

RESEARCH ARTICLE

A prospective study of antibiotic sensitivity profile of pathogens isolated from surgical site infection at major surgical departments at tertiary care hospital

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ABSTRACT

Background: A number of studies have been carried out in India and worldwide reporting different incidence rates of surgical site infections (SSIs), various pathogens isolated, and their antibiotic sensitivity pattern. The difference incidence rates of SSIs may be due to differences in the hospital set-up, preventive measures taken and the prophylactic use of antibiotics. Even in the same hospital, the same type of survey at different periods may report different incidence rates of SSIs depending on prevailing conditions at the time of survey. **Aims and Objectives:** To find out the current rate of incidence of SSI with common pathogen causing SSI and their susceptibility pattern in Sir Sayajirao General Hospital (SSGH), Vadodara. **Materials and Methods:** This prospective study included 953 patients undergoing major operations in major surgical departments of Shri Sayajirao General Hospital, Vadodara over a period of 8-month. **Results:** Out of 953 patients, 35 developed clinical signs and symptoms suggesting SSI (3.67%). Out of these 35 cases, no pathogen was isolated from 22 cases which may be due to subjective errors in collection and processing of samples. The predominant organisms isolated were Gram-negative organisms (84.6%), while *Staphylococcus aureus*-the only Gram-positive organism isolated contributed 15.4%. Imipenem, ampicillin+sulbactam, cefotaxime, and amikacin were the most sensitive antibiotic for Gram-negative organisms. Vancomycin, cloxacillin, oxacillin, and amoxicillin-clavulanic acid combination were most sensitive antibiotic for Gram-positive organisms. Most of the commonly used antibiotics have got resistance for isolated organisms. Among them, the predominant is cefazolin, chloramphenicol, ofloxacin (OFX), erythromycin, roxithromycin and penicillin for Gram-positive organisms and netilmicin, tobramycin, piperacillin, OFX and gatifloxacin for Gram-negative organisms. **Conclusion:** Regarding SSI, nowadays there is a trend toward comparative studies in the same hospital over years. In SSGH, Vadodara, there is a decrease in rate of incidence of SSI over years.

KEY WORDS: Surgical Site Infection; Antibiotic Sensitivity; Post-operative Complication

INTRODUCTION

One of the most common sites from which patients acquire infection is hospitals. Researchers have noticed post-operative fever even in 19th century. Overwhelming sepsis and death due to sepsis was common picture in patients who have undergone surgery and developed post-operative infection.^[1]

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Surgical site infection (SSI) is one of the most common hospitals acquired infection. Hospital-acquired/nosocomial infection is defined as an infection originating in a patient, while in a hospital or other healthcare facility. It denotes a new disorder (unrelated to patient's primary condition) associated with being in a hospital. That is, it was not present or incubating at the time of admission or the residual of an infection acquired during a previous admission. It also includes infections acquired in the hospital, but appearing after discharge and also such infections among the staff of facility.^[2] Nosocomial infections occur worldwide and affect both developed and resource-poor countries. Infections acquired in health care setting are among the major causes of death and increased morbidity among hospitalized patients. They are a significant burden both for the patient and for public health. The most common nosocomial infections are SSIs as well as infections of respiratory and urinary tract.^[3]

The center for disease control and prevention (CDC), USA has defined SSI as an infection when it occurs at the site of surgery within 30 days of operation or within 1 year of an operation if a foreign body (joint, artificial heart valve) is implanted as a part of surgery. Most SSIs are superficial infection involving the skin only. The remaining infections are more serious and can involve tissues under the skin, organs or implanted material. The majority of SSIs do not become life threatening.^[4]

The national nosocomial infection surveillance system of CDC, USA, has developed standardized surveillance criteria for defining SSIs. By these criteria, SSIs are classified as being either incisional or organ/space. Incisional SSIs are further divided into those involving only skin and subcutaneous tissue (superficial incisional SSI) and those involving deeper soft tissues of the incision (deep incisional SSI). Organ/space SSIs involve any part of the anatomy (e.g., organ or space) other than incised body wall layers.^[1]

SSIs add to functional disability and emotional stress of the patient and may in some cases, lead to disabling conditions that reduce the quality of life. The economic cost is considerable. The increased length of stay due to SSIs is the greatest contributor to cost. The WHO has reported that the overall increase in the duration of hospitalization for a patient with surgical wound infections was 8.2 days, ranging from 3 days for gynecology to 9.9 days for general surgery and 19.8 days for orthopedic surgery.^[3] Prolong stay not only increases direct costs to patients or payers but also indirect costs due to loss of work. The increased use of drugs, the need for isolation if required and the use of additional laboratory and other diagnostic studies also contribute to costs.

SSIs present a serious hazard to patients. Local complication includes tissue destructions, wound dehiscence, incisional and deep hernias, septic thrombophlebitis, recurrent pain and disfiguring and disabling scars. Systemic complications include

toxemia, bacteremia, shock, metastatic infection, failure of vital organs remote from the infection, and death. The severity of each complication depends in large part on the infecting pathogen and on the site of infection. SSIs are the third most frequent nosocomial infection in most hospitals and are an important cause of morbidity and excess hospital costs.^[1]

A number of studies have been carried out in India and worldwide reporting different incidence rates of SSIs, various pathogens isolated and their antibiotic sensitivity pattern. The difference incidence rates of SSIs may be due to differences in the hospital set-up, preventive measures taken, and the prophylactic use of antibiotics. Even in the same hospital, the same type of survey at different periods may report different incidence rates of SSIs depending on prevailing conditions at the time of survey.

Keeping this in mind, this study was planned in Sir Sayajirao General Hospital (SSGH), Vadodara, Gujarat with the primary objective of to find out the current rate of incidence of SSIs in major surgical departments of SSGH, Vadodara. Secondary objectives were to find out common pathogens responsible for SSIs and their antibiotic susceptibility.

MATERIALS AND METHODS

In the present prospective study, a total of 953 operative cases of both sex and different age groups consisting of 296 patients from obstetrics and gynecology, 313 patients from orthopedics, and 344 patients from general surgery departments of SSGH, Vadodara were taken during the period December 2007 to July 2008.

Routine history and the basic pre-operative investigations for all the patients were recorded in case record form which also included pre- and post-operative hospital stay; the use of prophylactic antibiotic and their timing (pre-operative and/or post-operative); data regarding surgery like, type of surgery (emergency/elective), type of anesthesia, surgery performed by senior consultant or junior doctor. Follow-up of all the patients were done in the respective ward till discharged.

Out of all 953 patients studied, patients who developed clinical signs and symptoms suggestive of post-operative wound infection, which included discharge from wound, pain at the site of wound, swelling, delayed or non-healing wound, foul smelling from wound were further studied for antimicrobial susceptibility.

Samples from wound discharge were collected using sterile swab and were studied for identification of organism if present by Gram-staining and culture growth. Samples were collected, transported and processed as per standard bacteriological methods. Utmost care was taken to avoid unnecessary delay in processing.

Antimicrobial susceptibility was carried out by disc Diffusion method (modified Kirby–Bauer method) against the 12 most commonly prescribed antimicrobials in SSGH for Gram-positive organisms cefazoline (CZ), chloramphenicol (C), ciprofloxacin (CIP), cloxacillin (CX), erythromycin (E), oxacillin (OX), penicillin (P), cefotaxime (CTX), roxithromycin (RXT), amoxycillin+clavulanic acid (AMC) and vancomycin and for Gram-negative organisms Ampicillin+sulbactam, gentamicin (G), CTX, Amikacin (AN), netilmicin (NET), CIP, imipenem (IPM), gatifloxacin (GF), ofloxacin (OFX), piperacillin (PIP), piperacillin+tazobactam (TZP), and tobramycin (TOB).

The clinical interpretation sensitive (S), resistant (R) or intermediate (M) is based on susceptibility value of the zone size as (minimum inhibitory concentration) measured by the diameter from the zone of inhibition.

The zone of inhibition for each antimicrobial agent was measured using a calibrated ruler to the nearest mm. The reading was done to the point of complete inhibition with the unaided eye.

The zone of inhibition (mm) on the culture plate was categorized as sensitive (S), intermediate (M) or resistant (R).

RESULTS

In this study, 296 cases from Obstetrics and Gynecology Department, 313 cases from Orthopedic Department and 344 cases from General Surgery Department, total 953 cases of both sex and different age groups, from SSGH, Vadodara, were studied for the period from December 2007 to July 2008.

After operation, all cases were followed up in wards till discharged from the hospital. Out of all surgeries during the post-operative period, 35 cases developed clinical signs and symptoms suggestive of post-operative wound infections. Hence, incidence of SSI was 3.67% in our study.

A maximum number of patients that developed post-operative wound infection were higher in the third and fourth decade of life in obstetrics and gynecology patients, fourth and fifth decade in general surgery patients and fifth decade in the case of orthopedic patients.

In Orthopedic Department, all patients were given surgical chemoprophylaxis. In Surgery Department, 109 patients out of 344 were given prophylactic antibiotic (31.68%), while in Obstetric and Gynecology Department, use of prophylactic antibiotic was in 61.48% patients. Hence, the overall usage of antibiotic prophylaxis was 63.27%.

In General Surgery Department, incidence of SSIs was higher in male gender (10% over 2.7%), while in orthopedic

Table 1: Frequency of organism isolated by culture from postoperative wound infections

Types of organism	Number of isolation (%)
<i>Staphylococcus aureus</i>	2 (15.38)
<i>Pseudomonas aeruginosa</i>	3 (23.07)
<i>Escherichia coli</i>	3 (23.07)
Klebsiella	4 (30.76)
<i>Acinetobacter</i>	1 (7.69)
<i>S. aureus: Staphylococcus aureus, P. aeruginosa: Pseudomonas aeruginosa, E. coli: Escherichia coli</i>	

Table 2: Efficacy of antibiotics commonly used for Gram-negative bacteria (total isolates-11)

Drugs	Number of isolates (%)	
	Sensitive	Resistant
SAM	7 (63.63)	4 (36.36)
Gentamicin (G)	4 (36.36)	7 (63.63)
CTX	7 (63.63)	4 (36.36)
AN	6 (54.54)	5 (45.45)
CIP	5 (45.45)	6 (54.54)
NET	1 (9.09)	10 (90.9)
IPM	8 (72.72)	3 (27.27)
GF	3 (27.27)	8 (72.72)
OFX	3 (27.27)	8 (72.72)
PIP	3 (27.27)	8 (72.72)
TZP	5 (45.45)	6 (54.54)
TOB	1 (9.09)	10 (90.9)

SAM: Ampicillin+sulbactam, CTX: Cefotaxime, AN: Amikacin, CIP: Ciprofloxacin, NET: Netilmicin, IPM: Imipenem, GF: Gatifloxacin, OFX: Ofloxacin, PIP: Piperacillin, TZP: Piperacillin+tazobactam, TOB: Tobramycin

department, it was slightly higher in female gender (3.48% over 3.14%).

Out of 35 samples collected from wound discharge, 13 samples showed bacterial growth, no organisms were isolated from 22 samples. Result of Gram-staining identified 2 Gram-negative and 11 Gram-positive organisms. Frequency of microorganisms isolated from surgical site infection are given in Table 1.

The result of antibiogram of *Staphylococcus aureus* showed that the organism was sensitive to CX, AMC, vancomycin and OX and resistant to cefazolin, chloramphenicol, erythromycin, OFX, penicillin, CTX and RXT.

Escherichia coli were sensitive to CTX, amikacin, IPM, PIP, TZP and resistant to gentamicin, CIP, NET, GF and tazobactam.

Klebsiella was sensitive to ampicillin+sulbactam, gentamicin, CTX, amikacin, CIP, IPM, OFX, PIP and TZP.

Pseudomonas were sensitive to ampicillin+sulbactam, gentamicin, CTX, amikacin, CIP, imipenem, PIP and TZP. Antibiogram of *acinetobacter* showed that it was sensitive to ampicillin+sulbactam, CTX, CIP, imipenem, PIP and TZP. Efficacy of commonly used antimicrobial agents against isolated microorganisms are given in Table 2

DISCUSSION

Hospital-acquired infections remain a major challenge to clinicians since many of them are now caused by organisms that are difficult to treat. Newer modalities of treatment often involve invasive procedures. These interfere with host defense making hospitalized patients more susceptible to infection. The organisms causing such nosocomial infections have become increasingly resistant to antimicrobial agents.^[5]

In our study of 953 cases, who underwent operations in major surgical departments (general surgery, orthopedics, obstetrics, and gynecology), 35 patients developed signs and symptoms suggestive of SSI. So, the rate of incidence of SSI in the present study was 3.67%.

There is considerable difference in the rate of incidence of SSI ranging from as low as 1.7% to as high as 25%. A number of studies carried out in India indicates an overall incidence rate of 6.09-25% for SSI.^[6-9] It may be misleading and fallacious to compare incidence rates of SSI in different setups. As the occurrence of SSI depends on different factors related to the patient and his disease; like age, sex, state of nutrition, existing medical condition, duration of pre-operative stay and duration of operative procedures as well as hospital environment, operating surgeons and techniques, etc. But, for the improvement, it may be compared with other studies in the same hospital over years.^[10]

The same type of studies conducted in SSGH, Vadodara in past showed a higher rate of incidence of SSI compared to the present study. A prospective study of 296 major surgical operations carried out in General Surgery Department of SSGHL, Vadodara found SSI rate of 17.24%.^[11] In another study, the rate of incidence of SSI reported was 17% during surgical procedures conducted at major Obstetric and Gynecology Department.^[12] In present study, rate of incidence of SSI was 3.67% which is quite lower than that reported by previous studies. Lower rate of SSI noted in the present study is probably because of proper use of prophylactic antibiotics and change in selection of antibiotic according to the prevalence of organisms responsible for nosocomial infections and their sensitivity pattern. Also adherence to very strict protocol and principles for prevention of SSI, supervised by Hospital Infection Control Committee) as well as continuing education and motivation of the staffs for appropriate use of antibiotics and proper aseptic practices or large number of sample size, played a major role in prevention as well as cure of SSI.

Bacteria can infect the patient through two major sources, exogenous (operation theater environment, ward environment, and dressing material) and endogenous. Some studies have found endogenous sources to be more important than exogenous sources in determining SSI.^[10,13] In contrast to these findings, few studies have found exogenous sources to be more important in the development of SSI.^[8] Hence, the pattern of pathogens isolated from SSI differs markedly in different studies. These differences may be due to variation in common nosocomial pathogens inhabitant in different hospital setups.

Comparing the pattern of pathogens isolated from SSI in different studies in our institute found predominantly Gram-negative organisms (71.2%) and Gram-positive organisms in only 28.8% isolates.^[11] In contrast 19 years later study found Gram-positive organisms in 44.2% samples, Gram-negative organisms in 47% samples and no organisms in 8.8% samples.^[12] In this study, we found the only Gram-positive organism (*S. aureus*) in 15.4% isolates while Gram-negative organisms contributed 84.6% isolates. The findings of this study differ from findings of previous studies done in the same hospital. This may be because the organisms most frequently involved in SSI change from time to time and also vary with hospital settings. Out of 35 patients with clinical signs and symptoms of SSI, no pathogen was isolated from 22 samples. This could be due to subjective error in collection and processing of sample. These 22 samples are not included while calculating percentage of different organisms causing SSI.

Increasing antibiotic resistance is really a major problem associated with hospital acquired infection including SSI. A number of studies in the literature indicate gradual increase in the emergence of antibiotic-resistant microorganisms in surgical patients.^[8,9]

If we compare antimicrobial susceptibility pattern of various organisms isolated from SSI in different studies there is major difference in susceptibility pattern. Type of antimicrobial susceptibility pattern also changes with different geographical area.

The antimicrobial susceptibility pattern of same organism varies over a period in the same hospital set up also. If we compare susceptibility pattern in 2 different studies carried out in SSGH, Vadodara at different time, it shows different patterns. In 2007, Gram-positive organisms were sensitive to vancomycin (92.33%), erythromycin (73.33%) and RXT (66.67%), while they were resistant to penicillin (100%), CX (86.67%), CTX (80%), cefazolin and Oxacillin (60%).^[12] While in present study 2 Gram-positive organisms isolated were fully sensitive to vancomycin, AMC, CX and OX while they were resistant to erythromycin, RXT, OFX, cefazolin, CTX, penicillin, and chloramphenicol. This pattern shows emergence of resistant organisms.

In 2007, Gram-negative organisms were sensitive to TZP (93.75%), GF (87.5%) while they were resistant to gentamicin (93.75%), NET and CTX (87.5%), TOB (81.25%), OFX and ampicillin-sulbactam combination (75%), CIP (68.75%), amikacin (62.5%) and IPM (53.3%).^[12] In this study Gram-negative organisms were sensitive to IPM (73%), CTX and ampicillin-sulbactam combination (64%) and amikacin (55%), while they were resistant to NET and TOB (91%), OFX, GF and PIP (73%), gentamicin (63%) and CIP and PIP - tazobactam combination (55%).

In this study, out of 953 patients, 603 were given pre-operative antibiotics as surgical chemoprophylaxis. In most of these patients, CTX and metronidazole were given. Few patients were given CIP, CX or cefadroxil as chemoprophylaxis. If we see the sensitivity patterns of organisms causing SSI for these antibiotics, Gram-positive organisms (*S. aureus*) were resistant to CTX and Gram-negative organisms were 36% resistant to it. Sensitivity of Gram-organisms for gentamicin was 37% only. Sensitivity of Gram-positive and Gram-negative organisms for CIP was 50% and 45%, respectively. Gram-positive organisms were sensitive to CX.

AN which is a broad spectrum antibiotic and was used for prophylaxis in some patients has shown 45% resistance. This shows that organisms causing SSI are by enlarge showing resistance to antibiotics used prophylactically. Hence, there should be a change in the antibiotic used as surgical chemoprophylaxis.

CONCLUSION

Review of various studies indicates gradual increase in the emergence of antibiotic-resistant microorganisms. In surgical patients, rate of incidence of SSI in any hospital depends much on hospital environment, dressing material, indiscriminate use of antibiotics, availability of antibiotics, etc. Antibigram may vary depending on the study group and hospital setup. Hence, now a day the trend is toward comparative studies in the same hospital over years. As clear from present study and comparison with previous studies done in SSGH, Vadodara, there is a decrease in rate of incidence of SSI which is likely to be due to adherence to protocol and principles for the prevention of SSI or use of prophylactic antibiotic. Still changes are needed like selection of prophylactic antibiotic according to the prevalence of organisms causing nosocomial infection and their susceptibility pattern, implementation of CDC guidelines for prevention of SSI and continuous education and motivation of staff for the same. This study

can assist HICC to take necessary action to further reduce the rate of incidence of SSI from prevailing rate.

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