43.4%]	<0.001(S)
	NO	73 [7.7%]	874 [92.3%]	
Nature of surgery	EMERGENCY	40 [17.6%]	187 [82.4.%]	<0.001(S)
	ELECTIVE	56 [7.2%]	717 [92.8%]	
Drain	YES	70 [26.7%]	192 [73.3%]	<0.001(S)
	NO	26 [3.5%]	712 [96.5%]	
Duration of surgery	1 HR	20 [3.7%]	516 [96.3%]	<0.001(S)
	2 HRS	32 [12.5%]	223 [87.5%]	
	3 HRS	34 [18.4%]	151 [81.6%]	
	4 &>4 HRS	10 [41.6%]	14 [58.4%]	
Type of wound	CLEAN	33 [5.6%]	560 [94.4%]	<0.001(S)
	CLEAN-CONTAMINATED	33 [10.9%]	270 [89.1%]	
	CONTAMINATED	19 [26.8%]	52 [73.2%]	
	DIRTY	11 [33.3%]	22 [66.7%]	
Type of closure	MONOLAYER	10 [4.2%]	229 [95.8%]	<0.001(S)
	MULTILAYER	86 [11.3%]	675 [88.7%]	

In infected cases, 43.8% shows no growth of any organisms. 22.90% shows S.aureus and 20.8% shows E.coli. Growth of K.pneumoniaea is seen in 4.2% cultures. Citrobactor, Enterobacter and Pseudomonas is seen in 2.1% of cases each. P.mirabilis and S.pneumoneaea are cultured in one case separately.

Table 4: Organisms associated with SSI

ORGANISM	FREQUENCY	PERCENTAGE
No Organism	42	43.8
S.aureus	22	22.9
E.coli	20	20.8
K.pneumoniae	4	4.2
P.aeruginosa	2	2.1
P.mirabilis	1	1
Citrobacter	2	2.1
Enterobacter species	2	2.1
S.pneumoniae	1	1

DISCUSSION:
The overall incidence of surgical wound infection in postoperative patients in J.J. Hospital using Southampton wound scoring system is 9.6% in our study [96 wound infections out of 1000 cases]. This figure is above the average SSI rate of 2.61% presented by National Nosocomial Infection Surveillance [NNIS] review in 200113. NNIS had mainly included incidence of SSI in developed countries and thus SSI was low. Being a developing country, incidence of SSI would be high in India as compared to NNIS review.

Comparing with other studies which were done in the past, overall

incidence varies considerably over a wide range. Incidence of SSIs was found to be 7.44% in a study conducted in 2013 in Dehradun by Kakati et al[14] and incidence of SSIs was found to be 16.16% in 2012 in Kolkata by Nandita et al[15]. One study conducted in tertiary care hospital of Gujarat in 2012 showed the incidence of 16%16. While in 2011, a study showed incidence of around 13.7%[17]. From January 2005 to December 2011, the International Nosocomial Infection Control Consortium (INICC) conducted a cohort prospective surveillance study on surgical site infections in 10 hospitals in 6 Indian cities. An incidence of 4.2% was documented in this study[18]. In 2010, 6 studies showed incidence between 9-23%[19,20,21]. The overall SSI incidence was 18.92% in 2008 study6. In 2000, SSI was 38.8% by Ganguly et al[22]. All studies are comparable with our study.

In developing countries like Nepal, Thailand, Peru, Brazil, Tanzania, Vietnam and Pakistan, various studies have been done to identify incidence of surgical site infection. Incidence of surgical site infection in developing countries ranges from minimum 3.3% in Brazil[24] to maximum of 26.7% in Peru[23]. The infection rate in Indian hospitals is much higher than that in other countries; for instance in the USA, it is 2.8% and it is 2-5% in European countries[25].

Our study confirms that there is a gradual rise in incidence of wound infection as age advances. The incidence showed a rise from 7.51% in below 50 age group to 16.7% in patients above 50 years. Likewise Cruse and Foord observed in their study that older patients are more likely to develop infection in Clean wounds than younger patient[26]. Study done by Patel et al in Gujarat in tertiary care hospital in 2012 showed highest incidence of infection in age group >55 years which was 36.4% [8 out of 22] [16]. The high incidence of 16.75% infection in patients above 50 years, in our study is perhaps due to decreased immunocompetence and increased chances of co-morbid factors like diabetes mellitus, hypertension, chronic ailments like asthma, arthritis, conditions requiring steroid therapy and personal habits like smoking and alcoholism.

In our study female patients have a higher rate of infection than male patients [10.9% in female compared to 8.7% in male]. However, this difference is not found to be statistically significant. Several studies have shown higher incidence in males compared to females. Higher incidence in male may be due to some other confounding factors like smoking, obesity and tobacco chewing which needs to be ruled out by further studies.

History of diabetes confers a higher risk of SSI. Out of 186 diabetic patients, 47 developed surgical site infection in our study. Incidence of surgical site infection in diabetic patients is found to be 25.3% compared to non-diabetic patients where the incidence is 6.0%. In our study, diabetes has been found to be statistically significant risk factor for SSI, specially uncontrolled sugar level in perioperative period. Undiagnosed diabetes and postoperative hyperglycemia more specifically within 48 hours of surgery have been associated with increased SSI risk [27,28,29]. National Academy of Science30 reported higher rate of infection in patients with Diabetes mellitus which is similar to our study.

In our study, low immunity group includes patients suffering from HIV infections, patients on immunosuppressive treatment like steroids, patients on chemotherapy and patients taking antituberculous treatment. Low immunity is associated with impaired wound healing and increases the risk of wound infection. 43.3% of the patients of this group [23 out of 53 cases] are found to be infected in our study which is statistically significant. Low immunity makes the patient more susceptible to nosocomial infection as it was explained by Luksamijarulkul et al[31].

Surgeries which are performed in emergency have more infection rates as compared to elective surgeries [17.6% v/s 7.2%]. Several other studies also corroborate the evidence that emergency surgeries are more prone to wound infections[32,33,34]. More frequency of contaminated or dirty wounds was seen in emergency surgeries which lead to higher incidence of SSI in this group25. The high rates of infection in emergency surgeries can be attributed to inadequate pre-operative preparation, the underlying conditions which predisposed to the emergency surgery like uncontrolled diabetes or other medical comorbidities.
Use of drains has long been thought to provide a portal of entry for microorganisms and increase the rate of SSIs. Incidence of surgical site infection in patients with drain is found to be 26.7% as compare to 3.5% of patient without drains. This difference statistically significant. Drains are generally used in contaminated and dirty wound surgeries in which the rate of infection is already high therefore, the presence of this confounding factor needs further evaluation. Difference in incidence of infection between closed suction drains and open suction drain also needs further evaluation. Delay in drain removal may also be related to increase SSIs due to the increase of bacterial colonization36. Open surgical drains lasting more than three days have been identified for increasing chances of infections[22,32,35].

The incidence rate of surgical site infections in our study as per the wound class is described below comparing with Cruise and Foord Assessment26 in 1980.

Table 5: Incidence of SSI according to type of wound

Type of Wound	J.J. H Study	Cruise and Foord
Clean	5.6%	1-2%
Clean contaminated	10.9%	6-9%
Contaminated	26.8%	13-20%
Dirty	33.33%	40%

A cross sectional study of 2012 in USA observed that the clean, clean-contaminated, contaminated, and dirty wound classifications had superficial SSI rates of 1.76%, 3.94%, 4.75%, and 5.16%, respectively[37]. In 2012, a study done in a tertiary care hospital in Gujarat showed incidence of 40.9% in dirty wounds16. Satyanarayana V et al have done a study in 2011 in India showing incidence of 56.7% in dirty wounds[17].

It has been demonstrated in number of previous studies that the risk of SSI increases with increase in duration of surgery [19,38,39]. Factors which are responsible include prolonged exposure of patient to environment, increased blood loss, prolonged hypothermia and declining levels of antibiotics etc. Longer the duration of surgery, greater is the fatigue in the surgical team which will lead to breaks in sterile technique. Incidence of SSI is 3.7%, 12.5%, 18.4%, 41.6% in surgeries performed in one, two, three, four or more hours respectively. Longer duration of surgery is a significant risk factor for SSI in our study.

Surgeries where multilayer closure is done shows higher infection rate which is 11.3% as compared to monolayer closure where infection rate is 4.2%. Multilayer closure uses more suture materials and is associated with more handling of tissues which can results in increased infection rate. Monolayer closure is time saving as compared to multilayer closure but closure is more anatomical using multilayer technique. It requires further research to confirm relation between infection and multilayer or monolayer closure.

In our study, about half of infected cases showed no growth. [22] cases showed growth of Staph. aureus mostly in clean surgeries [22.90%]. [20] cases showed growth of E.coli [20.8%]. NNIS report has shown infection by Staph. aureus in 34% cases and by E.coli in 8% cases in 1990-96. Comparing with NNIS, in our study, infection by Staph. aureus is less and infection by E.coli is more. Other organisms like Klebsiella, Proteus, Pseudomonas, Enterococci, Streptococci and Citrobactor are also seen in some cases in our study. Studies from developing countries show that Gram-negative organisms are more common, especially P. aeruginosa, Klebsiella spp, E coli.[40,41]

In most cases of SSI the organism is usually patient's endogenous flora. In abdominal surgeries the opening of the gastrointestinal tract increases the likelihood of coliforms, gram negative bacilli which was our finding in this study. This group of organisms tend

to be endemic in hospital environment by being easily transferred from object to object, they also tend to be resistant to common antiseptics and are difficult to eradicate in the long term. This group of organisms is increasingly playing a greater role in the many hospital acquired infections.

CONCLUSIONS:

Based on our study, we came to the following conclusions:

- Patient related risk factors responsible for higher surgical site infection were age > 50 years, history of diabetes mellitus and low immunity.
- Higher incidence of SSI is seen in male sex in our study but it is not statistically significant.
- Surgeries which were performed in emergency were having higher incidence of surgical site infection.
- Use of drain increases the risk of surgical site infection.
- Dirty wounds still have high rate of infections and there is need for active work on methods to decrease the risk in these surgeries .
- Increase in duration of surgery was also risk factor for development of surgical site infection.
- Surgeries where multilayer closure was done showed higher infection rate but further studies are needed.
- Microorganisms causing surgical site infection were mainly S.aureus, E.coli and Klebsiella. About half of surgical site infection showed no organisms.

RECOMMENDATIONS:

Areas where we need to improve in order to reduce risk of SSI are:

- Setting up of hospital infection control committee with its members.
- Antibiotic policy and strict adherence to it.
- Regular surveillance and feedback of results to surgeons and following strict surgical auditing.
- Reducing the pre-operative stay to minimum.
- Ensuring that the patient is as fit medically as possible especially in elective cases.
- Using a good surgical technique.
- Reconsidering the use of open drainage system especially for intra-abdominal surgeries.
- Proper collection and transport of samples from the surgical site, immediately on suspicion of infection.
- Environment of Operation Room, especially in emergency surgeries leaves much to be described. Strict Operation Room regulation practices are essential.
- Prolonged post-operative antibiotic use should be curtailed as it can cause emergence of resistant organisms.
- Finally, a uniform hospital protocol for antibiotic administration and Operation Room regulation is essential.

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