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A STUDY OF RISK FACTORS AND INCIDENCE OF SURGICAL SITE INFECTIONS IN A TERTIARY CARE HOSPITAL

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ABSTRACT

Background*: Surgical site infections (SSIs) are a major cause of postoperative morbidity and prolonged hospital stay. Identification of risk factors is essential for prevention. Aim: To determine the incidence and risk factors associated with surgical site infections in a tertiary care hospital. Methods: A prospective observational study was conducted among postoperative patients undergoing clean and clean-contaminated surgeries. Clinical data, demographic profile, and risk factors were analyzed. Results: The incidence of SSI was found to be 1.9%. Significant risk factors included prolonged duration of surgery, diabetes, anemia, and extended hospital stay.* ***Conclusion****: SSI remains a significant healthcare burden. Identification of modifiable risk factors can help in reducing infection rates.*

KEYWORDS: *Surgical Site Infection, Risk Factors, Postoperative Infection*

INTRODUCTION

Surgical site infection (SSI) is a common, generic post-operative event that causes considerable morbidity but seldom leads to death. Surveillance of SSI is an important infection control activity [1]. It is defined as an infection occurring within 30 days after a surgical procedure and affecting either the incision or deep tissues at the operation site. These infections may be superficial or deep or involving an organ space.[2] A survey sponsored by the World Health Organization demonstrated a prevalence of nosocomial infections in the range of 3-21%, with wound infections accounting for 5-34% of the total [3]. Infection cause delayed recovery and may leave permanent disability. So it is important to know the incidence of surgical site infection in the hospital. There are so many advances that have been made to control infection including improved sterilization methods, surgical technique, and antimicrobial prophylaxis. Still, SSI remains the cause of morbidity, long hospital stays, and death. There are many strategies to reduce SSI risk. Effective surveillance methods, stratification of SSI rates according to risk factors associated with SSI development, make the importance of knowing the burden of SSI, and do needful for the treatment of the patients [4,5]. Healthcare-associated infections (HAI) are recognized as a major cause of morbidity & mortality worldwide nowadays on a large scale. So if we want to provide a safer environment for its patients, every healthcare facility must adopt an infection control program[6,7]. Any infection developing in a patient after 48 hours of hospitalization can be labeled as a Healthcare-associated infection (HAI). Four major types of HAI commonly come across[6] :

1) Catheter-associated urinary tract infection (CAUTI)
2) Catheter-related bloodstream infection (CRBSI)
3) Ventilator-associated pneumonia (VAP)
4) Surgical site infection (SSI)

Surgical site infection refers to an infection that develops at an incision site after a surgical procedure. If left untreated can cause significant morbidity & mortality WHO report in 2011 mentioned that ,in developed countries on an average at any given time 7% of patients and 10% in developing countries acquire atleast one HAI[8,9].

AIMS &OBJECTIVES

- To find the incidence of postoperative surgical wound infections in clean and clean-contaminated surgeries in orthopaedic, surgery and obstetrics-gynaecology wards.
- Risk factors associated with surgical site infection.

MATERIAL & METHODS

This is an observational study titled as **"A Study Of Risk Factors and Incidence of Surgical Site Infections in a Tertiary Care Hospital"**

This study was conducted in the department of Microbiology. Samples were collected from the patients admitted in Obstetrics & Gynaecology, Surgery, and orthopedic wards who have undergone any clean & clean-contaminated surgery and developed any signs of infection around the surgical wound within 30 days of surgery.

A surgical wound was observed for 30 days after surgery, and it was considered as infected if any one of the following criteria was fulfilled post-operatively:

a) Fever

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b) signs of inflammation (edema, redness, localized swelling, a local rise of temperature, tenderness, induration at the site of surgery)
c) purulent discharge from the wound

A detailed history, underlying associated disease, and the results of all examinations and Laboratory investigations were recorded for each patient.

STUDY DURATION: 12 to 18 months

INCLUSION CRITERIA

All the confirmed cases as per the definition of SSI Clean surgeries (Class I operative wounds) and clean-contaminated surgeries (Class II operative wounds) were included in this study and also those who gave consent for the study were included.

EXCLUSION CRITERIA

Those Contaminated surgeries (Class III operative wounds) and dirty surgeries (Class IV operative wounds) were excluded and Stitch abscess, Episiotomy, circumcision wounds and those infections occur 30days after the surgery were also excluded.

SAMPLE COLLECTION FOR ISOLATION OF ORGANISM

Post surgery, the wound site was regularly observed for any signs of inflammation as mentioned above, any wound discharge or wound gaping, and whenever it was observed mentioned as the date of event (DOE). At that time sample was collected from the wound site and the Postoperative day (POD) when it was collected were recorded for each patient. Each patient was followed up to 30 days after surgery. We had also collected the samples from those patients who were discharged from the hospital without any symptoms but again admitted with any signs of inflammation, fever, or wound discharge within 30 days after surgery.

After taking all aseptic precautions the wound swab was collected from the edge of the surgical site and two swabs were collected at a time and loaded with the exudate to be sampled. The swabs which were used consist of cotton wool mounted on a stick. The swab sticks were moistened first with a little saline and then the sample is collected.

After that, both the swab sticks were put together in a single sterile glass container and immediately transported to the laboratory.
One of the swabs was used for Gram staining & another one was used for culture. On Gram staining, pus cells as well as any organisms were observed in the oil immersion field. Then for the culture of the swabs 5% sheep Blood agar and Mac-Conkey agar were used. Further, the swab was also passed into the Nutrient broth.

Culture

All plates were incubated overnight in a 5% carbon dioxide incubator at 37°C.Next day plates were observed for any growth. If no growth was detected on any plate the incubation was extended for another 24 hours. Colonies were picked up after 24 hours and Gram staining, biochemical tests for identification of bacteria were done.



Fig:1(a) Growth of beta haemolytic golden yellow colonies on blood agar media after 24 hours of incubation.

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Fig:1(b) Growth of lactose fermenting mucoid colonies of Klebsiella pneumonae on MacConkey's agar after 24 hours of incubation.

RESULTS & OBSERVATIONS

Total 5948 surgeries were conducted during the period of data collection. Among them 950 patients had post-operative complications like discharge, wound gap, inflammation of wound etc. Those 950 subjects were selected as study subjects in current study.

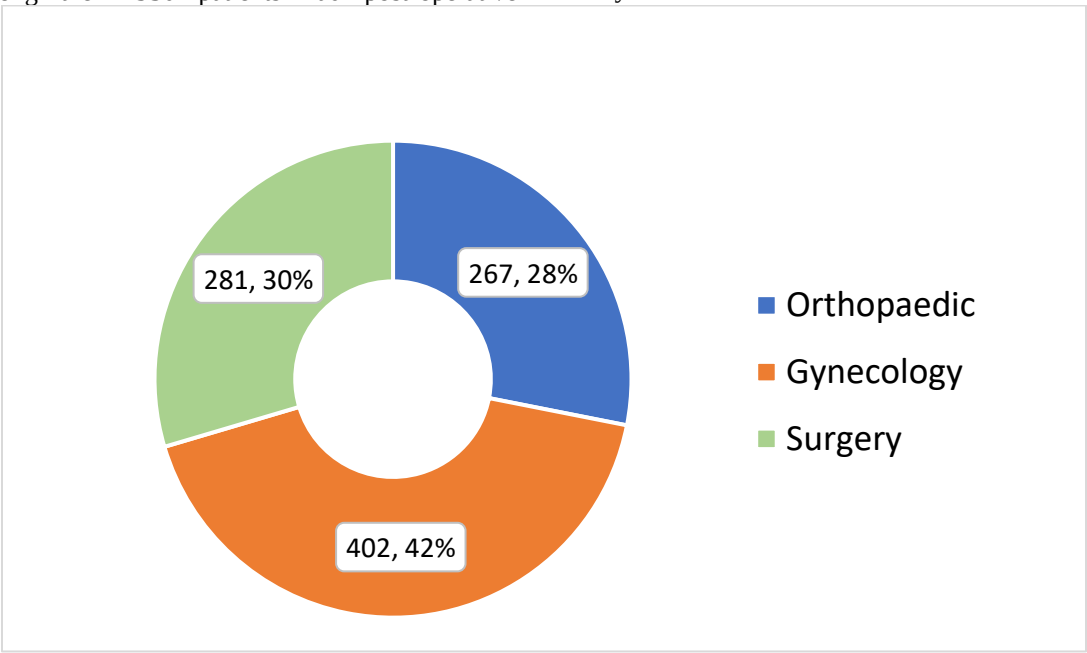


Figure 2: Distribution of Sample collection according to Ward [n = 950]

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Table 1: Distribution of Study Participants According to the Type of Surgery (n= 950)

Type of operation	Number	Percentage
Abdominal tubectomy	74	7.8
Appendicectomy	33	3.5
Emergency Caesarean section (LSCS)	119	12.6
Exploratory laparotomy	137	14.4
Hernioplasty	56	5.9
Implant removal	63	6.6
Caesarean section (LSCS)	103	10.8
Lumpectomy	36	3.8
Modified Radical Mastectomy	27	2.8
Open reduction & internal fixation	191	20.1
Total abdominal hysterectomy	72	7.6
Others	39	4.1
Total	950	100.0

* Others include Tuboplasty (1), Open cholecystectomy (1), Pyelolithotomy (2), Hemicolectomy (1), Spinal Decompression & stabilization (2), Excision of mass (3), Cystectomy (3), Nephrectomy (3), Herniorrhaphy (4), Cystolithotomy (8), Hemiarthroplasty (11)

- The patients who developed the signs & symptoms post-surgery most of them underwent open reduction and internal fixation (20.1%) followed by exploratory laparotomy (14.4%), emergency LSCS (12.5%), LSCS (10.8%), abdominal tubectomy (7.8%) and total abdominal hysterectomy (7.6%).

Table 2: Distribution of Study Participants According to Various Risk Factors [n= 950] *

Risk Factor	Number	Percentage
Diabetes Mellitus	43	4.5
Anaemia	49	5.2
Gestational Diabetes Mellitus	3	0.3
Hypertension	53	5.3
Blood transfusion	11	1.2
Long OT hours	8	0.8
Emergency Surgery	121	12.7
Hypothyroidism	25	2.6
Prolonged labour	4	0.4
Pregnancy induced hypertension [PIH]	17	1.7
Premature rupture of the membrane [PROM]	11	1.2
Sickle cell anaemia	6	0.6
Thrombocytopenia	2	0.2
Dengue fever	1	0.1
Hepatitis B infection	1	0.1

*Multiple response

- The prevalence of various risk factors like Hypertension was seen in 5.3% cases, Anemia was present in 5.2% cases and Diabetes Mellitus was present in 4.9% cases & history of Hypothyroidism was present in 2.6% cases. The proportion of PIH and PROM was 1.7% and 1.2% respectively.
- In one-eighth (12.7%) of cases surgeries were conducted in emergency.

Table 3: Distribution of Study Subjects According to the signs they developed Post-operatively [n= 950]

Name of the complaint	Number	Percentage
Inflammation	874	92.0
Wound discharge	50	5.3
Wound gap	24	2.5
Fever, inflammation	2	0.2
Total	950	100

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- The majority had developed signs of inflammation [92.0%] post-operatively, followed by wound discharge [5.3%] and wound gap [2.5%] respectively.

Table 4: Distribution of Study Participants According to Pre-operative Days stay [n =950]

Pre-Operative days	Number	Percentage	Descriptive Statistics
≤ 5	663	69.8	**Pre-operative days**
6-10	212	22.3	Mean (SD) = 4.3 (3.9)
11-15	59	6.2	Median (IQR)= 3 (1, 6)
16-20	15	1.6	Range = 0 to 21
> 20	1	0.1	
Total	950	100.0	

- Majority (69.8%) stayed ≤ 5 days pre-operative period. However some of them (7.9%) had longer (> 10 days) pre-operative period. Pre-operative stay ranged from 0 to 21 days with Mean (SD) of 4.3 (3.9) days and Median (IQR) of 3 (1, 6) days.

Table 5: Distribution of Study Participants According to Surgical Site Infection Rate (n= 5948)

Surgical Site Infection	Number	Percentage
Present	112	1.9
Absent	5836	98.1
Total	5948	100

Table 5 showed that, total 5948 surgeries were done during period of data collection and surgical site infection rate was nearly 2% among all Post-operative cases.

Table 6: Gram staining correlation with culture results [n=950]

Gram Stain Morphology	Culture Results		Total
Pus cell	**Growth positive Number (%)**	**No bacterial growth Number(%)**	**Number(%)**
Seen	96 (10.1%)	14 (1.5%)	110(11.6%)
Not seen	16 (1.7%)	824 (86.7%)	840 (88.4%)
Total	112 (11.8%)	838 (88.2%)	950 (100%)
Bacteria	**Growth positive Number (%)**	**No bacterial growth Number (%)**	**Number(%)**
Seen	108 (11.4%)	5(0.5%)	113 (11.9%)
Not seen	4 (0.4%)	833(87.7%)	837 (88.1%)
Total	112 (11.8%)	838 (88.2%)	950 (100%)

- Out of 950 swabs collected, pus cells were observed in 10.1% cases with bacterial growth and among them 14 cases where bacterial growth was not observed. Pus cells were not observed only in 1.7% cases with bacterial growth.
- Out of 950 swabs collected, On Gram staining along with pus cells bacteria were observed in 11.4% cases with growth positivity. Only 0.5% cases growth was absent though organism was observed on Gram staining.

Table 7: Univariate and Bivariate Logistic Regression Analysis Showing the Association of SSI with Different Variables [N= 950] ¥

Variable name	SSI		OR (CI)	P value
	Present Number (%)	**Absent Number (%)**		
Age ↑ Median (IQR)	31 (25, 50)	36 (26, 51)	0.99 (0.98 – 1.01)	0.75
POD ↑ Median (IQR)	10 (7, 12)	7 (7, 10)	1.40 (1.30 – 1.43)	<0.001
Pre-operative stay↑ Median (IQR)	3.5 (1, 8)	3 (1, 6)	1.07 (1.02 – 1.12)	0.003
Total hospital stay↑	25 (20, 30)	12 (10, 20)	1.21 (1.17 – 1.25)	<0.001

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Median (IQR)					
Gender	Male	14 (4.8%)	279 (95.2%)	1	<0.001
	Female	98 (14.9 %)	559 (85.1%)	3.50 (1.96 – 6.23)	
Ward	Ortho	2 (0.7%)	265 (99.3%)	1	
	Gynae	73(18.2%)	329 (81.8%)	29.4 (7.1 – 120.9)	<0.001
	Surgery	37(13.2%)	244 (86.8%)	20.1 (4.8 – 84.25)	<0.001
Anaemia	Present	24 (49.0%)	25 (51.0%)	8.8 (4.8 – 16.2)	<0.001
	Absent	88 (9.8%)	813 (90.2%)	1	
Hypertension	Present	15 (28.3%)	38 (71.7%)	3.3 (1.7 -6.1)	< 0.001
	Absent	97 (10.8%)	800 (89.2%)	1	
Emergency surgery	Present	44 (36.4%)	77 (63.6%)	6.4 (4.10- 9.99)	<0.001
	Absent	68 (8.2%)	761 (91.8%)	1	
Hypothyroidism	Present	13 (52.0%)	12 (48.0%)	9.0 (4.01 – 20.4)	<0.001
	Absent	99 (10.7%)	826 (89.3%)	1	
Pregnancy induced Hypertension	Present	13 (81.2%)	3 (18.8%)	36.6 (10.2 – 130.5)	<0.001
	Absent	99 (10.6%)	835 (89.4%)	1	
Diabetes Mellitus	Present	21 (48.8%)	22 (51.2%)	8.6 (4.5 – 16.2)	<0.001
	Absent	91 (10.0 %)	816 (90.0%)	1	
PROM	Present	11 (100.0)	0	*	<0.001
	Absent	101 (10.8%)	838 (89.2%)		
Blood transfusion	Present	11 (100.0%)	0	*	<0.001
	Absent	101 (10.8%)	838(89.2%)		
Long OT Hours	Present	8 (100.0%)	0	*	<0.001
	Absent	104 (11.0%)	838 (89.0%)		
Total		112 (11.8%)	838 (88.2%)		

¥ Continuous data was presented as Median (IQR). Categorical data was presented as Number (%). PIH- Pregnancy Induced Hypertension. PROM- Premature Rupture of Membrane, POD- Post Operative Days

* Odds Ratio could not be calculated because all cases who had this risk factor also had surgical site infection.

- The SSI was significantly associated with gender and ward of admission. The odds of having SSI among females was 3.5 times higher than the males and the difference was statistically significant (P value <0.001). But the SSI was not significantly associated with age (OR 0.99, P value 0.75).
- The odds of having SSI in Gyneacology Ward and Surgery ward was 29.4 times and 20.1 times higher than orthopedics ward and the difference was statistically significant (P value <0.001).
- The SSI was also significantly associated with Diabetes Mellitus (OR 8.6, P value <0.001), Anemia (OR: 8.8, P value <0.001), Hypertension (OR 3.3, P value <0.001), Hypothyroidism (OR 9.0, P value <0.001), History of emergency surgery (OR 6.4, P value <0.001), History of PIH (OR 36.6, P value <0.001) and increasing hospital stay (OR 1.2, P value <0.001) , pre-operative stay (OR 1.1, P value <0.003). As there was strong correlation between Total Hospital Stay and Preoperative Stay (Spearman's Rho 0.608) only Total Hospital Stay was considered for final model. These ten variables are considered for final multivariable model.
- The SSI was significantly associated with blood transfusion, long OT hours and PROM (P value <0.001) but the odds ratio could not be calculated because all the cases had SSI leaving no one in the group who had the risk factor but not having SSI. Thus these variables are not included in final model.

Table 8: Multivariable Logistic Regression Analysis Showing Association between SSI and Different Variables [n = 950]

Variable		OR (CI)	P value	AOR [CI]	P value
Gender	Male	1	0.001	1	0.045
	Female	3.5 (1.96 – 6.23)		2.5 (1.1-6.4)	
Ward	Ortho	1	0.001	1	
	Gynae	29.4 (7.1 – 120.9)		12.9 (2.7-61.5)	0.001
	Surgery	20.1 (4.8 – 84.25)		8.5 (1.9- 38.4)	0.006
POD ↑		1.4 (1.3-1.4)	<0.001	0.8 (0.7- 0.9)	<0.001
Total hospital stay↑		1.2 (1.2 – 1.3)	<0.001	1.3 (1.2 – 1.4)	<0.001

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Diabetes Mellitus	Present	8.6 (4.5 – 16.2)	0.001	7.2 (2.7 -19.2)	< 0.001
	Absent	1		1	
Anaemia	Present	8.8 (4.8 – 16.2)	0.001	8.5 (3.0-23.4)	< 0.001
	Absent	1		1	
Hypertension	Present	3.3 (1.7 -6.1)	< 0.001	0.5 (0.1- 1.4)	0.156
	Absent	1		1	
Emergency surgery	Present	6.4 (4.1-9.99)	<0.001	1.5 (0.67-3.2)	0.341
	Absent	1		1	
Hypothyroidism	Present	9.0 (4.01- 20.4)	<0.001	12.2 (4.0-37.0)	< 0.001
	Absent	1		1	
Pregnancy induced Hypertension	Present	54.9 (12.2- 246.8)	<0.001	52.6 (9.6- 288.5)	< 0.001
	Absent	1		1	

- Model fitting data: Cox & Snell R^2- 0.306, Nagelkerke R^2- 0.593, Hosmer and Lemeshow test: P value =0.094, Omnibus test P value < 0.001.
- Increased hospital stay (AOR 1.3, P value <0.001) remained as a significant predictor of SSI and with increase in each days of hospital stay a 30% higher odds of SSI was noted which was statistically significant.
- History of emergency surgery lost its significance in multivariable model (AOR 1.5, P value 0.341). The odds ratio of Diabetes (AOR 7.2, P value < 0.001), Anemia (AOR 8.5, P value < 0.001) and PIH (AOR 52.6 P value < 0.001) were flattened but maintained their significance after adjustment. For hypothyroidism, the odds ratio was augmented after adjustment but retained its significance (AOR 12.2, P value < 0.001). Odds Ratio of Hypertension was diminished and lost its significance (AOR 0.5, P value 0.156) after adjustment in this model. Model fitting was good as Hosmer and Lemeshow test was insignificant (P value = 0.094) and Omnibus test was significant (P value <0.001) and 30.6 % to 59.3 % variability of dependent variable was explained by this model as per Cox and Snell and Nagelkerke R^2 respectively.

DISCUSSION

- This study was planned to find out the incidence of Surgical site infection in our rural tertiary care hospital in central India. Before any surgical procedures, it is better to know about the risk factors and the most common organisms which are prevalent to cause surgical site infection, so that we can take pre-operative as well as post-operative measures accordingly to reduce the incidence of SSI. Also for the last few years, the increasing pattern of resistance among the isolates has become a great concern, to prevent this it is essential to stringent use of antibiotics in the hospital. The primary objective of our study was to know the incidence of postoperative surgical wound infections in clean and clean-contaminated surgeries in orthopedic, surgery, and obstetrics-gynecology wards.
- A total of 950 patients with symptoms of SSI was included in this study, among the total of 112 patients were found culture positive SSI in this period.
- In this study, a total of 5948 surgeries were done during this period and we had found that the overall SSI rate was 1.9 %. The incidence in our study is on par with the findings of chada et al who reported 3.83% as the incidence of SSI in their study[11]. The rate of SSI varies from 2.5% to 41.9% as per different studies[10].
- Similar results were seen in a study conducted by Ashish Pathak et al where they have found an SSI rate of 5%[11].
- In contrast to our study, a relatively higher SSI rate (32%) was found in a study conducted by Aniruddha S et al[12]. This higher SSI rate may be attributable to the inclusion of contaminated and dirty wounds types and also emergency surgeries in their studies. The study conducted by Akhter et al showed an SSI rate of 11%[13].

This difference in the SSI rate was observed because of different types of surgical wounds including the clean, clean-contaminated, contaminated & dirty wounds.

- The overall incidence rates of SSIs in most hospitals in the developed nations tend to have much lower rates when compared with hospitals in developing countries.
- Reasons for the higher SSI rates in Indian hospitals could be due to several factors, including the poor set-up of hospitals (lack of equipment and materials necessary to maintain strict guidelines for asepsis), poor hygiene of patients increasing colonization of the skin by bacterial flora, late presentation of patients to healthcare system leading to contaminated wounds, overwhelmed emergency services due to population burden, and prevalent use of open drainage system in intra-abdominal surgeries.

RISK FACTORS

It is important to understand the risk factors which are associated with SSI. Some major risk factors like Diabetes mellitus, Hypertension, duration of pre and post-operative stay in the hospital, anemia, co-existence of any infection, and most importantly the physical status of the patient at the time of surgery. Any of these present at the time of surgery can contribute to causing infection post-surgery. In our study, we have tried to find out such risk factors and this will help to control the infection in such cases in the future by implementing special infection control measures.

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The length of hospital stay was found to be a significant risk factor (AOR 1.3,p < 0.001) for SSI, and with an increase in each day of hospital stay a 30% higher odds of SSI was noted which was statistically significant. This finding is similar to the results obtained by Akhter et al where they have also documented total length of hospital stay as a significant risk factor for SSI[13].

This can be attributable to the result of a prolonged stay providing further opportunity for bacterial colonization with organisms that may be resistant to routine antimicrobial drugs.

Another major risk factor that was found to be associated with a high incidence of SSI was Diabetes mellitus. The history of DM was found to be a significant risk factor (AOR 7.2,p <0.001) for developing SSI. This result is in concordance with the results obtained by Akhter et al[13].

A history of Anemia in patients conferred a significantly higher rate of SSIs (AOR 8.5,p<0.001). This is in concordance with the study conducted by Valecha SM et al where they had documented anemia (23.68 %) as one of the common risk factors for developing SSI[14].
Devjani et al found 53.3% of patients with prolonged duration of surgery exceeding 45 minutes got infected. Lilani et al found that the infection rate of 1.47 % for operations lasting for 45 mins to 2 hours and infection rate of 38.46 % for procedures lasting for more than 2 hours[15]. In our study also, prolonged OT hours was significantly associated with SSI (p<0.001)

The simplest explanation for an increased infection rate with the long procedure is that a longer exposure time will increase the level of contamination of the wound and subsequently the degree of damage to the tissues, and greater fatigue among the members of the surgical team will lead to breaks in sterile technique[16].

Hypertension, preexisting or pregnancy-induced, HIV, and other comorbid states have been associated with SSI in several studies.PIH was significantly associated with SSI in the present study which is also found in the study of Debjani et al[15].

The infection rate was more with emergency surgery when compared to elective surgery as found in a study conducted by Anand Saxena same as that reported by Patel Sachin et al[16,17].

In our study, the univariate logistic regression analysis also shows a significant association of SSI with emergency surgical procedures

SUMMARY & CONCLUSION

Summary

- A total of 112 patients develop culture positive surgical site infection within 30 days of surgical procedure in surgery, orthopaedics & obstretic and gynaecology department.The clean and clean contaminated surgeries were included in our study.
- In this study, a total of 5948 surgeries were done during the study period and we had found that the overall SSI rate is 1.9 %
- The length of hospital stay was found to be a significant risk factor for SSI, and with an increase in each day of hospital stay a 30% higher odds of SSI was noted which was statistically significant.
- Another major risk factor was found to be associated with a high incidence of SSI was Diabetes mellitus. The history of DM was found to be a significant risk factor for developing SSI. A history of Anemia, pregnancy induced hypertension in patients conferred a significantly higher rate of SSIs. The infection rate was more with emergency surgery when compared to elective surgery.

Limitations

- However, this study had some limitations. Data on some known risk factors such as body mass index, intraoperative patient temperature, personal hygiene, patient's educational level and external factors such as surgical environment, intraoperative care, and home environment post discharge were not collected.

Conclusion

- Despite all the limitations in our study, it revealed that:

1] SSI rate in our study was 1.9% which was lower than other studies conducted.

2] Uncontrolled diabetes mellitus, hypertension were the important risk factors for developing Surgical site infection & the length of hospital stay had a significant association with Surgical site infection.

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