

Original Research Article

Single dose antibiotic prophylaxis for prevention of surgical site infection in elective surgery

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ABSTRACT

Background: Surgical site infections are associated with prolonged hospital stays and increased costs. Infection develops when endogenous flora is translocated to a normally sterile site. Seeding of the operative site from a distant site of infection can also occur (especially in patients with prosthesis or another implant). Factors influencing the development of surgical site infections include bacterial inoculums and virulence, host defences, preoperative care and intraoperative management. Hence there is the need for antibiotic prophylaxis to overcome this problem. This study was planned to evaluate the effect of prophylactic antibiotic in clean and clean contaminated cases and to assess the outcome.

Methods: A prospective study was conducted which include 100 patients undergoing elective surgery admitted to the department of general surgery IIMSR's Medical College and Hospital, Warudi, Jalna, relevant information of each patient was collected according to the Performa designed for the study. Cefuroxime was used preoperatively 30 min prior to incision and its impact on postoperative wound infection was studied.

Results: We had 100 cases in our study predominantly males with maximum individuals in 31-40 years age group, we had 67% clean and 33% clean contaminated surgeries done and had 3% case of superficial surgical site infection.

Conclusions: A single preoperative dose of antibiotic Cefuroxime is effective to prevent surgical site infection in elective case assuming an uncomplicated procedure.

Keywords: Antibiotic prophylaxis, Surgical site infection, Surgical wound infection

INTRODUCTION

Surgical site infections (SSIs) are the most common nosocomial infection, accounting for 38% of all infections among surgical patients.¹ Studies corroborate that increased length of hospital stay and cost are associated with SSIs.² A patient who develops an SSI while hospitalized has a greater than 60% greater risk of being admitted to the intensive care unit, is 15 times more likely to be readmitted to the hospital within 30 days after discharge, and incurs and attributable extra hospital stay of 6.5 days, leading to a direct cost of an additional \$3000 per infection.³ SSIs due to Methicillin-resistant S.

aureus (MRSA) in particular have also been shown to have a higher mortality than those due to Methicillin-sensitive strains of the organism.⁴

Over the past 20 years, the efficacy of antibiotic prophylaxis in clean surgery has been well established. The guiding principle of systemic antibiotic prophylaxis is the belief that antibiotics in the host tissues can augment natural immune defense mechanisms and help to kill bacteria that are inoculated into the wound. Every effort should be made to ensure that adequate antibiotic levels are maintained above the minimum inhibitory

concentration (MIC) of the pathogens of concern throughout the surgical procedure.¹

Surgical antimicrobial prophylaxis should be administered so as to ensure adequate tissue levels of antimicrobials from the time of the initial surgical incision until closure. The efficacy of prophylactic antibiotics has now been verified for most major surgical procedures with a wide variety of antimicrobials, when care has been given to provide adequate serum and tissue levels of antibiotics during the surgical procedure. Perioperative antibiotics and aseptic techniques have become routine aspects of care in most major surgical procedures.¹

Several large-scale studies have examined the relationship between the timing of delivery of antibiotic prophylaxis and the risk of SSI. The seminal study by Classen and colleagues noted that the risk of SSI was reduced when antibiotics were administered within 2 hours prior to incision. More recently, the Trial to Reduce Antimicrobial Prophylaxis Errors (TRAPE) examined the association, between SSI and timing of prophylaxis in cardiac, Orthopedic, and hysterectomy patients.⁵ The TRAPE investigators found that SSI risk was lowest in those patients who received prophylaxis within 30 minutes (if given cephalosporins) or within 1 hour (if given vancomycin or a fluoroquinolone) prior to incision. Post incision administration was associated with a significantly increased risk for SSI.

We conducted this study to evaluate the effectiveness of single dose antibiotic prophylaxis in elective surgeries for prevention of surgical site infection and to study the rate of SSI with antibiotic timing the dose 30 minutes prior to incision in elective surgeries (Clean and clean contaminated cases).

METHODS

After review and approval by the ethics study board of the hospital, informed consent was obtained, 100 consecutive patients posted for elective surgery in hospital were enrolled into study from October 2016 to March 2017. None of the patients received antibiotics during the 14 days before the operation. None of the patients had any clinical or laboratory signs of infection. All patients aged 18 years above, who were admitted for elective surgery, having no evidence of infection with normal renal profile, coagulation profile, were included in study. Patients below 18 years and those who did not give informed consent, on antiretroviral drugs, with cancer, using cortisone or other immunosuppressive drugs, with Comorbidity like (H.T, D.M, Asthma, Bleeding disorder etc.) not under control, allergic to cephalosporins/ β -lactam antibiotics, were excluded from study. All patients had preoperative tests done (Hemoglobin, renal function test, coagulation profile, chest x ray, electrolytes cardiogram, blood sugar, blood pressure). Patients had a bath using nonmedicated soap

the day before (NICE guideline). Done one day prior with razor. Clippers were not used. (not NICE guideline) Specific theatre wear (Washed and dried) was provided by the hospital. (NICE guideline) Nasal decontamination was not done with topical antimicrobial (NICE guideline) Number of personnel in operating room 10-16 (not NICE guideline). The operating team washed their hands prior to every operation. Sterile gowns were used by operating team in the operating theatre during the operation. Two pairs of sterile gloves were used. All staff had worn specific non-sterile theatre wear in all areas where operations are undertaken. Surgeons/assisting personnel wore sterile gowns (NICE guideline) Preparation the skin at the surgical site immediately before incision using an antiseptic povidone-iodine was done. Hand jewelry, artificial nails and nail polish was not used by any operating staff (NICE guidelines).

Antibiotic prophylaxis injection Cefuroxime 1.5 gm IV [approximately] 30 minutes prior to incision was given. Intraoperative homeostasis maintained (NICE guideline), wound irrigation and drains used in the required cases (not NICE guideline).

Surgical incisions dressing with an appropriate sterile dressing done at the end of procedure. Using an aseptic non-touch technique for removing surgical wound dressings done on post-operative day 2, left open thereafter. Regular assessment of surgical site till suture removal and then on follow up visits. On each visit other than surgical site examination patient was assessed for fever for deep SSI and if found to have fever complete blood count and further investigations done as needed if found to pus/signs of superficial SSI, pus was drained, and sample sent for culture sensitivity. Wound was allowed to heal with secondary intention and regular dressing was done. Post operatively all patients were followed up for a minimum of 30 days. Surgical site infection was classified as superficial or deep space and organ space. The wounds were examined for suggestive Signs/Symptoms of infection in the post-operative period, during wound dressing or when the dressings were soaked, until the patient was discharged from the hospital and also in the Out-patient department after discharge during follow up.

When infection was clinically suspected, the area around the surgical wound was cleaned with 70% ethyl alcohol. The exudates were collected from the depth of the wound using two sterile cotton swabs or pus collected in a syringe specimen collected were transported immediately to the laboratory for further processing. Broad spectrum antibiotics were started and then switched over to specific antibiotics when the report of pus culture and sensitivity came. Data were analyzed based on age, sex.

Criteria for defining a surgical site infection

The centers for disease control and prevention (CDC) term for infections associated with surgical procedures

was changed from surgical wound infection to surgical site infection in 1992.⁶ Incisional site infections are further divided into superficial (skin and subcutaneous tissue) and deep (deep soft tissue-muscle and fascia).

Superficial incisional SSI: 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-

- 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
- At least one of the following signs or symptoms of infection- pain or tenderness, localized swelling, redness, or heat.

Deep incision SSI: infection occurs within 30 days after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and infection involves deep soft tissues (e.g., fascial and muscle layers) of the incision and at least one of the following-

- Purulent drainage from the deep incision but not from the organ/space component of the surgical site.
- A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs or symptoms- fever (>38°C), localized pain, or tenderness, unless site is culture-negative.
- An abscess or other evidence of infection involving the deep incision is found on direct examination, during reoperation, or by histopathologic or radiologic examination.
- Diagnosis of a deep incisional SSI by a surgeon or attending physician.

Organ/space SSI: infection occurs within 30 days after the operation if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operation and infection involves any part of the anatomy (e.g., organs or spaces), other than the incision, which was opened or manipulated during an operation and at least one of the following-

- Purulent drainage from a drain that is placed through a stab wound into the organ/space
- Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space
- An abscess or other evidence of infection involving the organ/space that is found on direct examination, during reoperation, or by histopathologic or radiologic examination
- Diagnosis of an organ/space SSI by a surgeon or attending physician.

National nosocomial infection surveillance definition: a nonhuman-derived implantable foreign body (e.g.,

prosthetic heart valve, nonhuman vascular graft, mechanical heart, or hip prosthesis) that is permanently placed in a patient during surgery. If the area around a stab wound becomes infected, it is not an SSI. It is considered a skin or soft tissue infection, depending on its depth.

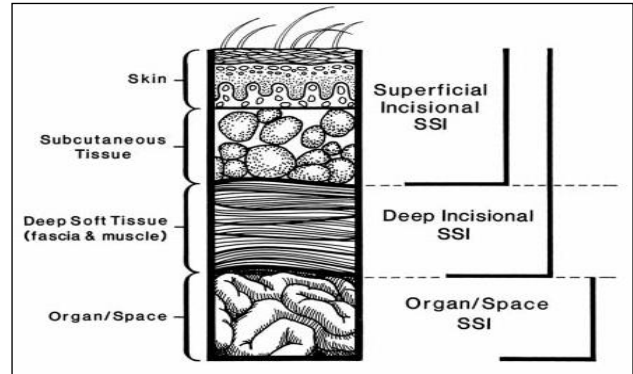


Figure 1: Cross-section of abdominal wall depicting CDC classifications of surgical site infection.

Classification

Table 1: Classification of operative wounds by level of bacterial contamination.⁷

Class I/clean wound
An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tract is not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage, operative incision wounds that follow no penetrating (blunt) trauma should be included in this category if they meet the criteria.
Class II/clean-contaminated wound
An operative wound in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operation involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered.
Class III/contaminated wound
Open, fresh, accidental wounds. In addition, operations with major breaks in sterile technique (e.g., open cardiac massage) or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered are included in this category.
Class IV/dirty-infected wound
Old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that the organisms causing postoperative infection were present in the operative field before the operation.

RESULTS

During October 2016- March 2017 (n=100) consecutive cases were taken into our study. Clean and contaminated cases were included. All patients underwent similar pre-operative preparation. In this study, the duration of

surgery in majority of the cases was less than 2 hours. We had 42 females and 58 males. Mean age 41. Age group ranged from 18 years to 85-year-old male. Most of patient belong to age group 30-40.

Table 2: Co-morbidities in patients.

Comorbidity	Number
COPD	3
Hypertension only	3
Diabetes only	3
Chronic smoking	8
Hypertension and diabetes	6
Obesity body mass index >30	4

Table 3: Spectrum of cases (67 clean cases and 33 clean contaminated cases).

Procedure	No.
Open appendectomy	8
Sebaceous cyst excision	9
Lichtenstein hernioplasty	12
Lipoma excision	6
Fibroadenoma excision	11
Dermoid cyst excision	2
Jaboulay's hydrocele repair	9
Laparoscopic cholecystectomy	13
Ventral hernia- mesh repair	5
Laparoscopic fundoplication for hiatus hernia	1
Umbilical hernia- mesh repair	4
Modified radical mastectomy	3
Incisional hernia- mesh repair	2
Cystolithotomy	4
Hemithyroidectomy	2
Pyelolithotomy	4
Circumcision	1
Ureterolithotomy	1
Laparoscopic appendectomy	3
Total	100

Author had 4 obese patients out of which two developed SSI, those who developed SSI had BMI; 39.52 (weight 83kg, height 147cm); 3.97 (weight 90kg, height 154cm) and were give cefuroxime 1.5gm; Author had 3% incidence of SSI.

Table 4: Case having surgical site infection.

Case	Level (Depth)	Morbidity
Ventral hernia	Superficial abscess	Repeated dressing and oral antibiotics
Umbilical hernia	Wound gaping with superficial abscess	Repeated dressing and oral antibiotics and secondary suturing
Inguinal hernia	Superficial abscess	Repeated dressing and oral antibiotics

These 3 cases had evidence of pus and sample was sent for pus culture and sensitivity.

Table 5: Possible cause and microbial flora (all were sensitive to cefuroxime).

Case	SSI	?cause	Organism isolated	Sensitivity pattern
Ventral hernia	Superficial abscess	Obese	<i>S. aureus</i>	Ciprofloxacin, Cefotaxime, Cefuroxime
Umbilical hernia	Superficial abscess with wound dapping	Obese	<i>S. aureus</i>	Cefuroxime, Cefoperazone + Sulbactam, Ciprofloxacin
Inguinal hernia	Superficial abscess	Skin cautery burn	-	-



Figure 2: Inguinal hernia superficial SSI.



Figure 3: Umbilical hernia superficial SSI.



Figure 4: Ventral hernia superficial SSI.

All the above patients were discharged by post-operative day 4-9. Patients who had surgical site infection had to

follow up regularly for dressing and oral antibiotics were started and one patient operated for umbilical hernia required secondary suturing. As a consequence of surgical site infection patients had a longer recovery time and incurred additional cost. Patient even needed repeated visits to hospital.

DISCUSSION

Before the mid-19th century, surgical patients commonly developed postoperative “irritative fever,” followed by purulent drainage from their incisions, overwhelming sepsis and often death.

It was not until the late 1860s, after Joseph Lister introduced the principles of antisepsis that 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.⁷

Miles and colleagues and Bruke, working with the guinea pig model of wound infection, demonstrated the remarkable brevity of the “window” of prophylactic efficacy. They noted that antibiotics given shortly before or at the time of bacterial inoculation of the subcutaneous tissue of the guinea pig produced a notable diminution in the size of the subsequent wound indurations compared with lesions in animals not receiving antibiotic prophylaxis.⁶

The use of Prophylactic antibiotics can reduce the rate of surgical infection, providing the right drug is chosen for the right occasion and given at the optimal time. The term prophylaxis is only appropriate when there has been no preoperative contamination or established infection. Many studies showed that properly administered prophylactic antibiotics could prevent postoperative infection.^{8,9} In present study an attempt was made to study the rate of surgical site infection. All patients who fulfil the inclusion criteria were included in this study. We follow a set of protocol for preoperative, intraoperative and post-operative care. Some of these protocols are similar to guidelines laid down by NICE and CDC. We are unable to follow some due to various reasons. All patients were given a single dose of antibiotic Cefuroxime 1.5gm and a study of surgical site infection was done. We had 42 females and 58 males in the study with maximum patients in age group of 31-40 years. The incidence rate of 3% of the study is well within the infection rates of 2.8% to 17% seen in other studies. The difference in incidence rates may probably due to variations in interpretations of infection. Also, a meaningful single infection rate for all types of wounds is not possible, as the likelihood of infection differs in each type of wound. Cruse and Ford observed that the rate of infection of clean wounds was more useful as an indicator of control of infection of. Surgical wounds than the overall incidence.⁸

Table 6: Comparison of SSI incidence with other studies.

Author	Year	Country	No. of operations	Infection (%)
Robertson	1958	Canada	1917	9.3
Williams et al	1958	England	722	4.3
Public health lab. service	1959	England	3276	9.4
Round tree, et al	1960	Australia	198	14.0
Myburgh	1964	S. Africa	Not noted	17.0
National Research council	1964	U.S.	17613	7.4
Clarke	1967	England	382	13.6
Cruse and Foord	1980	Canada	62939	4.7
Edwards	1984	U.S.	20193	2.8
Anvikar et al	1999	India	1980	6.09
Eveline P. et al	2000	Netherlands	18063	3.1
Present Study	2017	India	100	3

One of the most known important factors influencing the incidence of post-operative wound infections is wound contamination class. It was evident from the various studies that wound contaminated risk class is independently predictive of infection.

Table 7: Comparison in relationship to risk class.

Author	Type of wound	Cases studied	Cases infected	%
Cruse and Foord	Clean	47054	732	1.5
	Clean	9370	720	7.7
	Contaminated			
Olson, et al	Clean	11713	209	1.8
	Clean	5855	167	2.9
	Contaminated			
Ojiegbe, et al	Clean	--	--	14
	Clean	--	--	50
	Contaminated			
Anvikar, et al	Clean	2250	91	4.04
	Clean	1030	104	10.6
	Contaminated			
Present study	Clean		67	4.47
	Clean		33	
	Contaminated			

The incidence rate in clean wounds in our study of 4.47% is slightly higher than those of the other studies. We had no incidence of infection in clean contaminated cases.

Our incidence in the clean cases could be attributed to the fact that 2 patients were obese and received inadequate

dosing. One had a skin cautery burn which was neglected intraoperatively.

Table 8: Temporal relationship between administration of prophylactic antibiotic and rates of surgical wound infection.

Time of administration	No. of patients	Infection number	%
Early 2-24 hrs before incision	369	14	3.8
Preoperative 0-2 hrs before incision	1708	10	0.59
Perioperative within 3hrs incision	282	4	1.4
Postoperative more than 3hrs incision	488	16	3.3
All	2847	44	1.5
Our study 30min prior to incision	100	3	3

We had a higher incidence of SSI, reasons could be due to inadequate dosing in the obese patient, non-adherence to all standard guidelines (NICE, CDC), variation on subject population

In the present study in the clean wound category with no obvious of contamination, the cultured infected wound was *Staphylococcus aureus* predominantly and *Streptococci* similar pattern of micro flora was observed by Anvikar et al, Olson, et al with *Staphylococcus aureus* as most common.^{10,11} The pattern of organisms isolated in wound types in various studies suggests skin colonizers to be the main source of SSI in clean procedures.

CONCLUSION

Surgical wound infections are common and consume a considerable portion of health care finances. Although surgical wound infections cannot be completely eliminated, a reduction in the infection rate to a minimal level could have significant benefits, by reducing postoperative morbidity and mortality, and wastage of health care resources. A pre-existing medical illness, prolonged operating time, the wound class, and wound contamination strongly predispose to wound infection.

Recommendations

Finally following recommendations can be made based on the study-

- A single preoperative dose of antibiotic is as effective as a full 5-day course of therapy assuming an uncomplicated procedure.
- Prophylactic antibiotics can be administered within 30 minutes prior to incision and have a desired safety from surgical site infection.
- Complicated, contaminated, or dirty procedures should receive additional postoperative coverage.

- Before giving antibiotic, prophylaxis consider the timing and pharmacokinetics (for example, the serum, half-life) and necessary infusion time of the antibiotic.
- Give a repeat dose of antibiotic prophylaxis when the operation is longer than the half-life of the antibiotic given.
- Follow other guidelines of asepsis and perioperative techniques which help minimize incidence of surgical site infection.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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