Clinico-etiological profile of surgical site infections at a tertiary care center: A cross sectional study

Page S[a], Pande R[b]*, Pusdekar V [c, d], Javalekar P[e], Gupta D[f]

[a]Senior Resident, Department of Surgery, Mahatma Gandhi Institute of Medical Sciences, Sewagram, India

[b]Professor, Department of Surgery, Mahatma Gandhi Institute of Medical Sciences, Sewagram, India

[c] Ex- AssistantProfessor, Department of Surgery, Mahatma Gandhi Institute of Medical Sciences, Sewagram, India

[d]Assistant Professor, Department of Surgery, All India Institute of Medical Sciences, Nagpur

[e] Assistant Professor, Department of Surgery, Mahatma Gandhi Institute of Medical Sciences, Sewagram, India

[f] Director Professor and Head, Dept of Surgery, Mahatma Gandhi Institute of Medical Sciences, Sewagram, India

Abstract

Introduction: "Surgical Site Infections" (SSI) are reported to be the third most common hospital acquired infectionsleading to an adverse effect on the patient`s recovery from a surgical intervention. They may lead to several post-surgical complications affecting the quality of life.

Objective: The objective of the study is to assess the incidence of surgical site infections (SSIs) in our center and to delineate the microbial profile of these infections and to study the factors associated with SSIs as well as their outcomes.

Materials and Methodology: This cross-sectional analytical study was conducted on 1000 post operative cases admitted at the Surgical inpatient unit of the "Mahatma Gandhi Institute of Medical Sciences", Sewagram, Wardha which is a teaching tertiary care rural hospital in Central India. The study was conducted from November 2018 to September 2020.

Results: The overall incidence of SSI was 8.9%. The commonest organism isolated from the cases was staphylococcus aureus in 32 (39.5%) of the cases, followed by Methicillin resistant Staphylococcus aureus (MRSA) in 17 (19.1%) of the cases with SSI, E coli in 15 (16.6%) and Pseudomonas aeruginosa in 11 (12.3%) of the cases with SSIs. Among the less common organisms that were isolated from the SSIs were Klebsiella in 6 (6.7%), Enterococci in 5 (5.6%) and coagulase negative staphylococci in 3 (3.3%) of the cases with SSIs. The factors associated with SSIs were increased age (p=0.0328), those undergoing emergency surgery (p<0.001), those with a contaminated surgical wound (p<0.001) and those who were hospitalized more than 7 days prior to the surgery (p=0.047).

Conclusion: The SSI incidence was found within an acceptable range of the international limits. The commonest isolated microbes were staphylococcus aureus as well as the Methicillin Resistant Staphylococcus aureus. Therefore, strict protocols for surveillance of SSIs and its etiological factors are needed for preventing SSIs.

Keywords *"Surgical site infection", "Microbial etiology", "Risk factors", "Incidence","post operative cases"*
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1 Introduction

"Surgical Site Infections" (SSI) are third most common hospital acquired infections leading to an adverse effect on the patient`s recovery from a surgical intervention. They may lead to several post-surgical complications affecting the quality of life. Therefore, continued surveillance of SSIs and implementation of preventive measures is the cornerstone of managing post-surgical infections **(De Simone, 2020)**. Additionally, the surgical site infections (SSIs) pose a considerable disease as well as economic burden for healthcare systems **(Alfonso, 2007).**

The annual incidence of SSIs ranges from about 160,000 to 300,000 SSIs which forms a considerable burden to the health systems. These infections many a times prompt repeat surgical interventions along with continued post-surgical pain coupled with poor healing causing scarring and affecting cosmetic appearance, thereby decreasing the quality of life in addition to prolonged stay at the hospital **(Anderson, 2014, Bratzler, 2013 & Mangram, 1999)**.

They are defined as infections affecting the surgical incision or the underlying tissues that occurs up to 30 days after the surgery or may occur up to one year after surgery **(Schwart`z 2019)**.The World Health Organization defines SSI as the presence of purulent discharge from the wound or the surrounding area, or from the site of the drain, or spreading cellulitis originating from the wound site**(WHO, 2018)**.Whereas, according to the "Centre for Disease Control and Prevention", it is defined as infection that is observed mostly after the operative procedure affecting a part of the body that was subjected to surgery **(Horan, 1992)**. They are classified as Primary or secondary infections depending on the site of origin primary occurring at the surgical site and secondary affecting the surgical site with a primary focus elsewhere. The primary infections affecting the surgical sites are more serious and these appear within five to seven days postoperatively **(Negi, 2015)**.

Majority of SSIs do not lead to any complications as they involve only the superficial tissues like the skin and subcutaneous tissues. However, there is a risk of progression to necrotizing infections. The SSIs usually present as a surgical wound along with swelling at the site, pain, local tenderness, erythema and pus formation **(Negi, 2015)**.

In the previously conducted studies on bacteriological profile of SSIs, it has been revealed that Staphylococcus aureus is by far the commonest etiological agent for SSIs contributing to nearly two thirds of the cases. Other agents include Pseudomonas aeruginosa that is responsible for nearly a fourth of the SSIs, Escherichia coli, Staphylococcus epidermidis and Enterococcus faecalis are also the common causes of surgical site infections **(Giacometti, 2000)**. It was found that the causative organisms frequently originate from the patient's intrinsic flora. They vary according the type of procedure and the surgical site. In abdominal surgeries, microorganisms which are frequently isolated are, Escherichia coli (28%), Enterococcus spp. (15%), Streptococcus spp. (8%), Pseudomonas aeruginosa (7%), and Staphylococcus aureus (5%, resistant to methicillin 2%) **(Munez, 2011)**.

Several Host and environmental factors as well as factors related to the wound and surgery are implicated in the causation of SSIs **(Cheng2015, Marchant, 2009, Namba, 2012)**. These include higher BMI, elderly, comorbidities like cancer, diabetes, immunocompromised states or underlying chronic medical conditions **(Wu, 2014, Akhter, 2016)**. These need to be addressed in the preventive interventions at hospitals in order to reduce the incidence of SSIs. Similarly, the causative organisms involved in the SSIs are of importance in order to implement prophylactic measures. Therefore, it becomes necessary to study the causative microbes as well as the associated factors for SSIs in order to develop appropriate preventive strategies. In this context the present study was planned with the objectives to assess the incidence of "surgical site infections" (SSIs) in our center and to delineate the microbial profile of these infections and to study the factors associated with SSIs.

2 Materials and Methods

The present study was conducted in the "Department of Surgery", at the "Mahatma Gandhi Institute of Medical Sciences, Sewagram, Wardha" which is a teaching tertiary care hospital in the rural areas of Central India. The study duration was from November 2018 to September 2020. The department of surgery has approximately 5000 surgeries annually. An approval was obtained from Institutional Ethics Committee (IEC) before the study commencement. A written and informed consent was obtained from all the study participants before their enrolment for the study.

Study design: The study is an analytical Cross-sectional study.

Study setting: The study was conducted at the Department of Surgery, a teaching tertiary care rural hospital in Central India. The department of surgery has approximately 5000 surgeries annually.

Study duration: was from November 2018 to September 2020.

Study population: All patients operated on an elective or emergency basis for various clean or clean contaminated surgeries in the department of general surgery during the mentioned time frame.

Sample size: Sample size was calculated using open EPI software version 3. In a study conducted by Akhter et al (2016), that reported a 12% infection rate for SSIs. Annual surgeries in the study setting are 5000 per annum. With an absolute error of 5%, the desired sample size was calculated as 947. After rounding up 1000 cases were enrolled in the study **(Akhter, 2016)**.

Inclusion Criteria:

i) Patients operated for clean and clean contaminated surgeries in the study centre in the given study duration.

ii) Patients who were ready to give written and informed consent for this study.

Exclusion Criteria:

i) Patients not giving written and informed consent for this study.

ii) Patients who underwent contaminated surgeries having contaminated wounds with spilling of blood, fluids or gut contents etc.

iii) Patients with other comorbidities affecting occurrence of Surgical Site Infection like anaemia, malnutrition, uncontrolled diabetes mellitus.

iv) Patients operated in emergency settings

Study procedures: The patients admitted for undergoing clean and clean contaminated surgeries in the study setting and fulfilling the inclusion criteria were enrolled in the study after obtaining a written informed consent. The sociodemographic information including age, gender, place of residence, education, socioeconomic status etc was collected using a predesigned and pretested questionnaire.

Information about the clinical presentation, associated factors, clinical features, investigations, including the duration of Surgery, type of surgery, complications, treatment (antibiotics) given, days of hospital stay etc was also inquired. The previously studied risk factors were included like the kind of surgical wound, type of procedure whether elective or emergency, if antibiotic prophylaxis was given before surgery, duration of procedure, whether drain was present or absent and if any underlying conditions, if present were recorded. Swabs were collected from the affected post operative wounds and were processed using conventional methods **(Panpradist, 2014)**.

Statistical Analysis: The collected data was entered in MS Excel and analysed it using SPSS version 22 and OpenEPI software version 3. statistical significance with the dependent variables were assessed. Descriptive statistics like mean and standard deviations were elaborated along with bivariate as well as multivariable logistic regression analysis were performed to study the associations observed between dependent and independent variables. Variables showing a significant association in bivariate analysis with a p-value of < 0.25 were added to the multivariable logistic regression model. A p-value of < 0.05 was considered statistically significant in a multivariable logistic regression analysis and Odds ratio with its 95% CI were used to study the associations.

Table 1: Baseline characteristics of the study participants with SSIs (n=89)

Characteristic	Number	Percentage
Age (in years)		
< 20 years	18	20.2
21-40 years	13	14.7
41-60 years	14	15.7
61-80 years	14	15.7
> 80 years	30	33.7
Gender		
Male	53	59.5
Female	36	40.5
Education		
Illiterate	4	4.4
Primary school	41	46.0
High school	32	36.0
Graduate and above	12	13.4
Occupation		
Unemployed	17	19.1
Farmer	18	20.2
Self employed	33	37.0
Housewife	16	17.9
Government service	4	4.5
Place of residence		
Rural	68	76.4
Urban	21	23.6
Previous surgery		
Yes	45	50.6
No	44	49.4
Type of surgery		
Emergency	27	30.3
Elective	62	69.7
Days of Hospitalization before surgery		
≤ 7days	31	34.8
> 7days	58	65.2
Type of surgical wound		
Clean	25	28.0
Contaminated	64	72.0
Duration of surgery		
≤ 1 hour	30	33.7
1-2 hours	19	21.3
> 2 hours	40	45.0

Table 2: Clinical Profile of SSIs (n=89)

Signs and symptoms	**Number**	**Percentage**

None	5	5.6
Fever	67	72.3
Tenderness	28	31.5
Discharge	39	43.8
Gaping at the site	19	21.3

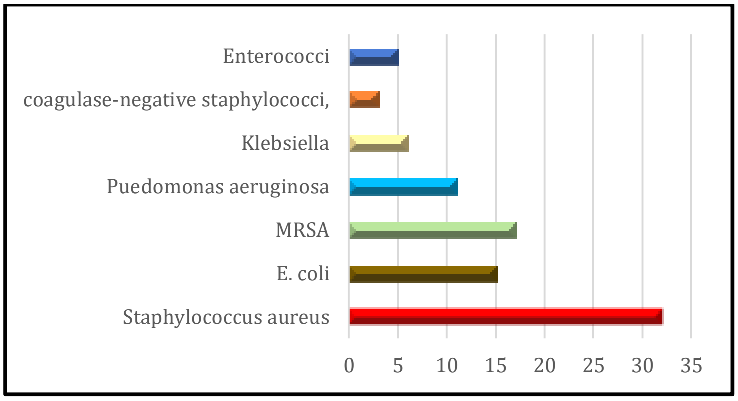

Figure 1: Etiological Profile of the SSI (n=89)

Table 3: Factors associated with SSIs (n=1000)

Characteristics	SSI cases (%) (n=89)	No SSIs (n=911)	AOR (95% CI)	p value
Age				
≤ 80 years	59 (66.3)	672 (73.7)	2.84 (1.82-8.55)	**0.0328***
> 80 years	30 (33.7)	239 (26.3)	Ref	--
Gender				
Male	53 (59.5)	721 (79.1)	Ref	--
Female	36 (40.5)	190 (20.9)	1.03 (0.83-6.34)	0.744
Education				
Illiterate	4 (4.4)	27 (3.0)	1.05 (0.92-2.66)	0.740
Primary school	41 (46.0)	382 (41.9)	Ref	0.944
High school	32 (36.0)	418 (45.8)	2.55 (1.84-8.49)	0.0626
Graduate and above	12 (13.4)	84 (9.2)	0.73 (0.52-0.99)	0.0859
Occupation				
Unemployed	17 (19.1)	336 (36.8)	0.86 (0.41-0.98)	0.853
Farmer	18 (20.2)	295 (32.4)	2.71 (1.35-4.72)	0.0691
Self employed	33 (37.0)	59 (6.5)	3.22 (1.68-7.21)	0.0774
Housewife	16 (17.9)	214 (23.4)	1.04 (0.93-7.96)	0.843
Government service	4 (4.5)	7 (0.7)	Ref	--
Place of residence				
Rural	68 (76.4)	631 (69.3)	Ref	--
Urban	21 (23.6)	280 (30.7)	0.943 (0.52-1.04)	0.076
Previous surgery				
Yes	45 (50.6)	455 (49.9)	Ref	--
No	44 (49.4)	456 (50.1)	2.93 (2.11-6.83)	0.063
Type of surgery				
Emergency	27 (30.3)	218 (23.9)	3.62 (2.31-	**<0.001**

Elective	62 (69.7)	693 (76.1)	42.76) Ref	--
Days of Hospitalization before surgery				
≤ 7days	31 (34.8)	374 (41.0)	Ref	--
> 7days	58 (65.2)	537 (59.0)	2.28 (1.21-7.84)	**0.047***
Type of surgical wound				
Clean	25 (28.0)	469 (54.4)	Ref	--
Contaminated	64 (72.0)	442 (45.6)	4.23 (2.91-26.5)	**<0.001***
Duration of				
surgery	30 (33.7)	262 (28.8)	Ref	--
≤ 1 hour	19 (21.3)	125 (13.7)	0.84 (0.41-1.03)	0.732
1-2 hours	40 (45.0)	524 (57.5)	2.48 (1.16-11.46)	**<0.001***
> 2 hours				

*p<0.05 is statistically significant

3 Results and Discussions

The study enrolled 1000 cases undergoing elective or emergency surgeries to assess the incidence, clinical and etiological profile, along with the factors associated with the occurrence of SSIs. In the present study, 89 of the 1,000 patients were observed to be suffering from SSIs, giving an incidence of 8.9%. The baseline characteristics of the study participants are shown in **Table 1**. The commonest age group was more than 60 years (49.4%) with higher prevalence in the age group of > 80 years (33.7%). Most of the SSI cases (59.5%) were males, educated till high school and above (49.4%), self-employed (37.0%) hailing from rural areas (76.4%). Approximately half of the cases had undergone a previous surgery. Nearly 70.0% had undergone an elective procedure and about two third of the cases were hospitalized for more than 7 days prior to surgery. Nearly 72.0% of the cases had contaminated wounds and 45.0% had prolonged duration of surgery lasting for more than two hours. **Table 2** shows the clinical profile of the surgical site infections in postoperative cases. Fever, was by far the commonest presenting symptom in 76 (72.3%) of the cases with SSIs indicating an infective etiology. Discharge from the wound was the next common manifestation observed in 39 (43.8%) of the cases, followed by local tenderness among 28 (31.5%) of the cases and gaping of the wound among 19 (21.3%) of the cases.

The incidence of SSIs was found to be 8.9% with 89 out of the 1000 participants reporting one or the other SSI. The etiological profile of the SSIs is described in **figure 1.** The commonest organism isolated from the cases was staphylococcus aureus in 32 (39.5%) of the cases, followed by Methicillin resistant Staphylococcus aureus (MRSA) in 17 (19.1%) of the cases with SSI, E coli in 15 (16.6%) and Pseudomonas aeruginosa in 11 (12.3%) of the cases with SSIs. Among the less common organisms that were isolated from the SSIs were Klebsiella in 6 (6.7%), Enterococci in 5 (5.6%) and coagulase negative staphylococci in 3 (3.3%) of the cases with SSIs. **Table 3** shows the multivariate analysis for the factors that were found to be associated with SSIs. It was observed that age above 80 years (p=0.0328), emergency surgery (p<0.001), contaminated wounds (p<0.001), duration of hospital stay > 7 days before undergoing surgery (0.047) and surgical duration lasting for > 2 hours (p<0.001) were significantly associated with SSIs.

This study aimed to assess prevalence, etiology and factors associated with SSIs among cases who underwent surgery at a tertiary care hospital. The study included 1000 cases who were operated at the hospital. Majority of the cases included in the study were post-operative cases from the

Department of Surgery (68.2%), followed by Obstetrics and Gynaecology (12.4%), Orthopaedics (12.2%) and 7.2% were from the Otorhinolaryngology Department.

The overall SSI prevalence was 8.9%, that was comparable to the average prevalence of 11.8% as reported by studies that were undertaken in developing countries **(Fan, 2014 &Allegranzi 2011)**. The reported prevalence from our study also shows similarity to that observed by studies from India **(Akhter, 2016, Awad 2012 & Khan, 2010)**. The SSI rates in our study were much higher than those reported by a studies from developed countries that showed a lower magnitude of SSI ("1.9% in the United States, 2.2% in Europe, 1.6% in Germany, 1.4% in England, 1.6% in France, and 2.0% in Portugal") **(Harihara, 2006)**.

The staggeringly higher rates of SSIs in the developing countries could be attributed to factors related to the healthcare systems as well as the patients. The glaring differences in the health care set ups in these countries like poorly maintained equipment, kind of materials used and lack of strict asepsis, poor hygienic conditions of the patients` undergoing surgery, presence of skin infections that contaminated the wounds and delayed presentation to the hospitals after acquiring infection contribute to the higher incidence of SSIs in developing countries. These were consistent with other studies conducted in the developing nations that highlighted some of these factors **(Fan 2014, Koneman 1997)**.

It was observed in the present study that SSIs were significantly higher in older age group (p=0.0328). Older patients are at a higher risk of acquiring infections due to their declining immune functions, poor nutrition and well as the presence of co-morbidities making them prone to acquiring infections **(Triantafyllopoulos, 2015)**. This was similarly described by previous research mentioning age as a non-modifiable risk factor for SSIs as it also indirectly influences wound healing thereby increasing the chances of poor surgical outcomes **(Ngowe, 2004)**.

In the present study, undergoing emergency surgery posed considerable risk of contamination (p<0.01). This was similarly reported by several other studies and might be the result of the fact that in emergency surgeries, the preoperative preparation is lacking as against the elective surgeries. As shown in **Table 3**, the incidence of SSI in emergency surgeries was significantly higher as compared to elective surgeries (30.3% versus 23.9%, respectively p<0.0001). This was similarly reported by other studies conducted in our region **(Anvikar, 1999, Lilani, 2005)**.

Patients undergoing emergency surgeries are mainly constituted by cases with acute abdominal conditions such as acute peritonitis present with prior infections due to contamination of the abdominal cavity with the bowel contents, thereby posing a significantly higher risk of SSIs. Therefore, most of the emergency surgical procedures pose high risk for SSIs as the operative sites might be previously infected. Other factors that contribute to SSIs in cases of emergency surgery includes the timing of these surgeries that are mainly performed after-hours and without adequate preoperative care. Thus, highlighting the need to urgently strengthen the steps taken in the management of emergency surgeries.

Additionally, table 3 also shows that the SSI prevalence was significantly greater in cases who had a contaminated incision as compared to a clean incision (72.0% vs 45.6%; p<0.0001). Contaminated incisions are likely to be infected and thereby induce SSIs despite the use of antiseptic measures during surgery. Other studies conducted by Arvikar et al. 1999 and Lilani et al. 2005 also reported higher incidence of SSis among those with a contaminated surgical wound as compared to clean contaminated and clean wounds **(Anvikar, 1999, Lilani, 2005)**.

Therefore, in patients with a contaminated wound special care should be taken for instituting appropriate preventive measures like skin protecting incision, minimizing surgical site contamination along with use of prophylactic antibiotics. However, with the rising rates of resistance to antimicrobials, reducing the incidence of SSI and at the same time limiting antibiotic resistance is a huge challenge for health facilities.

In this study, it was further observed that patients who were hospitalized for > 7 days during the preoperative period had a 2.28 times greater risk of SSIs as compared to those staying at the hospital for < 7 days [AOR 2.28; 95%CI (1.21-7.84); p=0.047]. This was similarly reported by Atif et al (2015) **(Atif, 2015)** and others **(Hella, 2018 & Legesse 2017)**. Prolonged hospital stay is fraught with greater risk of acquiring hospital acquired infections during the stay and may also be related to the ever-increasing prevalence of multidrug resistant strains in the hospital settings. Additionally, the use of ubiquitous diagnostic procedures, multiple therapies also might have led to the alterations in the protective microflora, which may in turn lead to a heightened risk for acquiring SSIs.

Prolonged duration of Surgery and prolonged hospital stay were independent risk factors for acquiring SSIs (Table 3). When the surgical duration exceeded two hours, incidence of SSIs also increased (45.0% for more than two hours vs 13.7% for duration between one to two hours). Thereby indicating that prolonged duration of Surgery facilitates exposure to microbes over a greater time period, hypothermia induction and declining levels of antibiotics with time that favours microbial multiplication causing SSIs. Similarly, prolonged hospital stays of more than 7 days before the surgery also posed a higher risk of acquiring SSIs (65.2% vs 41.0% respectively) among those staying for more than 7 days as compared to those who stayed for less than 7 days prior to their surgery (p = 0.047). Prolonged stay at the hospital exposes the patients to hospital acquitted infections in addition to providing further chances for bacterial colonization and multiplication in cases who are previously exposed to any infective agent or with contaminated wounds. Similar findings of long hospital stay and SSI were reported by other studies **(Hella, 2018, Legesse 2017, Suchitra, 2009 & Mathur 2011)** this may be a repercussion of the global emergence and spread of multi-drug resistant strains of infective agents in health care settings along with the ubiquitous procedures both diagnostic and therapeutic leading to microbial genetic alterations, thereby increasing the rate of “surgical site infections”.

4 Conclusion

The incidence of SSI in our study was within acceptable limits. The commonest isolated microbes were staphylococcus aureus as well as the Methicillin Resistant Staphylococcus aureus. Therefore, strict protocols for surveillance of SSIs and its etiological factors are needed for preventing SSIs. \

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Biography of Authors

	Dr. Subashree Page is the Senior resident in the department of Surgery at MGIMS, Sewagram. She is interested in laparoscopic and minimally invasive surgery. Her reaerch interests include Surgical oncology and Pediatric Surgery. *Email*: subhashree@mgims.ac.in
	Dr Rameshkumar Pandey is the Professor at the Department of Surgery at MGIMS. He is a life member of Association of Surgeons of India and Association of Colo-rectal Surgeons of India. He is adept at surgical skills and the art and science of hospital management. He has worked in charity hospitals in Maharashtra and Madhya Pradesh. *Email*: pande.rameshkumar71@gmail.com;ramesh@mgims.ac.in

	Dr. Vinod Pusdekar is presently working as Assitant Professor in the Department of Surgery at All India Institute of Medical Sciences, Nagpur and was previous working at MGIMS, Sewagram. He has authored a book on Surgery entitled, "Systematic Approach to Describe Instruments & Operative procedures in Surgery Orthopedics and Anesthesia". He is an academician and researcher with interests in Surgical oncology and Transplant surgery. *Email:* drvinodpusdekar20@gmail.com
	Dr. Prutha Javalekar is the Assistant Professor in the department of Surgery at MGIMS, Sewagram. She is interested in laparoscopic and minimally invasive surgery. Her reaerch interests include Surgical oncology and Pediatric Surgery. *Email*: prutha@mgims.ac.in
	Dr Dilip Gupta is the Director, Professor and Head, Department of Surgery at MGIMS, Sewagram.His areas of interest are in oncology, urology, and Pediatric Surgery besides medical education. A faculty in the medical education cell at MGIMS, he was awarded fellowship of Association of Rural Surgeons of India (ASRI): he is also a Governing Council member, Vice Chairman of the Academic Council and Editor of Journal of ARSI. *Email:* dilip@mgims.ac.in