Superficial Incisional Surgical Site Infection In Elective Abdominal Surgeries - A Prospective Study.

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Citation
S SAHU., J SHERGILL., P SACHAN., P GUPTA.. Superficial Incisional Surgical Site Infection In Elective Abdominal Surgeries - A Prospective Study.. The Internet Journal of Surgery. 2009 Volume 26 Number 1.

Abstract
All postoperative surgical infections occurring in an operative site are termed surgical site infections. Superficial incisional surgical site infection occurs within 30 days after the operation and infection involves only skin or subcutaneous tissue of the incision and represents a substantial burden of disease for patients and health services. Aim of the study: To determine the incidence of surgical site infection in elective abdominal surgeries; to correlate the surgical site infection with the nature of elective surgical procedure; to study the profile of bacterial isolates obtained from cases of surgical site infection. Material and Methods: The present study was carried out in the Department of General Surgery and Department of Microbiology at the Himalayan Institute of Medical Sciences, Dehradun, India from November 2008 to October 2009. The patients who underwent elective abdominal surgery were included in the study group. These patients were followed up for superficial incisional surgical site infections until complete wound healing occurred or on their discharge from the hospital. Observation: The incidence of surgical site infection in elective surgeries was found to be 5%. E. coli was the most common organism isolated followed by Staphylococcus aureus. Risk factors like diabetes mellitus, smoking and duration of surgery play a significant role in causing surgical site infection. Conclusion: An effective surveillance programme for surgical site infections should be a critical component of any hospital infection control programme to reduce the rate of infection.

INTRODUCTION
Wound infection continues to be a baffling problem since time immemorial. The sixteen-century French surgeon Ambroise Paré is famous for saying, “I dressed the wound, God healed it”. Before the mid-19th century, surgical patients commonly developed postoperative “irritative fever,” followed by purulent drainage from their incision, overwhelming sepsis and often death. In the late 1860s, Joseph Lister (1827-1912) introduced the principles of antisepsis and postoperative infectious morbidity decreased substantially. Lister’s work radically changed surgery from an activity associated with infection and death to a discipline that could eliminate suffering and prolong life. (1, 2)

All postoperative surgical infections occurring in an operative site are termed surgical site infections. Superficial incisional SSI (surgical site infection) occurs within 30 days after the operation and infection involves only skin or subcutaneous tissue of the incision and at least one of the following criteria: Purulent drainage, with or without laboratory confirmation, from the superficial incision; organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision; and at least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness or heat, superficial incision deliberately opened by surgeon, unless the incision is culture-negative; and diagnosis of superficial incisional SSI by the surgeon or attending physician. (3)

Superficial incisional surgical site infections are the consequence of a summation of several factors: the inoculum of bacteria introduced into the wound during the procedure, the virulence of the contaminants, the microenvironment of each wound and the integrity of the patient-host defense mechanisms and represents a substantial burden of disease for patients and health services. (4)

AIM AND OBJECTIVE OF THE STUDY
The aim of the study was to evaluate the incidence of superficial incisional surgical site infection in elective abdominal surgeries; to correlate superficial incisional surgical site infection with nature of elective surgical procedure; and to study the profile of bacterial isolates obtained from cases of superficial incisional surgical site infection.
MATERIAL AND METHODS

This prospective study was carried out in the Department of General Surgery and Microbiology at the Himalayan Institute of Medical Sciences. These patients underwent elective surgeries and were followed up for superficial incisional surgical site infections until complete wound healing occurred or on their discharge from the hospital.

The inclusion criteria for superficial incisional surgical site infections were: infections occurring within 30 days of operation involving only skin or subcutaneous tissue of the incision with purulent drainage, with or without laboratory confirmation from the superficial incision; organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision; and at least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness or heat, superficial incision deliberately opened by surgeon, unless the incision is culture-negative; and diagnosis of superficial incisional surgical site infection by the surgeon or attending physician.

Samples were collected either as sterile cotton wool swab or as an aspirate with a sterile syringe from the superficial wound and subjected to microscopy and culture isolation and identification of all isolates. The results were analyzed using simple statistical tests such as averages and percentages. The significance of the results was statistically evaluated using appropriate tests, e.g. ANOVA test, Chi-square and mean calculations.

OBSERVATIONS

This was a prospective study comprising 200 subjects from November 2008 to October 2009. The maximum numbers of cases were in the age group of 41-60 years (38 %) followed by 21-40 years (37.5 %). (TABLE 1)

The maximum superficial incisional surgical site infections were seen in the age group of 61-80 years (10.7%) followed by the age group of 41-60 years (5.2%). The lowest number of infections was found in the 21-40 year age group (4.1%). There was no case of superficial incisional surgical site infection in the age group of 0-20 years and >81 years. (TABLE 2)

Higher incidence of infection was found in males as compared with females. (TABLE 3)

The incidence of superficial incisional surgical site infection was 4.39% in midline incisions but was highest in thoracoabdominal incisions and lowest in Pfannenstiel incisions. (TABLE 4)
Superficial incisional surgical site infection is associated more with procedures involving bowel. (TABLE 5)

**Figure 5**
Table 5. Procedures associated with superficial incisional surgical site infection

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Procedure</th>
<th>No. of cases with superficial incisional surgical site infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Open choledochotomy</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Open choledochotomy + appendectomy</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Laparotomy closure</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Left adrenalectomy + splenectomy</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Pancreaticoduodenectomy</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Oesophagoectomy</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Salpingo-oophorectomy</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Bowel resection and anastomosis</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>10</td>
</tr>
</tbody>
</table>

**Figure 6**
FIG. 1. Comparison of incidence of superficial incisional surgical site infection with duration of surgery

Surgical site infection was nearly 4 times more frequent in cases in whom operating time was >2 hours as compared to cases in whom operating time was <2 hours. (FIG-1) By Chi-square test, p-value was 0.017. This p-value is <.05, hence it is significant. Moreover the infection was more often observed with increase in the length of hospital stay with maximum surgical site infections seen in cases (16.7 %) that had a length of stay between 16-20 days. ANOVA test was applied and an overall significance was seen in the cases that had a prolonged length of stay. Post-Hoc test in ANOVA showed a p-value <.05 which was significant. (FIG-2)

**Figure 7**
FIG. 2. Superficial incisional SSI in relation to length of hospital stay

Diabetes mellitus (20 %) was the major risk factor in cases of surgical site infection, followed by smoking and alcohol (12.5%). Smoking as a risk factor was seen in 8.3 % of cases of surgical site infection. (TABLE 6)

**Figure 8**
TABLE 6. Risk factors associated with Superficial Incisional SSI

Monomicrobial infection was seen in 8 cases and polymicrobial infection was seen in 2 cases. E. coli was the dominant organism (50 %) for surgical site infection. In one case E. coli was isolated along with Pseudomonas aeruginosa and in the other E. coli was isolated with Ent. faecalis. Staph. aureus was seen in 2 cases (20 %). One case (10%) each of Pseudomonas aeruginosa, Coagulase-negative staphylococci and Proteus mirabilis was noted. (FIG. 3)
E. coli was seen in cases operated for intestinal obstruction, cholelithiasis with appendicitis, and left adrenal mass. E. coli and Pseudomonas aeruginosa were seen in another case of intestinal obstruction. Ent. faecalis and E. coli were cultured from an operated case of carcinoma of the oesophagus. Pseudomonas aeruginosa was seen in a case operated for tubo-ovarian mass. Coagulase-negative staphylococcus was cultured in a case of cholecystitis, Proteus was cultured in a case of ileostomy closure and Staphylococcus aureus was seen after Whipple’s procedure and ileostomy closure.

**DISCUSSION**

Hospital infection control programs are an essential component of the quality of healthcare. Surgical site infections are one of the most common types of hospital-acquired infection, and feedback of rates has been associated with improvement.5

In the present study, a total of 200 patients undergoing various surgical procedures were assessed and the age of the patients ranged from 0.5 to 81 years. Extremes of age have been reported to have a higher incidence of wound infections, perhaps owing to decreased immunocompetence. The maximum number of patients was found in the age group of 41-60 years (38 %) followed by the age group of 21-40 years (37.5 %). Mean age was 43.31 years. Sohn et al. reported an average of 39 years in a study group of 280 cases.6

In our study, the maximum patient numbers were in the age group of 41-60 years and amongst the 10 patients with superficial incisional surgical site infection, the maximum infection rate was observed in patients of the age group of 61-80 years. The lowest infection rate was in the 21-40 year age group (4.1%). A higher incidence of infection was found in males as compared with females in our study. Similarly, a study conducted in a Peruvian Hospital in 2005 by Hernandez et al. reported 65.6% males and 34.4% females among the SSI patients.7

The patients selected underwent various elective abdominal surgical procedures like laparoscopic surgeries, splenectomy, hepatobiliary-pancreatic procedures, exploratory laparotomy, appendicectomy, hernioplasty, total abdominal hysterectomy with bilateral salpingo-ophorectomy, tubo-ovarian mass removal and bowel resection with anastomosis. The incidence of superficial incisional surgical site infection in midline incision was 4.39% but was highest in thoracoabdominal incision and lowest in Pfannenstiel incision. Similarly, in a study by Anvikar et al. on 3280 surgical wounds, the commonest surgery performed was lower-segment Cesarean section and prostatectomy followed by laparotomy and out of the surgical site infection cases, the cases of laparotomy (25%) were seen most frequently, followed by prostatectomy (20.5%).8

In the present study, the overall infection rate was 5%. This is in agreement with two recent Indian studies on surgical wounds conducted in Aurangabad and Mumbai, which showed almost similar infection incidences of 6.1% and 8.95%, respectively. Other older Indian studies by Agarwal (1972) and Rao Venkataraman MS. (1975) and other authors done at different periods of time reported an overall higher infection rate ranging from 10.2% to 25%. Studies conducted by Wanger MB et al. (1997), Vilar-Compte D et al. (1999) and Soleto et al. (2003) in other developing countries reported infection rates of 8.7%, 9.7% and 12% from Brazil, Mexico and Bolivia, respectively, and as high as 26.7% from Peru (Hernandez et al. in 2005). Surgical site infection rates assessed in a Canadian and Irish hospital over a prolonged period of 10-16 years showed a rate of only 4.7% and 4.5%, respectively, in a study by Creamer et al. (2002) and Cruse et al. in 1980. Reports from other developed countries by Gebubbels et al. (2000) and Saito et al (2005) also showed a lower incidence of infection of 3.1% in the UK (2000), 4.3% in the Netherlands and 7.6% in...
Japan. The above observations indicate that larger groups studied over longer duration may give a better assessment of surgical site infection rates. Besides this, a lower infective rate in developed countries as compared to developing countries indicates a better implementation of infection control practices along with availability of a proper surveillance system.

In the present study, the incidence of superficial incisional surgical site infection was found to be influenced by the duration of surgery. The incidence is higher with surgeries lasting more than 2 hours (24.3%). A similar trend was found in a study by Anvikar et al. (1999) which reported 2.6% SSI in surgeries of duration less than 1 hour, 4.8% SSI in surgeries between 1-2 hours and 5.4% SSI in surgeries that lasted for more than 2 hours. The infection rate in surgeries of 1-2 hour duration was significantly higher (p<0.02) than in those of less than 1 hour duration. From a study done in Thailand Kasatpibal et al. (2006) also reported an incidence of infection of 0.9% in surgeries less than 1 hour and 2.5% SSI in surgeries lasting for more than 1 hour which was similar to findings of other studies by different authors.

Length of hospitalization and duration of stay was significantly associated with surgical site infection. A prolonged preoperative stay with exposure to hospital environment and its ubiquitous diagnostic procedures, therapies and micro-flora has been shown to increase the rate of surgical site infection. Longer post-operative stay also results in prolonged exposure to the potentially infective hospital environment, and consequently higher infection rate. Similarly, in our study the incidence of infection was high with a post-operative hospital stay of more than 16-20 days (16.7%). However, in our patients the preoperative stay was limited to 1-2 days as all the cases were elective in nature.

A study by Cruse and Foord (1973) reported the infection rate in clean wounds as 10.7% in diabetics, compared with an overall clean wound infection rate of 1.8% in non-diabetic patients. In our study, the infection rate was 20% in diabetic cases and 8.3% of cases were smokers. Current cigarette smoking was found to be associated with a slightly increased wound infection rate by causing local and systemic vasoconstriction leading to tissue hypoxia which delays primary wound healing.

In our study, most of the specimens showed monobacterial growth. Studies by Classen et al. (1992) and Giacometti et al. (2000) reported monomicrobial and polymicrobial wound infections, respectively. For most surgical site infections, the source of pathogens is the endogenous flora of the patient’s skin, mucous membranes, or hollow viscera. These organisms are usually aerobic gram-positive cocci (e.g., Staphylococci), but may include fecal flora (e.g., anaerobic bacteria and gram negative aerobes) when incisions are made near the perineum or groin. When a gastrointestinal organ is opened during an operation and is the source of pathogens, gram-negative bacilli (e.g., E. coli), gram-positive organisms (e.g., Enterococci), and sometimes anaerobes (e.g., Bacillus fragilis) are the typical SSI isolates.

The most common bacterium isolated in our study was Escherichia coli (50%) followed by Staphylococcus aureus (20%). Other bacteria isolated were, Pseudomonas aeruginosa (20%), Enterococcus faecalis (10%), Proteus mirabilis (10%), and Coagulase-negative staphylococci (10%). Exogenous sources of SSI pathogens include surgical personnel (especially members of the surgical team), the operating room environment (including air), and all tools, instruments, and materials brought to the sterile field during an operation. Exogenous flora are primarily aerobes, especially gram-positive organisms.

CONCLUSION

Our study reveals a superficial incisional surgical site infection incidence rate of 5% in cases of elective abdominal surgeries. Length of stay and duration of surgery were found to be major risk factors responsible for causing surgical site infection followed by diabetes mellitus and smoking. Minimizing the incidence of postoperative wound infection relies on adequate asepsis and antisepsis, and preservation of the local host defenses.

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