Abstract

Introduction: Surgical site infections are associated with substantial morbidity and mortality, increase in hospital stay and enhanced cost of health care. Objective of present study is to analyse the incidence of surgical site infections after major abdominal surgeries and risk factors for development of SSIs. Methods: It is observational study carried out at Department of General Surgery, Dr. Vasantrao Pawar Medical College, Nashik, Maharashtra, India. This study carried on 70 patients operated in general surgery department. The various parameters studied were age and sex of patients, presence of diabetes, hypertension malignancy, type of surgery (emergency and elective surgery), duration of surgery, and the class of wound etc. Results: Hypertension, malignancy of operated patients had surgical site infection. Significant risk factors are age, obesity, emergency surgery, dirty and contaminated wounds, prolonged hospital stay, Diabetes mellitus. Staphylococcus aureus and E. coli are most commonly identified organisms in culture. Conclusions: Post-operative abdominal wound infection represents a substantial burden of disease, both for the patients and the healthcare services in terms of the morbidity, mortality and economic costs.

Keywords: Abdominal Surgery, Surgical Site Infection

1. Introduction

Surgical Site Infection (SSI) previously termed postoperative wound infection is defined as that infection presenting up to 30 days after a surgical procedure if no prosthesis is placed and up to 1 year if a prosthesis is implanted in the patient. According to the US Center for Disease Control (CDC), National Nosocomial Infections Surveillance system, SSI is the third most frequent nosocomial infection, accounting for 14%-16% of infections among hospitalized patients and 38% of infections in surgical patients. The surgical site infection rates for intra-abdominal procedures are still higher i.e., upto 20% (range from 3.4% - 36.1% in different studies). In India, a study conducted on SSI in tertiary care hospital showed incidence of 2.06% and 16.16% in MIS (minimal invasive surgery) and OS (open surgery) respectively. Another literature which has reviewed the studies on SSI 1995 to 2010 reported SSI incidence of 2% to 23% for all surgical procedures in India.

The incidence of SSI following abdominal surgery varies according to the nature of the procedure undertaken and the degree of wound contamination. For example, the incidence of wound infection following an elective splenectomy in which the Gastro-Intestinal (GI)
tract is not entered would be expected to be much lower than that of following an emergency laparotomy for a colonic perforation during which contamination of the surgical site is inevitable. In acknowledgment of this it is common practice to stratify surgical wounds according to the degree of contamination:

- **Clean**: an uninfected operative wound in which no inflammation is encountered and the alimentary, genital or urinary tract is not entered.
- **Clean contaminated**: a wound in which the alimentary, genital or urinary tract is entered in a controlled manner.
- **Contaminated**: open, new accidental wounds, or operations in which there is a significant break in aseptic technique (e.g. gross contamination with GI tract contents) or acute non-purulent inflammation is encountered.
- **Dirty**: old traumatic wounds with devitalised tissue, or those involving existing infection or visceral perforation.

SSI leads not only to substantial morbidity and mortality, but also to longer hospital stays and greater health-care costs. SSI can also influence patient quality of life and work productivity because of time spent in hospital. These infections are usually caused by exogenous and/or endogenous micro-organisms that enter the operative wound either during the surgery (primary infection) or after the surgery (secondary infection).

Primary infections are usually more serious, appearing within five to seven days of surgery. Majority of SSIs are uncomplicated involving only skin and subcutaneous tissue but sometimes can progress to necrotizing infections. The usual presentation of infected surgical wound can be characterized by pain, tenderness, warmth, erythema, swelling and pus formation.

A number of patient related factors (old age, nutritional status, pre-existing infection, co-morbid illness) and procedure related factors (suture material, poor surgical technique, prolonged duration of surgery, pre-operative part preparation and inadequate sterilization of surgical instruments) can influence the risk of SSIs significantly.

Studies on rates of SSIs as well as on the causative agents and their antimicrobial susceptibility from this part of India are relatively scanty. We thus aimed to study the incidence and investigate the risk factors for SSI together with the identification of the etiological bacterial agents and their antimicrobial susceptibility in a major teaching hospital in Maharashtra.

## 2. Aim and Objectives

1. To study the incidence of surgical site infection in surgical abdominal wounds in patients undergoing elective and emergency abdominal surgery at tertiary care centre.
2. To study the risk factors associated with surgical site infections.
3. To study the various micro-organisms causing surgical site infections.

## 3. Materials and Methods

This prospective observational study was conducted over 70 patients who underwent an elective or emergency open abdominal surgery during the period of August 2015 to December 2017, in the Department of General Surgery for various abdominal ailments. The method of including patients in the study was non-random, purposive, i.e., all the patients undergoing open abdominal surgeries. The design of Study was prospective. The target patient population was post-operative surgical patients. The initial criterion of including patients to the study was any patient who has undergone an “open” abdominal surgery, followed by primary closure of the wound, for any intra-abdominal pathology. Informed written consent was taken from the patients or their guardian willing to participate in the study. Detailed history was taken from the study group to establish proper diagnosis and to know about the presence of the risk factors regarding surgical site infection. The basic investigations and essential imaging reports were noted down. All of the preoperative factors, especially those known to increase the risk of Surgical Site Infection in the patient were noted down. The patients had satisfied the Inclusion and Exclusion Criteria.
3.1 Eligibility Criteria

Inclusion Criteria
- Patients in the age group of 16 – 80 years.
- Patients undergoing an open abdominal surgery (elective and emergency).
- Willing to participate in the study.

Exclusion Criteria
- Multiple abdominal surgeries in the past (defined as >2 surgeries).
- Pre-operative usage of antibiotics > 3 weeks.
- Presence of co-existing foci of infection (eg. Genito-Urinary tract infection, Pneumonia, Cellulitis).
- Prolonged hospitalization or multiple hospital admissions prior to surgery.

4. Results

Table 1. Incidence of SSI observed in study

| Incidence of SSI | N  | %     |
|------------------|----|-------|
| Yes              | 10 | 14.3% |
| No               | 60 | 85.7% |
| Total            | 70 | 100.0%|

Incidence of SSI observed in present study was 14.3% (Figure 1, Table 1).

Table 2. Association of SSI with gender

| Gender | SSI | Total |
|--------|-----|-------|
|        | No  | Yes   |       |
| Female | 26  | 4     | 30    |
|        | 86.7% | 13.3% | 100.0% |
| Male   | 34  | 6     | 40    |
|        | 85.0% | 15.0% | 100.0% |
| Total  | 60  | 10    | 70    |
|        | 85.7% | 14.3% | 100.0% |
| p-value | 1.0 |

No association was observed between incidences of SSI with gender (p-1.0) (Table 2).

Table 3. Mean comparison of age and BMI between cases with and without SSI

| Variables | SSI | N  | Mean | SD  | p-value |
|-----------|-----|----|------|-----|---------|
| Age       | Yes | 10 | 57.67| 5.67| <0.05   |
|           | No  | 60 | 53.42| 6.49|         |
| BMI       | Yes | 10 | 25.62| 3.32| <0.05   |
|           | No  | 60 | 21.97| 5.39|         |

Mean age (57.67 vs 53.42 years) and BMI (25.62 vs 21.97 Kg/m²) was higher in cases with SSI (p<0.05) (Table 3).

Table 4. Association of SSI with associated co-morbidities

| Associated Co-morbidity | SSI   | Total | p-value |
|-------------------------|-------|-------|---------|
|                         | No    | Yes   |         |
| Diabetes                | 18    | 7     | 25      | <0.05   |
|                         | 72.0% | 28.0% | 100.0%  |         |
| Hypertension            | 13    | 3     | 16      | 0.68    |
|                         | 81.3% | 18.8% | 100.0%  |         |
| Malignancy              | 3     | 1     | 4       | 0.46    |
|                         | 75.0% | 25.0% | 100.0%  |         |
| CRF                     | 5     | 2     | 7       | 0.26    |
|                         | 71.4% | 28.6% | 100.0%  |         |

Diabetes was observed to be significantly associated with incidence of SSI (28% vs 6.7%; p<0.05). No association was observed with hypertension, malignancy and CRF (Table 4).
Table 5. Association of SSI with type of surgery

| Type of Surgery | SSI | Total |
|----------------|-----|-------|
|                | No  | Yes   |     |
| Emergency      | 10  | 6     | 16  |
|                | 62.5% | 37.5% | 100.0% |
| Elective       | 50  | 4     | 54  |
|                | 92.6% | 7.4%  | 100.0% |
| Total          | 60  | 10    | 70  |
|                | 85.7% | 14.3% | 100.0% |

p-value < 0.05

Incidence of SSI was significantly higher in emergency surgeries (37.5%) as compared to elective surgeries (7.4%) (Table 5).

Table 6. Association of SSI with type of wound

| Type of Wound   | SSI | Total |
|-----------------|-----|-------|
|                 | No  | Yes   |     |
| Clean           | 22  | 1     | 23  |
|                 | 95.7% | 4.3%  | 100.0% |
| Clean Contaminated | 30  | 4     | 34  |
|                 | 88.2% | 11.8% | 100.0% |
| Contaminated    | 7   | 4     | 11  |
|                 | 63.6% | 36.4% | 100.0% |
| Dirty           | 1   | 1     | 2   |
|                 | 50.0% | 50.0% | 100.0% |
| Total           | 60  | 10    | 70  |
|                 | 85.7% | 14.3% | 100.0% |

p-value < 0.05

A significantly higher incidence of SSI was noted in contaminated (36.4%) and dirty wounds (50%) (p<0.05) (Table 6).

Table 7. Association of SSI with type of wound closure

| Closure of Wound | SSI | Total |
|------------------|-----|-------|
|                  | No  | Yes   |     |
| Monolayer        | 23  | 4     | 27  |
|                  | 85.2% | 14.8% | 100.0% |
| Multilayer       | 37  | 6     | 43  |
|                  | 86.0% | 14.0% | 100.0% |
| Total            | 60  | 10    | 70  |
|                  | 85.7% | 14.3% | 100.0% |

p-value = 1.0

No association of SSI was observed with type of wound closure i.e. monolayer or multiplayer (p=1.0) (Table 7).

Table 8. Association of SSI with duration of surgery and hospital stay

| Variables          | SSI | N | Mean | SD | p- value |
|--------------------|-----|---|------|----|----------|
| Duration of Surgery|     |   |      |    |          |
| Yes                | 10  | 2.13 | 0.49 | 0.67 |
| No                 | 60  | 2.37 | 0.67 |     |
| Duration of Hospital stay |     |   |      |    |          |
| Yes                | 10  | 16.52 | 6.71 | <0.05 |
| No                 | 60  | 11.23 | 5.41 |     |

Mean duration of surgery was comparable between cases with and without SSI (2.13 vs 2.37 hours; p=0.67). However, cases of SSIs had increased in prolonged preoperative hospitalization (16.52 vs 11.23 days; p<0.05) (Table 8).

Table 9. Association of SSI with type of surgery

| Type of Surgery        | N  | %   | SSI | %   |
|------------------------|----|-----|-----|-----|
| Inguinal Hernia        | 19 | 27.1% | 2 | 10.5% |
| Umbilical Hernia       | 2  | 2.9%  | 0 | 0.0%  |
| Paraumbilical Hernia   | 2  | 2.9%  | 0 | 0.0%  |
| Incisional Hernia      | 4  | 5.7%  | 1 | 25.0% |
| Appendectomy           | 14 | 20.0% | 2 | 14.3% |
| Laparotomy             | 15 | 21.4% | 4 | 26.7% |
| Cholecystectomy        | 10 | 14.3% | 1 | 10.0% |
| Pyelolithotomy         | 4  | 5.7%  | 0 | 0.0%  |
| Total                  | 70 | 100.0% | 10 | 14.3% |

Highest incidence of SSI was observed with Incisional hernia (25%) and laparotomy cases (26.7%) (Table 9).

Table 10. Distribution of organism from SSI isolates

| Organism            | N  | %   |
|---------------------|----|-----|
| Staphylococcus aureus | 3  | 30.0% |
| Escherichia Coli     | 3  | 30.0% |
| Klebsiella           | 1  | 10.0% |
| Citrobacter          | 1  | 10.0% |
| Enterococcus         | 1  | 10.0% |
| Pseudomonas          | 1  | 10.0% |
| Total               | 10 | 100.0% |

Most common organism isolated from the SSI isolates was S. aureus (3 cases) and E. coli (3 cases) (Table 10).
5. Discussion

Surgical site infection is a common complication of surgery. Its morbidities range from delayed healing to systemic sepsis. It has great impact on the economy and health care resources. According to CDC the overall incidence of SSI is estimated as 2.8% in the USA. In incidence rate, SSIs are still higher in developing countries like India (9-23%).

The present study was planned to evaluate the incidence of surgical site infection in surgical abdominal wounds in patients undergoing elective and emergency abdominal surgery at tertiary care centre. We also aimed to identify the associated risk factors and profile various micro-organisms causing surgical site infections.

5.1 Prevalence of Surgical Site Infection

Incidence of SSI observed in present study was 14.3%. Various authors have evaluated the incidence and risk factors for surgical site infection in surgical abdominal wounds. Giri S et al., observed that out of 230 patients included, 53 were identified as having a SSI, resulting in an overall rate of SSI of 23%. Nwankwo E et al., in their study observed that out of 2880 patients studied, 585 (20.3%) developed SSI.

However few others observed a somewhat lower incidence of SSI as compared to present study. Kakati B et al., studied 685 patients undergoing various abdominal surgical procedures admitted in the dept. of general surgery. The overall infection rate of 7.44% was observed among 685 patients included in the study. Incidence of SSI as observed in the study by Khairy et al., was 6.8%.

5.2 Risk Factors for Surgical Site Infections

5.2.1 Age and BMI

Mean age (57.67 vs 53.42 years) and BMI (25.62 vs 21.97 Kg/m²) was higher in cases with SSI (p<0.05).

Increasing age has been observed as a risk factor for SSI and overall infections in general have been observed in many previous studies. Dwindling immunity associated with age can be attributed for this observation. Superimposed co-morbidities further diminish the innate immunity in elderly.

Results from various studies show that risk of SSI increased with increase of BMI. Adipose tissue is poorly vascularised and the consequent effect on oxygenation of the tissues and functioning of immune response is thought to increase the risk of SSI.

5.3 Co-Morbidities

Diabetes was observed to be significantly associated with incidence of SSI (28% vs 6.7%; p<0.05). No association was observed with hypertension, malignancy and cases of CRF.

Patients with type 2 diabetes mellitus are at increased risk of infections. Various impairments in the immune system, in addition to poor metabolic control of diabetes may all contribute in the higher incidence of SSI in diabetics. Undiagnosed diabetes and postoperative hyperglycemia more specifically within 48 hours of surgery have been associated with increased SSI risk. Khairy et al., in their study observed rate of infection in diabetics to be significantly higher than non-diabetics.

5.4 Type of Surgery

Incidence of SSI was significantly higher in emergency surgeries (37.5%) as compared to elective surgeries (7.4%).

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. More frequency of contaminated or dirty wounds is seen in emergency surgeries which lead to higher incidence of SSI in this group.

Emergency surgeries as significant risk factor for development of SSI were observed by many authors. Khairy et al., observed that emergency operations showed significantly higher rates of infection compared to elective counterparts.

5.5 Type of Wound

There is considerable variation in each class according to the surgery performed. As expected, rates are highest for dirty surgeries like intestinal perforation and incisional hernias. In present study too, a significantly higher incidence of SSI was noted in contaminated (36.4%) and dirty wounds (50%) (p<0.05).

Nwankwo E et al., in their study observed incidence related to clean, clean contaminated, contaminated and dirty as 5.8%, 30.5%, 40.6%, and 64.8% wounds respectively. In 2012 study in tertiary care hospital in Gujarat, infection rates in different classes were as follows:
Clean - 3%, Clean contaminated- 11.4%, Contaminated - 20% and Dirty- 40.9%.

5.6 Hospital Stay
As expected, we observed that prolonged hospital stay (16.52 vs 11.23 days; p<0.05) to be significantly associated with incidence of SSI. In our study, we have taken total number of hospital stay including preoperative and postoperative hospital stay. Malik AZ et al., in their also observed significant mean difference (8.3±10.3 vs 3.3±2.9 days, p< 0.01) in duration of hospital stay in patients who developed SSI in comparison to those who did not.

Prolonged hospital stay leads to colonization with microorganisms which may be resistant to routine antimicrobial drugs and itself directly affects patient's susceptibility to infection either by lowering host resistance or by providing increased opportunity for ultimate bacterial colonization.

6. Isolated Organisms
Most common organism isolated from the SSI isolates was Staph. aureus (3 cases) and E. Coli (3 cases).

Kakati B et al., in their study observed E. coli as the commonest isolate (41.17%). The most commonly isolated bacteria in the study by Khairy et al., were: E. coli, Pseudomonas aeruginosa and Staphylococcus aureus. Khadilkar R et al., also observed that SSI infection with E. coli and S. aureus were more common. Malik AZ et al., observed that most common organisms isolated were Staphylococcus aureus (37.5%, 21/56), Escherichia coli (30.4%, 17/56) and Enterobacter (5.4%, 3/56).

7. Summary
1. Incidence of SSI observed in present study was 14.3%.
2. No association was observed between incidences of SSI with gender (p-1.0).
3. Mean age (57.67 vs 53.42 years) and BMI (25.62 vs 21.97 Kg/m^2) was higher in cases with SSI (p<0.05).
4. Diabetes was observed to be significantly associated with incidence of SSI (28% vs 6.7%; p<0.05). No association was observed with hypertension, malignancy and cases of CRF.
5. Incidence of SSI was significantly higher in emergency surgeries (37.5%) as compared to elective surgeries (7.4%).
6. A significantly higher incidence of SSI was noted in contaminated (36.4%) and dirty wounds (50%) (p<0.05).
7. No association of SSI was observed with type of wound closure i.e. monolayer or multilayer (p-1.0).
8. Mean duration of surgery was comparable between cases with and without SSI (2.13 vs 2.37 hours; p-0.67). However cases of SSI had increased hospitalization (16.52 vs 11.23 days; p<0.05).
9. Highest incidence of SSI was observed with incisional hernia (25%) and laparotomy cases (26%).
10. Most common organism isolated from the SSI isolates was Staph. aureus (3 cases) and E. Coli (3 cases).

8. Conclusion
The incidence of SSI observed in present study was comparable with other Indian studies and is considered as high as per international standards. The key risk factors for surgical site infection identified in present study were: increasing age elevated BMI, history of diabetes, emergency procedure and contamination of wounds. Other comorbidities did not directly affect the rate of surgical site infection in our series. E. coli and Staph. aureus were the most commonly isolated bacteria.

Identification of such risk factors is expected to help surgeons improve patient care and decrease mortality and morbidity as well as the hospital-care cost of surgical patients.

9. References
1. Awad SS, Palacio CH, Subramanian A, Byers PA, Abraham P, Lewis D, et al. Implementation of a methicillin-resistant Staphylococcus aureus (MRSA) prevention bundle results in decreased MRSA surgical site infections, American Journal Surgery. 2009; 198:607-10. PMid: 19887186. https://doi.org/10.1016/j.amjsurg.2009.07.010.
2. Owens CD, Stoessel K. Surgical site infections: Epidemiology, microbiology and prevention, Journal Hospital Infection. 2008; 70(Sul. 2):3 https://doi.org/10.1016/S0195-6701(08)60017-1.
3. Amit Agrawal, Singh RP. Surgical site infection in abdominal surgeries: A clinical study, Journal of Evolution of Medical and Dental Sciences. 2014; 3(40):10188–93. https://doi.org/10.14260/jemds/2014/3324.
4. Nandita Pal, Rajyasri Guhathakurta (Mukherjee). Surgical site infection in surgery ward at a tertiary care hospital: The infection rate and the bacteriological profile,
A Study of Incidence and Risk Factors in Post Operative Abdominal...

5. Jonathan T Tan, Kristina Coleman, Sarah Norris, Jayashree Mapari, Satyanand Shastri, Laurent Metz. SSI in India: A systemic review of incidence and economic burden, Health Technology Analysts Pty Ltd, Sydney, Australia, Johnson and Johnson Medical Asia-Pacific; 2010:01.

6. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Hospital Infection Control Practices Advisory Committee, Infection Control and Hospital Epidemiology. 1999 Apr; 20(4):250–78. https://doi.org/10.1086/501620. PMid: 10219875.

7. Anderson DJ, Sexton DJ, Kanafani ZA, Auten G, Kaye KS. Severe surgical site infection in community hospitals: Epidemiology, key procedures and the changing prevalence of methicillin resistant Staphylococcus aureus, Infection Control and Hospital Epidemiology. 2007; 28:1047–53. https://doi.org/10.1086/10962960260496307.

8. Barie PS. Surgical site infections: Epidemiology and prevention, Surg Infect (Larchmt). 2002; 3(Suppl 1): S9–21. https://doi.org/10.1089/ sup.2002. 3.s1-9, https://doi.org/10.1089 /10962960260496307.

9. Suchitra JB, Lakshmi Devi N. Impact of education on knowledge, attitudes and practices among various categories of health care workers on nosocomial infections, Indian Journal Medical Microbiology. 2007; 25:181–87. https://doi.org/10.4103/0255-0857.34757. PMid: 17901633.

10. Giri S, Kandel BP, Pant S, Lakhey PJ, Singh YP, Vaidya P. Risk factors for surgical site infections in abdominal surgery: A study in Nepal, Surgical Infections. 2013 Jun 1; 14(3):313–18. https://doi.org/10.1089/sur.2012.108. PMid: 23672239.

11. Nwankwo EO, Ibeh I, Enabulele OL. Incidence and risk factors of surgical site infection in a tertiary health institution in Kano, North Western Nigeria, International Journal of Infection Control. 2012 Oct 7; 8(4). https://doi.org/10.3396/ ijic.v8i4.035.12.

12. Kakati B, Kumar A, Gupta P, Sachan PK, Thakuria B. Surgical site abdominal wound infections: Experience at a north Indian tertiary care hospital, Indian Academy of Clinical Medicine. 2013 Jan.

13. Khairy GA, Kambal AM, Al-Dohayan AA, Al-Shehri MY, Zubaidi AM, Al-Naami MY, AlSaif FA, Al-Obaid OA, Al-Saif AA, El-Farouk OY, Al-Abdulkarim AA. Surgical site infection in a teaching hospital: A prospective study, Journal of Taibah University Medical Sciences. 2011 Dec 31; 6(2):114–20. https://doi.org/10.1016/S1658-3612(11)70172-X, https://doi.org/10.1016/S1658-3612(11)70181-0.

14. Mahesh CB, Shivakumar S, Suresh BS, Chidanand SP, Vishwanath Y. A prospective study of surgical site infections in a teaching hospital, Journal of Clinical and Diagnostic Research. Oct 2010; 4:3114–19.

15. Patel Sachin M, Patel Mitesh H, Patel Sanjeeta D et al. Surgical Site Infections: Incidence and Risk Factors in a Tertiary Care Hospital, Western India, National Journal of Community Medicine. 2012 Apr-Jun; 3(2):193–96.

16. Malik AZ, Ali Q. Surgical site infections after elective surgery in Pakistan: Surgipak Study, Journal of Rawalpindi Medical College (JRMC). 2015; 19(3):209–14.

17. Khadilkar R, Khirsagar V, Khadilkar S, Bendre M, Chavan S. A comprehensive study of 100 patients of SSI (Surgical Site Infections) in patients undergoing abdominal surgery, Elective/Emergency, in our Hospital. Journal Medical Science and Clinical Research. 2017; 5(4):20947–50. DOI: https://dx.doi.org/10.18535/jmscr/v5i4.192.

How to cite this article: Thombare D., Joshi D. A Study of Incidence and Risk Factors in Post Operative Abdominal Wound Infection in Tertiary Care Centre. MVP J. Med. Sci. 2019; 6(1):8-14.