# PREVALENCE OF SURGICAL SITE INFECTIONS IN AN URBAN TERTIARY CARE HOSPITAL IN CENTRAL MAHARASHTRA

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**ABSTRACT**

**BACKGROUND**

Surgical site infections (SSIs) is the third most frequently reported nosocomial infection, accounting for 12% to 16% of all nosocomial infections among hospitalised patients, as reported by the National Nosocomial Infections Surveillance (NNIS) system. The Centre for Disease Control and Prevention (CDC) and NNIS have developed criteria for defining SSIs, which have become national standards and are widely used by surveillance and surgical personnel. These criteria define SSIs as "infections related to the operative procedure that occur at or near the surgical incision (incisional or organ/space) within 30 days of an operative procedure or within one year if an implant is left in place". The estimates of the incidence of SSI are dependent upon voluntary self-reporting by surgeons, which is unreliable because most wound infections occur when the patient is discharged, and these infections may be treated in the community without hospital notification. Therefore, estimates of the prevalence of SSIs are almost underestimates, although the best data is available. Hence, present study was conducted so to estimate the prevalence of SSIs in tertiary care hospital in central Maharashtra.

**MATERIALS AND METHODS**

The study was carried out over a period of 2 years (2011-2013) in the Department of Microbiology, Indira Gandhi Government Medical College & Hospital, Nagpur, Maharashtra; around 19,127 patients were operated in different surgical departments and 517 (2.7%) patients developed SSIs.

The patients who were clinically diagnosed as cases of SSIs were included in study (517). A detailed history of patients was taken, (including age, gender, date of admission, presence of past or current infection, duration of pre & post-op hospital stay, antibiotic prophylaxis received, emergency or elective type of surgery, type and duration of anaesthesia, major or minor surgery, condition of wound at time of first post-op dressing, class of wound, number of dressings done and antibiotics received after surgery, etc.). The surgical wound was inspected at the time of first dressing and two specimens were collected and processed as per standard microbiological techniques.

**RESULTS**

Around 19,127 cases underwent surgery in various surgical departments. Out of these patients, the rate of SSIs was found in 517 patients (2.7%). It was found to be highest among patients of age group of 31 to 40 years (25.53%) and in males (56.86%) as compared to females (43.13%). SSIs rate was highest in surgeries performed under emergency conditions (54.15%) and under general anaesthesia (47.19%). SSIs rates increased with increase in duration of surgeries (>4 hours -22.05%) & with prolonged history of pre- & post-operative hospital stay (28.43%). Out of 517 cases, 370 (71.56%) patients received AMP.

Among various operative procedures, SSI was highest in surgeries for perforation peritonitis (11.99%) & LSCS (11.02%). SSIs rate was highest in deep surgical sites (49.51%) than in organ / space (40.81%) and superficial (9.67%) surgical sites. Also, the rate of SSIs in class IV (dirty) was highest (41.19%) than in class III (contaminated) (29.20%), class II (clean contaminated) (17.02%), and in class I (clean) type of wound (12.5%).

Out of 517 samples collected, 340 samples showed growth and 177 showed no growth and 40 samples had mixed growth.

The most frequently isolated organism was E. coli (23.33%), followed by A. baumannii (16%) and K. pneumoniae (15.66%). K. pneumoniae was found to be the commonest ESBL producer (40.62%) as well as AmpC producer (17.18%). While A. baumannii 18 (28.57%) was found to be the commonest MBL producer. The rate of MRSA was found to be (45%) and ICR was (17.5%).

**CONCLUSION**

Despite of all activities, SSIs remain a substantial cause of morbidity and mortality among hospitalized patients even in urban tertiary care centres. This may be partially explained by surgeons reporting the emergence of antimicrobial-resistant pathogens and the increased numbers of surgical patients who are elderly and/or have a wide variety of chronic, debilitating, or immune-compromising underlying diseases, etc.

Besides these, antibiotics have potential impact on preventing mortality in developing countries. The use of antimicrobial prophylaxis for selected surgical procedures is one of the measures used to prevent the development of a surgical site infection. Also, other infection control practices include improved operating room ventilation, sterilization methods, barriers, surgical technique, and availability of antimicrobial prophylaxis.

The points for intervention also include, reduction of duration of preoperative hospital stay, reduction in the duration of surgical procedures, avoiding unnecessary drains in addition to initiation of standardized SSI active surveillance and feedback of relevant data to surgeons that can help in reducing the rate of Surgical Site Infections.

Therefore, from our study, we can conclude that SSIs depend on multiple preventable factors, stressing upon those that can reduce the prevalence rate of SSIs to minimal in tertiary care hospitals.

**KEYWORDS**
SSIs, CDC, NNIS, AMP.

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## BACKGROUND

Surgical site infections (SSIs) is the third most frequently reported nosocomial infection, accounting for 12% to 16% of all nosocomial infections among hospitalised patients, as reported by the National Nosocomial Infections Surveillance (NNIS) system. [1]

Globally, SSIs rate have been reported to range from 2.5% to 41.9%.[2,3,4,5] The CDC has developed criteria for defining SSIs, which have become the national standard and are widely used by surveillance and surgical personnel. These criteria define SSIs as "infections related to the operative procedure that occur at or near the surgical incision (incisional or organ/space) within 30 days of an operative procedure or within one year if an implant is left in place".[6]

The collected data on incidence of wound infections underestimate true incidence. The estimates of the incidence of SSI are thus dependent upon voluntary self-reporting by surgeons, which is unreliable. Also, most wound infections occur when the patient is discharged, and these infections may be treated in the community without hospital notification. Therefore, estimates of the incidence of SSIs are almost underestimates, although the data are the best that are available. Hence, present study was conducted to estimate the prevalence of SSIs in tertiary care hospital in central Maharashtra, which ultimately depends on preventable factors.

## MATERIALS AND METHODS

The study was a prospective type of study, carried out over a period of 2 years (2011-2013) in department of Microbiology, Indira Gandhi Government Medical College & Hospital, Nagpur, Maharashtra, around 19,127 patients were operated in different surgical departments and 517 (2.7%) patients developed SSIs.

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The patients who were clinically diagnosed as cases of SSIs were included in study (517). A detail history of patient was taken, that included age, gender, date of admission, presence of past or current infection, duration of pre & post-op hospital stay, antibiotic prophylaxis received, emergency or elective type of surgery, type and duration of anaesthesia, major or minor surgery, condition of wound at time of first post-op dressing, class of wound, number of dressings done and antibiotics received after surgery, etc. The surgical wound was inspected at the time of first dressing and two specimens were collected and processed on routine culture media and identification of each isolate by appropriate biochemical tests followed by antimicrobial susceptibility testing as per standard techniques.[7]

## RESULTS

In this study, a total of 19,127 cases underwent different surgical procedures in various surgical departments. Out of these, 517(2.7%) patients developed Surgical Site Infections (SSIs). The rate of surgical site infections was studied according to different variables, as follows:

The rate of SSIs was compared in various age groups and gender of patients with SSIs.

| Age (Years) | Males | Females | Total Cases |
|---|---|---|---|
| 0 – 10 | 12 | 10 | 22 (4.25 %) |
| 11 – 20 | 14 | 12 | 26 (5.02 %) |
| 21 – 30 | 46 | 67 | 113 (21.85 %) |
| 31 – 40 | 79 | 53 | 132 (25.53 %) |
| 41 – 50 | 82 | 46 | 128 (24.75 %) |
| 51 – 60 | 45 | 26 | 71 (13.73 %) |
| Above 60 | 16 | 9 | 25 (4.83 %) |
| **Total** | **294 (56.86%)** | **223 (43.13%)** | **517** |

***Table 1. SSIs with respect to Age and Gender of the Patients***

The SSIs rate was found higher in age group of 31 to 40 (25.53%) years and in males (56.86%); (Chi-square=0.0005472, p=0.99).

SSIs rate was compared among various wards. It was found highest in Surgery ward (57.44%) followed by Obstetrics/Gynaecology (30.36%) and Orthopaedics wards (12.18%); (Chi-square=0.3823; p=0.8260).

The SSIs was found higher in surgeries performed under emergency conditions (54.15%) as compared to elective conditions (45.84%); (Chi-square=0.0002047; p=0.99).

It was observed that SSIs was increased in patients with hospital stay of more than 16 days (28.43%); (Chi-square=0.00002075; p=0.999).

SSIs were observed higher in surgeries performed under general anaesthesia (47.19%) than spinal anaesthesia (34.04%) and local anaesthesia (18.76%); (Chi-square=0.00005009; p=1.0).

SSIs were found to increase with increase in duration of surgeries (38.29%) of more than ½ to 2 hours; (Chi-square=0.00002528; p=0.999).

Among surgical procedure, SSIs was found to be highest among patients operated for perforation peritonitis (11.99%), followed by lower segment caesarean section (11.02%), Laparotomies (10.83%) and amputations (10.05%).

Based upon NNIS classification system, the surgical site infections were classified depending upon surgical sites and class of wounds.

| Surgical Sites | Total Cases |
|---|---|
| Deep | 256 (49.51 %) |
| Organ space | 211 (40.81 %) |
| Superficial | 50 (9.67 %) |
| **Total** | **517** |

***Table 2. SSIs with respect to Surgical Sites***

As shown in the above table, the surgical site infections were found more in deep surgical sites (49.51%) followed by organ / space surgical sites (40.81%) and superficial surgical sites (9.67%); (Chi-square=6.823; p=1.00).

According to class of wound, SSIs were found highest in class IV (dirty type of wound) as 41.19%. (Chi-square=0.0002277; p=0.99).

| Class of Wounds | Total Cases |
|---|---|
| Class I/ Clean | 65 (12.57 %) |
| Class II/ Clean contaminated | 88 (17.02 %) |
| Class III/ Contaminated | 151 (29.20 %) |
| Class IV/ Dirty | 213 (41.19 %) |
| **Total** | **517** |

***Table 3. SSIs with respect to Class of Wounds***

| Operative Procedures | Class I | Class II | Class III | Class IV | Total |
|---|---|---|---|---|---|
| Perforation Peritonitis | 10 | 17 | 19 | 16 | 62 |
| Lower Segment Caesarean Section (LSCS) | 12 | 12 | 20 | 13 | 57 |
| Laparotomy | 10 | 10 | 20 | 16 | 56 |
| Amputation | 6 | 10 | 11 | 25 | 52 |
| Wound Debridement | 4 | 8 | 12 | 18 | 42 |
| Sub-acute Intestinal Obstruction (SAIO) | 4 | 10 | 13 | 11 | 38 |
| Incision & Drainage | 3 | 0 | 14 | 14 | 31 |
| Appendicectomy | 6 | 7 | 11 | 6 | 30 |
| Hemi-colectomy | 1 | 5 | 7 | 14 | 27 |
| Malignancy Related Palliative Surgery | 1 | 2 | 5 | 19 | 27 |
| Herniotomy/ Herniorrhaphy | 2 | 2 | 4 | 18 | 26 |
| Total Abdominal Hysterectomy (TAH) | 4 | 2 | 3 | 13 | 22 |
| Fasciotomy | 1 | 2 | 6 | 10 | 19 |
| Miscellaneous Surgeries | 1 | 1 | 6 | 20 | 28 |
| **Total** | **65** | **88** | **151** | **213** | **517** |

***Table 4. Operative Procedures with respect to Different Class of Wounds***

As shown in above table, class III type of wound was found common in perforation peritonitis followed by class II type of wound. In lower segment caesarean section (LSCS), Laparotomies and in sub-acute intestinal obstruction (SAIO), class III type of wounds were common followed by class IV type of wound. While in amputations and wound debridement procedures, class IV type of wounds were common followed by class III type of wounds.

| AMP | Total Cases |
|---|---|
| AMP used | 370 (71.56 %) |
| AMP not used | 147 (28.43 %) |
| Total | 517 |

***Table 5. SSIs with respect to AMP in Pre-Operative Period***

As shown in above table, out of 517 cases, 71.56 % received antimicrobial prophylaxis (AMP) before surgery. (Chi-square=0.0002358; p=0.4994).

Around 517 samples were collected, 380 samples were culture positive and 177 were culture negative. The most frequently isolated organism was E. coli (23.33%), which was also commonest in all class of wounds, shown in table below.

| Sl. No. | Isolated Organisms | Class I (%) | Class II (%) | Class III (%) | Class IV (%) | Total |
|---|---|---|---|---|---|---|
| 1. | E. coli | 10 16.94) | 19 (23.75) | 22 (20.37) | 27 (20.30) | 78 |
| 2. | P. aeruginosa | 13 (22.03) | 15 (18.75) | 19 (17.59) | 22 (16.54) | 69 |
| 3. | K. pneumonia | 8 (13.55) | 11 (13.75) | 21 (19.44) | 24 (18.04) | 64 |
| 4. | A. baumannii | 11 (18.64) | 18 (22.5) | 10 (9.25) | 24 (18.04) | 63 |
| 5. | S. aureus | 9 (15.25) | 6 (7.5) | 16 (14.81) | 9 (6.76) | 40 |
| 6. | S. epidermidis | 4 (6.77) | 3 (3.75) | 6 (5.55) | 9 (6.76) | 22 |
| 7. | Proteus mirabilis | 4 (6.77) | 3 (3.75) | 5 (4.62) | 11 (8.27) | 23 |
| 8. | Citrobacter freundii | - | 2 (2.5) | 3 (2.77) | 4 (3.00) | 9 |
| 9. | Enterococcus faecalis | - | 2 (2.5) | 3 (2.77) | 3 (2.25) | 8 |
| 10. | Enterobacter aerogenes | - | 1 (1.25) | 1 (0.92) | - | 2 |
| 11. | Morganella morganii | - | - | 1 (0.92) | - | 1 |
| 12. | Serratia marcescens | - | - | 1 (0.92) | - | 1 |
| | **Total** | **59 (15.52)** | **80 (21.05)** | **108 (28.68)** | **133 (34.73)** | **380** |

***Table 6. Distribution of Organisms in Different Class of Wounds***

Around (45 %) Staphylococcus aureus were MRSA and (17.5 %) were inducible clindamycin resistant (ICR).

| Isolates | ESBL Producers | AmpC Producers |
|---|---|---|
| E. coli (n=78) | 28 (35.89%) | 8 (10.25%) |
| Klebsiella Pneumoniae (n=64) | 26 (40.62%) | 11 (17.18%) |
| Citrobacter Freundii (n=9) | 3 (33.33%) | 1 (11.11%) |
| Proteus Mirabilis (n=23) | 6 (26.08%) | 2 (8.69) |
| **Total** | **63** | **22** |

***Table 7. Distribution of ESBL Producers and AmpC Producers***

As seen in above table, Klebsiella pneumoniae was found as commonest ESBL (40.62%) as well as AmpC producer (17.18%).

The commonest MBL producing organism was Acinetobacter baumannii (28.57%). The rate of MRSA was found (45%) and (ICR) Inducible Clindamycin Resistant was (17.5%).

## DISCUSSION

After a surgical procedure, the patient may develop surgical site infections. The development of a SSI can be multicausal such as age, gender, type of surgery/ anaesthesia, class of wound, antibiotic prophylaxis, pre & post-operative hospital stay, etc. The major cause is damage to host barrier mechanisms induced by the trauma of a surgical incision. For most SSIs, the source of pathogens is the endogenous flora of the patient's skin, mucous membranes, or hollow viscera. However, contamination may also occur from an exogenous source such as surgical personnel, the operating environment, and all tools, instruments, and materials brought to the sterile field during an operation.[8,9]

Excellent surgical technique is widely believed to reduce the risk of SSI. Such technique includes maintaining effective haemostasis while preserving adequate blood supply, preventing hypothermia, gently handling tissues, avoiding unintentional entries into a hollow internal organ, removing devitalized (e.g., necrotic) tissues, using drains and suture material appropriately, eradicating dead space, and appropriately taking care of the postoperative incision.[10]

However, SSIs have adverse consequences like a longer duration of hospitalization of on an average a week, an increase in morbidity and mortality rates, and an increase in antibiotic use. Consequently, surgical site infections lead to an increase in healthcare costs. These costs refer to direct hospital costs, e.g., extra bed days, diagnostics, medication and revision surgery.[11,12,13,14]

As it is previously mentioned that rate of SSIs depends solely on surgeons reporting, therefore whatever data suggested may be under expressed. Considering the major causative factors contributing to rate of SSIs, our study helps to estimate that the prevalence rate in our tertiary care hospital of central Maharashtra.

In our study, the criteria employed for classifying surgical wound infections are those established by Centre for Disease Control (CDC), National Nosocomial Infection Surveillance (NNIS) program report.

During the study period 19,127 patients underwent various surgical procedures in different surgical departments. Out of these, 517 (2.7%) patients developed surgical site infections. This was comparable with study carried out by Shantanu et al (2011)[15] reported an incidence of 5%, while Heidi Misteli et al (2011)[16] reported 4.7%.

In our study, the maximum numbers of cases were in the age group of 31 to 40 years. The rate of surgical site infection was found to be increasing with age, with a maximum infection rate of 25.53% in the age group of 31 to 40 years. It is comparable with studies done by Amit K et al (2012),[17] Razavi SM et al (2005),[18] Moro ML et al (2005)[19] and Agarwal PK et al (1984).[20]

In our study; the infection rate was high in males (56.86%) as compared to females. Amit K et al (2012),[17] Shantanu K et al (2011)[15] and Mahesh et al (2010)[21] have reported higher rate of SSIs in males as compared to females.

The surgical site infections were evaluated according to type of surgical procedure undertaken. The percentage of surgical site infections is found as 54.15% in emergency surgeries as compared to 45.84% in elective surgeries. Studies carried out by Shantanu K et al (2011),[12] Franal et al (2010),[22] Mahesh et al (2010)[21] and Harbarth S et al (2009)[23] also noted higher rates of SSIs in emergency surgeries as compared to elective surgeries.

In our study, it was found that the rate of SSIs was increased with duration of surgery as well as with increase in duration of hospital stay. The studies carried out by Mahesh et al (2010)[21] reported an increase in rate of SSIs with prolonged pre-operative hospital stay. Whereas, Franal et al (2010)[22] have reported increase in rate of SSIs with increase in duration of post-operative hospital stay.

A higher rate of infection was observed in the patients who underwent surgeries under general anaesthesia (47.19%) and this is comparable with a study by Mahesh et al (2010).[21]

It was observed that the infection was highest among patients undergoing surgeries for perforation peritonitis (11.99%) followed by LSCS (11.02%), Laparotomies (10.83%) and amputation procedures (10.0 %). As more number of abdominal surgeries was performed as compared to other surgeries hence infection was found to be higher among abdominal surgeries. Amit K et al (2012)[17] also reported higher rates of SSIs in abdominal surgeries as compared to other procedures.

In our study, deep surgical wound was the commonest type found (49.51%). It is comparable to a study by Heidi Misteli et al (2011)[16] 30 %, Elena et al (2011)[24] 30%. Class IV (Dirty) wounds were found to be (41.19%) in our study while Franal et al (2010)[22] have reported 32.11 % of class IV wounds in his study.

AMP was received by (71.56%) cases and it was observed in studies carried out by Wassef et al (2012)[25] that preoperative antibiotic administration significantly reduces rate of SSIs.

In our study the predominant organism isolated was E.coli accounting for (23.33%). This is comparable to a study by Shafqat K et al (2010)[26] who reported (20.01%), Hiedi Misteli et al (2011)[16] (20.9%).

In our study, K. pneumoniae was found as commonest ESBL producer (40.62%) as well as AmpC producer (17.18%). While A. baumannii 18(28.57%) was found as commonest MBL producer. The rate of MRSA was found to be (45%) and ICR was (17.5%). These findings were comparable with studies carried out by Hemlatha et al,[27] Sanjay et al,[28] Eagye KM et al[29] and Azap OK et al[30] respectively.

## CONCLUSION

The risk of developing surgical-site infection is dependent on a myriad of host (intrinsic) and operative (extrinsic) risk factors. Infection is an unresolved problem while undertaking any surgical operations. Infections occur even though surgeons perform thoroughly clean procedures during surgery and patients are strictly managed before and after surgery.

Despite advances in infection control practices, SSIs remain a substantial cause of morbidity and mortality among hospitalized patients. This may be partially explained by the emergence of antimicrobial-resistant pathogens and the increased numbers of surgical patients who are elderly and/or have a wide variety of chronic, debilitating, or immuno-compromising underlying diseases.

Though the aim of asepsis and antisepsis in surgery is the prevention of infection, sepsis still complicates between 2 to 7% of all surgical procedures. The life-threatening nature of severe surgical site infection is well known. More than 75% of all deaths in patients with SSIs are attributable to the SSIs. For less severe varieties, associated morbidity of SSIs related complications and increased financial burden on the patients who survive is highly significant.

Points for intervention could be reduction of duration of preoperative hospital stay, reduction in the duration of surgical procedures, avoid unnecessary drains, in addition to initiation of standardized SSI active surveillance and feedback of relevant data to surgeons that can help in reducing the rate of Surgical Site Infections. Henceforth our study would help to estimate risk factors for SSIs and their prevalence rate.

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