



## Surgical Site Infection in Clean, Clean-Contaminated and Contaminated Cases

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### Abstract

**Objective-** To study the incidence, risk factors, most common organisms encountered and its antibiotic sensitivity and resistance in Surgical Site Infection cases of Clean, Clean-Contaminated and Contaminated cases.

**Material and Methods-** Study was carried out in the Department of General Surgery, from November 2014 to April 2016 on 200 admitted patients who underwent various surgical procedures (clean, clean-contaminated and contaminated cases) and were assessed pre-operatively, intra-operatively and post-operatively. Patients were followed up to 30 days post-operatively. Infected wounds were studied bacteriologically and clinically.

**Results-** The overall infection rate was 5.50%. Surgical site infection rate was 0.0% in clean surgeries, 4.82% in clean-contaminated surgeries, 23.33% in contaminated surgeries. Surgical site infection rate was higher (9.52%) in emergency surgeries than in elective surgeries (3.65%). The most common isolate was *Klebsiella spp.* followed by *Pseudomonas* and *E.coli*.

**Conclusion-** Incidence of General Surgical Site Infection is 5.5%. Emergency cases have high infection rate. Longer the duration of surgery more is the Surgical Site Infection rate. Gram -ve bacilli were more common isolates detected. Most of the bacterial isolates were multidrug resistant.

**Keywords-** Surgical site infection, *Klebsiella spp.*, *Pseudomonas aeruginosa*, Risk of Surgical site infection.

### Introduction

Surgical site infections are the most common healthcare associated infection (HAI) and account for \$3.2 billion in attributable cost per year in acute care hospitals.<sup>[1]</sup> Despite the advances made in asepsis and antisepsis and the availability of a wide range of powerful antibiotics, post-operative surgical site infection still remains most difficult and important problem in surgical practice.<sup>[2][3]</sup> Surgical site infection frequently leads to an increased morbidity that can result in increased length of stay in hospital and increased health care

costs. There are estimated additional 11 days of hospitalization for each surgical site infection per patient.<sup>[1]</sup> The incidence and pattern of post-operative surgical site infection differs not only from hospital to hospital but also from ward to ward depending upon patient's condition and type of operation.<sup>[4],[5]</sup> Objective of this study was to know the incidence, risk factors, most common organisms encountered and its antibiotic sensitivity and resistance in Surgical Site Infection cases of Clean, Clean-Contaminated and Contaminated cases.

## Material and Methods

The present study was carried out in the Department of General Surgery, Krishna Institute of Medical Sciences, Karad from November 2014 to April 2016 on 200 admitted patients who underwent various surgical procedures. All the patients were assessed pre-operatively, intra-operatively and post-operatively.

Surgical site was considered to be infected according to the criteria of CDC definitions of surgical site infections.<sup>[6]</sup> The surgical site were classified as clean, clean-contaminated, contaminated and dirty as per National Research Council Classification Criteria (1964). This classification is based on the extent of intra-operative contamination.<sup>[7]</sup> Each patient was followed up from the time of admission till discharge from the hospital and also for 30 days post-operatively.

A Performa was filled for each patient documenting age, sex, occupation, address, date of admission, chief complaints, associated diseases like diabetes, past history, personal history, clinical diagnosis, pre-operative hospital stay, date of surgery, type of surgery (emergency or elective), drain used and its type, duration of surgery, details of timing of antimicrobial prophylaxis, haemoglobin estimation, the wound class etc.

Post-operative findings which included; day of surgical site infection, day of 1st dressing and frequency of change of dressing noted. Surgical site were examined in post-operative period for 30 days for suggestive signs and symptoms of surgical site infection which included fever, erythema, increased local temperature, discharge and its type serous (non purulent) or purulent (pus). Sterile cotton swabs were obtained from the depth of wounds showing signs and symptoms of surgical site infection and were sent to Microbiology Department for culture and sensitivity.

In the microbiology department, the swabs were inoculated onto blood agar plate, McConkey's agar plates and nutrient broth. Inoculated media

were incubated aerobically at 37<sup>0</sup>C for 24-48 hrs. Nutrient broth was sub cultured if the original plates did not yield organisms. The bacteria isolated were identified by their morphological and cultural characteristics.

The samples collected were processed as follows:

1. Direct microscopic examination of Gram stained smear.
2. Inoculation of the samples onto different culture media for aerobic organisms.
3. Preliminary identification
4. Bio-chemical tests
5. Antibiotic sensitivity

## Results

Out of total 200 patients, 87 (43.5%) were clean surgeries, 83 (41.5%) were clean-contaminated surgeries and 30 (15%) were contaminated surgeries.

Of the total 200 patients included in this study, 11 developed surgical site infection with the overall infection rate was 5.5%. Surgical site infection rate was 0.0% in clean surgeries, 4.82% in clean-contaminated surgeries and 23.33% in contaminated surgeries. In clean-contaminated surgeries, infection rate in patients with surgeries for open cholecystectomy. In contaminated surgeries, infection rate in patients with surgeries for resection and anastomosis of bowel was done. Surgical site infection among Emergency surgeries was 9.52% whereas among Elective surgeries was 3.65%.

Out of total 200 patients, 106 patients had a pre-op hospitalization of 0 to 24 hours and infection rate was 3.77%. But infection was more among patients who had pre-op stay of 49 to 72 hours (i.e.11.11%). 150 cases had operation time <1.5 hours with incidence of infection was 2.0%, 50 of cases had operation time of >1.5 hours with an incidence of infection was 16.0%. Wound infection rate was much higher (13.89%) in cases where drain was used than in non-drained wounds (0.7%).

Out of 11 infected wounds, 1 case had infection detected on 2<sup>nd</sup> post-operative day(9.09%),

followed by 2 cases each had infection detected on 3<sup>rd</sup> and 4<sup>th</sup> post-operative day(18.18%), followed by 3 cases each had infection detected on 5<sup>th</sup> and 6<sup>th</sup> post-operative day(27.27%).

Out of 11 infected cases, one bacterial isolate was detected in 8 cases and two bacterial isolates were detected in 3 cases from which 6 cases had *Klebsiella* infection(42.86%), 3 cases each had *E. coli* (21.43%) and *Pseudomonas aeruginosa* (21.43%), 1 case each had coagulase positive *Staphylococcus* (7.14%) and *Diphtheroid* infection (7.14%).

*Staphylococci* was most sensitive to cefoperazone/sulbactam, meropenem and amoxicillin/clavulanic acid (100%). *Pseudomonas* was most sensitive to cefoperazone/sulbactam, cefepime, amikacin, meropenem and colistin (66.6%), followed by gentamycin, piperacillin/tazobactam, ceftriaxone and linezolid. *E. coli* was most sensitive to colistin (66.6%), followed by amikacin, piperacillin/tazobactam, meropenem, tigecycline, amoxicillin/ clavulanic acid and linezolid. *Klebsiella* was most sensitive to cefoperazone/sulbactam and cefepime (66.6%), followed by amoxicillin/ clavulanic acid, ampicillin and colistin. *Diphtheroids* was most sensitive to gentamycin, piperacillin/tazobactam and ceftriaxone.

*Staphylococci* was most resistant to gentamycin, ceftriaxone and linezolid (100%). *Pseudomonas* was most resistant to cefoperazone/sulbactam, cefepime, amikacin, gentamycin, piperacillin/tazobactam, tigecycline, ampicillin, colistin (33.3%), followed by other antibiotics. *E. coli* was most resistant to gentamycin and piperacillin/tazobactam (66.6%), followed by other antibiotics. *Klebsiella spp.* was most resistant to piperacillin/tazobactam (66.6%), followed by other antibiotics. *Diphtheroids* was most resistant to amikacin, azithromycin and tigecycline (100%). The mean postoperative stay, in patients who did not develop any surgical site infection, was 6.19 days, whereas the mean postoperative stay increased four times (24.82 days) in 11 patients, who developed surgical site infection.

## Discussion

The surgical site infection rate reports by different workers have differed considerably. The overall infection rate in the present study was 5.5% and compares favourably with other reported rates in India was ranging from 2.8% to 26.7%. [2],[3],[8],[9],[10],[11],[12],[15]

Number of studies carried out in India indicate an overall infection rate of 3.03% to 30% for clean surgeries, 9.28% to 45% for clean-contaminated surgeries and 22.22% to 64.8% for contaminated surgeries. [3],[10],[11],[12],[13],[14][15] Findings in the present study show that there is significant rise in infection rate with increased degree of operative contamination; rate of infection for clean surgeries was 0.0%, 4.82% in clean-contaminated surgeries, while it was 23.33% in contaminated surgeries.

Different studies show that infection rate was more in emergency surgeries as compared to elective surgeries. [2],[3] In present study the infection rate in elective surgery was found to be 3.65% which was much more in emergency surgeries at 9.52%. The high rates of infection in emergency cases can be attributed to inadequate pre-operative preparation, the underlying conditions which predisposed to the emergency surgery and the more frequency of contaminated or dirty wounds in emergency surgeries.

Patients who had pre-operative hospitalization of 49-72 hours, had surgical site infection incidence of 11.11% and patients who had >72 hours of pre-operative hospitalization had SSI incidence of 9.26% which was much higher than the patients who had pre-operative hospitalization of less than 48 hours being 3.25% to 3.77%. The higher incidence of infection rate due to a longer pre-operative stay in the hospital could be attributed to the increased colonization of patients and also, it reflected the severity of illness and the co-morbid conditions which required patient work-up and or therapy before operation. Similar observations were made by Anvikar et al. who reported an infection rate of 1.76% when pre-operative stay was upto one day and which increased to 5%

when pre-operative stay was more than one week.<sup>[12]</sup> Lilani SP et al. and Kowli et al. also made similar findings with regard to pre-operative hospital stay.<sup>[10],[15]</sup>

In the present study, 13.89% of cases (10/72) developed surgical site infection in which drain was used. Drains placed in the incision cause more infection than they prevent. The increased rate of infection in drained wounds may be due to:- 1) the foreign body effect of drain itself, 2) the drain setting as a microbial pathway, 3) the possible reduction of the infection dose required and 4) the nature of the operation itself.<sup>[17]</sup> Similar observations were made by Mawalla B et al. and Lilani SP et al. in their studies and found that infection rate was much higher in cases where a drain was used than in non drained clean and clean-contaminated cases.<sup>[16],[10]</sup>

In the present study, surgical site infection rate was 16% in cases in which the duration of surgery was >1.5 hours as compared to 2% surgical site infection rate in cases which took <1.5 hours for completion of procedure. Mawalla B et al. in their study reported surgical site infection rate of 20.9% in patients with duration of operation <3 hours and 50% in those which had operation time of >3 hours.<sup>[16]</sup>

In this study, monomicrobial isolates were detected in 8 cases and two microbial isolates in 3 cases. Most common organism isolated in this study is *Klebsiella* 42-86% followed by *Pseudomonas* and *E. coli* 21.43% each, and *Staphylococcus* and *Diphtheroids* 7.14% each. Gram negative bacilli are now replacing *Staphylococcus*.<sup>[12]</sup> Present study also showed the predominance of Gram -ve bacteria. Anvikar AR et al. also reported *Klebsiella* as the most common isolate.<sup>[12]</sup> Rao et al. also found similar results i.e. unimicrobial isolate in 64.8% cases and multiple isolates in 38.2% cases. He also reported that Gram negative bacilli as the more common isolate from surgical site infection cases than Gram positive *Staphylococci*.<sup>[18]</sup> In most cases of surgical site infection the organism responsible is usually patient's endogenous flora. In abdominal

surgeries the opening of the gastrointestinal tract increases the likelihood of coliforms, Gram negative bacilli which is our finding in this study.

In our study, *Staphylococci* was most sensitive to cefoperazone/sulbactam, meropenem and amoxicillin/ clavulanic acid (100%). *Klebsiella* was most sensitive to cefoperazone/sulbactam and cefepime (66.6%), followed by amoxicillin/ clavulanic acid, ampicillin and colistin. *Pseudomonas* was most sensitive to cefoperazone/sulbactam, cefepime, amikacin, meropenem and colistin (66.6%), followed by gentamycin, piperacillin/tazobactam, ceftriaxone and linezolid. *E. coli* was most sensitive to colistin (66.6%), followed by amikacin, piperacillin/ tazobactam, meropenem, tigecycline, amoxicillin/ clavulanic acid and linezolid. *Diphtheroids* was most sensitive to gentamycin, piperacillin/ tazobactam and ceftriaxone. Overall cefoperazone/sulbactam and colistin (50.0%) were the most sensitive antibiotics followed by cefepime (42.85%), amikacin, meropenem and amoxycillin/clavulanic acid (35.71%) each.

*Klebsiella spp.* was most resistant to piperacillin/tazobactam (66.6%), followed by amikacin (50%), gentamycin and meropenem (33.33%) each, followed by other antibiotics. *Staphylococci* was most resistant to gentamycin, ceftriaxone and linezolid (100%). *Pseudomonas* was resistant to cefoperazone/sulbactam, cefepime, amikacin, gentamycin, piperacillin/ tazobactam, tigecycline, ampicillin, colistin (33.3%). *E. coli* was most resistant to gentamycin and piperacillin /tazobactam (66.6%), followed by amoxycillin/clavulanic acid and ceftriaxone (33.33%). *Diphtheroids* was most resistant to amikacin, azithromycin and tigecycline (100%). Over all piperacillin/tazobactam (50.0%) was the most resistant antibiotic noted followed by amikacin, gentamycin and ceftriaxone.

Malik S et al. (2011) reported similar findings that *E.coli* and *Klebsiella spp.* were most sensitive to imipenem (91%) followed by cefoperazone/ sulbactam (89.5%), meropenem (88%) and piperacillin/tazobactam (85%), *Pseudomonas* was



most sensitive to colistin (100%) followed by meropenem (86.1%) and amikacin (83.33%).<sup>[19]</sup> Mahesh CB et al. (2011) reported that most of the bacterial isolates were multi-drug resistant. *Pseudomonas aeruginosa* showed maximum sensitivity to imipenem (80%) ceftazidime (60%) while it showed maximum resistance to amikacin (58%), ceftriaxone (75%) and cefotaxime (57.1%).<sup>[3]</sup>

These findings support the well known high prevalence of multiple antibiotic resistant nosocomial pathogens in our environment and may reflect the widespread inappropriate and injudicious use of antibiotics in the general population.

### Conclusion and Recommendations

Incidence of General Surgical Site Infection is 5.5%. Emergency cases have high infection rate. Longer the duration of surgery more is the Surgical Site Infection rate. Contaminated cases had more SSI rate (23.33%) as compared to clean-contaminated cases (4.82%). Gram -ve bacilli were more common isolates detected. *Klebsiella spp.* being the most common organism isolated in the study. Most of the bacterial isolates were multidrug resistant.

Regular surveillance of SSI followed by auditing and feedback of results to the surgeons on regular basis. Reducing the pre-operative stay to minimum. Minimizing the duration of operation through adequate training of staff on proper surgical techniques. Avoiding wound drains. If this is not possible, using a closed drainage system and removal of drains as soon as possible. Ensuring that the patient is as fit as possible. Proper intra-operative infection control measures by implementing strict antiseptic and aseptic methods. Encouraging efforts in reducing the known risk factors to a bare minimum in elderly patients. Proper collection and transport of samples from the surgical site, immediately on suspicion of infection. Awaiting antibiotic sensitivity test results for appropriate antibiotic therapy, to avoid emergence of resistant strains.

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